Ph.D. Thesis

EFFECT OF VITAMINS ON THE GROWTH AND DEVELOPMENT OF THE MULBERRY SILKWORM, *Bombyx mori* L.

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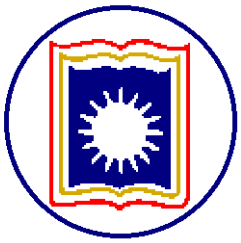

Ph.D. Thesis

A dissertation submitted to the University of Rajshahi in partial fulfillment of the requirements for the degree of Doctor of Philosophy

Submitted By

Tasnima Ferdous
Roll No: 12504
Reg. No: 2964
Session: 2012-2013

Sericulture Research Laboratory
Department of Zoology
University of Rajshahi
Rajshahi-6205
Bangladesh

June, 2016

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Bangladesh

June, 2016

DEDICATED

To

The memory of my respected teacher
Professor Dr. Md. Ataur Rahman Khan
and
To my beloved parents

DECLARATION

I hereby declare that the research work submitted as the thesis entitled **"Effect of vitamins on the growth and development of the mulberry silkworm, *Bombyx mori* L."** to the Department of Zoology, University of Rajshahi for the degree of Doctor of Philosophy is the result of my own investigation and has not ever been submitted before in any form for any other degree at any place. I further declare that the whole of the work submitted for the degree of Doctor of Philosophy to the University of Rajshahi is based on my original investigation except when due reference is made in the text of the thesis.

The Candidate

_____

Tasnima Ferdous

CERTIFICATE

This is to certify that Tasnima Ferdous carried out the investigation on "Effect of vitamins on the growth and development of the mulberry silkworm, *Bombyx mori* L." under my supervision in the Sericulture Research Laboratory of the Department of Zoology, University of Rajshahi. This thesis embodies the results of original investigation and all the data presented are based on the findings of Tasnima Ferdous. She fulfilled all the requirements and regulations relating to the nature and period of research for submission of a dissertation for the degree of Ph.D. in the University of Rajshahi. I forward this dissertation to be examined for the degree of Doctor of Philosophy.

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The Authoress

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ABBREVIATIONS USED

WML = Wight of mature larvae
LML = Length of mature larvae
BML = Breadth of mature larvae
PW = Pupal weight
CW = Cocoon weight
CL = Cocoon length
CB = Cocoon breadth
SW = Shell weight
SR = Shell ratio
SP = Surviving percentage
AE = Adult emergence
LP = Larval period
PP = Pupal period
TEL = Total number of eggs laid
EHP = Egg hatching percentage
FC = Food consumption
FU = Food utilization
AD = Approximate digestibility
FCI = Food consumption index
CFU = Co-efficient of food utilization
SS = Sum of squares
MS = Mean sum of squares
F = Variance ratio
df = Degree of freedom
FS = Feeding schedules
S = Season
FS = Feeding schedule

%	= Percentage
<	= Less then
>	= Getter then
B.	= *Bombyx*
i.e.	= That is
viz.	= Namely
e.g.	= Example given
et al.	= And others (Authors)
°C	= Degree centigrade
d-value	= Deviate value
mm	= Millimeter
gm	= Gram
SD	= Stand deviation
SE	= Standard Error
P	= Probability
ppm	= Parts per million
*	= Significant at 5% to level
**	= Significant at 1% level

ABSTRACT

The effect of the supplementation of mulberry leaves with vitamin B_2 and C at different concentrations (e.g. 60, 150, 240, 330 and 420ppm for vitamin B_2 and 10000, 15000, 20000, 25000 and 30000ppm for vitamin C) throughout different seasons, e.g. S-1, S-2, S-3 and S-4, at different feeding schedules, e.g. fed every day in 1^{st} feeding of 3^{rd} to 5^{th} instar larvae (FS-1), fed in 1^{st} to 5^{th} feeding of 3^{rd} to 5^{th} instar larvae (FS-2), fed only in 1^{st} feeding of 3^{rd} to 5^{th} instar larvae (FS-3) on the growth and development of *B. mori* were assessed in this investigation.

The supplementation of vitamin B_2 increased the WML, LML and BML under different concentrations (except 420ppm) compared to the control while fed according to FS-1, FS-2 and FS-3 in S-1. The highest and the lowest results of these parameters were observed at 240ppm and 420ppm respectively. Similar results were also found in S-2, S-3 and S-4. At FS-1, FS-2 and FS-3 while the supplementation of vitamin B_2 slightly increased the PW under different concentration, e.g. at 60ppm, 150ppm, 240ppm and 330ppm in comparison to the control in S-1, S-2, S-3 and S-4.

Vitamin B_2 significantly increased the CW, CL, CB, SW, SP, TEL and EHP of *B. mori* at different feeding schedules under different seasons. Generally, the highest and the lowest results for these parameters were recorded at 240ppm and 420ppm respectively. In case of SR% the most effective concentration of vitamin B_2 was not followed the normal trend as found in other parameters. On the other hand, vitamin B_2 slightly decreased the larval period, pupal period and mortality percent at different concentrations except 420ppm compared to the control.

The results of physiological parameters like food consumption, food utilization, food digestibility, food consumption index and co-efficient of food utilization were significantly increased in different concentrations (e.g. 60ppm, 150ppm, 240ppm and 330ppm.) under different feeding schedules and seasons.

The results of ANOVA indicated that the items of feeding schedules, seasons and doses showed highly significant differences for all the parameters at 1% level of significance. But the item dose × season showed insignificant results in majority of the cases. The effectiveness of vitamin B_2 with respect to different seasons on different characters under study followed the order S-2 > S-1 > S-3 > S-4, while in respect of different

feeding schedules this trend has been in the order of FS-2 > FS-3 > FS-1. The most effective dose of vitamin B_2 followed the order 240ppm > 150ppm > 60ppm > 330ppm.

In case of vitamin C supplementation, WML, LML and BML were increased at different concentrations except 30000ppm compared to the control while fed in FS-1, FS-2 and FS-3 during different seasons. The mean values of PW were also increased at different concentrations, e.g. at 10000ppm, 15000ppm, 20000ppm and 25000ppm in comparison to the control. Similar results were also recorded for CW, CL, CB, SW, AE%, TEL and EHP of *B. mori* at different feeding schedules and seasons. In these cases the highest and lowest results were observed at 15000ppm and 30000ppm respectively. Vitamin C supplementation reduced the developmental periods in *B. mori* at majority concentrations except 30000ppm. It was also found that the mortality percent of *B. mori* was significantly decreased in these concentrations. The physiological traits like FC, FU, AD%, FCI and CFU of *B. mori* were enhanced against all the concentrations except 30000ppm compared to the control.

In most of the cases the result of ANOVA indicated that the items of feeding schedules, seasons and doses showed highly significant differences at 1% level of significance. In majority of the cases it was observed that the effective dose of vitamin C on different characters followed in the order of 15000ppm>20000ppm>10000ppm> 25000ppm and in respect of feeding schedules it was in the order of FS-2> FS-1>FS-3. The most effective season was found in the following order S-2> S-1> S-3> S-4.

Finally, the results depicted that the supplementation of vitamin B_2 and C at some concentrations e.g. 60ppm, 150ppm, 240ppm, 330ppm of B_2 and 10000ppm, 15000ppm, 20000ppm, 25000ppm of vitamin C may have beneficial effects on the physiological parameters, larval growth, cocoon characters and survival percentage by stimulating metabolic processes of the silkworm *B. mori*. Although it was observed that the growth and development of *B. mori* took place upto a particular dose 240ppm of vitamin B_2 and 15000ppm of vitamin C at FS-2. So, this supplementation could be prescribed to the farmers to get more quantity of silk. On the contrary, higher concentrations, e.g. 420ppm of B_2 and 30000ppm of C reduced the growth parameters and increased the developmental period and mortality percent. It may be due to hypervitaminosis.

Chapter 1
General Introduction

1.1. Background of the present research

The mulberry silkworm, *Bombyx mori* L. (Lepidoptera: Bombycidae) is acquainted to man from primordial time as a beneficent insect. It is the most important source of natural silk. Today silkworm plays role in three major areas: silk production, employment and research. At present, research works are going on the improve silkworm breed with a view to enhance the quality and quantity of silk yield. Variant endeavours have been made to improve the indigenous races of mulberry silkworm. The most important physiological factor for silkworm growth and silk production is nutrition. Importance of research on effect of different fortifying agents on silkworm nutrition can be judged from the principle of cooperating supplements (House, 1965; Raj, 2000). Appropriate quantity of vitamins is important for silkworm feeding, growth, survival and population density. It has been proved that insufficient vitamin in diet reduced the growth rate of silkworm by imposing a metabolic load. Recently, it was found that growth and development of silkworm takes place up to a particular dose (95.29 ±142.46 µg/ml) of vit-B and C (Ahsan *et al.,* 2013). It was also observed that the enrichment of mulberry leaves with riboflavin at 77ppm enhanced certain economic characters of silkworm and improves silk production (Rajabi *et al*., 2006a). Faruki (2005) reported that higher concentrations of vitamins reduced the fecundity and fertility of silkworm. Etebari *et al.* (2004) showed that the ascorbic acid enriched silkworm diet decreased the yield. Moreover, it has been reported that ascorbic acid improves the growth and development of silkworms (Balasundaram *et al*., 2013; Singh and Bandey, 2012; Ito and Arai, 1965). These few observations suggest that the vitamins play an important role in the metabolic activity and on the economic parameters of silkworm. Thus, in this proposition the effect of vitamins on the growth and development of the mulberry silkworm was taken into consideration.

1.1.1. Description of silk and the silkworm

Silk is a fibred essence originated by many insects, mainly in the form of cocoon or veiling within which creatures are confined and protected during the period of their prime transformation in metamorphosis. These cocoons provide shelter and safeguard to those insects during their passive and the most troublesome pupal stage. In case of *B. mori*, after 20-25 days of feeding silkworm larvae acquire maturity and initiate to eject the silk fluid from the two glands through a spinneret of its mouth. The silk fluid thrown by the ripe silkworm larvae coming in touch with air solidifies into a thin silk string. Larva spins cocoons moving their head in the shape of figure of eight '8' from exterior to the interior. In order to complete whole structure of the cocoon the worms need to rotate around 60,000 to 3,00,000 times inside the cocoon depending upon the size of the larva. Silk string is nothing but a proteinaeous structure having core protein of fibroin (80%) encircled with gummy sericin (20%) fabricated from silk gland. The glands are second largest organs of the body which occupy 2/5 of its body weight and volume and extend between 4th and 8th segments of the body. These silk proteins are synthesized in the silk gland by the silkworm from the mulberry leaves spreads along the body on either side of the silkworm. By boiling in water sericin melts down and thus simplifies isolation of the silk string during the procedure of reeling. The quality of silk is also dependent on the quantity of sericin. The silk could not be completely washed out during boiling.

The natural silks are classified into mulberry and non-mulberry silk in broad sense. Since non-mulberry sericulture is originally a forest based industry it is familiar as wild silk. On the other hand, the mulberry silkworm too, was first found centuries before either in the mountains of the Himalayas or in lower slopes of the Eastern Himalayas, it was in the wild state causing damage to mulberry trees. For fine natural filament, it was brought under domestication for centuries and it became fully domesticated.

Table I. Various types of silk and silk producing organism

	Type of silk	Scientific name of silk producing organism	Name of major host plants		
			Scientific name	Local name	English name
I.	Mulberry silkworm	*Bombyx mori* L. *Theophila religiosae* *Bombyx mandarina*	*Morus indica* *Morus serrata* *Morus alba* *Morus nigra*	Tut	Mulberry
II.	Non mulberry silkworm				
1	Eri, endi or errandi silkworm	*Philosamia cynthia* *Semia Cynthia ricini*	*Ricinus communis*	Varenda	Castor
			Heteropanax fragrans	Kesseru	Kesseru
			Manihot utilissama	Cassava	Tapioca or cassava
2	Tasar silkworm				
	a. Indian tropical tasar	*Antheraea mylitta Dury*	*Terminalia arjuna*	Arjun	Arjun
			Shorea robusta	Sal	Sal
			Terminalia tomentosa	Asan	Asan
			Zizyphus jujube	Kul / Boroi	Jujube
			Terminalia catappa	Katbadam	Almound
			Terminalia chebula	Haritaki	Myrobalan
	b. Indian temperate tasar	*Antheraea proylei*	*Quercus serrata*	Uyung	Oak
			Quercus incana	Banj	Oak
			Quercus dealbata	Sahi	Oak
			Quercus himalayana	Moru	Oak
	c. Chinese tasar	*Antheraea pernyi*	*Quercus* sp.		Oak
	d. Japanese tasar	*Antheraea yamamai*	*Quercus* sp.		Oak
3	Muga silkworm	*Antheraea assamensis*	*Machilus bombycina*	Som	
			Litsaea polyantha	Soalu	
			Litsaea citrate	Mezankari	
4	Anaphe silk	*Anaphe ventra*	*Triplochiton scleroxylon*		
5	Gonometa silkworm	*Gonometa*	*Acacia torilis*		
6	Fragra silk	*Attacus atlas*			
7	Coan silkworm	*Pachypasa otus* *Pachypasa lineosa*			Pine, juniper and oak
8	Mussel silk	*Pinna squamosa*			
9	Spider silk	*Nephila madagascarensis* *Miranda aurentia* *Eperia sp.*			

According to Barnett (1963), nearly 1000 varieties of silkworm are reared in the world. Some varieties or races are named on the basis of the number of generations in a year. Such races are called uni, bi or multivoltine. A number of hypotheses have been advocated on the inheritance of the voltinism. It is supposed to be genetically controlled and also influenced by environmental factors (Kasture, 1984). Moreover, multivoltine silkworm breeds are available in tropical regions (Sidhu *et al.*, 1968).

Systematic position of *B. mori*

Phylum : Arthropoda

Class : Insecta

Order : Lepidoptera

Family : Bombycidae

Genous : *Bombyx*

Species : *B. mori*

Fig. *B. mori*

It is an inconspicuous moth of an ashy-white color. The larvae are ashy-grey or cream color and are slender in form with a spine like horn or protuberance at the tail. The larva passes through five different stages called instars. The 5^{th} instar spins to form cocoons within which it undergoes pupation. Adult moths come out of the cocoons which are incapable of flight as a result of their domestication for more than four thousand years (Krishnaswami *et al.*, 1973).

1.1.2. Importance of sericulture

Silk had played a vital role in the economic life of man ever since its discovery. It has been traditionally accompanied with socio-economic life of many Asian and Central Asian countries. Nevertheless, today despite of intense attack of man-made fibers, silk continues to realm supreme as the “Queen of Textiles”, because of its unparalleled glossiness, delicacy, resiliency, crispness and artistic appearance. These distinguished characteristics draw a center of affection of the consumers at

the first sight. Silk has been woven into comfortable tapestries, blankets, carpets and other accessories. Silk items for expenditure give the realization of material comfort that no other textiles can be comparable with it. In recent years, the popularity of artificial fabrics in the fashion craze promote to a large extent, in spite of that, nature's reward "the silk" offered to make a glamorous human civilization continues to hold top rank in the world of textiles.

The importance of the silk industry in the economy of Bangladesh can be observed in the light of its rural employment aspects, establishment of cottage industries in the remote villages and distribution of wealth to the downward stream, as well as development of the neglected area. Even sericulture provides great opportunities for human resource development, which can successfully control migration of people to urban area. It is estimated that about 60 percent of activities in sericulture industry could be carried out by women (Datta and Kumar, 1988). Under this context, sericulture has appeared as an economically endurable agricultural industry in Bangladesh. Reports have tended to convey the impression that environmental conditions of Bangladesh offer ideal situations for the development of sericulture (Anonymous, 1994; Islam *et al.*, 2010; Rashid *et al.*, 2014). A thorough analysis revealed that Bangladesh could offer a wide range of areas to support the production of quality silk to satisfy our domestic need.

1.1.3. Origin and development of sericulture

We get many a fascinating several thousand years old history of the production of silk from the mulberry silkworm. Since the medieval period, sericulture was patronized by the Kings and Mughal emperors during 16^{th} and 17^{th} Centuries (Chatterjee, 1993). The accepted theory is that the origin of silk was from the silkworm, *Bombyx mandarina* Moore (Krishnaswami *et al.,* 1973). But according to some Indian scholars, silkworms (*B. mori*) were first domesticated in the foothills of the Himalayas. There is also evidence in the ancient Sanskrit literature that certain kinds of wild silks were cultivated in India from time immemorial. The ancient records depict that sericulture industry has developed under the care of

Empress Shi-Ling-Chi of Emperor Huang-Tai, who ruled over China about 2640 B.C. It is said, one day the 14 years old queen was enjoying a tea ceremony in her palace garden with her friends and maids under a mulberry tree. Suddenly a golden cocoon dropped in her teacup. When she tried to remove the cocoon from the teacup, an end of the filament come out of the cocoon and it was a continuous one. Then she collected some more cocoons, carried them to her palace, preserved them till adult emergence and reared them to the next generation and later invented better method of reeling and look for weaving (Sarker, 1977). Silk thus originated in China and the secret was jealously guarded by the Chinese for about 3,000 years (Krishnaswami *et al.,* 1973). The industry is said to have spread to Tibet when a Chinese princess carrying silkworm eggs and mulberry tree seeds in the headdress and married the king of Khotan in Tibet. The silk originated in China has spread to various regions of the world i.e. Europe, Japan, Korea and Southern Asia through the 6,000 miles "Silk road" (Gamo, 1981; Hirobe, 1968; Nanavaty, 1965), which passed through Tashkant, Bagdad, Damuscus and Istambul. Later on the basis of geographical distribution, they have been renamed as Japanese, Chinese, European and Tropical races. Out of these four, the first three are mostly either bivoltine or univoltine silkworms.

The techniques of silkworm rearing were transmitted from China to India via Tibet about 140 B.C. (Krishnaswami *et al.,* 1973). On the other hand others thought that the Hindus discovered it in the sub-Himalayan regions, the history of which was older than the Chinese (Sarker, 1958). According to them, *B. mori* was first domesticated at the foothills of the Himalays. Later on silkworm rearing began to spread and established on the bank of the rivers Brahmaputra and the Ganges (Krishnaswami *et al.,* 1973; Rahman, 1983).

1.1.4. Global status of silk production

Although silk has a small percentage of the worldwide textile market (less than 0.2%), its production basis is spread over sixty countries in the world. While the major producer are in Asia (90% of mulberry production and all most 100 % of non-mulberry silk), sericulture industries have been lately established in Brazil,

Bulgaria, Egypt and Madagascar as well. Sericulture is a labour-based industry. This industry provides employment to 7.9 million people in India, about one million people in China and 20,000 weaving families in Thailand. China is the world's single biggest producer and chief supplier of silk to the global market. India is the world's second largest silk producing country. Sericulture can help keeping the rural population employed and prevent migration to big cities and securing remunerative employment; it requires small investment while providing raw materials for textile industries.

The major silk consumer of the world are industrialized countries, viz. USA, UK, Italy, Japan, India, France, China, Switzerland, Germany, etc. But the silk production is being a highly labour intensive. The production cost of silk is becoming very high in the industrialized countries. As a result most of the industrialized countries are almost giving up sericulture.

The major silk producing countries in the world are- China, India, Uzbekistan, Brazil, Japan, North Korea, Thailand, Vietnam, South Korea, Iran, etc. Few other countries are also engaged in the production of cocoons and raw silk in negligible quantities: Kenya, Botswana, Nigeria, Zambia, Zimbabwe, Bangladesh, Columbia, Egypt, Bulgaria, Turkey, Uganda, Malaysia, Romania, Bolivia, etc. (Table II).

Table II. World mulberry raw silk production in metric tons.

Country	2008	2009	2010	2011	2012	2013	2014
Bangladesh	-	-	40	38	42.50	43	44.5
Brazil	1177	811	770	558	614	550	560
Bulgaria	7.5	6.3	9.4	6	8.5	8.5	8
China	98620	84000	115000	104000	126000	130000	146000
Colombia	0.6	0.6	0.6	0.6	0.6	0.6	0.5
Egypt	3	3	0.3	0.7	0.7	0.7	0.82
India	18370	19690	21005	23060	23679	26480	28708
Indonesia	37	19	20	20	20	16	10
Iran	180	82	75	120	123	123	110
Japan	96	72	54	42	30	30	30
N. Korea	-	-	-	300	300	300	320
S. Korea	3	3	3	3	1.5	1.6	1.2
Philippines	1	1	1	1	0.89	1	1.1
Syria	0.4	0.6	0.6	0.5	0.5	0.7	0.5
Thailand	1100	665	655	655	655	680	692
Tunisia	0.08	0.04	0.12	3	3.95	4	4
Turkey	15	20	18	22	22	25	32
Uzbekistan	770.5	780	940	940	940	980	1100
Vietnam	-	-	550	500	450	475	420
Madagascar	15	16	16	16	18	18	15
Total	120396	106169	139100	129661	152845	159737	178057

[ISC web-site update as on May, 2016]

1.1.5. Sericulture in Bangladesh

Bangladesh sericulture has a glorious history. It shares the same tradition of sericulture heritage with the undivided Bengal of the pre-independence day (Barmon and Sarker, 1987). The silk industry developed in this region in the beginning of the 17th century. During the regime of Emperor Kanishk, there was a rising trade of Bengal silk with Rome and Greece. The then Bengal was recognized as the "store house of silk" (Sarkar, 1958). During that time a quantity of 250 metric tons of silk yarn was exported from undivided Bengal to various parts of Mughal Empire, to the neighbouring countries and to Europe (Quasim, 1990). During the middle of the 18th Century varieties of silk cloths and raw silk were exported to Europe and to the markets of Western Asia including Basra, Mecca, Jeddah and Malacca.

Unfortunately, the silk industry gradually declined and exports were fully stopped by the early 20th Century due to spread of pebrine disease in a pandemic form which cleaned out the economic solidity of the silkworm growers. The silk reeling industries were obligated to stop their production due to an intensive shortage of silk cocoons. The Bengal farmers were able to fight the pebrine outbreak through the introduction of Pasteur's system of silkworm egg preparation. The cocoon growers, who were trained this method, no longer face the cocoon crop failure and precarious.

Silk industry in Bangladesh suffered once again following the partition of India in 1947. After the partition the then East Pakistan (Bangladesh after 1971) received only two ill equipped sericulture nurseries. One of them was situated at Bogra and the other at Mirganj (Rajshahi). Some traditional silk growing areas of Bholahat and Shibgonj were also fallen in this part. Many of the expert grower involved in sericulture migrated to Indian part. At that time, the industry was at the verge of extinction. Records showed that only a little more than 100lbs of raw silk was produced from a few villages in Rajshahi district. From 1947 to 1961 the

Directorate of Industry looked after the sericulture industry of the country. In July, 1961 sericulture project was transferred to the East Pakistan Small and Cottage Industries Corporation (EPSCIC after 1971 BSCIC) and some schemes were chalked out and put under implementation (BMDC, 1984).

Under this new initiative in addition to the re-organization of two existing nurseries (Bogra and Mirganj), ten new nurseries were set up at Bholahat, Chapai Nawabganj, Ishwardi, Rangpur, Dinajpur, Konabari, Mainamati, Khadimnagar (Sylhet), Bhatiari and Chondraghona. Twenty two extension centers, one silk factory and one sericulture research and training institute were also established. During the Pakistan regime and even within the First Five Year Plan (1973-1978) period of Bangladesh, sericulture could not show any tangible improvement. In fact BSCIC could not pay much attention in sericulture development, as it was very big organization dealing with a good number of development projects. Institutional whole-hearted effort was necessary in tapping the potentials of sericulture. However, the progress achieved from 1971-72 to 1977-78 is shown in Table III.

Table III. Progress achieved before establishment of Bangladesh Sericulture Board.

Item (unit)	1971-72	1975-76	1976-77	1977-78
Mulberry plantation (acre)	850	1124	995	1250
DFLs production (N.)	649130	1369280	1039557	1160000
Cocoon production (kg)	136116	229292	246824	273223
Silk yarn production (kg)	8686	14330	15426	18003
Silk fabrics (m)	130302	214950	231390	270045

To further streamline the activities of the sector, Bangladesh Sericulture Board (BSB) was established in 1978 under a presidential ordinance. BSB was assigned with some specific functions to render the welfare service to the persons engaged in sericulture and silk industry.

At the primary stage of BSB, Swiss-Bangladesh Bilateral Project in Sericulture played a key role for the expansion of sericulture throughout the country and intensifying the research activities. Meticulous efforts were made to improve the state of affairs supplemented by the ADP schemes of the Government of Bangladesh. Consequently, mulberry acreage increased considerably during 1978-81 from 1250 acres to 4100 acres (Khan, 1983), still then the motivation work in the extension area held-up due to some unavoidable reasons. Many of the farmers entering this occupation failed to keep up cultivation of mulberry. A number of them expressed their disinclination to continue in this field. For short of expertise in mulberry cultivation and silkworm rearing they could not grow mulberry and rear silkworm as looked-for. Thus achievements in this respect were much below the anticipation. Total production of raw silk rose from 14.52 tons in 1978-79 to 25.72 tons in 1980-81 (Anonymous, 1994). The highest raw silk production in the history of sericulture in Bangladesh was reported 58.45 metric tons during the year 1995-96 (Anonymous, 2003). In contrast to the world production Bangladesh shares only 0.06 percent of raw silk production.

After that it suffered once more and the production of raw silk turned down. However, the employment opening in this sector rose from 35,000 in 1979-80 to 6,00,000 in 2001-2002 (Anonymous, 2005). Rashid (2014) reported that the total annual demand of raw silk in Bangladesh is 300 metric tonnes but the local production is 40 metric tonnes. The rest of the demand is filled up by the imported raw silk from China. The production of raw silk is shown at table IV and figure I during the period 2005-2010.

Table IV. Raw silk production (2005-2010) (Value in metric tonne)

Present year	2005-06	2006-07	2007-08	2008-09	2009-2010
Raw silk production	38.00	38.00	39.00	39.50	40.00

Source: National Board of Revenue Report.

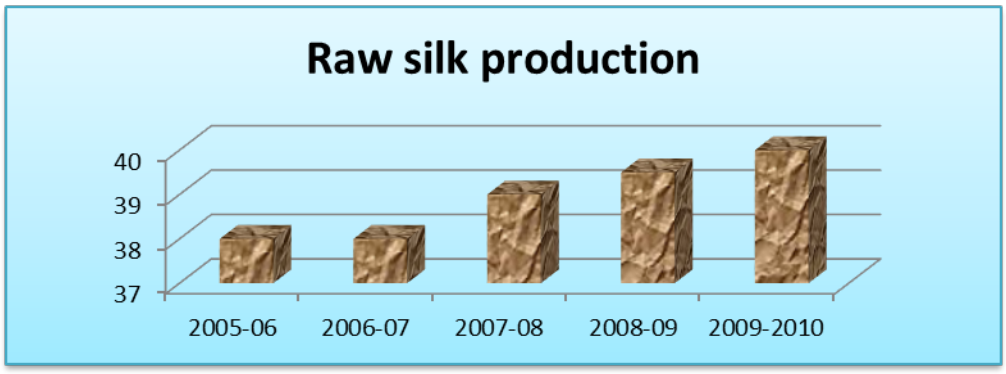


Figure I. Raw Silk Production (2005-2010)

Table V. Raw silk import (2005-2010) (Value in metric tonne)

Present year	2005-06	2006-07	2007-08	2008-09	2009-2010
Raw silk import	197.777	246.029	281.747	203.194	197.501

Source: National Board of Revenue Report.

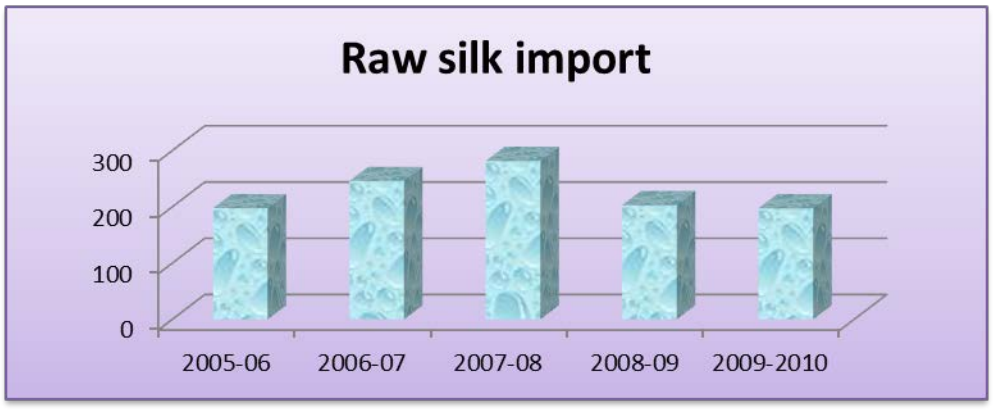


Figure II: Raw Silk import (2005-2010)

It shows that the total import fluctuates depending on the demand of the customers of silk goods and on the amount of local production.

1.2. Nutrition of the silkworm

The study of larval growth is an important field of research for the insects, which are economically significant insects. Effective cocoon crops in sericulture depend mostly on a healthy larval growth. The multivoltine races of *B.mori* are of great importance to the tropical sericulture like in Bangladesh. About 85% of total cocoons produced in India come from multi × bivoltine crosses (Datta, 1984). Accordingly, both multivoltine and bivoltine breeds are to be simultaneously improved to increase the silk yield in the country. In the present investigation BSRI-85/3 and Nistari races has been used. *B. mori* is an oligophagus insect that feeds mainly on mulberry leaves. The silkworm and the mulberry tree have a great partnership because the silkworm cannot thrive without the leaves of mulberry plants. The silkworm's natural food is the foliage of mulberry trees. The leaves of *Morus* are the main source of the food for silkworm, *B. mori* L. In all the years silkworms never changed their feeding habits. So, the quality of leaves greatly influence the biology of these worms (Frassie and Arnoux, 1954; Arai and Ito, 1963).

Nutrition is an important growth regulation factor in the silkworm like in any other organisms. Nutrition quality of leaves plays a vital role in determining the health and growth of larvae. The feeding of nutritionally enriched leaves showed better growth and development of silkworm larvae, as well as it directly influences on the quality and quantity of silk production.

Variations in the quality of the mulberry leaves and climatic factors are many times reflected on the performance of the cocoon production. Significance of research on effect of different fortification agents in silkworm nutrition can be judged from the principle of co-operating supplements. When supplementary nutrients are added to normal food the nutritional value of the food increases making it more useful.

Feeding of nutritionally enriched leaves showed better growth and development of silkworms as well as gain in economic characters of cocoons (Krishnaswami *et al.,* 1971). Vishwanath and Krishnamurthy (1983) also studied influence of

micronutrients on larval development and cocoon characters of silkworm. The effects of artificial diets with different nutrients on better production of cocoon crops and silk have been investigated by many researchers, e.g. Sharda *et al*. (1956), Ito (1960), Fukuda and Higuchi (1963), Yokoyama (1964), Hamamura (1964), Ito (1964), Legay and Pascal (1964), Ito and Arai (1965 a,b), Yanagawa (1973), Gomma *et al.* (1976, 1977), El-Shaarawy *et. al.* (1976, 1977a.b) and Li and Chiang (1982).

1.2.1. Information on the host plant

The mulberry plant: A methodical plantation of mulberry plant is the first step in the production of mulberry silk. Mulberry plant is considered as the most effective food plant of *B. mori.* So, this is known as a monophagous insect. Mulberry plant belongs to the genus *Morus* of family Moraceae. Different species of the genus are known to be important for sericulture. In Bangladesh *M. indica* and *M. alba* species are usually found. Recently, most of the high yielding varieties of silkworm under cultivation depends on the species *M. alba*. A description of this species are summarize below in brief:

Mulberry plant, *Morus alba*, known as white mulberry. It is a fast growing bush or a medium sized tree with a simply sylindrical and straight stem. Its height is up to 3.5m and circumference is 1.8m. Its bark is dark greyish-brown, rough with vertical crack and latex colour is white or yellowish white. Leaves are very variable. Like as, ovate or broadly ovate, simple to 3- lobed, notched, palmately 3-veined at base; stipules lateral. Flower is greenish, inconspicuous, with 4 free imbricate petals. Male and female flowers are usually on separate trees although they may occur on the same tree. The fruit is 1 to 2.5cm long; in the species in the wild it is deep purple, but in many cultivated plants it varies from white to pink; it is sweet but bland, unlike the more intense flavor of the red mulberry and black mulberry.

The species is native to northern China, and is widely cultivated and naturalized elsewhere. It is known as Toot in Hindi, *Tuta* in Sanskrit, *Tuti* in Marathi and *Toot* in Persian and in Armenian, In Bengali, it is popularly known as "Tut gaach". The white mulberry is widely cultivated to feed the silkworms employed in the commercial production of silk. It is also notable for the rapid release of its pollen, which is launched at over half the speed of sound.

Systematic position of *Morus alba*

Kingdom: Plantae
Division: Magnoliophyta
Class: Eudicots
Order: Rosales
Family: Moraceae
Genus: *Morus*
Species: *M. alba* L.

Fig. *M. alba* L.

The major chemical composition of mulberry leaf

i) Flavone and flavone glycosides

The mulberry leaf contains compounds of rutin, quercetin, isoquercitin and Quercetin-3- Triglucoside, etc.

ii) Steroids

Including *β*- sitosterol, stigmasterol, campesterol, *β*-sitosteryl-*β*-D-glucoside, mesoinositol and metamorphic hormone, such as inokosteron and ecdysterone.

iii) Volatile oils

Acetic acid, propionic acid, butyric acid, isobutyric acid, valeric acid, isovaleric acid, caproic acid, isocaproic acid, methyl salicylate, guaiacol. phenol, o-cresol, m-cresol, eugenol, etc. also containing oxalic acid,

fumarate, tartaric acid, citric acid, succinic acid, palmitic acid, ethyl palmitate, henthriacontane, hydroxycoumarin, etc.

iv) Saccharides and amino acids

Including sucrose, frucrose, fructose, glucose and 17 kinds of amino acids such as aspartic acid and glutamic acid. The content of blood level-decrease component γ-amino butanoic acid is up to 226mg/100g. For γ-amino butanoic acid is conversed from glutamic acid, so the glutamic acid in mulberry leaf is up to 23.23mg/100g.

v) Vitamins and trace elements

Containing vitamin A, B1, C, nicotinic acid, carotene and food fibres, also with zinc, copper, boron, manganese, iron, etc. In addition, mulberry leaf contains alkaloids, especially one particular component called 1-deoxynojirimycin (DNJ).

Various uses of mulberry plant

Food: Mulberry leaves are highly nutritious and contain vitamin B-complex, C, D and flavonols. They are sometimes eaten as vegetables. Fruit is eaten fresh or made into juice and stews.

Feed: Leaves are used as feed for livestock (cattle, goats, etc.) in areas where dry seasons restrict the availability of ground vegetation.

Fibre: Wood manufactures sulphate pulp with satisfactory strength for white writing and printing paper, bark is worked into paper pulp and fibre is suitable for the textile industry.

Fuel: *M. alba* makes medium quality fuelhood.

Timber: The timber value of mulberry plant is good enough. It is compatible for house building, boats, beams, flooring, bridge building, agricultural implements, cabinet work, furniture, sports equipments, etc.

Alcohol: Fruit juice may be fermented and used to make wine.

Tannin: Leaves are useful for tanning and colouring purposes.

Essential oil: Mulberry fruit contains major components of the essential oils.

Medicine: The bark of mulberry is said to be good in the treatment of stomach-ache, neuralgic pains and dropsy. Leaves and young branchlets used for treating heavy colds, cough, red eye, insects bites and wounds. Fruit used in the treatment of sore throat, dyspepsia and melancholia.

1.2.2. Information of vitamin

Vitamin: It must be an important organic dietary essence. It is a group of unrelated organic compounds needed only in minute quantities in the diet but essential for specific metabolic reactions within the cell and necessary for normal growth and maintenance of health. It prevents an associated deficient disease. Animals fed on pure mixtures of carbohydrate, fat, protein, water and minerals fail to grow properly and thrive because, as is now known, they lack vitamins. Vitamins vary widely in chemical structure and functions. The term "Vitamine" meaning a vital amine to designate the accessory food factors necessary to life.

Many act as coenzymes or a prosthetic group of enzymes responsible for promoting essential chemical reactions. They ate often called accessory food factors in view of the fact that they do not supply calories nor contribute appreciably to body mass. Vitamins regulate metabolism, help convert fat and carbohydrate into energy, and assist in forming bones and tissues.

It is compatible to divide the vitamins into two categories on the ground of solubility:

(i) The fat soluble vitamins (A, D, E and K) and
(ii) The water soluble vitamins (B complex group and C).

One of the most rewarding scientific accomplishments of biochemistry in the first half of this century was the isolation and chemical characterization of the B-vitamin. The 'B' group, in general, plays an essential role in the metabolic processes of all living cells by serving as co factors in the various enzyme systems

involved in the oxidation of food and production of energy. They function as co-enzymes or as a prosthetic group bound to an apo enzyme, an enzyme protein. 13-vitamins are nutritional requirements for a broad spectrum of living organisms.

Table VI: B-Vitamins, their coenzymes and enzymatic functions

B-vitamin	Coenzyme form	Enzymatic function
Thiamin (B_1)	Thiamin pyrohosphate (TPP)	Aldehyde group removal or transfer
Riboflavin (B_2)	Flavin adenine dinucleotide (FAD)	Hydrogen transfer
	Flavin mononucleotide (FMN)	Hydrogen transfer
Nicotinamide (B_3)	Nicotinamide adenine dinucleotide (NAD^+)	Hydrogen transfer
	Nicotinamide adenine dinucleotide pyrophosphate ($NADP^+$)	Hydrogen transfer
Pantothenic acid (B_5)	Coenzyme A (CoA)	Acyl-group carrier or transfer
Pyridoxine (B_6)	Pyridoxal phosphate	Amino-group transfer, Carboxyl group transfer, recemization
Biotin (B_8)	Biocytin	Carboxyl group removal or transfer
Folic acid (Folacin) (B_9)	Tetrahydrofolic acid (FH_4)	One-carbon transfer.
Vitamin (B_{12}) (cyanocobalamin)	Coenzyme B_{12}	1,2-shift of hydrogen atom, methyl-group carrier

Here, among the eight basic vitamins in this group of water-soluble compounds, thiamin, riboflavin and niacin are the three classic deficiency disease factors. Pyridoxine, pantothenic acid and biotin are the coenzyme factors. And finally are the blood forming factors: folic acid and cobalamin.

It has been demonstrated that biotin, choline, folic acid, inositol, nicotinic acid, pantothenate, riboflavin and thiamin are the essential vitamins for the growth and development of *B. mori* larvae (Horie and Ito, 1963; Horie *et al.,* 1966) and the minimal optimal levels of vitamins in the diet have also been determined (Horie and Ito, 1965; Horie *et al.,* 1966). The effect of ascorbic acid on the fecundity was significant and a non-significant effect was recorded on the hatching percentage (Rahman *et al.,* 1990). According to Horie and Watanabe (1980), the specific requirements of various vitamins suggest their specificity for different metabolic functions. Fe-PLUS® supplementation significantly increased the weight of larvae, pupae and adults when compared with that of the untreated controls (Khan and

Saha, 1996). It has been also reported that supplementation of ascorbic acid to silkworm larvae increased the fecundity (Chauhan and Singh, 1992), and cocoon yield and filament length (Sarker *et al.,* 1995).

The principal vitamins required by insects belong to the B-complex group, and these have been demonstrated to have profound effects on the growth and development of insects. Ito (1961 a,b) recorded that ascorbic acid acted both as a phagostimulant and nutrient for the *B. mori.* It entirely depends on mulberry leaves for ascorbic acid. Ascorbic acid improved the growth and development of silkworms (Ito and Arai, 1965). However, this research was engaged in the effect of vitamin B_2 and C on the growth and development of the silkworm, *B. mori.*

A brief description of vitamin B_2 and C

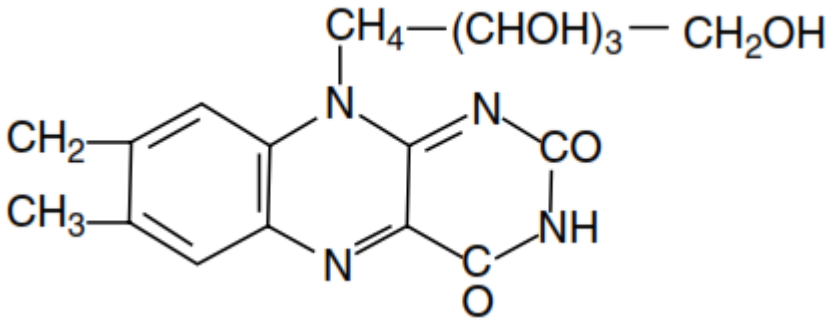
1. Riboflavin (B_2)

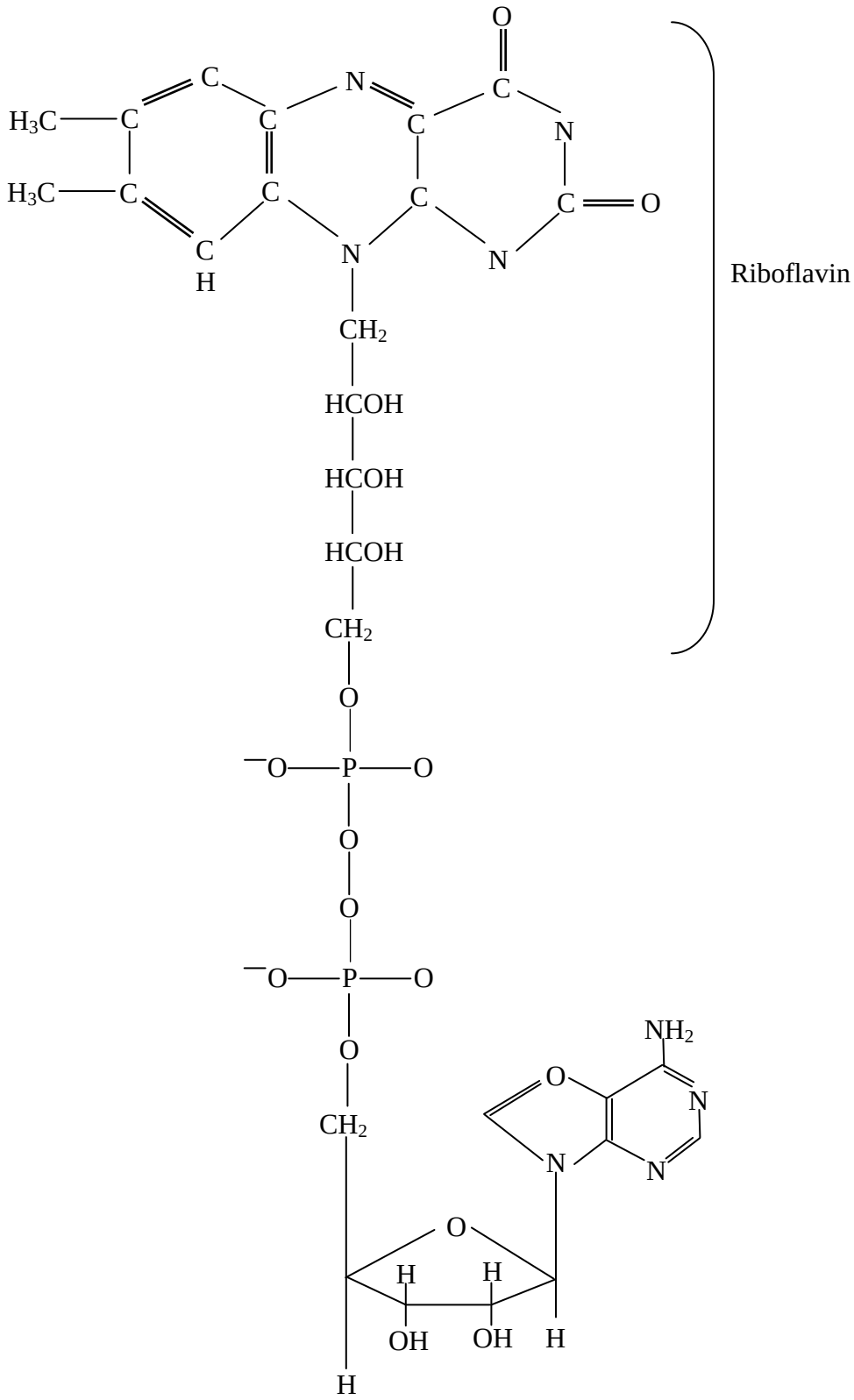
Chemical and physical nature

The vitamin was given the chemical group name flavins from the Latin word for yellow. The structure of vitamin B_2 riboflavin, contains D-ribitol (ribo-), a five-carbon sugar alcohol and an isoalloxazine (flavin) derivative. There are two coenzyme forms of riboflavin, such as (i) flavin mononucleotide (FMN) or riboflavin moimphosphate in one of the coenzymes and (ii) flavin adenine dinucleotide (FAD) in the other.

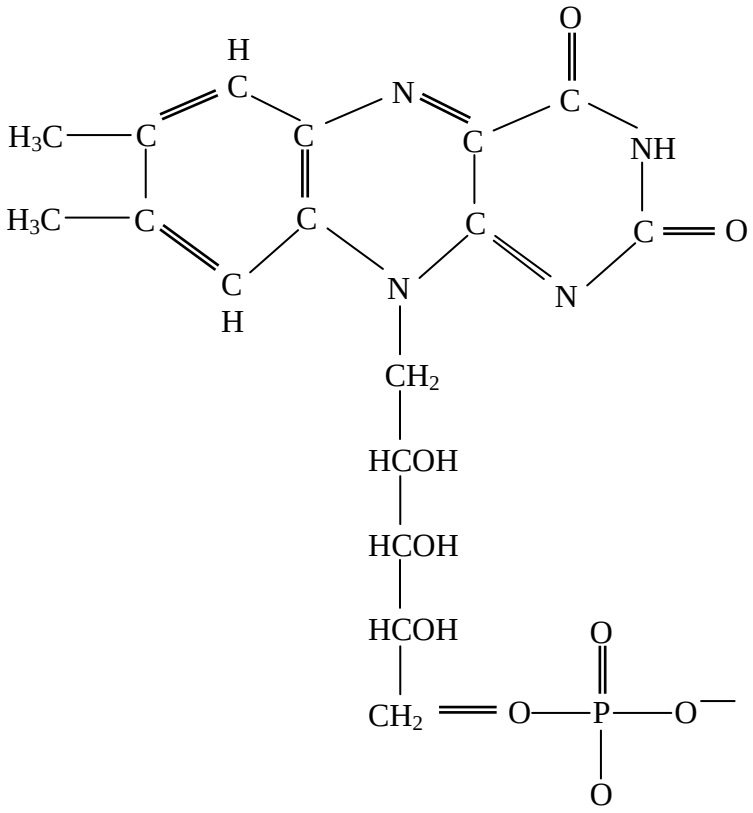
a) Riboflavin is a yellow-green fluorescent pigment that forms yellowish brown, needle, like crystals.
b) It is water-soluble.
c) Relatively stable to heat but easily destroyed by light and irradiation.
d) It is stable in acid media and is not easily oxidized.
e) It is sensitive to strong alkalis.

Chemical structure of riboflavin (Vitamin B_2)





Coenzyme form, flavin adenine dinucleotide (FMN)



Coenzyme form, flavin mononucleotide

Functions of riboflavin

Basic coenzyme role

The cell enzymes of which riboflavin is an important part are called flavoproteins. Riboflavin enzymes operate at vital reaction points in the process of energy metabolism and determination. Thus riboflavin acts as a control agent in both energy production and tissue building.

Effect of riboflavin

Deficiency of riboflavin leads to dermatitis.

2. Ascorbic acid

Chemical and physical nature

Its empirical formula is $C_6H_8O_6$ and molecular weight is 176.1.

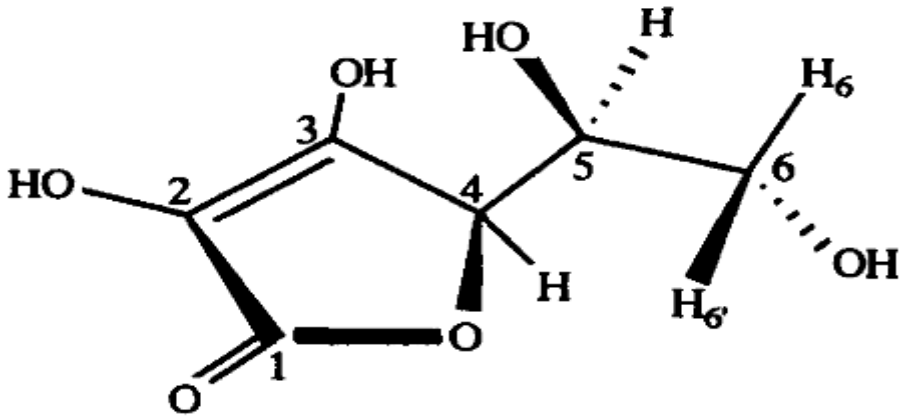
(a) It is water soluble

(b) White to slightly yellowish crystalline powder

(c) Practically odorless and

(d) With a strong acidic taste

Chemical structure of L-ascorbic acid (Vitamin C)



Absorption & storage

Ascorbic acid is easily absorbed in the intestine. It is stored in body tissue and in blood.

Function of vitamin-C

(a) Vitamin-C is required for the growth and repair of tissues in all parts of the body.

(b) It is necessary to form collagen, an important protein used to mark skin, scar tissue, tendons, ligaments, and blood vessels.

(c) Vitamin-C is essential for the healing of wounds and for the repair and maintenance of cartilage, bones and teeth.

(d) It is one of many antioxidants.

Effect of vitamin-C

Severe deficiency of vitamin-C causes scurvy.

1.2.3. Vitamins B_2 and C as a supplemented food

Vitamins are largely synthesized by animals (Rajendiran *et al.,* 1993) and the insects (Wakayama *et al.,* 1984). B-vitamins may be used by the rearers to increase

the economic characters of the indigenous poor silk-yielding varieties, like Nistari (Saha and Khan, 1997). Para-amino benzoic acid (hereinafter called PABA) is a growth regulator which in a moiety of pteroylglutamic acid, one of the forms of folic acid, and in one of the substances comprising the vitamin B complex group. The effect of supplementation of mulberry leaves with the vitamin para-amino benzoic acid slightly increased larval and pupal growth at lower doses (Khan and Faruki, 1990). It plays an important role as vitamin in bacteria and is considered as an essential dietary constituent for insects, particularly, silkworms (Pai *et al.*, 1988).

It has been reported that feeding of butter, vitamin B-complex and glucose smeared leaves to *Antheraea mylitta* resulted in increase in larval weight, cocoon weight and fecundity (Kumarilalita *et al.,* 1992). Thianomin® supplementation enhanced the economic characters of *B. mori* (Faruki, 1998).

Pyridoxine is reported to be involved in amino acid metabolism (Friedrich, 1988). The vitamin riboflavin may have some stimulatory effect on the metabolism thereby increasing the economic parameters, and glycogen and protein contents of the fat body and trehalose and protein contents of the haemolymph of the silkworm larvae (Nirwani *et al.,* 1998). When silkworm larvae were reared on a vitamin B_2 deficient diet, their growth retarded gradually whereas the total vitamin B_2 content in larval body was decreased rapidly (Nakamura, 2000).

Ascorbic acid has many important functions in the animal body. It is a powerful antioxidant, protecting against oxidative damage to DNA membrane lipids and proteins. Antioxidant activity of ascorbic acid decreases reactive oxygen species and oxidative pressure, and as a result, the absorption of nutritious substances in the midgut would increase (Felton and Summers, 1993). Ascorbic acid shows a particular behaviour as it is very susceptible to degradation, especially when in

solution, and/or exposed to light, oxygen, and free radicals. Ito (1961) recorded relationship of ascorbic acid supplementation and growth of silkworm. The absence of ascorbic acid in the diet of first and second instar larvae postponed growth and development of silkworm. There is enough vitamin C in mulberry leaves and ascorbic acid content of growing larvae is dependent on the amount of this vitamin in diet supplementation of mulberry leaves more than any other vitamin ascorbic acid has been used (Etebari *et al.,* 2004). Several research demonstrated phagostimulatory effect of ascorbic acid for insects (Ito, 1978; Dobzhenok, 1974). In silkworm a gustatory stimulating activity have been observed to some extent (Ito, 1961). Gomma *et al.* (1977) observed that ascorbic acid significantly increased the weight of silkworm larvae. Babu *et al.* (1992) observed that the first and second instar larvae reared on 1.5% ascorbic acid enriched mulberry leaves resulted in higher silk filament length, weight and denier values. Sengupta *et al.* (1972) reported that silk production increased with 1% ascorbic acid in the diet of silkworm. Etebari *et al.* (2004) demonstrated that feeding on mulberry leaves enriched with ascorbic acid at 3% concentration decreased larval weight due to hypervitaminosis. Chauhan and Singh (1992) showed that 1% ascorbic acid could increase the number of eggs in the silkworm. Although its lower concentration the leaves in the first and second generation also did not have positive effects on the fecundity in the silkworm.

These few reports suggest that the vitamins play an important role in the metabolic activity and on the economic parameters of the silkworm. Vitamin B_2 and C are nutritional requirements for wide spectrum of living organism. They act as coenzymes. In this context, riboflavin and ascorbic acid were used as a supplemented food in this study.

1.3. Objectives of the present study

- To investigate the effectiveness of vitamins as a supplemented food with mulberry leaves on the growth and development of *B. mori* L.
- To study the efficacy of the selected vitamins in improving the cocoon characters of *B. mori.*
- To see the significance of the vitamins as food supplement with mulberry leaves on the 'biological efficiency' of *B. mori*, such as fecundity, fertility and rate of survival %.
- To determine the effect of vitamin on the physiological parameters in relation to feeding efficacy.
- To help increasing the production rate of silk.

Chapter 2

Review of Literature

Nutrition plays an important role in improving the growth and development of the silkworm, *Bombyx mori* L., like other organisms. Unlike other insects, silkworm is monophagous, deriving almost all the constituents required for its growth from the mulberry leaves itself. Improvement in quality and quantity of silk by enriching mulberry leaves with inorganic and organic supplements has been tried by many researchers. Willis *et al.* (1995**)** reported that **s**ilkworm nutrition is to be considered as the major area of research in sericulture from the scientific point of view.

Growth, development and economic parameters of silkworm

Sengupta *et al*. (1972) showed that *B. mori* requires certain essential sugars, proteins, amino acids and vitamins for its normal growth, survival and also for the growth of its silkgland. Legay (1958) stated that silk production is dependent on the larval nutrition and nutritive value of mulberry leaves and it plays a very effective role through producing good quality cocoons. Akhtar and Asgher (1972) found that vitamins and mineral salts played important role in the nutrition of silkworm.

Numerous works on the nutritional effects on *B. mori* have also been carried out (Islam and khan, 1993; Babu *et al*., 1992; Haque, 1991; Rahman *et al.,* 1990; Faruki, 1990; Khalequzzaman and Ansary, 1982; Khalequzzaman and Mannan, 1982; Gomma *et al.,* 1977 and 1976; Kumararaj *et al.,* 1972; Yasuhiro and Sholchi, 1971; Ito and Arai, 1965 a; Ito, 1961). Various important works relevant to this study are reviewed here.

2.1. Effect of vitamin supplementation on silkworm

Studies of Ito (1978) determined that generally vitamins present in the mulberry leaves satisfy minimum needs of silkworm but the amount of vitamins present in

mulberry leaves varies on the basis of environmental conditions, usage of fertilizers in field and mulberry varieties and other field practices.

2.1.1. Vitamin B-complex

The vitamin B-complex is traditionally made up of 10 members that differ in their biological action. Many works on the effects of vitamin B-complex on *B. mori* biology carried out are discussed below:

Table VII: List of vitamin B-complex oriented research references.

Vitamin	Journal/Book/ Thesis	Location	Authors
B_1 (Thiamine)	Journal	Bangladesh	Khan and Shah (2003)
	Journal	India	Nirwani and Kaliwal (1998)
	Journal	Bangladesh	Faruki (1998)
	Journal	India	Nirwani and Kaliwal (1996)
	Journal	Japan	Horie and Ito (1963)
B_2 (Riboflavin)	Journal	Iran	Rajabi *et al.* (2006a)
	Journal	India	Nirwani and Kaliwal (1998)
	Journal	Japan	Ito (1978)
B_3 (Niacin)	Journal	China	Chang and Li (2004)
	Journal	Iran	Etebari and Matindoost (2004)
	Journal	Bangladesh	Shah and Khan (1996)
	Journal	Japan	Horie (1995)
	Journal	Japan	Horie and Ito (1965)
B_6 (Pyridoxine)	Journal	Iran	Rajabi *et al.* (2006b)
	Journal	Iran	Etebari and Matindoost (2005)
	Journal	Bangladesh	Faruki (2005)
	Journal	Bangladesh	Banerjee and Khan (1992)
B_8 (Biotin)	Journal	Japan	Horie *et al.* (1966)
	Journal	Japan	Horie and Ito (1965)
	Journal	Japan	Horie and Nakasone (1968)
B_9 (Folic acid)	Journal	India	Rahmathulla *et al.* (2007)
	Book	USA	Chapman (1998)
	Journal	Bangladesh	Khan and Shah (1996)
	Journal	India	Nirwani & Kaliwal (1996)
	Journal	Bangladesh	Faruki and Khan (1992)
	Journal	Bangladesh	Khan and Faruki (1990)
	Conf. paper	India	Pai *et al*. (1988)
	Journal	Japan	Yasuhiro and Sholchi (1971)

	Journal	India	Das and Medda (1998)
B_{12}	Book	India	Halarnkar and Blomquist (1989)
(cyanocobalamin)	Journal	India	Bhattacharya and Medda (1981b)
	Journal	India	Majumdar and Medda (1975)

B_1

Thiamine is important for energy metabolism (National Research Council, US, 1987). Nirwani and Kaliwal (1998) reported that the weight of larvae and silk glands in all the thiamine fed groups had not shown any significant changes. It has been found that thiamine has no phagostimulatory effect on silkworm (Horie and Ito, 1963; Nirwani and Kaliwal, 1996). Thiamine was the first B- vitamins to be obtained in a pure form. The highest concentration, i.e., 0.40% produced detrimental effects on all the parameters, such as larval weight, cocoon weight, pupal weight, shell weight, shell ratio, developmental periods and reproductive potential, etc. studied (Khan and Shah, 2003). Faruki (1998) reported that the thiamine derivative thianomin enhanced the growth of silkworm larvae, pupae and adults with various concentrations (50,100, 500, and 1000 ppm).

B_2

Ito (1978) reported that riboflavin enhances the silk production and reduced the uric acid excretion and the choline and its derivatives sprayed on mulberry leaf and feeding to silkworm enhanced the fiber yield. Nirwani and Kaliwal (1998) observed that the vitamin B_2 may have some stimulatory effect on metabolism in silkworm larvae. Oral supplementation of B_2 to silkworm larvae (*B. mori*) resulted in a significant increase in the cocoon weight and shell weight whereas the larval duration was decreased significantly. The enrichment of mulberry leaves with riboflavin at 77ppm enhanced certain economic characters of silkworm and improves silk production in the climatic conditions of Iran (Rajabi *et al*., 2006a).

B_3

Niacin is important for the release of energy from carbohydrates and fats, and for the metabolism of proteins and production of several hormones (National Research

Council, US, 1987). Chang and Li (2004) reported that nutritional interactions exist between vitamin B_3 and other groups of vitamin B. Horie and Ito (1965) showed the required level of niacin for silkworm is highly regulated to the most appropriate level of 33µg/L of dry weight and the increase of niacin reduced the larval weight. Horie (1995) further showed a reduction of requirement pattern with increasing larval weight. The analogues of niacin, 4-acetyl pyridine interrupts the larval growth when added to mulberry leaves and acted as an antimetabolite (Horie and Ito (1965). Etebari and Matindoost (2004) reported that niacin caused significant deleterious effects on larval growth and cocoon parameters, such as cocoon weight, pupal weight and cocoon shell weight also showed significant decrease in all treatments. High doses (20 and 30g/l) of nicotinamide killed all larvae before entering the 5^{th} instars (Etebari and Matindoost, 2004). They further observed that niacin with 0.5 g/L acted as an antifeedant for silkworm larvae and decreased their metabolism. Shah and Khan (1999) reported that food supplemented with nicotinic acid at 0.05, 0.10, 0.20 and 0.40% from the first day of the third instar up to the end of the feeding period of *B. mori* significantly increased the larval, pupal and adult weight.

B_5

Pantothenic acid (B_5) is the precursor of coenzyme and that is vital for the metabolism of carbohydrates, the synthesis and degradation of fats, the synthesis of sterols and the resultant steroid hormones, and the synthesis of many other important compounds (National Research Council, US, 1987).

B_6

According to the US National Research Council (1987) pyridoxine is necessary for the proper functioning of over 60 enzymes that participate in amino acid metabolism. It is also involved in carbohydrate and fat metabolism. Without pyridoxine or its derivatives no larva reached the third instar under aseptic condition. Pyridoxine is important in protein metabolism and its deficiency in mammals results in decrease in phosphorylases. Anonymous (1998) reported that

pyridoxine also known as vitamin B_6 is part of the B group vitamins and it is water soluble. It stimulates growth and is important in protein metabolism, and its deficiency in mammals results in a decrease in phosphorylases. Faruki (2005) reported that mulberry leaf fortification by pyrol® (Pyridoxine hydrochloride HCl 1.25) in various concentrations treated from the third instar arvae significantly reduced the fecundity in the adult stage. In this experiment it was found the lowest number of eggs was produced at the lowest concentration (10µ/*g*ml) and at higher concentrations it remains lower than in the control. Faruki (2005) observed that higher concentration of vitamins reduced the fecundity and fertility of silkworm. Further, the percent reproduction control (PRC) in lower concentrations was more than the higher concentrations (Faruki 2005). Banerjee and Khan (1992) observed that vitamin B_6 enhances the oviposition of the silkworm infected by *Bacillus thuringiensis* var. *Kurstaki* but the rate was lower than the control. The reproductive success in lower concentrations was prominent which compared with the higher concentrations (Faruki 2005; Etebari and Matindoost, 2005). Rajabi *et al.* (2006b) showed that in climatic conditions of northern Iran, larval weight reached a maximum 2.601g at the end of 5^{th} instar. Rajabi *et al.* (2006b) further reported that effective rate of rearing (ERR%) was higher (75.33%) at 100ppm concentration compared with other concentrations (10,500 and 1000ppm). Larval and silk indices reached their maximum at 100ppm concentration while pupal and adult indices reached their maximum at 1000ppm concentration in male and female. Larval duration was longer (622.5h) in treatments against control (604.5h). Treatment differences were recorded also in respect of other economic characteristics (Rajabi *et al.,* 2006b).

B_8

Horie and Ito (1966) observed that biotin has an important role in carbohydrate and fat metabolism. It has been showed that biotin is one of the essential vitamins for the silkworm *B. mori.* Horie and Ito (1965) also said that biotin has an important role in the synthesis of fatty acids in the silkworm and it is confirmed that minimal

optimal level of biotin for growth and survival of the silkworm was much lower than those of other vitamins including B_3, B_5 and B_6. It is identical with the minimal threshold for alternation of fatty acid composition (Horie and Nakasone, 1968).

B_9

Folic acid plays a major role in cellular metabolism including the synthesis of some of the components of DNA and pigment precursor (Chapman 1998, National Research Council, US, 1987). Yasuhiro and Sholchi (1971) noted that the silkworm growth decreased when folic acid was eliminated from artificial diet. Nirwani and Kaliwal (1996) determined that folic acid has phagostimulatory effects with significant increase in female and male cocoon weight and shell weight. Para- amino benzoic acid (PABA) is a growth regulator and represents one of the forms of folic acid. Nirwani and kaliwal (1996a) further showed that folic acid act as a co-factor and is essential in the reaction of transforming phenyl alanine into tyrosine. It was also reported that dietary supplementation of folic acid to silkworm larvae did not significantly increase the glycogen content of the body, where as in haemolymph trehalose content increases significantly. It is one of the substances belonging to the vitamin B-complex group supports vital function in insects and especially in silkworm (Pai *et al*., 1988). Khan and Faruki (1990) showed that PABA slightly increased larval and pupal growth at lower doses (1and 10ppm). PABA supplementation has no significant effects on adult weight whereas it caused deleterious effects on their length and wing-span (Faruki and Khan, 1992). Fe-PLUS (ferrus fumarate + folic acid) supplementation significantly increased larval, pupal and adult weight in comparison to controls with lowest and highest growth obtained at the concentrations of 0.32 and 0.64% respectively (Khan and Saha,1996). They further reported that the larval and pupal periods decreased at lower doses (0.08 and 0.16%) while they increased after exposure to higher doses (0.32 and 0.64%). Fertility increased significantly in all treatments when compared to control except for the concentration of 0.64%. Rahmathulla *et*

al. (2007) showed that the folic acid solution spraying on mulberry leaf and feeding to silkworm significantly improved the larval weight, silkgland weight and the growth rate.

B_{12}

Das and Medda (1998) reported that supplementation of mulberry leaves with B_{12} vitamin could increase the synthesis of nucleic acid and protein in the silk glands of the silkworm. Cyanocobalamin plays an important role in silkworm because it is a co-factor of propionate metabolism which is an important substrate for biosynthesis of juvenile hormone in insects (Halarnkar and Blomquist, 1989).

2.1.2. Vitamin C (Ascorbic acid)

Supplementation of vitamin C to mulberry leaves improved economic traits in the silkworm as studied by many researchers (Chauhan and Singh 1992; Prassad *et. al.*, 1994; Cappellozza *et al.*, 2005; Balsundaram *et al.*, 2013).

Table VIII: List of ascorbic acid oriented research references

Supplemented food	Journal/Book/Theses	Location	Authors
Vit-C (Ascorbic acid)	Journal	India	Balasundaram *et al.* (2013)
	Journal	India	Singh and Bandey (2012)
	Journal	Egypt	El-Karaksy and Idriss (1990)
	Journal	India	Balasundaram *et al.* (2008)
	Journal	Egypt	Zanoon, AA *et al.* (2008)
	Journal	Iran	Razabi R *et al.* (2007)
	Journal	Italy	Cappellozza *et al.* (2005)
	Journal	Iran	Etebari and Matindoost (2005)
	Journal	Iran	Etebari *et al.* (2004)
	Journal	Iran	Hossain and Javed (2002)
	Journal	Iran	Javed and Gondal (2002)
	Journal	Srilanka	Miranda *et al.* (1998)
	Journal	India	Sarkar *et al.* (1995)
	Journal	India	Prashad *et al.* (1994)
	Journal	---	Felton and Summers (1993)
	Journal	India	Chauhan and Singh (1992)
	Journal	India	Babu *et al.* (1992)
	Book	Japan	Ito (1978)

Journal		Gomma *et al.* (1977)
Book	Italy	Anon (1975)
Journal	---	Dobzhenok (1974)
Journal	India	Sengupta *et al.* (1972)
Journal	Japan	Ito and Niminura (1966a and b).
Book	Italy	Anon (1965)
Journal	Japan	Ito and Ari (1965a, b)
Journal	Japan	Ito (1961)
Book	---	Bessey J (1944)

Silkworm larvae requires large amount of choline, inositol and vitamin C (Anon, 1975). Babu *et al.* (1992) observed that the first and second instar larvae reared on 1.5% ascorbic acid enriched mulberry leaves resulted in higher silk filament length, weight and denier values. Balasundaram *et al.* (2013) have reported that the vitamin C exhibits the presence of certain growth stimulant activity and can be used increase the feed efficacy in commercial silkworm rearing with reference to sericulture. The larval length, width and weight have been improved when the larvae fed with the supplementation of vitamin C treated mulberry leaves (Balasundaram *et al*., 2008). Cappellozza *et al.* (2005) recorded the negative effect of Vitamin C on the development and productivity of the silkworm, as a result of diet supplementation with ascorbic acid followed by the assumption that Vitamin C has adverse effects on the silkworm. Chauhan and Singh (1992) showed that 1% ascorbic acid could increase the number of eggs in the silkworm. The tested concentrations of ascorbic acid raised the coefficient of food utilization and growth of mulberry silkworm larvae. Vitamin C as a food additive, affected significantly the CA volume and increased the juvenile (El-Karaksy and Idriss, 1990). Etebari *et al.* (2004) demonstrated that feeding on mulberry leaves enriched with ascorbic acid at 3% concentration decreased larval weight due to hypervitaminosis. Etebari and Matindoost, (2005) administered a vitamin complex (ascorbic acid, thiamin, riboflavin, pyridoxine, B_{12}, niacin, calcium panthotenate, vitamins A and D_3) to silkworm in concentrations of 1, 2.5 and 5% in the 4th and 5th larval stages, supplementation being executed by pulverizing the vitamin substances onto the

leaves. This treatment led to significant increases in the larval body mass, cocoon mass, chrysalis weight and egg productivity compared to the control group. Etebari *et al.,* (2004) reported the yield decrease, when ascorbic acid concentration is enhanced in silkworm diet. Antioxidant activity of ascorbic acid decreases reactive oxygen species and oxidative pressure, and as a result, the absorption of nutritious substances in the midgut would increase (Felton and Summers, 1993). B- carotene, thiamin, riboflavin and ascorbic acid contents of fresh leaves were determined according to the method of Anon (1965) and Bessey (1944) respectively. Gomma *et al.* (1977) observed that ascorbic acid significantly increased the weight of silkworm larvae. Ascorbic acid is reported to enhance the larval survival rate (Ito and Niminura, 1966 a and b). Ascorbic acid is an indispensable vitamin in the diet of silkworm and other polyphagous insect (Ito and Arai, 1965a,b). Ito (1961) recorded that a gustatory stimulating activity in silkworm has been observed to some extent due to effect of ascorbic acid. Several research demonstrated phagostimulatory effect of ascorbic acid for insects Ito (1978), Debzhenok (1974). Ascorbic acid had effect on the growth of silkworm (Javed and Gondal, 2002) and combination of 0.2% of N which enhances the growth of silk production (Hussain and Javed, 2002). Mulberry leaves immersed in solutions of 0.5, 1 and 1.5% ascorbic acid solution significantly increase the weights of both larvae and cocoons of silkworms compared with untreated leaves (Miranda *et al*., 1998). Prasad *et al.* (1994) found significantly higher silk productivity on 2% ascorbic acid supplemented diet in Pure Mysore, NB_4D_2 and $PM \times NB_4D_2$ breeds. While vitamin C supplemented with mulberry leaves, silkworm showed significant improvemint in the parameters studied, such as LW, CW, SW, Shell% over the control batch (Singh and Bandey, 2012). Sengupta *et al.* (1972) reported that silk production increased with 1% ascorbic acid in the diet of silkworm. Ascorbic acid is known to have phagostimulation action in insect and promotion of growth and reduction in larval mortality of *Bombyx mori* (Ito, 1961). Zanoon *et al.* (2008) showed that mulberry leaves (*Morus alba* var. Kokuso-27) with nutritional additives vita- C

were enriched significantly larval duration, larval mortality and increase larval fitness, cocoon characters, fecundity and fertility.

2.1.3. Multi vitamin

Application of multivitamins as supplementary nutrients on biological and economical characteristics of silkworm, *Bombyx mori* L. had radically changed the results based on the concentration they were administered (Etebari and Matindoost, 2005). They further reported that feeding of silkworm on mulberry leaves enriched with multivitamins from 4th instar increased female cocoon shell weight in 2.5% concentration, while female pupal weight increased in 1% concentration. However, male and female shell ratio did not increase compared to control.

Table IX. List of multivitamin oriented research references

Supplemented food	Journal/Book/Theses	Location	Authors
Multivitamin	Journal	Bangladesh	Ahsan *et al.* (2013)
	Journal	Iran	Etebari and Matindoost (2005)
	Journal	Iran	Talebi *et al.* (2001)
	Journal	---	Evanglista *et al.* (1997)
	Journal	Bangladesh	Saha and Khan (1996)
	Journal	India	Muniandy *et al*. (1995)

Ahsan *et al.* (2013) observed that oral supplementation of vitamin B and C with mulberry leaves significantly increased in the various growth parameters of *B. mori.* Saha and Khan (1996) described the extensive effects of multivitamin compounds as diet factors on growth interruption and the decrease of cocoon characteristics. Evanglista *et al.* (1997) reported that the larval and cocoon weight increased under multivitamin compound treatment, but did not have any positive effects on cocoon shell weight. Feeding with multivitamins in the larval stage adversely affected the hatchability of eggs. Multivitamins even though could increase some biological characteristics in silkworm, did not influence the economical and yield contributing parameters. It is showed that multivitamin and

mineral compounds could increase the food intake, growth and conversion efficiency of silkworm (Muniandy *et al*., 1995). Talebi *et al.* (2001) observed that the effect of multivitamins on some traits of the silkworm showed significant result, such as larval weight, cocoon weight, pupal weight, egg production, etc.

2.1.4. Vitamin E

Alpha-tocopherol is slightly effective in increasing the number of eggs laid by moths and ß-carotene has also some growth-promoting effects (Ito, 1978). Enrichment of mulberry leaves with E vitamin did not have significant effect on food consumption in silkworm larvae (Mosallanejad, 2002).

2.2. Effect of other nutrients on silkworm

The effect of artificial diets with different nutrients on better production of cocoon crops and silk were investigated by many researchers, e.g. Ahsan *et al.* (2013), Gomma *et al*. (1976, 1977), El-Shaarawy *et al*. (1976, 1977a,b), Yonagawa (1973), Ito and Arai (1965a,b), Yokoyama (1964), Hamamura (1964), Ito (1964), Legay and Pascal (1964), Fukuda and Higuchi (1963). Addition of extra nutrients to the mulberry leaf in case silkworm enhanced their growth and cocoon yield (Sharda *et al*., 1956; Ito, 1960; Li and Chiang, 1982).

2.2.1. Mineral and salt supplementation

The larvae fed with mulberry leaves supplemented with multiminerals showed greater body weight at the end of larval stage in comparison to the larva that didn't received supplements.

Ashfaq *et al.* (2009) studied the toxic effect of food contamination with cobalt (Co (II)), observing that cobalt, in particular Co (II), is not a recommendable nutritive supplement. Implicitly, the mineral salts of potassium and magnesium present in lemon juice could have significantly contributed to the rise in the levels of fat body protein (Bhattacharya and Kaliwal, 2004). However, a high concentration of potassium iodide decreased fecundity, increased silk-gland weight, enhanced metabolic activity, acid and alkaline phosphatase activity and decreased the

glycogen content of the silkgland (Bhattacharya and Medda, 1981a,b; 1983). The supplementation of food with potassium permanganate leads to an increase of proteins from hemolymph and insect's fat body (Bhattacharya and Kaliwal, 2004). Balamani *et al.* (1995) showed that zinc treatment up to 100ppm level produced no adverse effects on the nutritional indices, economic characters of cocoon and quality of silk produced, instead improvement was observed in them in more than 50% of the concentrations tested. The mineral enrichment studies concentrated on the application of salts of cobalt, potassium, magnesium, calcium and zinc (Bhattacharya and Kaliwal, 2005a, 2005b, 2005c, 2005d; Kavitha *et al.*, 2012), often with mixed results on economic traits of silkworm. Feeding of mulberry leaves treated with cobalt chloride enhanced the larval and cocoon shell weight and egg productivity in the nistari race of *B. mori* (Chakrobarti and Medda, 1977, 1978a,b) and the worms fed on leaves treated with potassium iodide increased the economic parameters and reduced the larval duration (Majumdar, 1982). Total proteins present a significant increase in all treatments with multiminerals (Etebari and Fazilati, 2003). Similar results had been reported with potassium nitrate supplementation (Goudar, 2001). Hugar *et al.* (1998) found that lower concentration of nickel chloride supplementation significantly increased the silkgland weight, female and male cocoon weight and the length, weight and denier of the silk filament in all the treated groups. Islam and Khan (1993) recorded that supplementation of mulberry leaves with lower concentrations of manganese sulphate significantly increased the larval, pupal and adult growth, decreased the total developmental period, enhanced the cocoon characters and the reproductive potential of the mulberry silkworm. Islam *et al.* (2004) suggested that the nickel chloride can be used at low concentrations for enhancing the economic characters of silkworm, *B. mori* L. Administration of additional copper sulphate, nickel chloride and potassium iodide in the food increased economic parameters of the silkworms. Islam *et al.* (2004) mentioned that the cocoon weight, shell weight, and shell/cocoon ratio of silkworm increased when treated with various combinations of urea, ascorbic acid, and nickel chloride. Khan and Talukder (1985,

1986) assessed the effect of addition of potassium, sodium, magnesium and ammonium chlorides to castor leaves on the eri silkworm, *Samia cynthia ricini* (Boisd). Khan and Saha (1996) observed that the supplementation of potassium dichromate significantly increased the weight of larvae, pupae and adults; enhanced the cocoon characters; decreased the developmental periods and increased the reproductive potential of *B. mori* at 0.10, 0.20 and 0.40% concentrations. Kavitha *et al*. (2011) reported that the fat body responds well to higher doses of zinc, silkgland and haemolymph respond at low concentrations. Devi and Yellamma (2013) suggested that zinc induced active turnover of all profiles of protein metabolic events in the posterior silk gland, creating the conditions that are highly congenial for growth and silk production. Cocoon parameters in the silkworm, *Bombyx mori* on exposure to trace element and nutrients was traced by Devi and Yellamma (2013). The modulatory effect of zinc chloride, nickel chloride, ascorbic acid, magnesium sulphate, ferrous chloride, potassium sulphate, thyroxin (Majumdar and Medda, 1995) on the silkworm metabolism, immune response and silk production has been extensively studied. Magadum *et al.* (1992) noted that supplementation of feed with copper sulphate significantly increased the larval and female cocoon shell weight but decreased the larval period, cocooning and moth emergence in *B. mori*. Majumdar (1982) recorded that a high concentration of potassium iodide produced higher larval and pupal mortalities in the nistari race of *B. mori.* Nirwani and Kaliwal (1996) reported that the supplementation of feed with ferrous and magnesium sulphate produced beneficial effects on the economic characters of *B. mori*. Further, recent experimental findings suggests that cofactor functions of iron and zinc are considered as the most universal importance to organisms and trace elements can be essential for insects in general (Nichol *et al.*, 2002). Administering of potassium sulfate in the food determines protein decrease in the fat body and the hemolymph (Nirwani and Kaliwal, 1996), but zinc chloride causes a significant decrease of fat body protein content and a significant increase in hemolymph protein content (Hugar *et al.*, 1998). An increase in the larval weight has been reported in the eri

silkworm by feeding leaves treated with mineral salts such as cupric chloride, magnesium sulphate and cobalt chloride (Padki, 1991). Quader *et al.* (1993) found that 500ppm concentration of iodized salt significantly increased larval weight, single cocoon weight and shell percentage and 40ppm concentration of iodized salt increased shell weight, length of filament and size of cocoon filament. Quader *et al.* (1993) found that iodized salt (sodium chloride containing 35ppm potassium iodide) significantly increased the larval weight over potassium iodide and control treatments and they suggested the use of iodized salt as a growth stimulator of the silkworm, *B. mori.* Srinivasababu *et al.* (1992) observed that dietary supplementation of iodophore significantly increased the larval weight, cocoon weight, shell weight, pupation rate and fecundity and decreased the duration of the 5^{th} instar. Saha and Khan (1995) observed that supplementation of diet with magnesium nitrate enhanced the economic parameters of the silkworm. They recorded that lower concentrations of nickel chloride significantly increased the growth of larvae, pupae and adults, enhanced the cocoon characters, reduced the larval and pupal periods and decreased mortality and enhanced reproductive potential of *B. mori.* Supplementation of calcium and magnesium chlorides showed an increase in cocoon shell weight and shell ratio in *B. mori* (Rathinam *et al.*, 1990). Thangavelu and Bania (1990) recorded that trace amounts of minerals, e.g. calcium, magnesium, iron, and their salts present in rain water presumably stimulated metabolic activity in *B. mori* resulting in the shorter larval duration and increase in the effective rearing rate, oviposition and silk content of cocoons.

Beside the above findings the beneficial effects of mineral and salt supplementation on silkworm more works have been done by many researchers e.g., Muniandy (1995), Trager (1953), Horie and Watanabe (1980), House (1965), Ito (1964), Underwood (1971), Vallee, (1976), Ito and Niminura (1966a,b), Chakrobarti and Medda (1977, 1978a,b), Miyoshi *et al.* (1978), Bhattacharrya and Medda (1981a,b, 1983), Majumdar (1982), Narasimhamurthy and Gobindappa (1988), Thangavelu and Bania (1990), Magadum *et al.* (1992), Islam and Khan

(1993), Wigglesworth (1972), Bracken (1965), Sing and Brown (1957), Arnaudo (1954),Takahashi (1955, 1956), Chakrobarti and Medda (1978b), Chakrobarti and Medda (1978a), Magadum (1987) and Dasmahapatra *et al*. (1989).

2.2.2. Hormone supplementation

A number of experiments have been carried out on the effect of hormones on the growth and development of *B. mori* by Padki (1991), Magadum *et al*. (1992), Trivedy *et al*. (1993), Saha and Khan (1997a), Reddy *et al.* (1994) and Magadum and Hooli (1989).

Daillie (1979) reported that development of silkgland remarkably differed in different days of 5^{th} instars due to the effect of different doses of juvenile hormone on silkworm. The cocoon weight increased when the silkworm larvae were fed with blood meal fortified mulberry leaves (Majumdar and Medda 1995; Isaiarasu and Ganga, 2000). The ecdysone has been noticed to influence the reproductive potential of *Bombyx mori* (Pondeville *et al*., 2008; Parlak *et al*., 1992; Kawaguchi *et al*., 1993 and Okuda *et al*., 1993). Ecdysteroids play key role in moulting and metamorphosis in insects. Plant produced insects moulting hormones, known as phytoecdysteroids (PEs), assume the functions of defense against insects by acting either as feeding deterrents or as agents that induce developmental disruption (Schmulz *et al.*, 2002). The moulting hormones are hydrophilic in nature because of a number of hydroxyl group present in the molecules (Sehnal, 1989; Sehnal and Akai, 1990). Effects of phytoecdysteroids on weight of ovary and weight of egg (Srivastava and Upadhyay, 2012a); on length of silk filament and non breakbale filament of multivoltine mulberry silkworm (Srivastava and Upadhyay, 2012b); on the spinning duration (Pandey and Upadhyay, 2014); changes of protein content in the larvae of silkworm (Srivastava and Upadhyay, 2013a); on silk producing potential (Srivastava and Upadhyay, 2013a) and on incubation period and percent fertilization of eggs of multivoltine silkworm (Srivastava and Upadhyay, 2013b) have been studied extensively with an aim to utilize the results for commercial cocoon production.

2.2.3. Proteins, amino acids and enzymes

The requirements of amino acids in *B. mori*. have been also confirmed by Qadar *et al*. (1994); Eid *et al*. (1989); Saha and Khan, (1995) and Saha *et al*. (1994).

Amway is the best supplement protein for the production of good qualified cocoon and silk suggested by Rani *et al.* (2011). Babu (1994) observed an increased silk productivity when the silkworms were reared on glycine supplemented leaves during their fifth instars. Bose and Majumder (1989) studied amino acid requirements in silkworm nutrition. Effect of dietary levels of protein and pyridoxine on the growth of younger larvae of *B. mori* was observed by Krishnappa (1987) and this author also observed the influence of amino acid supplementation on growth and development of *B. mori.* According to Horie and Watanabe (1983) amino acids can influence the development of the whole organism. In *B. mori*, in particular, up to 65% of digested nitrogen is utilized for silk production during the last instar and the level of dietary protein and limiting amino acids in the diet strongly affects larval growth and silk production. Amylase is one of the key enzymes involved in digestion and carbohydrate metabolism in insect (Horie and Watanabe, 1980). The weight and the size of cocoon, shell ratio and fibroin content of the shell increased with the supplementation of the amino acid, glycine (Isaiarasu and Ganga, 2000). Leonardi *et al.* (2001) demonstrated that intestinal amino acid absorption is an important step in nitrogen metabolism and it directs the biological development of the whole organism. Majumdar and Medda (1995) reported the supplementation of tyrosine to enhance the cocoon weight due to the increased synthesis of DNA, RNA and proteins in silk gland. Further, it has been reported by various workers that some weed plants influence the growth and metabolic activity of silk gland in sericigenous insects (Mane and Patil, 2000a,b; Mamadapur, 1994). Rajabi (2010) mentioned that asparagine and alanine amino acids could not improve silk production in sericulture significantly. An experiment was carried out by laz (2010) to determine the effects of methionine and tryptophan on some quantitative traits of silkworm, *B. mori* L. The economic

characters of the silk cocoon were reported to improve by feeding the silkworm with mulberry leaves treated with amino acids (Rathinam *et al*., 1990). This author also observed the enrichment of mulberry leaves with calcium chloride to increase the cocoon characters like cocoon weight, shell weight, shell ratio and silk proteins. The cocoon weight was increased when the silkworm larvae were fed with blood meal fortified mulberry leaves.

2.2.4. Plant extracts supplementation

Aloe vera contains over 75 nutrients and 200 active compounds, including vitamins, enzymes, minerals, sugars, lignin, anthraquinones, saponins, salicylic acid and amino acids (Park and Jo, 2006). Further, *Aloe vera* herbal tonic 'Iogen' (Balamurugan and Isaiarasu, 2007); ‘alloe’ (Manimutha and Isaiarasu, 2010) and ‘Aloe’ (Deshmukh and Khyade, 2013) tonic treated mulberry leaves influenced the cocoons, pupal and growth parameters of *B. mori*. Impact of feeding of Japanese weed leaves (*Mikania micrantha*) on amino acid concentrations of silk fiber of eri silkworm, *Samia cinthia ricinii* Donovan has been investigated by Devi (2012). The leaves of weed plant *Mikania micrantha* had been found to have significant effect on growth, development and yield of eri silk worm, *Samia cynthia ricini* Donovan (Devi, 2010). Ganesh Bhawane *et al.* (2014) studied on the effect of ethanolic plant extracts on BmNPV innoculated silkworm *Bombyx mori* in relation to the midgut antioxidant enzymes, acid phosphatase and non-specific esterase. Various extracts of medicinal plants have been tested by supplementation in the silkworm, *Bombyx mori* and were seen to influence the body weight, silk gland weight and the silk thread length in *Bombyx mori* (Murugan *et al.*, 1998). The growth and the cocoon parameters were improved with the supplementation of *A. vera* commercial preparations (Manimuthu and Isaiarasu, 2010). Similarly, dusting of *Lantana camara* and *Clearodendron inermae* at 5% has increased silk and fecundity by eri silk worm (Mamadapur, 1994). Murugan *et al.* (1998) noticed a strong correlation between the growth of silkworm and the silk production in the silkworm after the treatment with plant extracts and attributed the growth promoting effect of the plant extracts to the stimulation of biochemical processes

leading to protein synthesis. Some plants like *Pinus longifolia, Abies balsamea, Psoralea corylifolia* and *Azadirachta indica* act on *Bombyx mori* larvae as bioactive juvenoid compounds **(**Nair *et al.*, 2009). Dietary supplementation of the leaf, flower and pod extracts of Moringa oleifera (Rajeswari and Isaiarasu, 2004) and chitosan solution elicited varied responses in the final instar larvae of *Bombyx mori*. The plant extracts phytochemicals could benefit sericulture by improving the silk yield of *B. mori* and commercial silk production (Rajasekaragouda *et al.*, 1997). The effect of plant extract containing phytoecdysteroids (*β*-ecdysone) on the spinning behavior of silkworms (NB4D2 × SH6) and (SK28 × SK30) was investigated by Rufaie *et al.* (2012). Saravanan *et al.* (2011) suggested that the co-administration of *Vigna unguiculata* with mulberry leaves at a concentration of 7.5% enhanced the biochemical reaction involved in the silk production in the silkworm. Selvi *et al.* (2014) mentioned that the treatment of *Spinacia oleracea* at the concentration of 25% may have beneficial effects on the growth of the silkworm larval and pupal length, width and weight and also increased the quantity of silk production by enhancing the feed efficacy in comparison to control. Shivkumar *et al*. (1995) reported weed plant *Cassiatora* extracts in accelerating the maturity of *Bombyx mori*. Thulasi and Sivaprasad (2014) suggested lemon juice (LJ) as a profitable supplementary diet for silkworm. Minimum effective concentration of LJ was determined and its positive impact demonstrated on *B. mori*, with reference to larval growth, protein profiles and economic parameters of sericulture.

Chapter 3

Materials and Methods

3.1. Experimental silkworm varieties:

The material of this research work contains two varieties of silkworm, *Bombyx mori* L. viz. BSRI- 85/3 and Nistari. The eggs of these races were collected from the Germplasm Bank, Bangladesh Sericulture Research and Training Institute, Rajshahi. Description of the selected silkworm varieties are given below:

A. BSRI- 85/3

This variety was developed with that of 85/1 at BSRTI, Rajshahi, through breeding during 1985. BSRI– 801 and bivoltine (Japanese) were utilized for this race breeding programme. Cocoons are yellow in colour, cocoon shape is slightly elongated oval with constriction in the middle in comparing to BSRI-85/1 and BSRI/2. Larvae are with normal marking. Floss percentage is very low with good reliability. As a combiner this breed always showed much encouraging performance.

B. Nistari

This variety is also called as Nistri or Madrassi. It is a long-established variety of indigenous origin (Jolly, 1983a) supposed to be introduced in this region of sub-continent during the nineteenth century (Datta, 1984). This multivoltine race is continuously being reared not only for producing cross breed hybrids, but also as a commercial indigenous race. It was introduced in 1881 from China and continues to dominate commercial rearing in the entire North India, especially in the then Bengal (Ganga and Chetty, 1999). The larvae are small and spin spindle-shaped, soft and flossy cocoons of golden-yellow colour. Unlike the cross-breeds, it can withstand the high humidity of heavy rainy season and the dry spells which are characteristic of Bangladesh. It is more

resistant to diseases than the cross-breeds. Farmers have experienced less crop failures with this race and prefer to rear this race.

3.2. Silkworm rearing:

Rearing of this race of silkworms demands certain environmental requirements in respect of temperature and humidity. To serve the purpose of the present experiment, the rearing was conducted in the Sericulture Research Laboratory, Department of Zoology, Rajshahi University.

The practice of sericulture involves two major activities, viz. (a) Mulberry cultivation for feeding the silkworms and (b) Rearing of silkworm for the production of cocoons which are the raw materials for the silk reeling industry. Silkworm rearing is a complicated procedure. It requires diverse technical aspect, specific management skill, due understanding and experience. Distinct technical aspects of silkworm rearing are discussed under the following headlines:

3.2.1. Materials for silkworm rearing:

Rearing houses

Department has a satisfactory rearing house that includes all the necessary appliances for all seasons. Adequate facilities were available in the house. The length and breadth of this rearing house is 7 and 5 meters respectively. It has four windows and one door which are fitted with wire nets and glasses. The ceiling of the room was quite high (4.5 m.) and wide fluctuations in environmental conditions outside the room did not affect seriously the room conditions. During summer when the dry temperature prevailed the windows of the laboratory were kept open during night and during winter the door and windows were kept closed at night. To check humidity in dry season the floor were moistened with water.

Rearing equipment

In the rearing house, the following equipment was used for rearing and mounting the silkworms:

Rearing almirahs: The almirahs were wire-netted to protect the larvae, pupae and adults from parasites and predators like tachinid flies, lizards, rats, etc. The almirahs measured $1.5\times0.7\times2.5m^3$. Each almirah consists of five racks, on which rearing trays were placed containing the silkworm.

Rearing trays: Rearing trays made of wooden frame having hardboard bottom ($40 \times 25 \times 5$ cms^3) were used.

Thermometer: Wet and dry bulb thermometers and hydrometers were used to record daily temperature and relative humidity two times.

Polythene paper: Thick polythene paper was used to keep the silkworm beds covered during rearing, so as to prevent withering of leaf and also to maintain the desired humidity in the rearing bed.

Foam pad: Long foam pads, 2.5 cm × 2.5 cm thick, dipped in water were kept around the silkworm rearing beds during first two instars for maintaining optimum humidity in the rearing beds (Krishnaswami, 1979).

Leaf chamber: A simple leaf chamber made tip of a framework of wooden strips was used for the preservation of harvested mulberry leaves as fresh as possible.

Feathers: Feathers were used for brushing newly hatched worms and also changing beds in the early stages. The use of feather during brushing saved the worms from the injurious contact of hand.

Chopsticks: Chopsticks were made of bamboo, about 17 to 22 cm long, thin and tapering at one end. They were used for picking the young larvae. This ensures hygienic handling of delicate worms, and also prevents damage to them (Ullal and Narasimhanna, 1978).

Chopping boards, knives and mats etc.: For chopping mulberry leaves for feeding the worms, a chopping board made of softwood with size of 0.50 meter × 0.50 meter × 7.6 cm, and a chopping knife were used. Mats were used at the

tune of chopping leaves. A plastic basin was used as receptacle for chopped leaves for young stage worms.

Cleaning nets: To remove old mulberry leaves, facial matters of silkworm, and dead worms, cleaning nets were spread on the bed before- feeding. The chopped leaves were given on them and when the larvae crawled through the net holes then the old leaves and other facial matters were removed.

The recommended mesh-size of the nets is as follows:

Age of silkworms	Net mesh size
1st instar	2 mm × 2 mm
2nd instar	2 mm × 2 mm
3rd instar	10 mm × 10 mm
4th instar	20 mm × 20 mm
5th instar	20 mm × 20 mm

Mountages or chondrakis: Mountages were used for ripe worms to ensure their spinning of cocoons. They measured 6′ × 4′. In this present experiment locally made “Chandraki”was used as mountage. This comprises a rectangular bamboo mat on which a spiral of bamboo tape is fixed.

Other appliances: The rearing stands were wooden frames on which rearing tray (dalas) containing silkworms were placed. Plastic lids for mating and laying, white egg cards etc. were used. An electronic balance was used for taking weight and a scale and a compass for measuring the insects.

Host plant of silkworm

Host plant of silkworm was another material included mulberry leaves of *Morus alba* species maintained in the garden of the Department of Zoology, Rajshahi University, Rajshahi. The fresh tender chopped mulberry leaves were supplied to the larvae after hatching till spinning. The leaves were well preserved under a moist gunny mat during dry season.

Rearing almirahs

Polythene paper

Rearing trays

Foam pad

Feather

Plate 1: Different rearing equipments

Chopping board and knife

Cleaning nets

Chondrakis

Plastic lids

Electric balance

Incubator

Plate 2: Different rearing equipments

3.2.2. Rearing procedure maintained in the experiment

Disinfection of rearing house and appliances

Disinfection is the destruction of disease causing pathogens. Silkworms are susceptible to a number of diseases. Bacteria, virus, fungi and some protozoan parasites attack the silkworm rapidly. To prevent the incidence of these diseases it is necessary to maintain good sanitation. This can be done by the disinfection of the rearing house and appliances. In the present experiment, prior to disinfection, the rearing house and appliances were thoroughly washed with water and the appliances were dried in the sun. Rearing house and rearing appliance were disinfected with bleaching powder.

During this experiment the rearing house and appliances were disinfected in three times and by different methods.

(1) Before rearing,

(2) During rearing and

(3) After rearing.

Incubation and disinfection of eggs

The eggs were incubated at 28°C ± 2°C and a relative humidity of 75% ± 6%. Normal day light and dark in the night was maintained through out the incubation period. Two days before hatching a blue point appeared on the egg and on the next day it turned completely blue called body pigmentation of the egg. At the pin head stage, the eggs were disinfected with 2% formaldehyde solution for 5 minutes (Jolly, 1983). Immediately after washing and drying, the eggs were transferred to the rearing house.

Hatching and brushing

When the eggs were completely blue, the eggs were preserved in dark for 24 hours. On the day of hatching, several newly hatched worms came out from eggs. The eggs were exposed to light at 8 A.M. which ensured uniform egg hatching.

The process of transferring silkworms to rearing trays is called "brushing" which was performed around 9.00 A.M. The hatching larvae are called 'kego' or 'ant'. They were brushed with a feather following the brushing techniques of Ullal and Narasimhanna (1978). For transferring the newly hatched larvae to a rearing tray, very fine chopped leaves (0.5 cm^2 were sprinkles over the worms for feeding. The leaves containing the larvae were transferred to rearing trays.

Feeding of silkworm larvae

Fresh and succulent leaves were harvested form the Mulberry Garden, Department of Zoology, Rajshahi University. During the first three instars larvae, tender leaves of recommended size (Krishnaswami, 1979) were supplied. The fourth and final (5^{th}) instar larvae were fed on whole mature leaves. The worms were feed four times a day at an interval of six hours, i.e. at 6 A.M., 12 A.M., 6 P.M., and 12 P.M. The recommended size of the chopped leaves (Krishnaswami, 1979) for feeding early three instar larvae were:

Age of silkworm	Size of the chopped leaf
1^{st} instar	0.5 cm – 2.0 cm
2^{nd} instar	2.0 cm – 4.0 cm
3^{rd} instar	4.0 cm – 6.0 cm

Mulberry garden

Mulberry trees

2nd instar larvae

3rd instar larvae

4th instar larvae

5th instar larvae

Plate 3: Feeding of silkworm larvae

Bed cleaning:

The unconsumed mulberry leaves, silkworms faces, dead larvae etc. make the bed uncomfortable which affect the physiology of silkworms. The removal of the unwanted materials from the rearing bed is known as bed cleaning. The frequency, time and techniques of bed cleaning as suggested by Rahman (1983) were followed:

Age of silkworm	No. of bed cleaning/instar	Time of bed cleaning/instar
1st instar	1	Just befor moulting
2nd instar	2	1 after two feeds and 2 just before moulting
3rd instar	3	1 after two feeds, 2 after two days, 3 just before moulting
4th & 5th instar	1/day	1/every day morning

Care at moulting:

Silkworm larvae cast skin four times during larval period. The moulting period is a critical and delicate time in the larval stage. During moulting, the worms do not fed at all. No feeds were supplied at that period and the beds were kept dried. The moulted worms become shout and shinny and the head of the worms become small and dark. When 90-95% larvae had settled to moult and some of the worms (1%) came out of that moult, lime dusting on the rearing bed was made using slaked lime. Dusting of the lime stopped the feeding of the advanced worms that had already come out of the moult. In this way regularity in the growth of the worms was maintained.

Spacing:

Silkworm larvae show a fantastic rate of growth and exhibit a many fold increase both in weight and size. As a result of which bed becomes narrow and therefore, bed spacing is required. During the rearing of the worms in the present experiment, the following standard was followed for bed spacing, as suggested by Sengupta (1978):

Age of silkworm	Space required
1st & 2nd instar	Length × breadth × No of worms × 1.02
3rd instar	Length × breadth × No of worms × 2.02
4th instar	Length × breadth × No of worms × 3.00
5th instar	Length × breadth × No of worms × 4.00

Mounting and harvesting:

Towards the close of the final instar, larval body became translucent and worms released soft excreta, and they stopped feeding. The larvae searched suitable places for cocoon spinning. The mature worms were collected from the rearing bed and were place on the bamboo made mountages called 'chandrakis'. Cocoons were harvested after 4-5 days of mounting. For production of disease free layings (dfls) following grainage techniques were followed:

Grainage Techniques

For production of disease free layings (dfls) following grainage techniques were followed:

Selection of cocoons: Harvested cocoons were deflossed and the defective cocoons were removed. After cutting the cocoons with a sharp blade and then the desired number of pupae were collected.

Emergence of moths: After 8-12 days of spinning the adults came out by rupturing one end of the shell as moths in the early morning at about 6 A.M. and the emergence continued up to 8 A.M. Within 4 minutes they become fully active and were prepared for mating.

Coupling: After emergence the fresh, healthy moths were allowed to mate. Coupling normally look place between 8-10 hours of emergence and the natural duration for coupling was 24 hours although 3-6 hours are adequate (Jolly *et al.,* 1979). Each couple was then placed on a clean paper and covered with an aluminium lid to check them from vivid light and other environmental disturbances.

Egg-laying: After 2-3 hours of mating the moths were separated by holding the female moth and frequently sliding the male anticlockwise with fingers. The female moths were then kept on a white paper where they started egg-laying and were covered with Plastic lids. After completion of egg-laying, they were discarded and eggs were preserved for the next rearing.

Mounting and harvesting

Selection of cocoons

Emergence of moth

Cupling

Egg laying

Plate 4: Different stages of *B. mori* L.

Control of Vit-B_2

Vit-B_2 (240 ppm)

Vit-B_2 (150 ppm)

Vit-C (20,000 ppm)

Control of Vit-C

Vit-C (15,000 ppm)

Plate 5: Different doses of egg cards

3.3. Test material and Experimental design

Two vitamins selected for food supplementation, which are Riboflavin and Ascorbic acid.

Collection of vitamins

Riboflavin and Ascorbic acid were collected from LOBA chemic Pvt. Ltd., Mumbai, India through Jusco trading, Rajshahi, Bangladesh.

Preparation of solution

To prepare different concentrations of vitamins solution collected powdered of vitamin B_2 and C were weighed and mixed with required quantity of distilled water. Five concentrations of the each vitamin were prepared. Five different concentrations of vitamin B_2 were 60 ppm, 150 ppm, 240 ppm, 330 ppm, 420 ppm and vitamin C were 10000 ppm, 15000 ppm, 20000 ppm, 25000 ppm, 30000 ppm in separately.

Treatment procedure

After disinfection and incubation of collected eggs of BSRI-85/3 and Nistari, the larvae that hatched out were reared up to the second instar on fresh mulberry leaves. Third instar larvae were divided into forty eight experimental groups including the control. Each group consisted of three replications, each of 50 worms. The experiment was conducted at 28 ± 2°C and a relative humidity of 75.00±6%.

Fresh, whole mulberry leaves were treated by dipping in those solutions and then were dried by fanning. The treated leaves were fed at different feeding schedule to the worms from 3^{rd} to 5^{th} instars, 4 times in a day. The control insects were reared on mulberry leaves dipped in distilled water only. The feeding schedules were as follows:

Vitamin B_2 and C

Plate 6: Prepared solution

Code name	Schedule	Feeding schedule
FS-1	Feeding schedule-1	Fed every day in 1st feeding of 3rd to 5th instar larvae
FS-2	Feeding schedule-2	Fed in 1st and 5th feeding of 3rd to 5th instar larvae
FS-3	Feeding schedule-3	Fed only in 1st feeding of 3rd to 5th instar larvae

Silkworm rearing schedule

Four consecutive silkworms rearing were conducted separately for each vitamin to find out their effect on the growth and development of *Bombyx mori* at different environmental conditions. The rearing schedule has been shown in the following table:

Name of the symbol of the seasons	Name of the rearing season	Date of brushing of silkworm larvae
S-1	Agrahyani	October-November 2012
S-2	Chaita	February- March 2013
S-3	Jaistha	May- June 2013
S-4	Bhaduri	August-September 2013

3.4. Experimental parameter

Following parameters were selected for the present investigation. Method of data collection of these parameters has been described as follows:

Weight of mature larvae (WML): The weight of mature larva was taken at the end of the 5th instar, *i.e.* one day before spinning. Thirty larvae were collected at random from each rearing-bed. Individual weight of these larvae was taken in gram on an electronic balance. A mean of 30 observations for each replication was used for statistical analysis.

Length of mature larvae (LML): The length of mature larva was taken at the end of the 5th instar, *i.e.* one day before spinning. Thirty larvae were collected at random from each rearing-bed. Individual length of these larvae was taken in millimetre. A mean of 30 observations for each replication was used for statistical analysis.

Breadth of mature larvae (BML): The breadth of larva was also taken at fully mature stage, *i.e.* one day before spinning in the mid abdominal segment. Thirty larvae were collected at random from each rearing-bed. Breadth of randomly picked individual larvae was taken in millimetre. A mean of 30 observations for each replication was used for statistical analysis.

Pupal weight (PW): To determine the weight of pupae from various concentrations of vitamins, mature larvae were transferred to bamboo- made mountages (1.8×1.2m). After the formation of cocoons, they were harvested and cut very carefully at one end obliquely with a sharp blade to observe pupal characters. They were then individually weighed on an electric balance in grams. Pupal weight was taken for the cocoon selected for cocoon weight.

Cocoon weight (CW): Cocoons were selected randomly from each replication. Individual weight of cocoons was taken in gram by an electric balance.

Cocoon length (CL): To measure the length of randomly selected cocoons were taken in millimetre using scales.

Cocoon breadth (CB): To determine the breadth of selected cocoons were taken in millimetre using scales.

Shell weight (SW): To observe the shell weight cocoons were cut at one end to isolate shell from pupa. Shell weight was then measured from the cocoons selected cocoon weight.

Plate 7: Larva, pupa and cocoon weighting on an electric balance in the laboratory

Shell ratio (%): The shell ratio was computed by using the following formula:

$$\text{Shell ratio (\%)} = \frac{\text{Weight of shell}}{\text{Weight of whole cocoon}} \times 100$$

Surviving percentage (SP): The surviving percentage is computed by using the following formula:

$$\text{SP} = \frac{\text{Total no. of cocoons harvested}}{\text{Total no. of larvae selected in the early 3rd instar}} \times 100$$

The data collected in percentage for SP were transformed into corresponding angles before statistical analysis (Bliss, 1937).

Adult emergence (AE): The percentage of adult emergence was calculated by using the following formula.

$$\text{Emergence (\%)} = \frac{\text{No.of adults emerged}}{\text{No.of larvae emerged}} \times 100$$

Larval period (LP): Larval period was calculated from the date of brushing to date of pre pupa formation, which was recorded in days from the log sheet of rearing for each replication separately.

Pupal period (PP): Pupal period constitute the days between the date of pupa formation in the cocoon and emergence of moth from the cocoon. The data collected of individual pupa for each replication separately are used for statistical analysis.

Total number of eggs laid (TEL) or fecundity: The total number of eggs laid by the individual female moth was counted. A mean of 30 laying for each replication was used for statistical analysis.

Egg hatching percentage (EHP) or fertility: For evaluating the fertility of the silkworm, hatching percentage was recorded and following formula is used for estimating EHP.

$$EHP = \frac{\text{Total no. of eggs hatched in a laying}}{\text{Total no. of eggs in a laying}} \times 100$$

The data collected in percentage for EHP were transformed into corresponding angles before statistical analysis (Bliss, 1937).

Mortality (%): To determine the effect of vitamins on the mortality, the kill of worms at various developmental stages was carefully noted. After the formation of cocoons, pupae were isolated from the cocoons by cutting them with a sharp blade and their numbers were counted carefully. Mortality was computed as follows:

$$\text{Larval mortality (\%)} = \frac{\text{No. of larvae dead}}{\text{No. of larvae sampled}} \times 100$$

$$\text{Pupal mortality (\%)} = \frac{\text{No. of larvae dead}}{\text{No. of cocoons sampled}} \times 100$$

Total mortality (%) = Larval mortality (%) + Pupal mortality (%)

3.5. Statistical analyses:

Physiological test

The result of the study of biological parameter, physiological test have been expressed in term of Mean ± Standard error ($\overline{X} \pm SD_{\bar{\chi}}$) and the success or failure was confirm by test of significance at different levels.

Mean or Average ($\overline{X}$)

Some of data divided by the number of items in the data will give the mean average.

$$\overline{X} = \frac{Xi}{n}$$

Where, Xi = Summation of individual values

n = number of observations

Standard Deviation (SD or σ)

A measure of the dispersion of a set of data from its mean. The more spread apart the data, the higher the deviation. Standard deviation is calculated as the square root of variance.

$$s = \sqrt{\frac{1}{N-1}\sum_{i=1}^{N}(\chi_i - \overline{\chi})^2}$$

Where, $(Xi-\overline{X})$ = Summation of squares of individual deviations from the mean values

N = number of observations

Standard Error (Sd)

The standard error of two means obtained from separate sets of similar experiments was calculated from the formula.

$$SD_{\bar{\chi}} = \frac{\sigma}{\sqrt{n}}$$

Where

σ = is the standard deviation of the population

n = number of observations

Degree of Freedom (DF)

The degree of freedom can be defined as the minimum number of independent coordinates that can specify the position of the systems completely.

$$\mathbf{DF = n_1 + n_1 - 1}$$

Where, n1 and n2 are number of two sets of observations

F – Test

For testing the significance of different parameter on the effect of food supplementation, the collected data were statistically analysed (ANOVA) using Microsoft Excel in a microcomputer.

T-Test

The standardized normal deviate values (d-values) were calculated by the formula:

$$d = \frac{p_1 \; p_2}{\sqrt{\frac{p_1 q_1}{N_1} + \frac{p_2 q_2}{N_2}}}$$

Where,

d = Standardized normal deviate,

P_1 = Total mortality of control, worms/100

P_2 = Total mortality of treated worms /100,

q_1 = 1-p_1

q_2 = 1-p_2

N_1 = No. of control worms and

N_2 = No. of treated worms

Feeding efficacy test

The quantity of mulberry leaf offered to the entire groups was similar and B. *mori* larvae feed four times in a day. The left over mulberry leaves and litter were weighted daily and recorded. Similarly, initial and final weights of the 5^{th} instar larvae were recorded in control and other treated groups. Fresh leaves were cut into two halves- one half was used to determine the initial water content. Another half was dried in a hot air oven to constant weight determines the dry weights. Based on this weights, the feed efficacy parameter like food consumption rate, food utilization rate, digestibility rate, food consumption index and co-efficient of food utilization were calculated (Arsenev and Bromlei, 1957). Food consumption rate, food utilization rate, digestibility rate, food consumption index and co-efficient of food utilization were calculated by following formula:

Food Consumption rate = Dry weight of leaves offered – Dry weight of residual leaves.

Food Utilization rate = Weight of food consumed – weight of faecal matter.

$$\text{Digestibility rate} = \frac{\text{Dry weight of food eaten - Dry weight of faecal produced}}{\text{Dry weight of food eaten}} \times 100$$

$$\text{Food consumption index} = \frac{E}{T \times A}$$

Where,

E = Dry weight of food eaten,

T = Duration of Experimental period

A = Mean dry weight of animal during experiential period.

Co-efficient of food Utilization =

$$\frac{\text{Dry weight of food consumed - Dry weight of faeces}}{\text{Dry weight of food consumed}} \times 100$$

Chapter 4

Results

4.1. Effect of riboflavin supplementation with mulberry leaves on *B.mori*L.

Results on the effect of thesupplementation of vitamin B_2on *B.mori*during different seasons, viz. S-1, S-2, S-3, S-4 and at different feeding schedules, viz. fed every day in 1^{st} feeding of $3^{rd}$to 5^{th}instar larvae (FS-1), fed in 1^{st} to 5^{th} feeding of $3^{rd}$to 5^{th}instar larvae (FS-2), fedonly in 1^{st} feeding of $3^{rd}$to 5^{th}instar larvae (FS-3) were evaluated and are presented in Tables 1-16 and the graphical presentation are showed in Figures 1-16. The data of different parameters were subjected to analysis of variance to determine the variations among concentrations, seasons and feeding schedules are presented in Appendices Table I-XIV. The results obtained in the present experiment are discussed as follows:

4.1.1. Effect of riboflavin on the larval growth of *B. mori*

The results ofvit- B_2 supplementation on the larval growth of*B.mori*under different seasons anddifferent feeding schedules are given bellow:

Weight of mature larvae (WML):

The effect of vit- B_2 supplementation on the WML of *B.mori*under different seasons, viz. S-1, S-2, S-3 and S-4 at different feeding schedules, viz. FS-1, FS-2, FS-3 are shown inTable1, the graphical presentation are showed in Figure 1 and their statistical analysis is presented in AppendixTable I.

The mean values of WML were increased in S-1 under different dosesof vit-B_2except 420 ppm compared to the control while fed according to FS-1. The highest and lowest mean values of WML were found at 240ppm(2.51±0.02gm) and 420ppm(2.13±0.02gm)respectively. While maintaining FS-2, the highest and lowestmean values of WML wereobserved at 240ppm(2.61±0.01gm)and 420ppm(2.19±0.02gm)respectively. In case of FS-3,the WML were also increased

under different doses, viz. at 60ppm(2.25±0.02gm), 150ppm(2.31±0.01gm), 240ppm(2.38±0.01gm), 330ppm(2.19±0.01gm) compared to the control(2.24±0.01gm) but the mean value of WML was decreased at 420ppm(1.98±0.02gm).

The supplementation of vit- B_2 significantly increasedthe mean values of WML of *B. mori*inS-2under different concentrations and at different feeding schedules. While fed according to FS-1, the highest and the lowestmean of WML were seenat 240ppm (2.67±0.02gm) and at 420ppm(2.34±0.02gm)successively. In case of FS-2,the WML were increased under different concentrations, viz. at 60ppm(2.61±0.01gm), 150ppm(2.66±0.02gm), 240ppm(2.75±0.01gm), 330ppm(2.50±0.03gm) compared to the control(2.41±0.01gm) but the mean value of WML was decreased at 420ppm(2.36 ±0.01gm). At FS-3, the highest and the lowest mean values of WML were observed at 240ppm (2.58±0.02gm)and at 420ppm(2.31±0.01gm)gradually.

The mean values of WML were significantly increased atvarious feeding schedules under different doses ofvit- B_2 in S-3. The highest and lowest mean of WML were found at 240ppm (2.33±0.02gm) and at 420ppm (1.87±0.02gm) for FS-1, at 240ppm (2.42±0.01gm)and at 420ppm (1.88±0.02gm) for FS-2 and at 240ppm (2.23±0.01gm)and at 420ppm(1.76±0.03gm)for FS-3 respectively.

The mean values of WML were significantly increased inS-4under different concentrations and atvarious feeding schedules. While fed according to FS-1, the highest and the lowestmean of WML were observed at 240ppm (2.24±0.01gm) and at 420ppm(1.78±0.02gm)serially. In case of FS-2,the WML wereincreased under different doses, viz. at 60ppm (2.12±0.01gm), 150ppm(2.21±0.01gm), 240ppm(2.29±0.02gm), 330ppm (2.12±0.02gm) compared to the control(1.90±0.01gm) but the mean value of WML was decreased at 420ppm(1.84±0.01gm). While maintaining FS-3, the highest and the lowest mean values of

WML were noticed at 240ppm (1.83±0.03gm)and at 420ppm (1.62±0.01gm)gradually.

The Results of analyses of variance have been presented in Appendix Table I. Majorityof the items viz. feeding schedules (F=10.06), seasons (F=50.63), doses (F=64.69)except dose×season showed highly significant differences at 1% level of significance.

The effectiveness of different concentrations ofvit- B_2under different seasons on WML followed the order S-2>S-1>S-3 > S-4 and in respect of feeding schedule FS-2> FS-1> FS-3. The most effective dose of the vit- $B_2$was found to be 240ppm followed by 150ppm, 60ppm and 330ppm.

Length of mature larvae (LML):

The result of vit- B_2supplementation under different seasons on LML of *B.mori* at different feeding schedules, viz. FS-1, FS-2, FS-3 are shown in Table2, the graphical presentation are showed in Figure 2 and their statistical analysis is presented in Appendix Table II.

The mean values of LML were increased under different doses compared to the control in S-1 while fed FS-1. The highest and the lowest mean of LML were observed at 240ppm (62.55±0.15mm) and at 420ppm(57.85±0.22mm) respectively. While maintaining FS-2, the highest and the lowest LML were observed at 240ppm (64.36±0.19mm) and at 420ppm(58.31±0.14mm) respectively. On FS-3,the LML were also increased under different doses viz. at 60ppm (59.83±0.06mm), 150ppm (60.75±0.13mm), 240ppm (61.08±0.17mm), 330ppm (59.61±0.11mm) compared to the control (58.50±0.18mm).

The supplementation of vit- B_2significantly increased the LML in S-2under different concentrations at different feeding schedules. While fed according to FS-1, the highest and the lowest LML were recorded at 240ppm (62.77±0.35mm) and at 420ppm (58.68±0.31mm) respectively. In case of FS-2, the LML were also

increased under different doses, viz. at 60ppm (62.48±0.07mm), 150ppm (63.65±0.03mm), 240ppm (64.90±0.32mm), 330ppm (62.29±0.06mm) comparedto thecontrol (59.20±0.19mm) but the lowest mean value of LML was at 420ppm (59.06±0.16mm). The highest and the lowest mean of LML were observed at 240ppm (61.42±0.25mm) and at 420ppm (59.02±0.18mm) gradually while fed according to FS-3.

At different feeding schedules, the mean values of LML were significantly increased under different concentrations ofvit- B_2in S-3. The highest and the lowest mean of LML were observed at 240ppm (62.01±0.05mm) and at 420ppm (57.65±0.06mm) for FS-1, at 240ppm (64.17±0.15mm) and at 420ppm(58.03±0.17mm) for FS-2 and at 240ppm (60.97±0.24mm) and at 420 (58.01±0.12mm) for FS-3 respectively.

In S-4, the mean values of LML under different doses at different feeding schedules were increased. While fed according to FS-1, the highest and the lowestmean of LML were found at 240ppm (61.82±0.05mm) and at 420ppm(57.39±0.07mm) respectively. At FS-2, the LML were increased under different doses, viz. at 60ppm (61.69±0.07mm), 150ppm(62.79±0.09mm), 240ppm(63.90±0.18mm), 330ppm(61.61±0.07mm) compared to the control(57.83±0.12mm) but the LML was decreased at 420ppm(57.60±0.03mm). The highest and the lowest mean values ofLML were observed at 240ppm (60.85±0.20mm) and at 420ppm (57.25±0.12mm)respectively at FS-3.

The results of ANOVA have been presented in Appendix Table II. The items, viz. feeding schedules (F=1567.71), seasons (F=215.12), doses (F=70.05) revealed significant results ($P<0.01$).

The efficacy of vit- B_2under different seasons on LML followed the order S-2>S-1>S-3> S-4 and ondifferent feeding schedule the effectiveness in this regard was FS-2 > FS-1> FS-3. The most effective dose ofvit- B_2in all cases was240ppm followed by 150ppm, 60ppm and 330ppm.

Breadth of mature larvae (BML):

The effect of vit- B_2 supplementation under different seasons, viz. S-1, S-2, S-3 and S-4 on BML of *B.mori* at different feeding schedules, viz. FS-1, FS-2, FS-3 are shown in Table 3, the graphical presentation are showed in Figure 3 and their statistical analysis is presented inAppendix Table III.

In S-1,results were showed that the BML were increased under different concentrations in comparison to the control except 420ppm while fed at FS-1. The highest and the lowest mean of BML were observed at 240ppm (20.66±0.05mm) and at 420ppm (18.57±0.04mm) respectively. While fed according to FS-2, the highest and the lowest BML were recorded at 240ppm (20.80±0.03mm) and at 420ppm (18.60±0.05mm) respectively. In case of FS-3, the BML werealso increased under different concentrations, viz. at 60ppm (19.69±0.02mm), 150ppm (20.22±0.06mm), 240ppm (20.53±0.04mm), 330ppm (19.52±0.02mm) comparedtothe control (18.66±0.03mm) but the mean value of BML was decreased at 420ppm(18.52±0.02mm).

DuringS-2, the mean values of BML were increasedsignificantlyunder different concentrations and at different feeding schedules. At FS-1, the highest and the lowestBML were recorded at 240ppm (20.60±0.05mm) and at 420ppm(18.75±0.03mm) respectively. At FS-2,the BML were increased under different concentrations, viz. at 60ppm (20.59±0.02mm), 150ppm(20.72±0.05mm), 240ppm(21.52±0.03mm), 330ppm(20.42±0.04mm) compared to the control(18.89±0.02mm) but the mean value of BML was decreased at 420ppm(18.79±0.05mm). The highest and the lowest mean values ofBML were observed at 240ppm (20.54±0.01mm) and at 420ppm (18.67±0.03mm)gradually while fed according to FS-3.

On different feeding schedules, the mean values of BML were significantly increased under different concentrations ofvit- B_2in S-3. The highest and the lowest mean values of BML were observed at 240ppm (20.40±0.03mm) and at 420ppm (18.48±0.05mm) for FS-1, at 240ppm (20.69±0.04mm) and at 420ppm

(18.52±0.04mm) for FS-2 and at 240ppm (20.34±0.02mm) and at 420ppm (18.38±0.01mm) for FS-3 respectively.

The mean values of BML under different concentrations at different feeding schedules were increasedsignificantly inS-4. While fed according to FS-1, the highest and the lowestBML were observed at 240ppm (20.27±0.02mm) and at 420ppm(18.38±0.03mm) respectively. At FS-2, the BML were increased under different doses, viz. at 60ppm (19.72±0.05mm), 150ppm(20.16±0.03mm), 240ppm(20.58±0.04mm), 330ppm(19.57±0.03mm) compared to the control(18.49±0.02mm) but the mean value of BML was decreased at 420ppm(18.44±0.02mm). The highest and the lowest BML were observed at 240ppm (20.12±0.01mm) and at 420ppm (18.24±0.01mm)respectively at FS-3.

Analysis of variance showed highly significant differences among feeding schedules (F=29.24),seasons (F=19.33), doses (F=273.46) at 1% level of significance but dose× season (F=0.29) showed insignificant results in Appendix Table III.

The effectiveness of vit- $B_2$with respect to different seasons on BML followed the order S-2>S-1>S-3> S-4 and while in respect of different feeding schedule this trend was FS-2 > FS-1> FS-3.In most of the cases for bothseasons and feeding scheduleseffective doses of vit- B_2followed the order 240ppm >150ppm >60ppm >330ppm.

4.1.2.Effect of riboflavin on the pupal growth of *B. mori*

The results ofvit- B_2 supplementation on the growth of pupae of*B.mori*under different seasons and different feeding schedules are given bellow:

Pupalweight (PW):

The effect of vit- B_2 supplementation under different seasons, viz. S-1, S-2, S-3 and S-4 on PW of *B.mori* at different feeding schedules, viz. FS-1, FS-2, FS-3 are

shown in Table4, the graphical presentation are showed inFigure 4 and their statistical analysis is presented in Appendix Table IV.

The mean values of PW were increased in S-1 under different doses except 420ppmin comparisonto the control while fed according to FS-1. The highest and the lowest mean of PW were observed at 240ppm (1.51±0.01gm) and at 420ppm (1.00±0.01gm) respectively. While maintaining FS-2, the highest and the lowest PW were observed at 240ppm (1.54±0.01gm) and at 420ppm(1.04±0.01gm) respectively. Incase of FS-3, the PW also increased under different concentrations, viz. at 60ppm (1.18±0.01gm), 150ppm (1.32±0.03gm), 240ppm (1.42±0.03gm) and 330ppm (1.13±0.01gm) compared to the control (1.05±0.01gm) but the mean value of BMLwas decreased at 420ppm (0.94±0.01gm).

The supplementation of vit- B_2 significantly increasedthe mean values of PW under different concentrations and atvarious feeding schedulesinS-2. While fed according to FS-1, the highest and the lowest PW were recorded at 240ppm (1.56±0.02gm) and at 420ppm (1.06±0.02gm) respectively. In case of FS-2, the PW were increased under different doses, viz. at 60ppm (1.32±0.01gm), 150ppm (1.48±0.01gm), 240ppm (1.58±0.01gm) and 330ppm (1.24±0.01gm) compared to control(1.09±0.01gm). While maintaining FS-3, the highest and the lowest mean of PW were observed at 240ppm (1.50±0.01gm) and at 420ppm (1.03±0.02gm) gradually.

On different feeding schedules, the mean values of PW were significantly increased under different concentrations ofvit- B_2 in S-3. The highest and the PW were observed at 240ppm (1.40±0.01gm) and at 420ppm (0.91±0.01gm) for FS-1, at 240ppm (1.46±0.02gm) and at 420 (0.96±0.01gm) for FS-2 and at 240ppm (1.32±0.01gm) and at 420ppm (0.84±0.01gm) for FS-3 respectively.

The mean values of PWwere significantly increased under different concentrations and at different feeding schedules inS-4. While fed according to FS-1, the highest and the lowestmean of PW observed at 240ppm (1.36±0.01gm) and at 420ppm

(0.83±0.02gm) respectively. In case of FS-2, the PW were increased at different doses, viz. at 60ppm (1.19±0.02gm), 150ppm(1.29±0.01gm), 240ppm(1.40±0.02gm), 330ppm(1.14±0.02gm) compared to control(0.94±0.01gm) but the mean value of PW has been decreased at 420ppm(0.87±0.01gm). The highest and the lowest mean values ofPW were observed at 240ppm (1.27±0.00gm) and at 420ppm (0.78±0.01gm)respectively at FS-3.

Analysis of variance showed highly significant differences among feeding schedules (F=20.18),seasons (F=38.44), doses (F=164.66) at 1% level of significance in Appendix Table IV.

The effectiveness of vit- $B_2$with respect to different seasons on PW followed the order S-2>S-1>S-3 > S-4 and while in respect of different feeding schedule this trend was FS-2 > FS-1> FS-3.In most of the cases for bothseasons and feeding schedule effective doses of vit- B_2followed the order 240ppm >150ppm >60ppm >330ppm.

4.1.3. Effect of riboflavin on the cocoon characters of *B. mori*

The results of vit- B_2 supplementation under different seasons anddifferent feeding schedules on the growth of cocoon characters of *B.mori* are given bellow:

Cocoonweight (CW):

The effect of vit- B_2 supplementation under different seasons, viz. S-1, S-2, S-3 and S-4 on CW of *B.mori* at different feeding schedules, viz. FS-1, FS-2 and FS-3 is shown in Table 5, the graphical presentation are showed in Figure 5 and their statistical analysis is presented in Appendix Table V.

The mean values of CW were increased under different doses except 420ppm in comparisontothe control maintaining FS-1in S-1. The highest and the lowest mean of CW were observed at 240ppm (1.66±0.01gm) and at 420ppm (1.11±0.01gm) respectively. While fed according to FS-2, the highest and the lowest CW were noticed at 240ppm (1.68±0.01gm) and at 420ppm (1.15±0.01gm)

respectively. In case of FS-3, the CW also increased under different doses, viz. at 60ppm (1.31±0.01gm), 150ppm (1.46±0.03gm), 240ppm (1.57±0.02gm) and 330ppm (1.25±0.01gm) compared to the control (1.17±0.01gm) but the mean value of CW has been decreased at 420ppm(1.06±0.01gm).

The supplementations of vit- B_2significantly increased the mean values of CWin S-2under different concentrations and different feeding schedules. While fed according to FS-1, the highest and the lowest CW were observed at 240ppm (1.72±0.02gm) and at 420ppm (1.18±0.02gm) respectively. In case of FS-2, the CW was increased under different concentrations, viz. at 60ppm (1.46±0.01gm), 150ppm (1.64±0.01gm), 240ppm (1.75±0.02gm) and 330ppm (1.38±0.01gm) compared to the control (1.22±0.01gm). While maintaining FS-3,the highest and the lowest mean of CW were recorded at 240ppm (1.65±0.02gm) and at 420ppm (1.15±0.02gm) successively.

On different feeding schedules, the mean values of CW were significantly increased under different concentrations ofvit- B_2 in S-3. The highest and the lowest mean of CW were observed at 240ppm (1.54±0.01gm) and at 420ppm (1.01±0.01gm) for FS-1, at 240ppm (1.62±0.02gm) and at 420ppm (1.07±0.01gm) for FS-2 and at 240ppm (1.46±0.01gm) and at 420ppm (0.94±0.01gm) for FS-3 gradually.

In S-4, the mean values of CW were significantly increased under different concentrations and at different feeding schedules. While fed according to FS-1, the highest and the lowestmean of CW were observed at 240ppm (1.49±0.01gm) and at 420ppm (0.92±0.01gm) respectively. In case of FS-2, the CW were increased under different doses, viz. at 60ppm (1.32±0.02gm), 150ppm (1.42±0.01gm), 240ppm (1.52±0.02gm), 330ppm (1.26±0.02gm) compared to control (1.04±0.01gm) but the mean value of CW was decreased at 420ppm (0.98±0.01gm). The highest and the lowest mean values of CW were observed at 240ppm (1.39±0.01gm) and at 420ppm (0.81±0.01gm) respectively at FS-3.

Analysis of variance showed highly significant differences among feeding schedules (F=101.97),seasons (F=284.50) anddoses (F=572.85) at 1% level of significance butin this case dose×seasons (F=2.10)showed significant result at 5% level of significance in Appendix Table V.

The effectiveness of vit- B_2 with respect to different seasons on CW followed the order S-2 > S-1 > S-3 > S-4 and while in respect of different feeding schedule this trend was FS-2 > FS-1 > FS-3. In most of the cases for both seasons and feeding schedule effective doses of vit- B_2 followed the order 240ppm > 150ppm > 60ppm > 330ppm.

Cocoon length (CL):

The effect of vit- B_2on CL of *B.mori*under different seasons at different feeding schedules, viz. FS-1, FS-2, FS-3 is shown in Table 6, the graphical presentation are showed in Figure 6 and their statistical analysis is presented in Appendix Table VI.

In S-1, the mean values of CLwere increased under different doses except 420ppm in comparison to the control while fed according to FS-1. The highest and the lowest mean of CL were observed at 240ppm (40.68±0.02mm) and at 420ppm (35.29±0.02mm) respectively. While maintaining FS-2, the highest and the lowest CL were seen at 240ppm (40.84±0.01mm) and at 420ppm (35.35±0.02mm) respectively. In case of FS-3,the CL wasalso increased under different concentrations viz. at 60ppm (38.62±0.31mm), 150ppm (39.26±0.02mm), 240ppm (40.58±0.01mm), 330ppm (38.55±0.02mm) compared to the control (35.38±0.01mm).

The mean values of CLwere significantly increased in S-2 under different concentrations and different feeding schedules. At FS-1, the highest and the lowest CL were recorded at 240ppm (40.82±0.02mm) and at 420ppm (35.38±0.01mm) respectively. In case of FS-2, the CLwas also increased under different doses, viz. at 60ppm (39.45±0.02mm), 150ppm (39.83±0.02mm), 240ppm (40.97±0.02mm), 330ppm (39.06±0.03mm) compared to the control (35.49±0.03mm) but the lowest

mean value of CL at 420ppm (35.47±0.02mm). While maintaining FS-3, the highest and the lowest mean of CL were observed at 240ppm (40.65±0.02mm) and at 420ppm (35.30±0.01mm) respectively.

On different feeding schedules, the mean values of CL were significantly increased under different concentrations ofvit- B_2 in S-3. The highest and the lowest mean of CL were observed at 240ppm (40.56±0.02mm) and at 420ppm (35.12±0.01mm) for FS-1, at 240ppm (40.74±0.02mm) and at 420ppm (35.22±0.01mm) for FS-2 and at 240ppm (40.45±0.02mm) and at 420ppm (35.08±0.02mm)for FS-3 respectively.

The supplementation of vit- B_2 significantly increasedthe mean values of CLin S-4under different concentrations and different feeding schedules. While fed according to FS-1, the highest and the lowestCL were noticed at 240ppm (40.43±0.03mm) and at 420ppm (35.07±0.02mm) respectively. In case of FS-2, the CL were increased undervarious concentrations, viz. at 60ppm (39.08±0.01mm), 150ppm (39.39±0.02mm), 240ppm (40.58±0.01mm), 330ppm (38.55±0.03mm) compared to the control (35.22±0.02mm) but the mean value of CLwas decreased at 420ppm (35.15±0.02mm). AtFS-3, the highest and the lowest mean of CLwere observed at 240ppm (40.22±0.01mm) and at 420ppm (35.01±0.01mm) respectively.

The results of ANOVA have been presented in Appendix Table VI. The items, viz. feeding schedules (F=136.99), seasons (F=168.33), doses (F=5055.16) revealed significant results ($P<0.01$).

The efficacy of vit- B_2 under different seasons on CL followed the order S-2 > S-1 > S-3> S-4 and at different feeding schedule the effectiveness in this regard was FS-2 > FS-1 > FS-3. The most effective dose of vit- B_2 in majority of the cases was 240ppm followed by 150ppm, 60ppm and 330ppm.

Cocoon breadth (CB):

The effect of vit- B_2 supplementation on CB of *B.mori* under different seasons, viz. S-1, S-2, S-3, S-4 and at different feeding schedules, viz. FS-1, FS-2, FS-3 are shown in Table 7, the graphical presentation are showed in Figure 7 and their statistical analysis is presented in Appendix Table VII.

The results were showed that the CBwas increased underdifferent feeding schedulesand different doses except 420ppm in comparison to the controlin S-1. While maintaining FS-1, the highest and the lowest mean of CB were observed at 240ppm (24.35±1.02mm) and at 420ppm (20.74±0.02mm) respectively. At FS-2 the highest and the lowest CB were recorded at 240ppm (24.61±0.02mm) and at 420ppm (20.82±0.01mm) respectively. In case of FS-3, the CB were also increased under different concentrations, viz. at 60ppm (23.92±0.01mm), 150ppm (24.07±0.02mm), 240ppm (24.28±0.01mm), 330ppm (23.62±0.01mm) comparedto thecontrol (20.98±0.01mm) but the mean value of CBwas decreased at 420ppm(20.77±0.01mm).

The mean values of CBwere significantly increased under different concentrations and different feeding schedulesin S-2. At FS-1, the highest and the lowest CB were recorded at 240ppm (24.58±0.01mm) and at 420ppm (20.98±0.01mm) respectively. While fed according to FS-2, the CB were increased under different doses, viz. at 60ppm (24.48±0.01mm), 150ppm (24.64±0.02mm), 240ppm (24.79±0.01mm), 330ppm (24.12±0.01mm) compared to the control (21.20±0.02mm) but the mean value of CBwas decreased at 420ppm (21.02±0.01mm). The highest and the lowest mean values of CB were observed at 240ppm (24.50±0.01mm) and at 420ppm (20.85±0.02mm) respectively while maintaining FS-3.

The supplementation ofvit- B_2 significantly increased the mean values of CB under different concentrations and different feeding schedules in S-3. The highest and the lowest mean values of CB were observed at 240ppm (24.15±0.02mm) and at 420ppm (20.57±0.01mm) for FS-1, at 240ppm (24.41±0.02mm) and at 420ppm

(20.62±0.01mm) for FS-2 and at 240ppm (24.02±0.01mm) and at 420ppm (20.44±0.01mm) for FS-3 respectively.

In S-4, the mean values of CBwere significantly increased under different concentrations andvarious feeding schedules. While fed according to FS-1, the highest and the lowestCB were noticed at 240ppm (23.95±0.02mm) and at 420ppm (20.32±0.01mm) respectively. At FS-2, the CB were increased under different concentrations, viz. at 60ppm (23.88±0.01mm), 150ppm (24.02±0.02mm), 240ppm (24.22±0.02mm), 330ppm (23.52±0.01mm) compared to the control (20.52±0.01mm) but the CBwas decreased at 420ppm (20.42±0.01mm). At FS-3, the highest and the lowest mean values of CBwere observed at 240ppm (23.84±0.01mm) and at 420ppm (20.26±0.01mm) respectively.

Analysis of variance showed highly significant differences among feeding schedules (F=543.85), seasons (F=1903.16) anddoses (F=563.36) at 1% level of significance but dose × seasons (F=0.14) showed insignificant results in Appendix Table VII.

The effectiveness of vit- B_2 with respect to different seasons on CB followed the order S-2 > S-1 > S-3 > S-4 and while in respect of different feeding schedule this trend was FS-2 > FS-1 > FS-3. In most of the cases for both seasons and feeding schedule effective doses of vit- B_2 followed the order 240ppm > 150ppm > 60ppm > 330ppm.

Shell weight (SW):

Effect of vit- B_2 supplementation under different seasons, viz. S-1, S-2, S-3 and S-4 on SW of *B.mori* at different feeding schedules, viz. FS-1, FS-2, FS-3 in shown in the Table 8, the graphical presentation are showed in the Figure 8 and their statistical analysis is presented in Appendix Table VIII.

Vit- B_2 supplementation increased the SW under different doses except 420 ppm in comparison to the control while fed according to FS-1in S-1. The highest and the lowest mean of SW were observed at 240ppm (0.150±0.000gm) and at 420ppm (0.113±0.003gm) respectively. While fed according to FS-2, the highest and the lowest SW were noticed at 240ppm, (0.163±0.003gm) and at 420ppm (0.117±0.003gm) respectively. In case of FS-3, the SW wasalso increased under different doses, viz. at 60ppm (0.127±0.003gm), 150ppm (0.140±0.000gm), 240ppm (0.147±0.003gm), 330ppm (0.120±0.000gm) compared to the control (0.120±0.000gm). But the mean value of SW was decreased at 420ppm(0.110±0.003gm).

In S-2, the mean values of SW significantly increased under different concentrations and at different feeding schedules. While fed according to FS-1, the highest and the lowest SW were observed at 240ppm (0.160±0.000gm) and at 420ppm (0.123±0.003gm) respectively. At FS-2, the SW were increased under different doses, viz. at 60ppm (0.143±0.003gm), 150ppm (0.157±0.003gm), 240ppm (0.167±0.003gm) and 330ppm (0.140±0.000gm) compared to the control (0.133±0.003gm). The highest and the lowest mean of SW were noticed at 240ppm (0.153±0.003gm) and at 420ppm (0.120±0.000gm) respectively at FS-3.

The mean values of SW were significantly increased under different concentrations ofvit- B_2at different feeding schedules, in S-3. The highest mean of SW was observed at 240ppm (0.143±0.003gm) at FS-1, at 240ppm (0.153±0.003gm) for FS-2 and at 240ppm (0.140±0.000gm) for FS-3 and the lowest at 420ppm for all of the cases,viz. (0.103±0.003gm) for FS-1, (0.110±0.000gm) for FS-2 and (0.100±0.000gm) for FS-3 respectively.

The supplementation ofvit- B_2increased the mean values of SW under different concentrations and at different feeding schedules in S-4. While fed according to FS-1, the highest and the lowest larvae were recorded at 240ppm (0.130±0.000gm)and at 420ppm (0.093±0.003gm)) respectively. In case of FS-2, the SW were

increased under different doses, viz. at 60ppm (0.123±0.003gm), 150ppm (0.133±0.003gm), 240ppm (0.143±0.003gm), 330ppm (0.120±0.000gm)compared to the control (0.103±0.003gm)but the mean value of SW was decreased at 420ppm (0.097±0.003gm). While maintaining FS-3,the highest and the lowest mean values of SW were observed at 240ppm (0.127±0.003gm)and at 420ppm (0.087±0.003gm)respectively.

Analysis of variance showed highly significant differences among feeding schedules (F=43.98),seasons(F=154.17), doses (F=188.94)at 1% level of significance in Appendix Table VIII.

The effectiveness of vit- B_2 with respect to different seasons on SW followed the order S-2 > S-1 > S-3 > S-4 and while in respect of different feeding schedule this trend was FS-2 > FS-1 > FS-3. In majority of the cases for both seasons and feeding schedule effective doses of vit- B_2 followed the order 240ppm > 150ppm > 60ppm > 330ppm.

Shell ratio (%)

The effect of vit- B_2on SR% of *B.mori* under different seasons at different feeding schedules, viz. FS-1, FS-2, FS-3 is shown in Tables 9, the graphical presentation are showed in Figure 9 and their statistical analysis is presented in Appendix Table IX.

In S-1, the mean values of SR%were decreased under different doses in comparison to the control while fed according to FS-1. The highest and the lowest mean of SR% were observed at control(10.26±0.09%)and at 240ppm (9.04±0.05%) respectively. While maintaining FS-2, the highest and lowest mean of SR% were found at control (10.26±0.09%) and at 150ppm (9.20±0.18%) respectively. In case of FS-3, the SR% was also decreased under different concentrations viz. at 60ppm (6.69±0.24%), 150ppm (9.60±0.20%), 240ppm

(9.37±0.33%), 330ppm (9.63±0.11%) compared to the control (10.26±0.09%). But in this case highest mean value of SR% was 420ppm (11.01±0.41%).

The mean values of SR%were significantly decreased in S-2 under different concentrations and different feeding schedules. At FS-1, the highest and the lowest SR% were recorded atcontrol (10.90±0.16%) and at 240ppm (9.32±0.09%) respectively. While maintaining both FS-2 and FS-3, the results were the same as FS-1.

In different feeding schedules, the mean values of SR% were significantly decreased under different concentrations ofvit- B_2 in S-3. The highest and the lowest mean of SR% were observed at 420ppm and at 240ppm for all the feeding schedules.

The supplementation of vit- B_2 significantly decreasedthe mean values of SR%in S-4under different concentrations and different feeding schedules. While fed according to FS-1, the highest and the lowestSR% were noticed at 420ppm (10.12±0.50%) and at 60ppm (8.60±0.20%) gradually. In case of FS-2, the SR% were decreased undervarious concentrations, viz. at 60ppm (9.37±0.33%), 150ppm (9.37±0.15%), 240ppm (9.46±0.34%), 330ppm (9.56±0.18%) compared to the control (9.93±0.28%) but the mean value of SR% was increased at 420ppm (10.58±0.35%). AtFS-3, the highest and the lowest mean of SR% were observed at 420ppm (10.74±0.38%) and at 150ppm (8.51±0.26%) respectively.

The results of ANOVA have been presented in Appendix Table IX. The items, viz. feeding schedules ($F=5.50$), seasons ($F=16.51$), doses ($F=64.11$) and dose ×season ($F=2.65$) revealed significant results ($P<0.01$).

The efficacy of vit- B_2 under different seasons on SR% followed the order S-2 > S-3> S-1> S-4 and at different feeding schedule the effectiveness in this regard was S-2 > FS-3> FS-1. The most effective dose of vit- B_2 was not followed the normal trend as found in other parameters and it was different in different cases.

4.1.4. Effect of riboflavin on the survival percentage and adult emergence (%)of *B. mori*

The cocoon yield is significantly dependent on the production of various stages as well as the developmental period. The present work was initiated to determine the effect of various concentrations of vit- B_2on the survival percentageand adult emergence % of *B. mori.*under different seasons andvarious feeding schedules. The results are given bellow:

Survival percentage (SP):

Effect of vit- B_2 supplementation under different seasons, viz. S-1, S-2, S-3, S-4 on SP of *B.mori* at different feeding schedules, viz. FS-1, FS-2, FS-3 are shown inTable 10, the graphical presentation are showed in Figure 10 and their statistical analysis is presented in Appendix Table X.

The results were showed that the SP was increased under different doses except 420 ppm in comparison to the control while fed according to FS-1during S-1. The highest and the lowest mean of SPwere observed at 240ppm (95.33±0.04%) and at 420ppm (89.33±0.07%) respectively. While maintaining FS-2, the highest and the lowest SPwere recorded at 240ppm (96.67±0.06%) and at 420ppm (90.00±0.10%) respectively. At FS-3, the SPwere also increased under different concentrations, viz. at 60ppm (92.00±0.09%), 150ppm (92.67±0.04%), 240ppm (93.33±0.05%), 330ppm (91.33±0.12%) comparedto thecontrol (90.67±0.03%) but the mean value of SPwas decreased at 420ppm(88.00±0.00%).

The supplementation ofvit- B_2increasedthe mean values of SPin S-2under different concentrations and various different feeding schedules. While fed according to FS-1, the highest and the lowest SP were recorded at 240ppm (96.67±0.06%) and at 420ppm (90.00±0.10%) respectively. At FS-2, the SPwas increased under different doses, viz. at 60ppm (95.33±0.05%) 150ppm (96.00±0.10%), 240ppm (98.00±0.12%), 330ppm(94.00±0.06%) compared to the

control (92.00±0.09%) but the mean value of SPwas decreased at 420ppm (90.67±0.03%). The highest and the lowest mean values of SP were observed at 240ppm (95.33±0.05%) and at 420ppm (88.67±0.04%) respectively while maintaining FS-3.

On different feeding schedules, the mean values of SP were significantly increased under different concentrations ofvit- B_2 in S-3. The highest and the lowest mean values of SPwere observed at 240ppm (94.00±0.06%) and at 420ppm (86.67±0.07%) for FS-1, at 240ppm (94.67±0.08%) and at 420ppm (88.00±0.10%) for FS-2 and at 240ppm (92.00±0.09%) and at 420ppm (85.33±0.07%) for FS-3 respectively.

In S-4, the mean values of SPwere significantly increasedunder different concentrations and at different feeding schedules. While fed according to FS-1, the highest and the lowestSP were recorded at 240ppm (92.00±0.17%) and at 420ppm (85.33±0.07%) respectively. In case of FS-2, the SP were increased under various concentrations, viz. at 60ppm (90.67±0.03%), 150ppm (92.00±0.17%), 240ppm (94.00±0.06%), 330ppm (90.00±0.10%) compare to the control (86.67±0.01%) but the mean value of SPwas decreased at 420ppm (86.62±0.06%). The highest and the lowest mean values of SP were observed at 240ppm (90.67±0.03%) and at 420ppm (84.00±0.07%) respectively at FS-3.

The results of ANOVA have been presented in Appendix Table X. It indicated highly significant differences among feeding schedules (F=95.73), seasons (F=331.43) and doses (F=221.43) at 1% level of significance. The results was insignificant for the interaction itemdose × seasons (F=1.35).

The effectiveness of vit- B_2 with respect to different seasons on SP followed the order S-2 > S-1 > S-3 > S-4 and while in respect of different feeding schedule this trend was FS-2 > FS-1 > FS-3. In most of the cases for both seasons and feeding schedule effective doses of vit- B_2 followed the order 240ppm > 150ppm > 60ppm > 330ppm.

Adult emergence (%)

The effect of vit- B_2 supplementation on AE% of *B.mori*under different seasons, viz. S-1, S-2, S-3 and S-4 at different feeding schedules, viz. FS-1, FS-2, FS-3 are shown in Table 11, the graphical presentation are showed in Figure 11 and their deviate values (T-test) are presented in Table 11.

During S-1, the mean values of AE% were increased under different doses except 420 ppm in comparison to the control while maintaining FS-1. The highest and the lowest mean of AE% were observed at 240ppm (92.00%)and at 420ppm (85.33%)respectively. While fed according to FS-2, the highest and the lowest AE% were recorded at 240ppm (93.33%) and at 420ppm (86.87%)respectively. In case of FS-3, the AE%was also increased under different doses, viz. at 60ppm (89.33%), 150ppm (90.00%), 240ppm (91.33%) and 330ppm (88.67%)compared to the control (88.00%). But the mean value of AE% was decreased at 420ppm(84.67%).

The mean values of AE%were increased significantlyunder different concentrations of vit-B_2at different feeding schedules in S-2. While fed according to FS-1, the highest and the lowest AE% were observed at 240ppm (94.67%) and at 420ppm (88.00%) respectively. In case of FS-2, the AE% was increased under different doses, viz. at 60ppm (92.67%), 150ppm (93.33%), 240ppm (95.33) and 330ppm (91.33%) compared to the control (90%). The highest and the lowest mean of AE% were recorded at 240ppm (93.33%)and at 420ppm (86.67%)respectively while fed according to FS-3.

At different feeding schedules, the mean values of AE% were significantly increased under different concentrations ofvit- B_2 in S-3. The highest and the lowest mean of AE% were observed at 240ppm (90.67%) and at 420ppm (82.67%)for FS-1, at 240ppm (92.00%) and at 420ppm (84.00%)for FS-2 and at 240ppm (89.33%)and at 420ppm (81.33%)for FS-3 respectively.

In S-4, the mean values of AE% under different concentrations at different feeding schedules were significantly increased. While fed according to FS-1, the highest and the lowestmean of AE% were observed at 240ppm (88.00%)and at 420ppm (81.33%)respectively. In case of FS-2, the AE% were increased under different doses, viz. at 60ppm (88.00%), 150ppm (89.33%), 240ppm (90.67%), 330ppm (86.67%)compared to the control (86.33%)but the mean value of AE%was decreased at 420ppm (82.67%). The highest and the lowest mean values of AE% were observed at 240ppm (86.67%) and at 420ppm (80.00%)respectively at FS-3.

The results of deviate values have been presented in Table 11. The items concentrations, seasons and feeding schedules revealed significant.

The effectiveness of vit- B_2 with respect to different seasons on AE% followed the order S-2 > S-1 > S-3 > S-4 and while in respect of different feeding schedule this trend was FS-2 > FS-1 > FS-3. In most of the cases for both seasons and feeding schedule effective doses of vit- B_2 followed the order 240ppm > 150ppm > 60ppm > 330ppm.

4.1.5.Effect of riboflavin on the developmental stages of *B. mori*

The results of vit- B_2 supplementationon the developmental stages of *B.mori* under different seasons and different feeding schedules are given bellow:

Larval period (LP):

Effect of vit- B_2 supplementation under different seasons, viz. S-1, S-2, S-3 and S-4 on LP of *B.mori* at different feeding schedules, viz. FS-1, FS-2, FS-3 are shown inTable 12, the graphical presentation are showed in Figure 12 and their statistical analysis is presented in Appendix Table XI.

The supplementation of vit- B_2 decreased the mean ofLP under different doses except 420 ppmin comparison to the control while maintaining FS-1 in S-1. The highest and the lowest mean of LP were noticed at 420ppm (23.49±0.01 days) and

at 240ppm (23.33±.017 days) respectively. While fed according to FS-2 the highest and the lowest LP were recorded at 420ppm (23.48±0.02 days) and at 240ppm (23.30±0.01 days) respectively. In case of FS-3, the LP were also decreased under various concentrations, viz. at 60ppm (23.44±0.02 days), 150ppm (23.43±0.01 days), 240ppm (23.34±0.02 days), 330ppm (23.45±0.02 days) comparedto thecontrol (23.45±0.02 days). But the mean value of LPwasincreased at 420ppm(23.50±0.02 days).

The mean values of LPwere significantly decreased in S-2 under different concentrations and different feeding schedules. According to FS-1, the highest and the lowest LP were recorded at 420ppm (23.46±0.010 days) and at 240ppm (23.26±0.010 days) respectively. At FS-2, the LP were decreased under different doses, viz. at 60ppm (23.32±0.017 days), 150ppm (23.25±0.017 days), 240ppm (23.21±0.021 days), 330ppm (23.33±0.010 days) compared to the control (23.38±0.033 days). But the mean value of LP wasincreased at 420ppm (23.40±0.029 days). While maintaining FS-3, the highest and the lowest LP were observed at 420ppm (23.48±0.033 days) and at 240ppm (23.34±0.010 days) respectively.

In different feeding schedules, the mean values of LP were significantly decreased under different concentrations ofvit- B_2 in S-3. The highest and the lowest mean values of LP were observed at 420ppm (23.52±0.015 days), at 240ppm (23.39±0.007 days) for FS-1, at 420ppm (23.50±0.007 days), at 240ppm (23.36±0.010 days) for FS-2 and at 420ppm (23.50±0.012 days) and at 240ppm (23.41±0.007 days) for FS-3 respectively.

The supplementations of vit- B_2significantly decreased the mean values of LPin S-4under different concentrations and different feeding schedules. While maintaining FS-1 the highest and the lowestLP were recorded at 420ppm (23.57±0.010 days) and at 240ppm (23.41±0.007 days) respectively. In case of FS-2, the LP were decreased under different doses, viz. at 60ppm (23.49±0.007 days),

150ppm (23.46±0.010 days), 240ppm (23.40±0.007 days), 330ppm (23.49±0.021 days) compared to the control (23.53±0.010 days). But the mean value of LPwasincreased at 420ppm (23.56±0.010 days). The highest and the lowest mean values of LP were observed at 420ppm (23.58±0.010 days) and at 240ppm (23.46±0.010 days) respectively at FS-3.

The results of ANOVA have been presented in Appendix Table XI. It indicated highly significant differences among feeding schedules (F=15.35), seasons (F=79.17) and doses (F=98.92) at 1% level of significance. The results was insignificant for the interaction item dose × seasons (F=0.96).

The effectiveness of vit- B_2 under different seasons on LP followed the order S-4> S-3> S-1> S-2 and while in respect of different feeding schedules this trend was FS-3 > FS-1 > FS-2. In most of the cases for all seasons and feeding schedule effective doses of vit- B_2 followed the order 240ppm > 150ppm > 60ppm > 330ppm.

Pupalperiod (PP):

The effect of vit- B_2under different seasons on PP of *B.mori* at different feeding schedules, viz. FS-1, FS-2, FS-3 are shown in Table 13, the graphical presentation are showed in Figure 13 and their statistical analysis is presented in Appendix Table XII.

The supplementation ofvit- B_2 in S-1decreased the mean values of PPunder different doses except 420 ppm in comparison to the control while fed according to FS-1. The highest and the lowest mean ofPP were observed at 420ppm (09.52±0.007 days) and at 240ppm(09.35±0.029 days) respectively. While maintaining FS-2, the highest and the lowest PP were observed at 420ppm (09.51±0.007 days) and at 240ppm(09.28±0.020 days) respectively. In case of FS-3, the PPwasalso decreased under different concentrations viz. at 60ppm (09.48±0.026 days), 150ppm (09.47±0.010 days), 240ppm (09.46±0.010 days) and

330ppm (09.49±0.020 days) compared to the control (09.50±0.029 days).But the highest mean value of PP were observed at 420ppm (09.55±0.017 days).

The mean values of PPwere significantly decreasedin S-2under different concentrations and different feeding schedules. While fed according to FS-1, the highest and the lowest PP were recorded at 420ppm (09.48±0.017 days) and at 240ppm (09.29±0.021days) respectively. In case of FS-2, the PPwas alsodecreased at different doses, viz. at 60ppm (09.38±0.020 days), 150ppm (09.32±0.015 days), 240ppm (09.26±0.023 days), 330ppm (09.40±0.023 days) comparedto thecontrol (09.45±0.029 days). But the highest mean value of PP were seen at 420ppm (09.46±0.017 days). The highest and the lowest mean ofPP were noticed at 420ppm (09.50±0.017 days) and at 240ppm (09.31±0.007 days) respectively while fed according to FS-3.

The supplementation of vit- B_2 decreased the mean values of PP in S-3 under different concentrations and different feeding schedules. The highest and the lowest mean of PP were observed at 420ppm (09.60±0.030 days and at 240ppm (09.42±0.017 days) for FS-1, at 420ppm (09.57±0.013 days) and at 240ppm (09.32±0.015 days) for FS-2 and at 420ppm (09.62±0.015 days) and at 240ppm (09.47±0.007 days) for FS-3 respectively.

In S-4, the mean values of PP were significantly decreasedunder different concentrations and different feeding schedules. According to FS-1, the highest and the lowestPP were noticed at 420ppm (09.65±0.021 days) and at 240ppm(09.45±0.029 days) respectively. In case of FS-2, the PP weredecreased under different concentrations, viz. at 60ppm (09.54±0.023 days), 150ppm(09.46±0.010 days), 240ppm(09.39±0.007 days), 330ppm(09.55±0.017 days) compared to the control(09.60±0.029 days) but the mean value of PP has been increased at 420ppm(09.62±0.015 days). While maintaining FS-3, the highest and the lowest mean values ofPP were observed at 420ppm (09.68±0.010 days) and at 240ppm (09.51±0.007 days) respectively.

The results of ANOVA have been presented in Appendix Table XII. The items, viz. feeding schedules (F=37.37), seasons (F=181.41), doses (F=68.70) revealed significant results (P<0.01).

The efficacy of vit- B_2under different seasons on PP followed the order S-4>S-3>S-1> S-2 and at different feeding schedule the effectiveness in this regard was FS-3> FS-1> FS-2. The most effective dose ofvit- B_2in most of the cases was 240ppm followed by 150ppm, 60ppm and 330ppm.

4.1.6. Effect of riboflavinon thetotal number of eggs laid (TEL) and egg hatching percentage (EHP) of *B. mori.*

In the present experimenttotal number of eggs laid was evaluated on the basis of egg laying potential, *i.e.* total number of eggs laid by individual female moth of *B. mori*and for fertility parameter egg hatching percentage was computed.

The results ofvit- B_2 supplementation onthe total number of eggs laid (TEL)and egg hatching percentage (EHP) of*B.mori*under different seasons anddifferent feeding schedules are given bellow:

Total number of eggs laid (TEL):

The effect of vit- B_2 supplementation on the TEL of *B.mori*under different seasons, viz. S-1, S-2, S-3 and S-4 at different feeding schedules, viz. FS-1, FS-2 and FS-3 are shown in Table14, the graphical presentation are showed in Figure 14 and their statistical analysis is presented in Appendix Table XIII.

The supplementation of vit- B_2 increased the TELin S-1 under different doses except 420ppm in comparison to the control while fed according to FS-1. The highest and lowest mean values of TEL were observed at 240ppm(406.56±0.58) and 420 ppm(297.07±0.85) respectively. While maintaining FS-2, the highest and lowest mean of TEL were seen at 240ppm(407.25±0.38)and 420ppm(298.35±0.88)respectively. At FS-3, the mean ofTEL were also increased undervariousconcentrations, viz. at 60ppm(385.68±0.51), 150ppm(389.19±0.53),

240ppm(395.51±0.28), 330ppm(367.02±1.57) compared to the control(299.59±0.51)but the mean value of TELwas decreased at 420ppm(296.95±0.98).

InS-2, the mean values of TELwere significantly increasedunder different concentrations and different feeding schedules. While fed according to FS-1, the highest and the lowestTEL were viewedat 240ppm (408.59±0.95) and at 420ppm (298.54±0.20) respectively. At FS-2, the mean ofTELwere increased under different doses, viz. at 60ppm (395.61±0.18), 150ppm(405.34±0.27), 240ppm(409.93±1.04), 330ppm(394.84±0.14) compared to the control(303.18±1.62) but the mean value of TELwas decreased at 420ppm(299.87±0.50).While maintaining FS-3, the highest and the lowest mean values ofTEL were observed at 240ppm (398.34±0.13)and at 420ppm(397.77±0.31) respectively.

The mean values of TEL were significantly increased underdifferent concentrations andvarious feeding schedules in S-3. The highest and lowest mean of TEL were observed at 240ppm (404.83±0.57) and at 420ppm (296.69±0.79) for FS-1, at 240ppm(405.27±0.64) and at 420ppm(297.49±0.83) for FS-2 and at 240ppm(394.39±0.81and at 420ppm (295.25±0.13) for FS-3.

The supplementation of vit- B_2 increasedthe mean values of TELduringS-4undervarious concentrations and different feeding schedules. While fed according to FS-1, the highest and the lowestmean of TEL were observed at 240ppm (403.01±1.08) and at 420ppm (296.68±0.14) respectively. In case of FS-2, the TEL were increased under different doses, viz. at 60ppm (391.99±0.77), 150ppm(401.71±0.86), 240ppm(404.28±0.77), 330ppm(387.92±1.76) compared to the control(298.03±0.12) but the mean value of TELwas decreased at 420ppm(297.34±0.41). At FS-3, the highest and the lowest mean values ofTEL were observed at 240ppm (390.80±0.09) and at 420ppm (294.41±0.11) respectively.

The results of ANOVA have been presented in Appendix TableXIII. The items, viz. feeding schedules (F=243.09), seasons (F=29.62), doses (F=1570.67) revealed significant results (P<0.01).

The effectiveness of different concentrations of vit- B_2under different seasons on TEL followed the order S-2>S-1>S-3 > S-4 and in respect of feeding schedule FS-2> FS-1> FS-3. The most effective doses of the vit- B_2 was found to be 240ppm followed by 150ppm, 60ppm and 330ppm.

Egg hatching percentage (EHP):

The effect of vit- B_2supplementation on EHP of *B.mori*under different seasons viz. S-1, S-2, S-3 and S-4 andat different feeding schedules, viz. FS-1, FS-2, FS-3 are shown in Table 15, the graphical presentation are showed in Figure 15 and their statistical analysis is presented in Appendix Table XIV.

During S-1 the mean values of EHP were increased under different doses except 420 ppm in comparison to the control while fed according to FS-1. The highest and the lowest mean of EHP were observed at 240ppm (95.81±0.02%) and at 420ppm (94.22±0.05%) respectively. While maintaining FS-2, the highest and the lowest EHP were observed at 240ppm (95.83±0.05%)and at 420ppm (94.32±0.03%)respectively. At FS-3, the EHPwasalso increased under different concentrations viz. at 60ppm (94.92±0.02%), 150ppm (95.25±0.02%), 240ppm (95.38±0.02%), 330ppm (94.70±0.01%)compared to control (94.38±0.03%).

The mean values of EHPwere increased significantly during S-2 under different concentrations andat different feeding schedules. While fed according to FS-1, the highest and the lowest EHP were recorded at 240ppm (95.88±0.01%)and at 420ppm (94.55±0.06%)respectively. In case of FS-2, the mean ofEHP were also increased under different doses, viz. at 60ppm (95.70±0.03%), 150ppm (95.82±0.02%), 240ppm (96.06±0.04%), 330ppm (95.68±0.04%)compare to the control (94.61±0.05%). But the lowest mean value of EHP at 420ppm

(94.58±0.07%). While fed according to FS-3, the highest and the lowest mean of EHP were noticed at 240ppm (95.62±0.02%)and at 420ppm (94.50±0.03%)respectively.

On different feeding schedules, the mean values of EHP were significantly increased under different concentrations ofvit- B_2 in S-3. The highest and the lowest mean of EHP were observed at 240ppm (95.69±0.02%) and at 420ppm (94.14±0.02%)for FS-1, at 240ppm (95.73±0.06%)and at 420ppm(94.21±0.04%)for FS-2 and at 240ppm (95.28±0.01%)and at 420ppm(94.09±0.01%)for FS-3 respectively.

The supplementation of vit- B_2significantly increasedthe mean values of EHP in S-4under different concentrations andat different feeding schedules. While fed according to FS-1, the highest and the lowestEHP were recorded at 240ppm (95.57±0.01%)and at 420ppm (94.11±0.01%)respectively. In case of FS-2, the EHPwere increased under different doses, viz. at 60 ppm (95.44±0.02%), 150ppm (95.54±0.02%), 240ppm (95.64±0.03%), 330ppm (95.36±0.03%) compared to the control (94.22±0.01%)but the mean value of EHP was decreased at 420ppm (94.16±0.03%). At FS-3, the highest and the lowest mean values of EHP were observed at 240ppm (95.13±0.01%) and at 420ppm (94.07±0.01%)respectively.

The results ofanalysis of variance have been presented in Appendix Table XIV. The items, viz. feeding schedules (F=893.58), seasons (F=270.11), doses (F=113.89) revealed significant results ($P<0.01$).

The efficacy of vit- B_2 on EHPunder different seasons followed the order S-2 > S-1 > S-3> S-4 and at different feeding schedule the effectiveness in this regard was FS-2 > FS-1 > FS-3. The most effective doses of vit- B_2 in majority of the cases was 240ppm followed by 150ppm, 60ppm and 330ppm.

4.1.7. Effect of riboflavin on the Mortality% of *B. mori*

The purpose of the following investigation is to find out the effect of vit-B_2 supplementation on the Mortality of *B. mori*under different seasons and different feeding schedules.The results are given bellow:

Mortality(%)

The effect of vit- B_2 on Mortality% of *B.mori* under different seasons, viz. S-1, S-2, S-3, S-4 and at different feeding schedules, viz. FS-1, FS-2, FS-3 are shown in Table 16, the graphical presentation are showed in Figure 16 and their deviate values (T-test)is presented in Table 16.

The mean values of Mortality% were decreased under different doses except 420ppm in comparison to the control maintaining scheduled FS-1during S-1. The highest and the lowest mean of Mortality% were observed at 420ppm (22.61%) and at 240ppm (9.57%) respectively. While fed according to FS-2, the highest and the lowest Mortality%were recorded at 420ppm (21.11%) and at 240ppm (6.78%) respectively. At FS-3, the Mortality% also decreased under different concentrations, viz. at 60ppm (16.70%), 150ppm (15.24%), 240ppm (13.81%) and 330ppm (18.17%) compared to the control (19.62%). But the mean value of AD% wasincreased at 420ppm (25.64%).

The mean values of Mortality%under different doses of vit-B_2at different feeding schedules in S-2were decreased significantly. While fed according to FS-1, the highest and the lowest Mortality% were observed at 420ppm (21.11%) and at 240ppm (6.78%) respectively. At FS-2, the Mortality% was decreased under different doses, viz. at 60ppm (9.57%), 150ppm (8.17%), 240ppm (4.04%) and 330ppm (12.38%) compared to the control (16.70%). The highest and the lowest mean of Mortality% were recorded at 420ppm (24.11%) and at 240ppm (9.57%) respectively while fed according to FS-3.

At different feeding schedules, the mean values of Mortality% were significantly decreased under different concentrations ofvit- B_2 in S-3. The highest and the lowest mean of Mortality% were observed at 420ppm (28.71%) and at 240ppm (12.38%) for FS-1, at 420ppm (25.64%) and at 240ppm (10.96%) for FS-2 and at 420ppm (31.86%) and at 240ppm (16.70%) for FS-3 respectively.

During S-4 the mean values of Mortality% under different concentrations at different feeding schedules were significantly decreased. While fed according to FS-1, the highest and the lowestmean of Mortality% were observed at 420ppm (31.86%) and at 240ppm (16.69%) respectively. In case of FS-2, the Mortality% were decreasedunder different doses, viz. at 60ppm (19.62%), 150ppm (16.70%), 240ppm (12.38%), 330ppm (21.11%) compared to the control (28.71%) but the mean value of Mortality%wasincreased at 420ppm (28.71%). The highest and the lowest mean values of Mortality% were observed at 420ppm (35.05%) and at 240ppm (19.62%) respectively at FS-3.

The results of deviate valueshave been presented in Table 16. The items concentrations and feeding schedules revealed insignificant.

The effectiveness of vit- B_2 with respect to different seasons on Mortality% followed the order S-4> S-3> S-1> S-2 and while in respect of different feeding schedule this trend was FS-3> FS-1 > FS-2. In most of the cases for both seasons and feeding schedule effective doses of vit- B_2 followed the order 240ppm > 150ppm > 60ppm > 330ppm.

4.1.8. Effect of riboflavin on feed efficacy of *B. mori*L.

The results of physiological parameters like food consumption, food utilization, food digestibility, food consumption index and co-efficient of food utilization of 5^{th} instar larvae of *B. mori* fed with control mulberry leaves and different concentrations of vitamin B_2 treated mulberry leaves under different seasons and at various feeding schedule were showed in Tables 17-21, the graphical presentation

was shown in Figures 17-21and their statistical analysis was presented in Appendix Table XV-XIX.

Food consumption (FC):

The effect of vit- B_2 supplementation on the FC of *B.mori*under different seasons, viz. S-1, S-2, S-3 and S-4 and at different feeding schedules, viz. FS-1, FS-2, FS-3 are shown in Table 17, the graphical presentation is showed in Figure 17 and their statistical analysis ispresented in Appendix Table XV.

The mean values ofFC were increased in S-1 under different dosesof vit- B_2except 420 ppm in comparison to the control while fed according to FS-1. The highest and lowest mean values of FC were found at 240ppm(48.43±0.08gm) and 420ppm(45.24±0.08gm) respectively. While fed according to FS-2 the highest and lowest of FC were observed at 240ppm(49.13±0.27gm)and 420ppm(45.36±0.11gm)respectively. In case of FS-3, the FC werealso increased under different doses, viz. at 60ppm(46.45±0.09gm), 150ppm(47.33±0.07gm), 240ppm (48.03±0.12gm), 330ppm(46.08±0.06gm)compared to the control(45.45±0.58gm)but the mean value of FC was decreased at 420ppm(44.98±0.07gm).

InS-2, the mean values of FCwere increasedsignificantlyunder different concentrations and at different feeding schedules. While fed according to FS-1, the highest and the lowestmean of FCwere noticed at 240ppm (48.91±0.06gm) and at 420ppm(45.92±0.05gm) respectively. In case of FS-2, the FCwere increased under different concentrations, viz. at 60ppm (47.65±0.09gm), 150ppm(48.17±0.28gm), 240ppm(50.47±0.16gm), 330ppm (47.23±0.39gm) compared to the control (46.56±0.60gm) but the mean value of FCwasconsiderably decreased at 420ppm (46.24±0.25gm). The highest and the lowest mean values ofFC were observed at 240ppm(48.40±0.03gm)and at 420ppm (45.58±0.10gm)respectively at FS-3.

The mean values of FC were increasedsignificantly at different feeding schedules under different doses ofvit- B_2 in S-3. The highest and lowest mean of FC were found at 240ppm (48.14±0.08gm) and at 420ppm (44.52±0.02gm) for FS-1, at 240ppm (48.31±0.07gm)and at 420ppm (44.70±0.06gm)for FS-2 and at 240ppm (47.75±0.06gm) and at 420ppm (44.22±0.07gm) for FS-3.

The mean values of FC were significantly increased inS-4under different concentrations and atvarious feeding schedules. While fed according to FS-1, the highest and the lowestmean of FC were observed at 240ppm (47.67±0.07gm)and at 420ppm(44.27±0.02gm)) respectively. In case of FS-2, the FCwasincreased under different doses, viz. at 60ppm (45.70±0.07gm), 150ppm(46.58±0.08gm), 240ppm(47.90±0.06gm), 330ppm(45.50±0.09gm) compared to the control (44.60±0.09gm) but the mean value of FCwas decreased at 420ppm (44.46±0.05gm). The highest and the lowest mean values ofFC were viewed at 240ppm (47.42±0.04gm)and at 420ppm (43.99±0.08gm) respectively at FS-3.

Analysis of variance showed highly significant differences among feeding schedules (F=34.03),seasons (F=179.87), doses (F=350.74) at 1% level of significance in Appendix Table XV.

The effectiveness of vit- B_2supplementations under different seasons on FC followed the order S-2>S-1>S-3 > S-4 and in respect of feeding schedule FS-2> FS-1> FS-3. The most effective doses of vit- B_2 was found to be 240ppm followed by 150ppm, 60ppm and 330ppm.

Food utilization (FU):

The effects of the supplementation ofvit- B_2 on the FU of *B.mori* under different seasons and various feeding schedules are shown in Table18, the graphical presentation are showed in Figure 18 and their statistical analysis was presented in Appendix Table XVI.

The supplementation ofvit- B_2in S-1 under different doses while feeding FS-1increased the mean values of FU of *B mori*. The highest and the lowest mean ofFU were found at 240ppm (67.43±0.08gm) and at 420ppm(59.37±0.08gm) respectively. While maintaining FS-2, the highest and the lowest FU were observed at 240ppm (67.80±0.09gm) and at 420ppm(59.78±0.05gm) respectively. On FS-3, the FUwere also increased under different concentrations viz. at 60ppm (64.33±0.06gm), 150ppm (65.28±0.04gm), 240ppm (67.03±0.06gm), 330ppm (64.03±0.03gm) compared to the control (60.06±0.03gm).

The mean values of FU in S-2under different concentrations at different feeding schedules were increasedsignificantly. While fed according to FS-1, the highest and the lowest FU were recorded at 240ppm (67.91±0.06gm) and at 420ppm (60.07±0.04gm) respectively. In case of FS-2, the FU were also increased at various concentrations, viz. at 60ppm (65.63±0.06gm), 150ppm (66.48±0.08gm), 240ppm (68.58±0.10gm), 330ppm (65.28±0.03gm) comparedto thecontrol (60.55±0.03gm). But the lowest mean value of FU at 420ppm (60.40±0.03gm). The highest and the lowest mean ofFU were observed at 240ppm (67.39±0.02m) and at 420ppm (59.76±0.03gm) respectively while fed according to FS-3.

At different feeding schedules, the mean values of FU were significantly increased under different concentrations ofvit- B_2in S-3. The highest and the lowest mean of FU were observed at 240ppm (66.57±0.04gm) and at 420ppm (58.96±0.02gm) for FS-1, at 240ppm (66.82±0.08gm) and at 420ppm (59.37±0.02gm) for FS-2 and at 240ppm (65.78±0.05gm) and at 420ppm (58.75±0.03gm) for FS-3 respectively.

In S-4, the mean values of FU under different concentrations at different feeding schedules were significantly increased. While fed according to FS-1, the highest and the lowestmean of FU were found at 240ppm (65.79±0.05gm) and at 420ppm(58.66±0.04gm) respectively. At FS-2, the FU were increased under different doses, viz. at 60ppm (64.47±0.04gm), 150ppm(65.56±0.08gm), 240ppm(66.43±0.04gm), 330ppm(64.25±0.03gm) compared to the control

(59.11±0.06gm) but the mean value of FUwas decreased at 420ppm(59.02±0.02gm). The highest and the lowest mean values ofFU were observed at 240ppm (65.40±0.03gm) and at 420ppm (58.27±0.03gm)respectively at FS-3.

The results of ANOVA have been presented in TableXVI. The items, viz. feeding schedules (F=148.48), seasons (F=302.83), doses (F=2534.24)at 1% level of significance.

The efficacy of vit- B_2under different seasons on FU followed the order S-2>S-1>S-3> S-4 and ondifferent feeding schedule the effectiveness in this regard was FS-2 > FS-1> FS-3. The most effective dose ofvit- B_2in most of the cases was 240ppm followed by 150ppm, 60ppm and 330ppm.

Approximate digestibility (AD %)

The results of vit- B_2 supplementation on AD% of *B.mori*under different seasons and different feeding schedules areshown in Table 19, the graphical presentation are showed in Figure 19 and their statistical analysis is presented in Appendix Table XVII.

In S-1,results were showed thatAD%was increased under different concentrations of vit-B_2 except 420 ppm in comparison to the control while fed at FS-1. The highest and the lowest mean of AD% were observed at 240ppm (68.43±0.05%) and at 420ppm (61.46±0.04%) respectively. While fed according to FS-2 the highest and the lowest AD% were recorded at 240ppm (68.88±0.03%) and at 420ppm (61.75±0.04%) respectively. In case of FS-3, the AD%was also increased under different concentrations; viz. at 60ppm (66.47±0.04%), 150ppm (67.17±0.04%), 240ppm (68.02±0.07%), 330ppm (66.03±0.02%) comparedtothe control (62.08±0.04%) but the mean value of AD% has been decreased at 420ppm(61.07±0.04%).

The mean values of AD%under different concentrations and at different feeding schedules were increased significantly in S-2. At FS-1, the highest and the lowest AD% were recorded at 240ppm (68.96±0.10%) and at 420ppm(62.07±0.04%)

respectively. While maintaining FS-2, the AD% were increased under different concentrations, viz. at 60ppm (68.14±0.03%), 150ppm(68.52±0.05%), 240ppm(70.48±0.03%), 330ppm(67.82±0.03%) compared to the control(62.57±0.04%) but the mean value of AD%was decreased at 420ppm(62.19±0.02%). The highest and the lowest mean values ofAD% were observed at 240ppm (68.38±0.02%) and at 420ppm (61.87±0.03%)respectively while fed according to FS-3.

On different feeding schedules, the mean values of AD% were significantly increased under different concentrations ofvit- B_2 in S-3. The highest and the lowest mean values ofAD% were observed at 240ppm (67.88±0.04%) and at 420ppm (60.96±0.02%) for FS-1, at 240ppm (68.43±0.05%) and at 420ppm (61.50±0.02%) for FS-2 and at 240ppm (67.37±0.02%) and at 420ppm (60.76±0.03%) for FS-3 respectively.

The mean values of AD% under different concentrations and at different feeding schedules were increasedsignificantly inS-4. While fed according to FS-1, the highest and the lowest larvae were observed at 240ppm (67.77±0.05%) and at 420ppm(60.05±0.04%) respectively. At FS-2, the AD% were increased under different doses, viz. at 60ppm (66.72±0.04%), 150ppm(67.31±0.05%), 240ppm(68.10±0.06%), 330ppm(66.39±0.02%) compared to the control(60.50±0.03%) but the mean value of AD%was decreased at 420ppm(60.25±0.04%). The highest and the lowest mean values ofAD% were noticed at 240ppm (66.86±0.03%) and at 420ppm (59.71±0.02%)respectively at FS-3.

Analysis of variance showed highly significant differences among feeding schedules (F=299.94),seasons (F=637.70), doses (F=1327.92) at 1% level of significance but dose× seasons (F=1.13) showed insignificant results in Appendix Table XVII.

The effectiveness of vit- $B_2$with respect to different seasons on AD% followed the order S-2>S-1>S-3 > S-4 and while in respect of different feeding schedulethis trendwas FS-2 > FS-1> FS-3.In most of the cases for both seasons and feeding

schedule effective doses of vit- B_2followed the order 240ppm >150ppm >60ppm >330ppm.

Food consumption index (FCI)

The effect of vit- B_2 supplementation under different seasons, viz. S-1, S-2, S-3 and S-4 on FCI of *B.mori* at different feeding schedules, viz. FS-1, FS-2, FS-3 are shown in Table20, the graphical presentation are showed inFigure 20 and their statistical analysis is presented in Appendix Table XVIII.

In S-1, the mean values of FCI of *B mori*were increased at different doses except 420 ppm when compared to control in respect of FS-1. The highest and the lowest mean ofFCI were observed at 240ppm (66.38±0.06%) and at 420ppm (55.87±0.03%) respectively. While maintaining scheduled FS-2, the highest and the lowest FCI were observed at 240ppm (66.52±0.05%) and at 420ppm(56.10±0.03%) respectively. In case of FS-3, the FCI also increased at different doses, viz. at 60ppm (58.42±0.04%), 150ppm (62.30±0.03%), 240ppm (63.60±0.03%) and 330ppm (58.16±0.02%) compared to control (56.30±0.03%). But the mean value of FCIwas decreased at 420ppm(55.70±0.03%).

The mean values of FCI of *B mori*under different concentrations and at different feeding schedules were significantly increasedinS-2. While fed according to FS-1, the highest and the lowest FCI were recorded at 240ppm (66.47±0.03%) and at 420ppm (56.38±0.03%) respectively. In case of FS-2, the FCI were increased at different doses, viz. at 60ppm (60.55±0.04%), 150ppm (64.72±0.03%), 240ppm (66.76±0.04%) and 330ppm (60.45±0.04%) compared to the control(56.60±0.03%). The highest and the lowest mean ofFCI were observed at 240ppm (63.86±0.03%) and at 420ppm (56.29±0.02%) respectively while fed according to FS-3.

In different feeding schedules, the mean values of FCI were increased significantly under different concentrations of vit- B_2 in S-3. The highest and the lowest mean ofFCI were observed at 240ppm (64.46±0.05%) and at 420ppm (55.29±0.03%) for

FS-1, at 240ppm (64.70±0.03%) and at 420ppm (55.45±0.02%) for FS-2 and at 240ppm (63.30±0.03%) and at 420ppm (54.87±0.02%) for FS-3 respectively.

InS-4, the supplementationof vit- B_2significantly increased theFCIunder different concentrations and at different feeding schedules. While fed according to FS-1, the highest and the lowestmean of FCI observed at 240ppm (64.22±0.04%) and at 420ppm(54.86±0.02%) respectively. In case of FS-2, the FCI were increased at different doses, viz. at 60ppm (58.50±0.03%), 150ppm(62.51±0.04%), 240ppm(64.44±0.03%), 330ppm(58.32±0.02%) compared to control(55.63±0.03%) but the mean value of FCIwas decreased at 420ppm(55.25±0.04%). The highest and the lowest mean values ofFCI were observed at 240ppm (62.89±0.02%) and at 420ppm (54.62±0.02%)respectively at FS-3.

Analysis of variance showed highly significant differences among feeding schedules (F=42.80),seasons (F=48.89), doses (F=653.82) at 1% level of significance but dose× seasons (F=.65) showed insignificant results in Appendix Table XVIII.

The effectiveness of vit- $B_2$with respect under different seasons on FCI followed the order S-2>S-1>S-3 > S-4 and while in respect of different feeding schedule this trend was FS-2 > FS-1> FS-3.In most of the cases for bothseasons and feeding schedule effective doses of vit-B_2followed the order 240ppm >150ppm >60ppm >330ppm.

Co-efficient of food utilization:

The effect of vit- B_2on co-efficient of food utilization of *B.mori*under different seasons, viz. S-1, S-2, S-3 and S-4 and at different feeding schedules, viz. FS-1, FS-2, FS-3 are shown in Table 21, the graphical presentation are showed in Figure 21 and their statistical analysis is presented in Appendix Table XIX.

The mean values of co-efficient of food utilization were increased in S-1at different doses except 420ppm when compared to the control maintaining

scheduled FS-1. The highest and the lowest mean of co-efficient of food utilization were observed at 240ppm (56.28±0.04%) and at 420ppm (45.87±0.02%) respectively. While fed according to FS-2, the highest and the lowest co-efficient of food utilization were recorded at 240ppm (56.49±0.06%) and at 420ppm (46.10±0.03%) respectively. In case of FS-3, the co-efficient of food utilization also increased at different doses, viz. at 60ppm (47.40±0.03%), 150ppm (52.72±0.04%), 240ppm (55.82±0.03%) and 330ppm (47.16±0.02%) compared to the control (46.30±0.03%). But the mean value of co-efficient of food utilizationwas decreased at 420ppm(45.70±0.03%).

The supplementation of vit- B_2increased co-efficient of food utilization in S-2 under different concentrations and feeding schedules. The highest and the lowest co-efficient of food utilization were observed at 240ppm (56.47±0.04%) and at 420ppm (46.12±0.04%) respectivelywhile fed according to FS-1. In case of FS-2, the co-efficient of food utilization was increased under different doses, viz. at 60ppm (48.52±0.03%), 150ppm (54.77±0.02%), 240ppm (56.75±0.05%) and 330ppm (48.41±0.03%) compared to the control (46.60±0.02%). The highest and the lowest mean of co-efficient of food utilization were recorded at 240ppm (56.22±0.02%) and at 420ppm (45.86±0.03%) respectively while fed according to FS-3.

In different feeding schedules, the mean values of co-efficient of food utilization were significantly increased under different concentration ofvit- B_2 in S-3. The highest and the lowest mean of co-efficient of food utilization were observed at 240ppm (55.37±0.02%) and at 420ppm (45.27±0.02%) for FS-1, at 240ppm (55.71±0.03%) and at 420ppm (45.45±0.03%) for FS-2 and at 240ppm (55.20±0.03%) and at 420ppm (44.75±0.03%) for FS-3 respectively.

During S-4 the mean values of co-efficient of food utilization of *B mori*were significantly increased under different concentrations andat various feeding schedules. While fed according to FS-1, the highest and the lowestmean of co-

efficient of food utilization were observed at 240ppm (55.22±0.04%) and at 420ppm (44.86±0.02%) respectively. In case of FS-2, the co-efficient of food utilization were increased under different doses, viz. at 60ppm (47.50±0.03%), 150ppm (52.41±0.04%), 240ppm (55.42±0.04%), 330ppm (47.31±0.02%) compared to control (45.46±0.03%) but the mean value of co-efficient of food utilizationwas decreased at 420ppm (45.26±0.03%). The highest and the lowest mean values of co-efficient of food utilizationwere observed at 240ppm (54.89±0.01%) and at 420ppm (44.65±0.04%) respectively at FS-3.

The Results of analyses of variance have been presented in Appendix Table XIX. All of the items viz. feeding schedules (F=37.27), seasons (F=133.58), doses (F=4496.95) and dose× seasons (F=3.61) showed highly significant differences at 1% level of significance.

The effectiveness of vit- B_2 with respect to different seasons on co-efficient of food utilization followed the order S-2 > S-1 > S-3 > S-4 and while in respect of different feeding schedule this trend was FS-2 > FS-1 > FS-3. In most of the cases for both seasons and feeding schedule effective doses of vit- B_2 followed the order 240ppm > 150ppm > 60ppm > 330ppm.

Table 1. Effect of vit-B_2 under different feeding schedules, seasons and doses on the larval weight (gm) of *B. mori*L.

Feeding Schedule	Dose (ppm)	Mean ± SE			
		S-1	S-2	S-3	S-4
FS-1	Control	2.24±0.01	2.41±0.01	2.03±0.01	1.90±0.01
	60	2.38±0.01	2.57±0.02	2.19±0.01	2.08±0.01
	150	2.44±0.01	2.59±0.02	2.25±0.02	2.16±0.01
	240	2.51±0.02	2.67±0.02	2.33±0.02	2.24±0.01
	330	2.33±0.01	2.47±0.02	2.12±0.01	2.02±0.02
	420	2.13±0.02	2.34±0.02	1.87±0.02	1.78±0.02
FS-2	Control	2.24±0.01	2.41±0.01	2.03±0.01	1.90±0.01
	60	2.42±0.01	2.61±0.01	2.25±0.02	2.12±0.01
	150	2.53±0.01	2.66±0.02	2.33±0.02	2.21±0.01
	240	2.61±0.01	2.75±0.01	2.42±0.01	2.29±0.02
	330	2.33±0.02	2.50±0.03	2.17±0.02	2.12±0.02
	420	2.19±0.02	2.36±0.01	1.88±0.02	1.84±0.01
FS-3	Control	2.24±0.01	2.41±0.01	2.03±0.01	1.90±0.01
	60	2.25±0.02	2.45±0.01	2.11±0.01	1.73±0.02
	150	2.31±0.01	2.52±0.01	2.17±0.01	1.75±0.03
	240	2.38±0.01	2.58±0.02	2.23±0.01	1.83±0.03
	330	2.19±0.01	2.41±0.01	2.05±0.01	1.70±0.01
	420	1.98±0.02	2.31±0.01	1.76±0.03	1.62±0.01

FS- 1: Feeding Schedule-1, Fed every day in 1st feeding of 3rd to 5th instar larvae
FS- 2: Feeding Schedule- 2, Fed in 1st and 5th feeding of 3rd to 5th instar larvae
FS- 3: Feeding Schedule-3, Fed only in 1st feeding of 3rd to 5th instar larvae

S-1: Season-1, Agrahyani
S-2: Season-2, Chaita
S-3: Season-3, Jaista
S-4 : Season-4 , Baduri

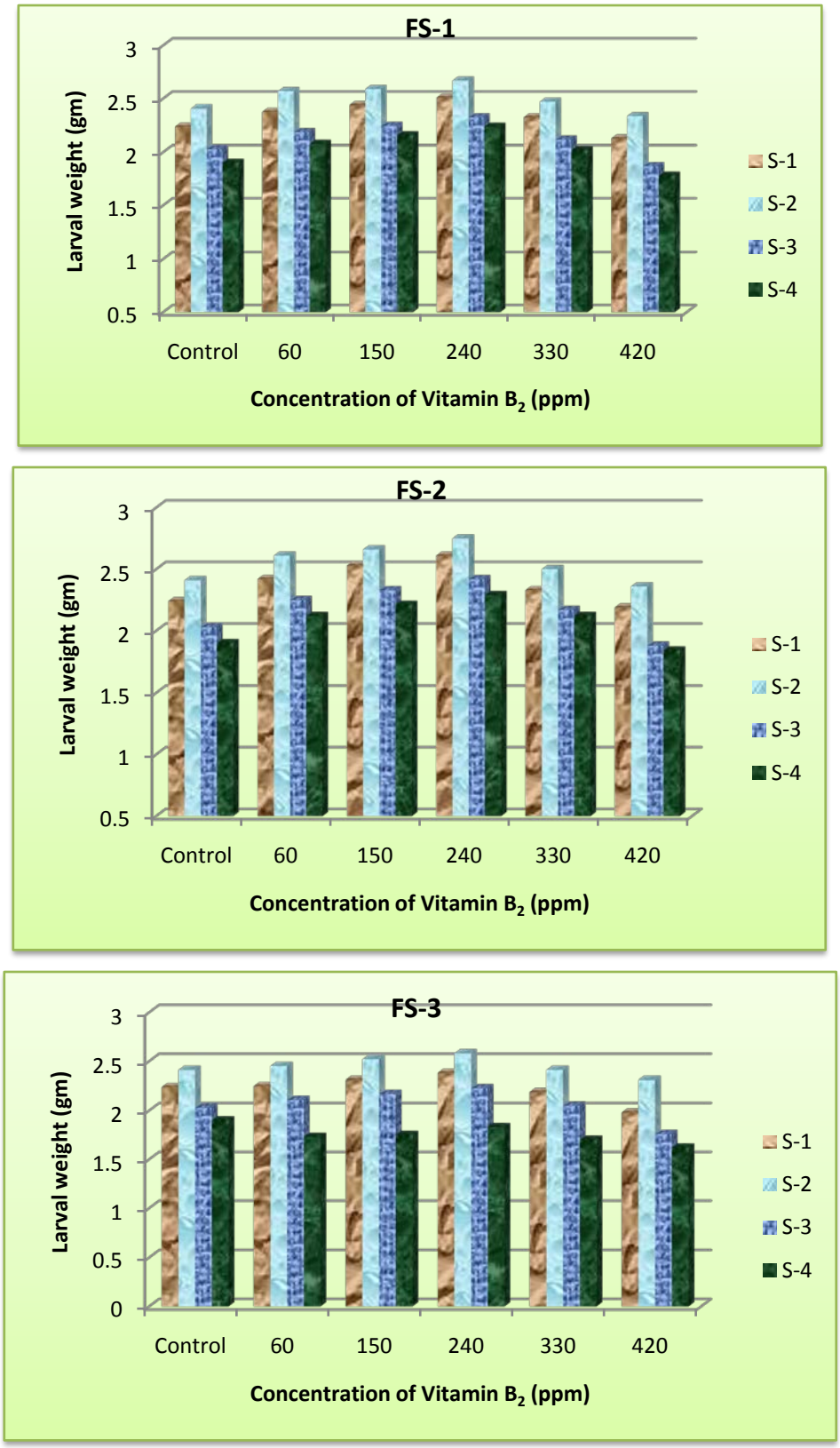


Figure 1.Effect of vit-B_2 supplemented food on LW(gm) of *B. mori* L. at different feeding schedules.

Table 2. Effect of vit-B_2 under different feeding schedules, seasons and doses on the larval length(mm) of *B. mori*L.

Feeding Schedule	Dose (ppm)	Mean ± SE			
		S-1	S-2	S-3	S-4
FS-1	Control	58.50±0.18	59.20±0.19	58.39±0.31	57.83±0.12
	60	61.63±0.27	62.13±0.44	61.38±0.25	61.27±0.21
	150	61.98±0.11	62.40±0.10	61.77±0.06	61.54±0.07
	240	62.55±0.15	62.77±0.35	62.01±0.05	61.82±0.05
	330	60.49±0.11	61.00±0.08	61.23±0.25	61.03±0.22
	420	57.85±0.22	58.68±0.31	57.65±0.06	57.39±0.07
FS-2	Control	58.50±0.18	59.20±0.19	58.39±0.31	57.83±0.12
	60	62.25±0.08	62.48±0.07	61.88±0.06	61.69±0.07
	150	63.45±0.03	63.65±0.03	63.04±0.11	62.79±0.09
	240	64.36±0.19	64.90±0.32	64.17±0.15	63.90±0.18
	330	62.05±0.09	62.29±0.06	61.82±0.09	61.61±0.07
	420	58.31±0.14	59.06±0.16	58.03±0.17	57.60±0.03
FS-3	Control	58.50±0.18	59.20±0.19	58.39±0.31	57.83±0.12
	60	59.83±0.06	60.00±0.10	59.58±0.07	59.35±0.06
	150	60.75±0.13	60.97±0.10	60.49±0.11	60.26±0.10
	240	61.08±0.17	61.42±0.25	60.97±0.24	60.85±0.20
	330	59.61±0.11	59.84±0.12	59.37±0.12	59.14±0.08
	420	58.25±0.18	59.02±0.18	58.01±0.12	57.25±0.12

FS- 1: Feeding Schedule-1, Fed every day in 1st feeding of 3rd to 5th instar larvae
FS- 2: Feeding Schedule- 2, Fed in 1st and 5th feeding of 3rd to 5th instar larvae
FS- 3: Feeding Schedule-3, Fed only in 1st feeding of 3rd to 5th instar larvae

S-1: Season-1, Agrahyani
S-2: Season-2, Chaita
S-3: Season-3, Jaista
S-4 : Season-4 , Baduri

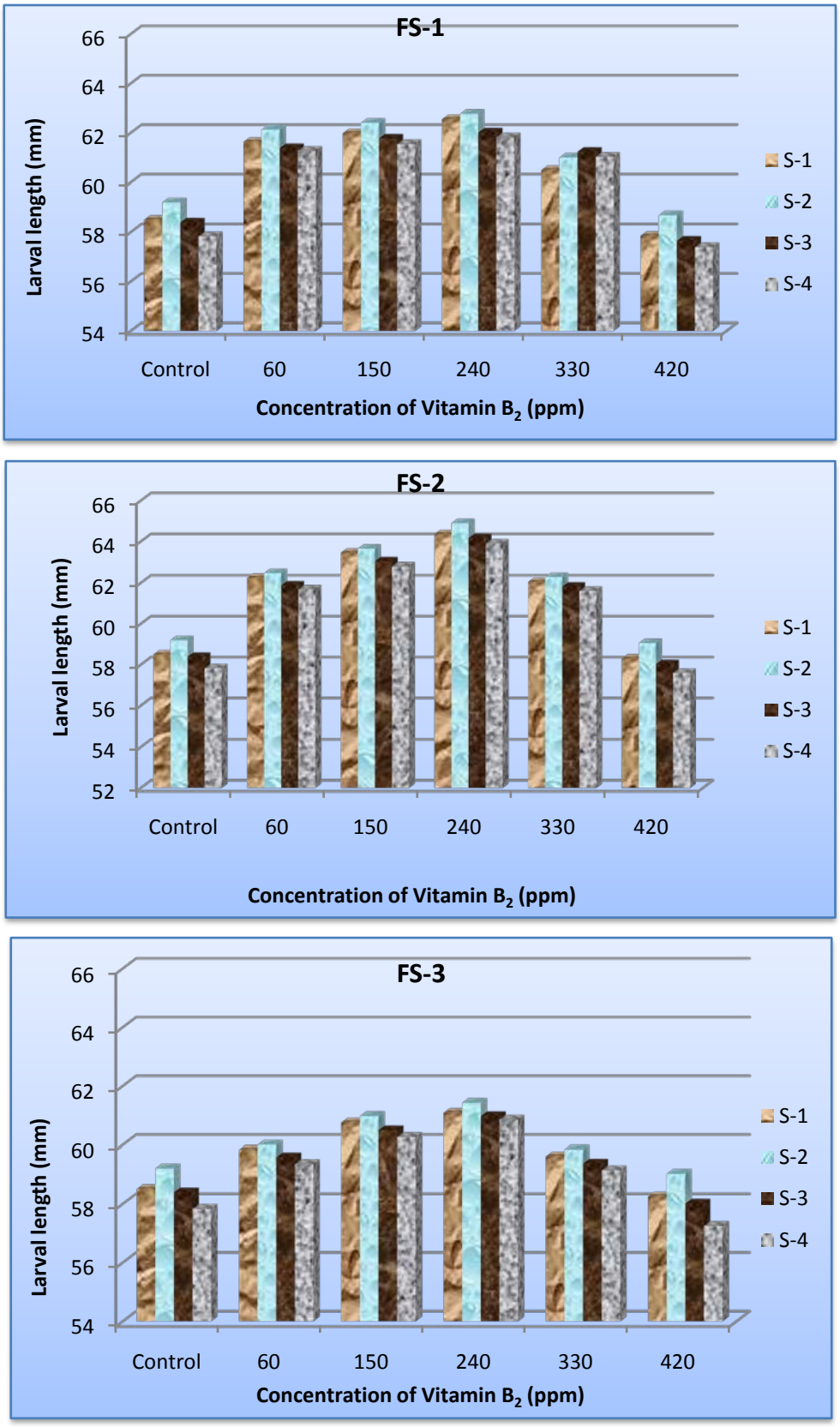


Figure 2.Effect of vit-B_2 supplemented food on LL(mm) of *B. mori* L. at different feeding schedules.

Table 3. Effect of vit-B_2 under different feeding schedules, seasons and doses on the larval breath (mm) of *B. mori*L.

Feeding Schedule	Dose (ppm)	Mean ± SE			
		S-1	S-2	S-3	S-4
FS-1	Control	18.66±0.03	18.89±0.02	18.57±0.01	18.49±0.02
	60	19.79±0.06	19.87±0.08	19.69±0.07	19.59±0.06
	150	20.27±0.05	20.34±0.06	20.17±0.05	20.06±0.03
	240	20.66±0.05	20.60±0.05	20.40±0.03	20.27±0.02
	330	19.66±0.10	19.74±0.11	19.57±0.05	19.43±0.02
	420	18.57±0.04	18.75±0.03	18.48±0.05	18.38±0.03
FS-2	Control	18.66±0.03	18.89±0.02	18.57±0.01	18.49±0.02
	60	20.44±0.02	20.59±0.02	20.37±0.02	19.72±0.05
	150	20.54±0.02	20.72±0.05	20.46±0.02	20.16±0.03
	240	20.80±0.03	21.52±0.03	20.69±0.04	20.58±0.04
	330	20.35±0.02	20.42±0.04	20.25±0.03	19.57±0.03
	420	18.60±0.05	18.79±0.05	18.52±0.04	18.44±0.02
FS-3	Control	18.66±0.03	18.89±0.02	18.57±0.01	18.49±0.02
	60	19.69±0.02	19.82±0.02	19.59±0.04	19.48±0.02
	150	20.22±0.06	20.27±0.04	20.05±0.07	19.95±0.06
	240	20.53±0.04	20.54±0.01	20.34±0.02	20.12±0.01
	330	19.52±0.02	19.61±0.05	19.47±0.04	19.32±0.01
	420	18.52±0.02	18.67±0.03	18.38±0.01	18.24±0.01

FS- 1: Feeding Schedule-1, Fed every day in 1st feeding of 3rd to 5th instar larvae
FS- 2: Feeding Schedule- 2, Fed in 1st and 5th feeding of 3rd to 5th instar larvae
FS- 3: Feeding Schedule-3, Fed only in 1st feeding of 3rd to 5th instar larvae

S-1: Season-1, Agrahyani
S-2: Season-2, Chaita
S-3: Season-3, Jaista
S-4 : Season-4 , Baduri

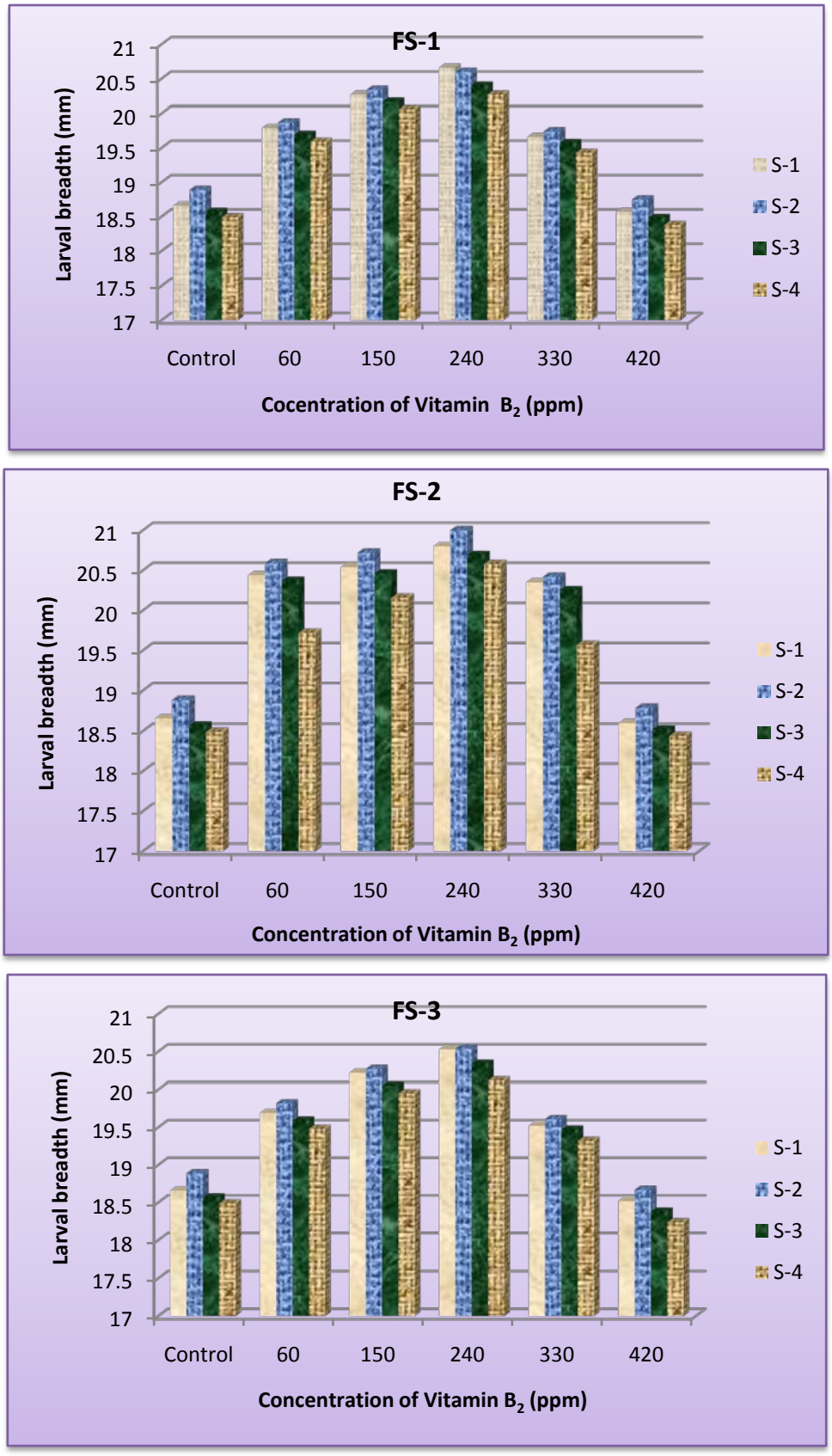


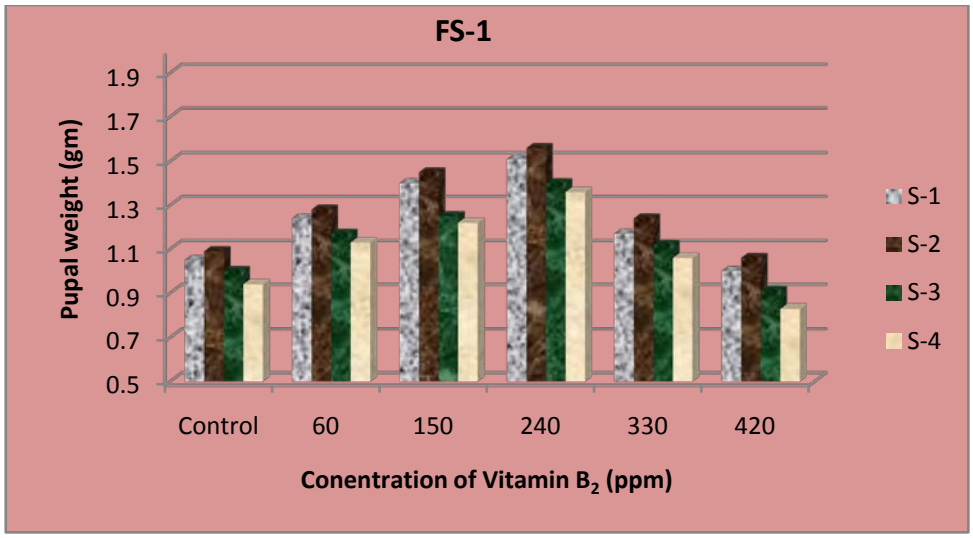
Figure 3.Effect of vit-B_2 supplemented food on LB(mm) of *B. mori* L. at different feeding schedules.

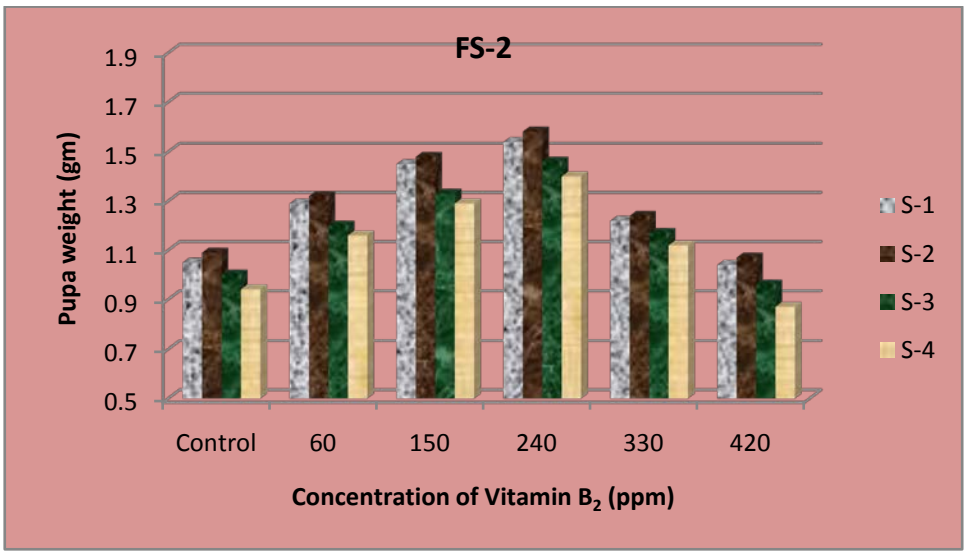
Table 4. Effect of vit-B_2 under different feeding schedules, seasons and doses on the pupa weight (gm) of *B. mori*L.

Feeding Schedule	Dose (ppm)	Mean ± SE			
		S-1	S-2	S-3	S-4
FS-1	Control	1.05 ±0.01	1.09±0.01	1.00±0.01	0.94±0.01
	60	1.24±0.01	1.28±0.01	1.17±0.01	1.13±0.01
	150	1.40±0.01	1.45±0.01	1.25±0.02	1.22±0.02
	240	1.51±0.01	1.56±0.02	1.40±0.01	1.36±0.01
	330	1.17±0.00	1.24±0.01	1.12±0.01	1.06±0.01
	420	1.00±0.01	1.06±0.02	0.91±0.01	0.83±0.02
FS-2	Control	1.05±0.01	1.09±0.01	1.00±0.01	0.94±0.01
	60	1.29±0.02	1.32±0.01	1.20±0.33	1.16±0.02
	150	1.45±0.01	1.48±0.01	1.33±0.02	1.29±0.01
	240	1.54±0.01	1.58±0.01	1.46±0.02	1.40±0.02
	330	1.22±0.02	1.24±0.01	1.17±0.02	1.12±0.02
	420	1.04±0.01	1.07±0.01	0.96±0.01	0.87±0.01
FS-3	Control	1.05±0.01	1.09±0.01	1.00±0.01	0.94±0.01
	60	1.18±0.01	1.23±0.01	1.12±0.01	1.09±±0.01
	150	1.32±0.03	1.37±0.02	1.21±0.01	1.18±0.01
	240	1.42±0.03	1.50±0.01	1.32±0.01	1.27±0.00
	330	1.13±0.01	1.18±0.01	1.08±0.00	1.04±0.00
	420	0.94±0.01	1.03±0.02	0.84±0.01	0.72±0.01

FS- 1: Feeding Schedule-1, Fed every day in 1st feeding of 3rd to 5th instar larvae
FS- 2: Feeding Schedule- 2, Fed in 1st and 5th feeding of 3rd to 5th instar larvae
FS- 3: Feeding Schedule-3, Fed only in 1st feeding of 3rd to 5th instar larvae

S-1: Season-1, Agrahyani
S-2: Season-2, Chaita
S-3: Season-3, Jaista
S-4 : Season-4 , Baduri





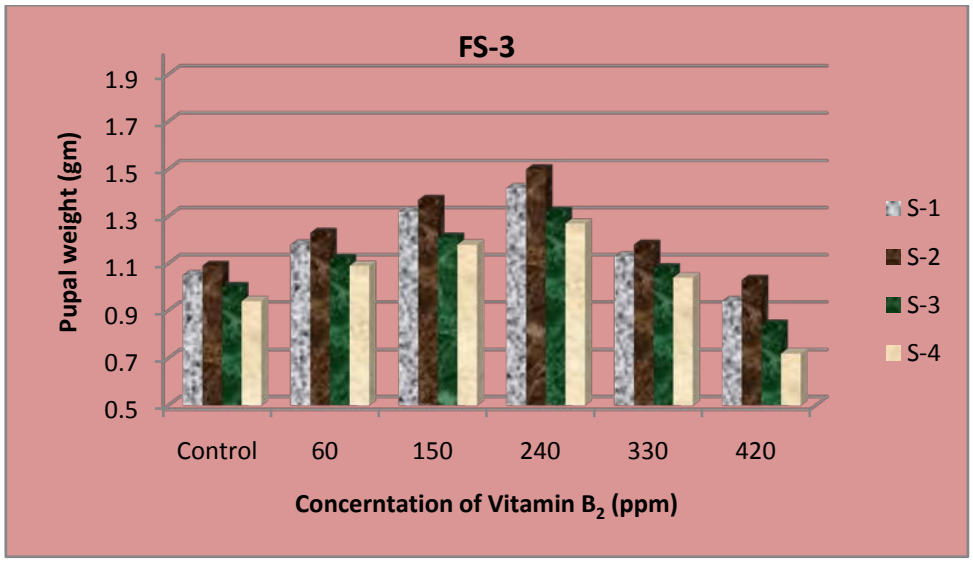


Figure 4.Effect of vit-B_2 supplemented food on PW(gm) of *B. mori* L. at different feeding schedules.

Table 5. Effect of vit-B_2 under different feeding schedules, seasons and doses on the cocoon weight (gm) of *B. mori*L.

Feeding Schedule	Dose (ppm)	Mean ± SE			
		S-1	S-2	S-3	S-4
FS-1	Control	1.17±0.01	1.22±0.01	1.11±0.01	1.04±0.01
	60	1.37±0.01	1.42±0.01	1.29±0.01	1.24±0.01
	150	1.54±0.01	1.60±0.01	1.38±0.02	1.33±0.02
	240	1.66±0.01	1.72±0.02	1.54±0.01	1.49±0.01
	330	1.29±0.01	1.37±0.01	1.24±0.01	1.17±0.01
	420	1.11±0.01	1.18±0.02	1.01±0.01	0.92±0.01
FS-2	Control	1.17±0.01	1.22±0.01	1.11±0.01	1.04±0.01
	60	1.42±0.01	1.46±0.01	1.38±0.01	1.32±0.02
	150	1.59±0.01	1.64±0.01	1.48±0.01	1.42±0.01
	240	1.68±0.01	1.75±0.02	1.62±0.02	1.52±0.02
	330	1.35±0.02	1.38±0.01	1.33±0.02	1.26±0.02
	420	1.15±0.01	1.20±0.01	1.07±0.01	0.98±0.01
FS-3	Control	1.17±0.01	1.22±0.01	1.11±0.01	1.04±0.01
	60	1.31±0.01	1.36±0.01	1.24±0.01	1.19±0.01
	150	1.46±0.03	1.52±0.02	1.34±0.01	1.29±0.01
	240	1.57±0.02	1.65±0.02	1.46±0.01	1.39±0.01
	330	1.25±0.01	1.31±0.01	1.19±0.01	1.15±0.00
	420	1.06±0.01	1.15±0.02	0.94±0.01	0.81±0.01

FS- 1: Feeding Schedule-1, Fed every day in 1st feeding of 3rd to 5th instar larvae
FS- 2: Feeding Schedule- 2, Fed in 1st and 5th feeding of 3rd to 5th instar larvae
FS- 3: Feeding Schedule-3, Fed only in 1st feeding of 3rd to 5th instar larvae

S-1: Season-1, Agrahyani
S-2: Season-2, Chaita
S-3: Season-3, Jaista
S-4 : Season-4 , Baduri

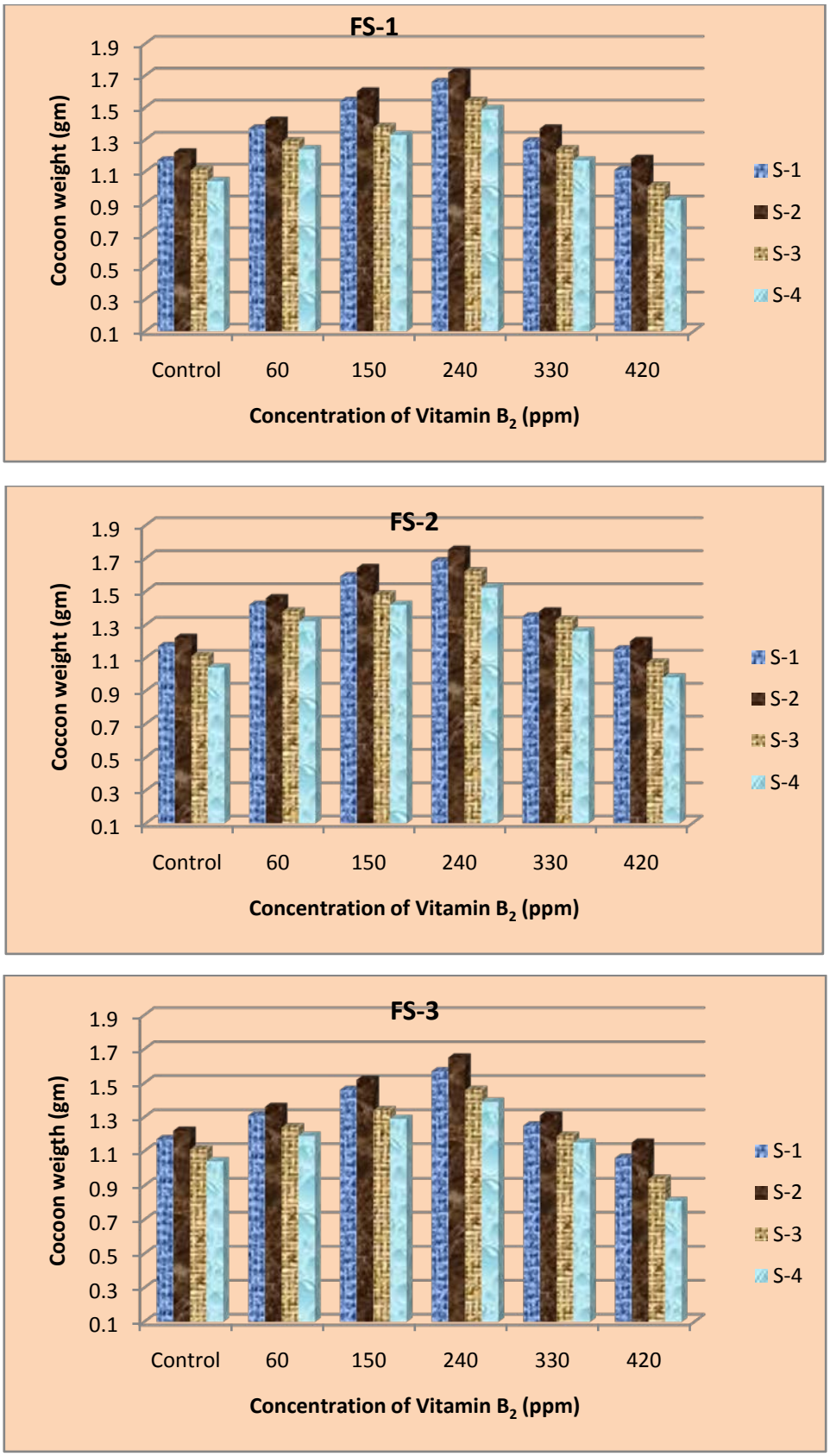


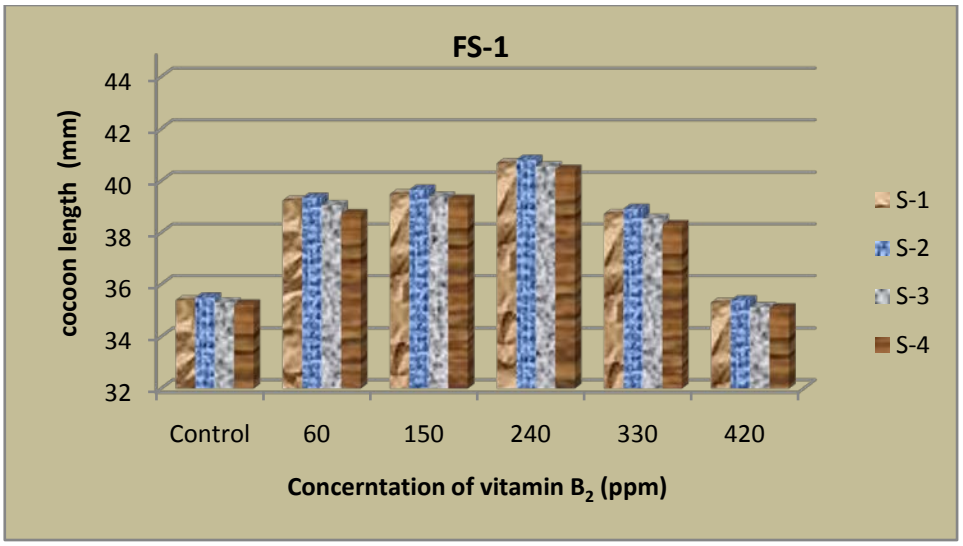
Figure 5. Effect of vit-B_2 supplemented food on CW(gm) of *B. mori* L. at different feeding schedules.

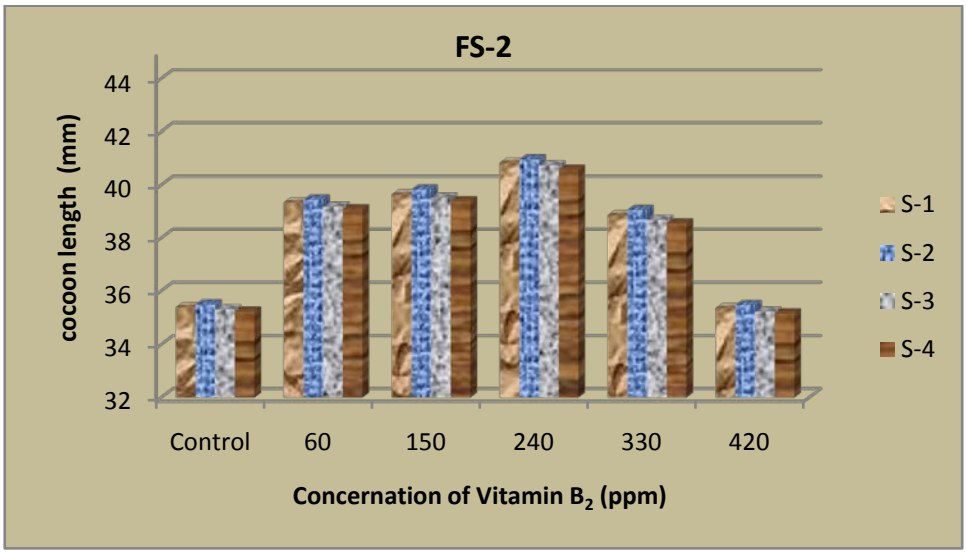
Table 6. Effect of vit-B_2 under different feeding schedules, seasons and doses on the cocoon length (mm) of *B. mori*L.

Feeding Schedule	Dose (ppm)	Mean ± SE			
		S-1	S-2	S-3	S-4
FS-1	Control	35.38 ±0.01	35.49±0.03	35.30±0.01	35.22±0.02
	60	39.24±0.02	39.35±0.02	39.06±0.03	38.72±0.01
	150	39.48±0.01	39.66±0.02	39.39±0.02	39.28±0.01
	240	40.68±0.02	40.82±0.02	40.56±0.02	40.43±0.03
	330	38.72±0.01	38.92±0.01	38.54±0.02	38.29±0.02
	420	35.29±0.02	35.38±0.01	35.12±0.01	35.07±0.02
FS-2	Control	35.38±0.01	35.49±0.03	35.30±0.01	35.22±0.02
	60	39.34±0.02	39.45±0.02	39.18±0.02	39.08±0.01
	150	39.64±0.02	39.83±0.02	39.52±0.01	39.39±0.02
	240	40.84±0.01	40.97±0.02	40.74±0.02	40.58±0.01
	330	38.86±0.02	39.06±0.03	38.68±0.01	38.55±0.03
	420	35.35±0.02	35.47±0.02	35.22±0.01	35.15±0.02
FS-3	Control	35.38±0.01	35.49±0.03	35.30±0.01	35.22±0.02
	60	38.62±0.31	39.28±0.01	38.78±0.01	38.58±0.01
	150	39.26±0.02	39.46±0.02	39.02±0.01	38.82±0.01
	240	40.58±0.01	40.65±0.02	40.45±0.02	40.22±0.01
	330	38.55±0.02	38.71±0.02	38.35±0.02	38.15±0.02
	420	35.17±0.03	35.30±0.01	35.08±0.02	35.01±0.01

FS- 1: Feeding Schedule-1, Fed every day in 1st feeding of 3rd to 5th instar larvae
FS- 2: Feeding Schedule- 2, Fed in 1st and 5th feeding of 3rd to 5th instar larvae
FS- 3: Feeding Schedule-3, Fed only in 1st feeding of 3rd to 5th instar larvae

S-1: Season-1, Agrahyani
S-2: Season-2, Chaita
S-3: Season-3, Jaista
S-4 : Season-4 , Baduri





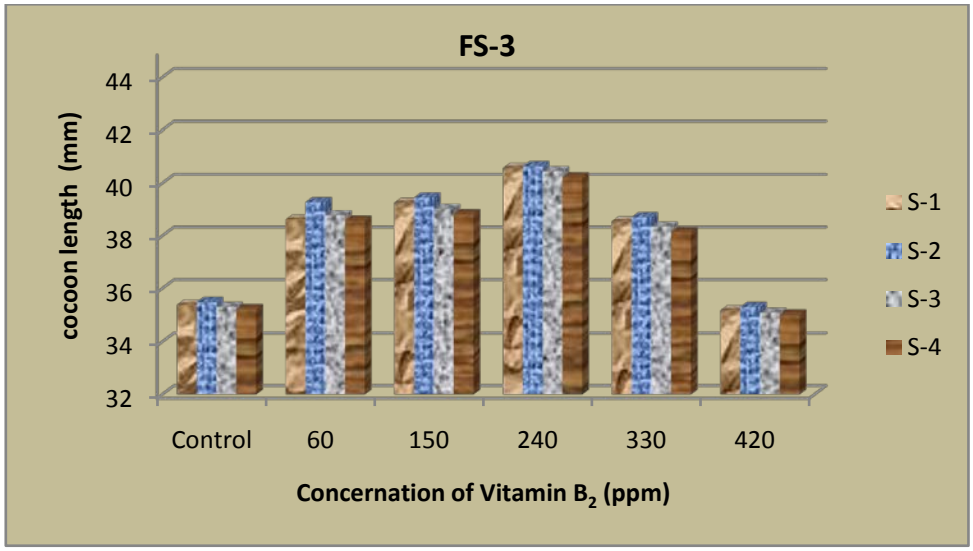


Figure 6.Effect of vit-B_2 supplemented food on CL(mm) of *B. mori* L. at different feeding schedules.

Table 7. Effect of vit-B_2 under different feeding schedules, seasons and doses on the cocoon breadth (mm) of *B. mori* L.

Feeding Schedule	Dose (ppm)	Mean ± SE			
		S-1	S-2	S-3	S-4
FS-1	Control	20.98±0.01	21.20±0.02	20.78±0.01	20.52±0.01
	60	24.12±0.02	24.32±0.02	23.92±0.01	23.71±0.01
	150	24.14±0.02	24.36±0.03	23.98±0.02	23.79±0.01
	240	24.35±0.02	24.58±0.01	24.15±0.02	23.95±0.02
	330	23.69±0.02	23.91±0.02	23.48±0.01	23.24±0.02
	420	20.74±0.02	20.98±0.01	20.57±0.01	20.32±0.01
FS-2	Control	20.98±0.01	21.20±0.02	20.78±0.01	20.52±0.01
	60	24.28±0.01	24.48±0.01	24.08±0.01	23.88±0.01
	150	24.43±0.01	24.64±0.02	24.22±0.01	24.02±0.02
	240	24.61±0.02	24.79±0.01	24.41±0.02	24.22±0.02
	330	23.92±0.01	24.12±0.01	23.72±0.01	23.52±0.01
	420	20.82±0.01	21.02±0.01	20.62±0.01	20.42±0.01
FS-3	Control	20.98±0.01	21.20±0.02	20.78±0.01	20.52±0.01
	60	23.92±0.01	24.18±0.01	23.72±0.01	23.60±0.01
	150	24.07±0.02	24.28±0.02	23.86±0.01	23.71±0.01
	240	24.28±0.01	24.50±0.01	24.02±0.01	23.84±0.01
	330	23.62±0.01	23.84±0.02	23.42±0.01	23.20±0.01
	420	20.77±0.01	20.85±0.02	20.44±0.01	20.26±0.01

FS- 1: Feeding Schedule-1, Fed every day in 1st feeding of 3rd to 5th instar larvae
FS- 2: Feeding Schedule- 2, Fed in 1st and 5th feeding of 3rd to 5th instar larvae
FS- 3: Feeding Schedule-3, Fed only in 1st feeding of 3rd to 5th instar larvae

S-1: Season-1, Agrahyani
S-2: Season-2, Chaita
S-3: Season-3, Jaista
S-4 : Season-4 , Baduri

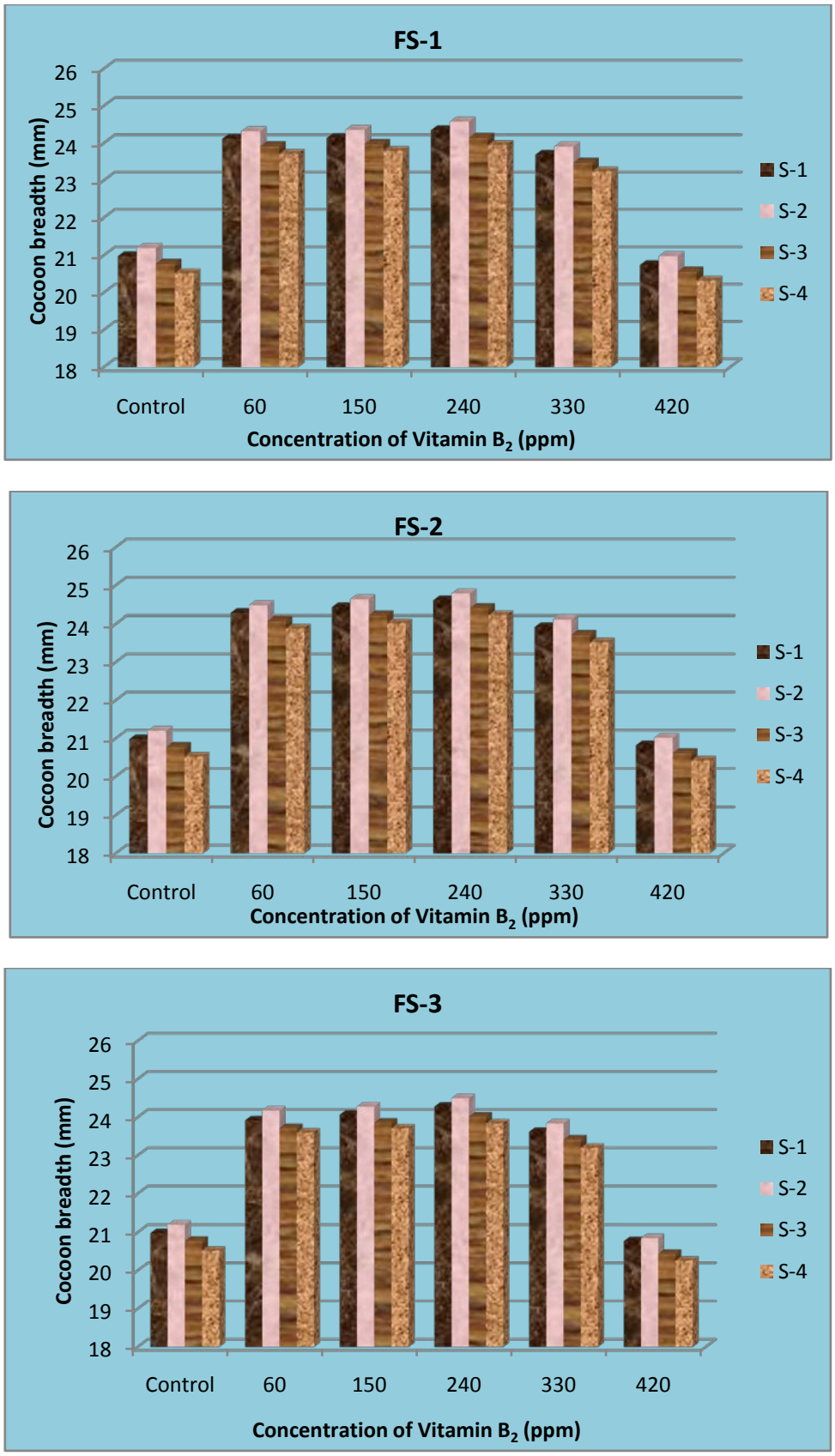


Figure 7.Effect of vit-B_2 supplemented food on CB(mm) of *B. mori* L. at different feeding schedules.

Table 8. Effect of vit-B_2 under different feeding schedules, seasons and doses on the shell weight (gm) of *B. mori*L.

Feeding Schedule	Dose (ppm)	Mean ± SE			
		S-1	S-2	S-3	S-4
FS-1	Control	0.120±0.000	0.133±0.003	0.113±0.003	0.103±0.003
	60	0.133±0.003	0.140±0.000	0.123±0.003	0.107±0.003
	150	0.143±0.003	0.153±0.003	0.133±0.003	0.117±0.003
	240	0.150±0.000	0.160±0.000	0.143±0.003	0.130±0.000
	330	0.127±0.003	0.130±0.000	0.120±0.000	0.113±0.003
	420	0.113±0.003	0.123±0.003	0.103±0.003	0.093±0.003
FS-2	Control	0.120±0.000	0.133±0.003	0.113±0.003	0.103±0.003
	60	0.137±0.003	0.143±0.003	0.133±0.003	0.123±0.003
	150	0.147±0.003	0.157±0.003	0.143±0.003	0.133±0.003
	240	0.163±0.003	0.167±0.003	0.153±0.003	0.143±0.003
	330	0.133±0.003	0.140±0.000	0.130±0.000	0.120±0.000
	420	0.117±0.003	0.130±0.000	0.110±0.000	0.097±0.003
FS-3	Control	0.120±0.000	0.133±0.003	0.113±0.003	0.103±0.003
	60	0.127±0.003	0.133±0.003	0.120±0.000	0.103±0.003
	150	0.140±0.000	0.147±0.003	0.130±0.000	0.110±0.000
	240	0.147±0.003	0.153±0.003	0.140±0.000	0.127±0.003
	330	0.120±0.000	0.127±0.003	0.117±0.003	0.110±0.000
	420	0.110±0.003	0.120±0.000	0.100±0.000	0.087±0.003

FS- 1: Feeding Schedule-1, Fed every day in 1st feeding of 3rd to 5th instar larvae
FS- 2: Feeding Schedule- 2, Fed in 1st and 5th feeding of 3rd to 5th instar larvae
FS- 3: Feeding Schedule-3, Fed only in 1st feeding of 3rd to 5th instar larvae

S-1: Season-1, Agrahyani
S-2: Season-2, Chaita
S-3: Season-3, Jaista
S-4 : Season-4 , Baduri

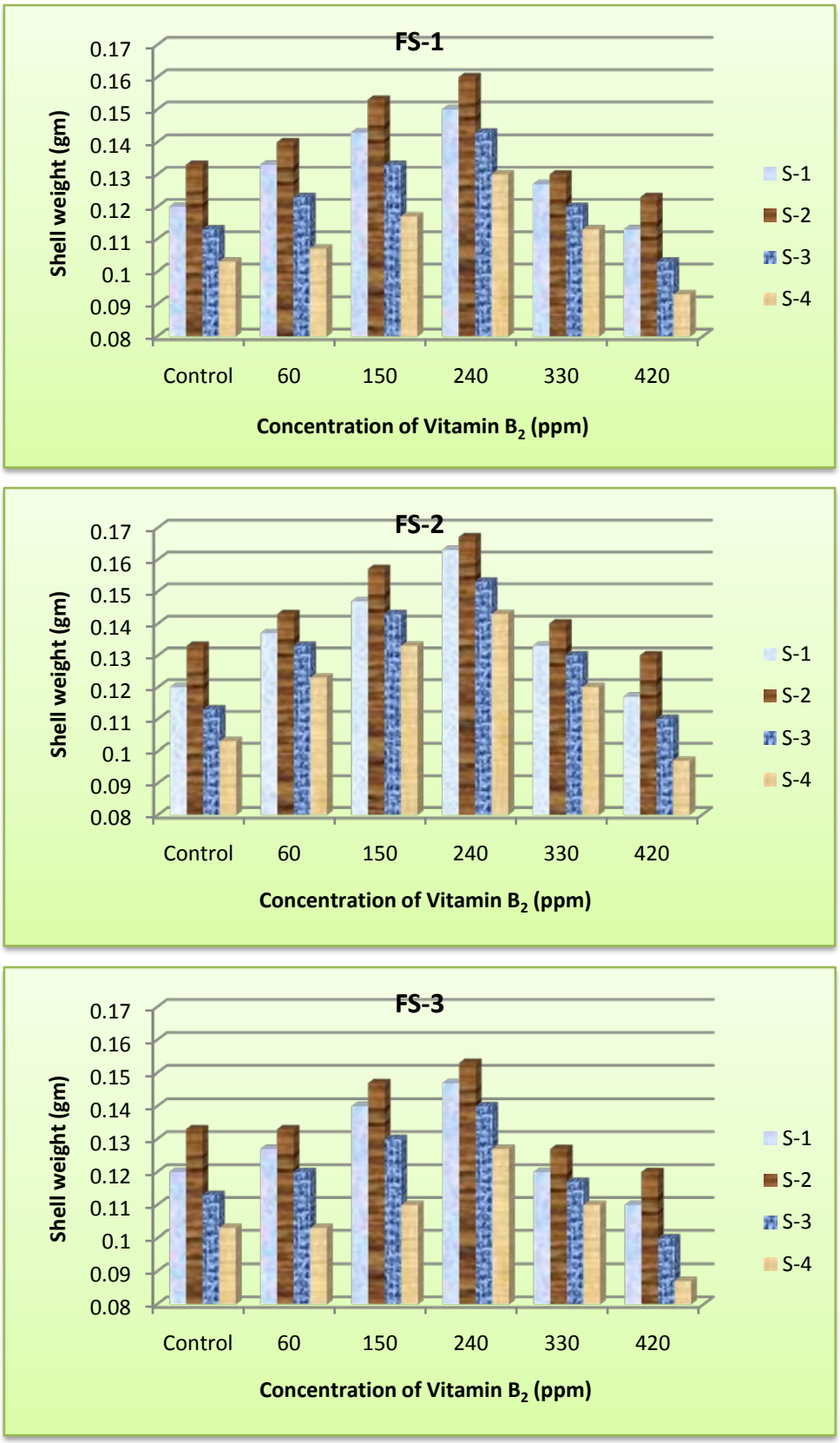


Figure 8. Effect of vit-B_2 supplemented food on SW(gm) of *B. mori* L. at different feeding schedules.

Table 9. Effect of vit-B_2 under different feeding schedules, seasons and doses on the shell ratio (%) of *B. mori*L.

Feeding Schedule	Dose (ppm)	Mean ± SE			
		S-1	S-2	S-3	S-4
FS-1	Control	10.26±0.09	10.90±0.16	10.18±0.27	9.93±0.28
	60	9.73±0.22	9.84±0.10	9.54±0.31	8.60±0.20
	150	9.31±0.19	9.58±0.22	9.64±0.21	8.76±0.32
	240	9.04±0.05	9.32±0.09	9.31±0.19	8.71±0.04
	330	9.79±0.21	9.49±0.07	9.68±0.08	9.69±0.25
	420	10.18±0.27	10.42±0.24	10.20±0.30	10.12±0.50
FS-2	Control	10.26±0.09	10.90±0.16	10.18±0.27	9.93±0.28
	60	9.61±0.32	9.80±0.25	9.66±0.25	9.37±0.33
	150	9.20±0.18	9.57±0.24	9.71±0.32	9.37±0.15
	240	9.74±0.14	9.52±0.12	9.49±0.32	9.46±0.34
	330	9.89±0.37	10.17±0.11	9.75±0.12	9.56±0.18
	420	10.12±0.37	10.84±0.10	10.93±0.07	10.58±0.35
FS-3	Control	10.26±.09	10.90±0.16	10.18±0.27	9.93±0.28
	60	9.69±0.24	9.81±0.29	9.68±0.08	8.66±0.26
	150	9.60±0.20	9.67±0.12	9.70±0.07	8.51±0.04
	240	9.37±0.33	9.29±0.13	9.59±0.07	9.09±0.20
	330	9.63±0.11	9.69±0.24	9.77±0.23	9.57±0.00
	420	11.01±0.41	10.44±0.16	10.60±0.08	10.74±0.38

FS- 1: Feeding Schedule-1, Fed every day in 1st feeding of 3rd to 5th instar larvae
FS- 2: Feeding Schedule- 2, Fed in 1st and 5th feeding of 3rd to 5th instar larvae
FS- 3: Feeding Schedule-3, Fed only in 1st feeding of 3rd to 5th instar larvae

S-1: Season-1, Agrahyani
S-2: Season-2, Chaita
S-3: Season-3, Jaista
S-4 : Season-4 , Baduri

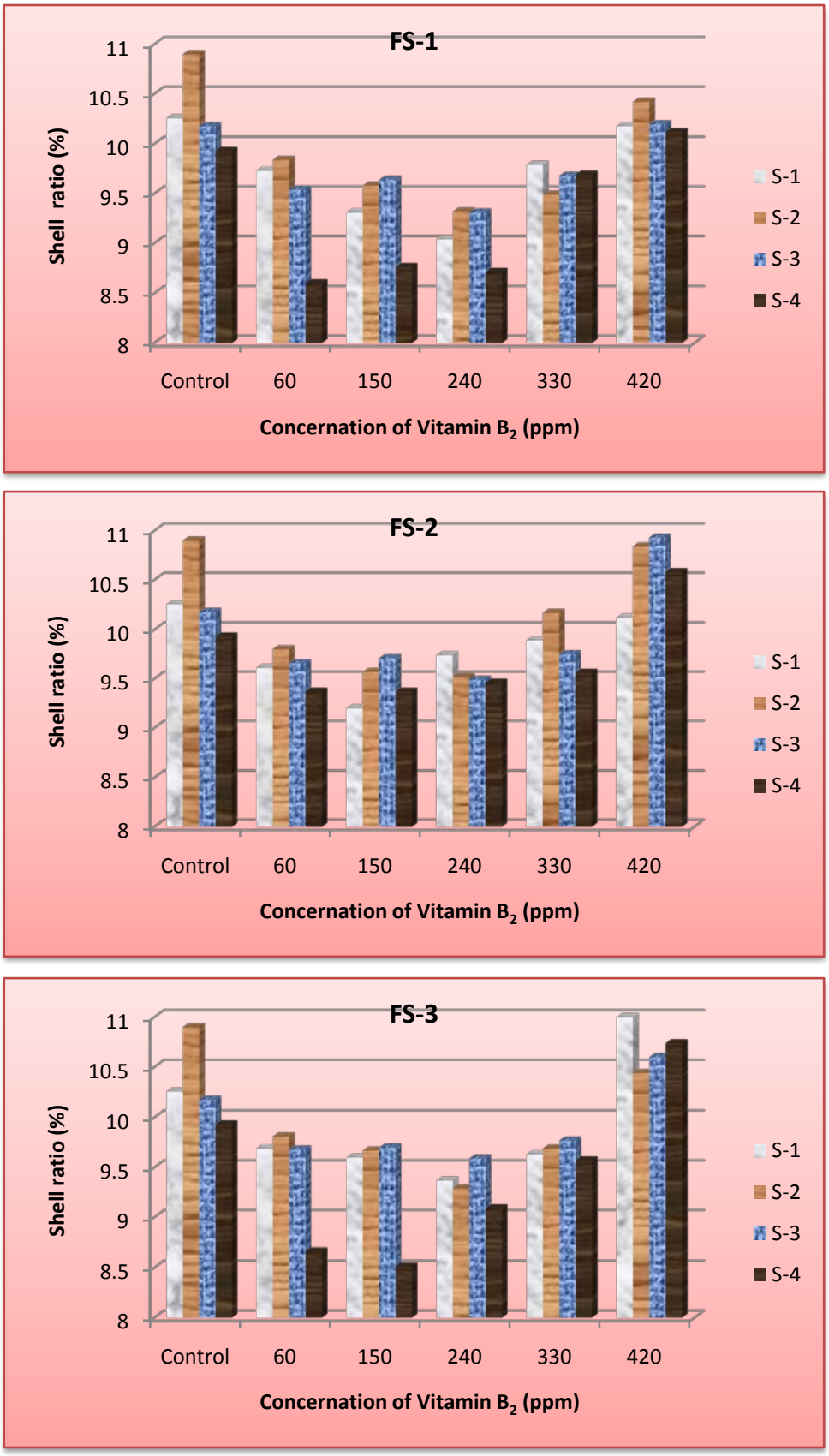


Figure 9. Effect of vit-B_2 supplemented food on SR(%) of *B. mori* L. at different feeding schedules.

Table 10. Effect of vit-B_2 under different feeding schedules, seasons and doses on the survival percentage of *B. mori*L.

Feeding Schedule	Dose (ppm)	Mean ± SE			
		S-1	S-2	S-3	S-4
FS-1	Control	90.67±0.03	92.00±0.09	90.00±0.10	86.67±0.01
	60	93.33±0.05	94.00±0.07	91.33±0.12	89.33±0.07
	150	94.00±0.06	94.67±0.08	92.67±0.04	90.67±0.03
	240	95.33±0.04	96.67±0.06	94.00±0.06	92.00±0.17
	330	92.67±0.04	93.33±0.05	90.67±0.03	88.00±0.10
	420	89.33±0.07	90.00±0.10	86.67±0.07	85.33±0.07
FS-2	Control	90.67±0.03	92.00±0.09	90.00±0.10	86.67±0.01
	60	93.38±0.12	95.33±0.05	92.00±0.09	90.67±0.03
	150	94.67±0.08	96.00±0.10	93.33±0.05	92.00±0.17
	240	96.67±0.06	98.00±0.12	94.67±0.08	94.00±0.06
	330	93.62±0.25	94.00±0.06	91.33±0.12	90.00±0.10
	420	90.00±0.10	90.67±0.03	88.00±0.10	86.62±0.06
FS-3	Control	90.67±0.03	92.00±0.09	90.00±0.10	86.67±0.01
	60	92.00±0.09	93.33±0.05	90.67±0.03	88.00±0.10
	150	92.67±0.04	94.00±0.07	91.33±0.12	89.33±0.07
	240	93.33±0.05	95.33±0.05	92.00±0.09	90.67±0.03
	330	91.33±0.12	92.67±0.04	89.33±0.07	87.33±0.12
	420	88.00±0.10	88.67±0.04	85.33±0.07	84.00±0.07

FS- 1: Feeding Schedule-1, Fed every day in 1st feeding of 3rd to 5th instar larvae
FS- 2: Feeding Schedule- 2, Fed in 1st and 5th feeding of 3rd to 5th instar larvae
FS- 3: Feeding Schedule-3, Fed only in 1st feeding of 3rd to 5th instar larvae

S-1: Season-1, Agrahyani
S-2: Season-2, Chaita
S-3: Season-3, Jaista
S-4 : Season-4 , Baduri

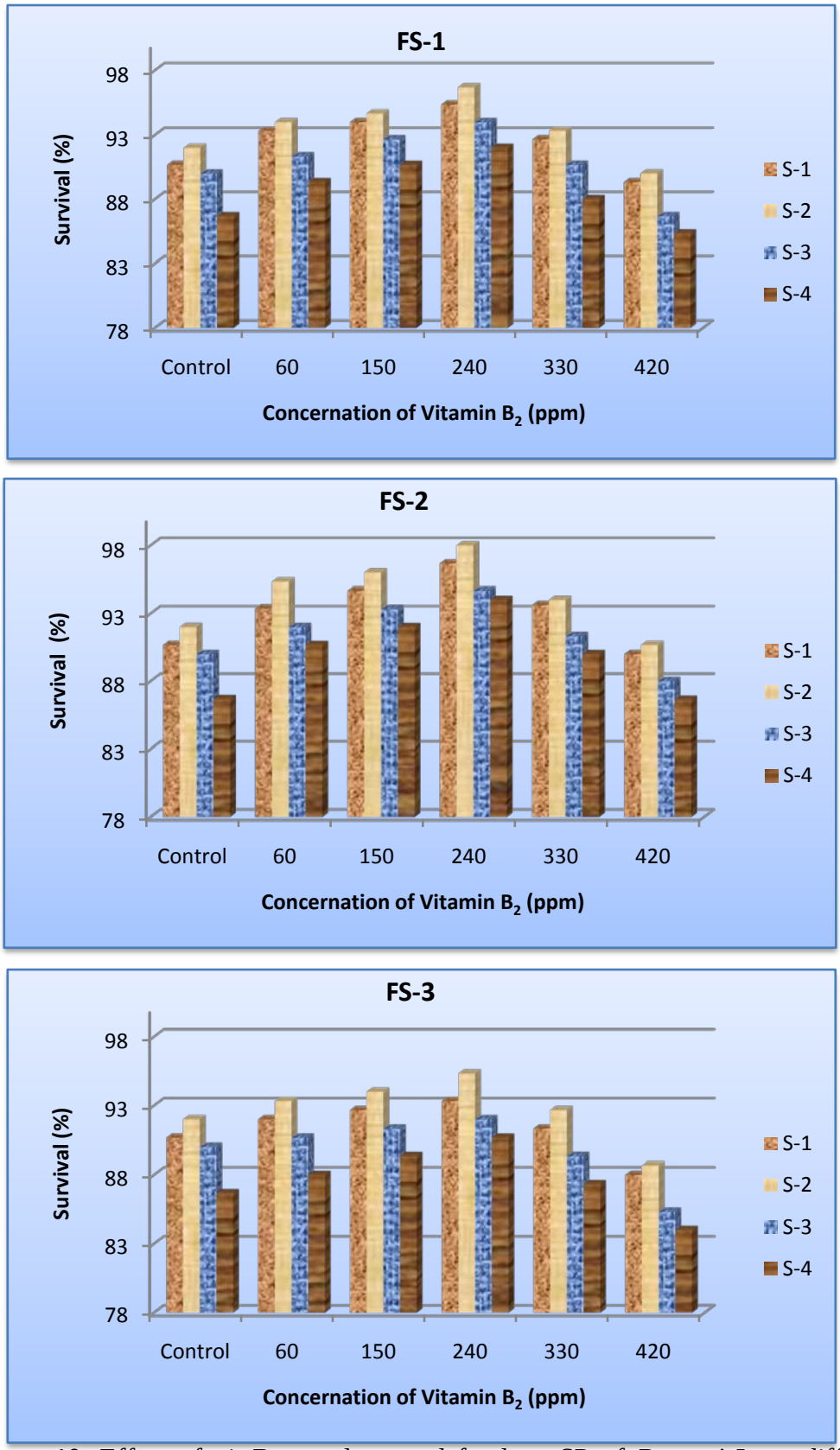


Figure 10. Effect of vit-B_2 supplemented food on SP of *B. mori* L. at different feeding schedules.

Table 11. Effect of vit-B_2 under different feeding schedules, seasons and doses on the adult emergence (%) of *B. mori*L.

Feeding Schedule	Dose (ppm)	S-1		S-2		S-3		S-4	
		AE%	d-value	AE%	d-value	AE%	d-value	AE%	d-value
FS-1	Control	88	---	90	---	85.33	---	83.33	---
	60	90	21.93**	92	25.07**	88	19.14**	85.33	16.95**
	150	90.67	22.41**	92.67	25.70**	89.33	19.88**	86.67	17.54**
	240	92	23.42**	94.67	27.84**	90.67	20.69**	88	18.16**
	330	89.33	21.48**	90.67	23.92**	86.67	18.46**	84	16.40**
	420	85.33	19.14**	88	21.93**	82.67	16.68**	81.33	15.39**
FS-2	Control	88	---	90	---	85.33	---	83.33	---
	60	90.67	22.41**	92.67	25.07**	89.33	19.88**	88	18.16**
	150	92	23.42**	93.33	26.37**	90.67	20.69**	89.33	18.84**
	240	93.33	24.55**	95.33	28.65**	92	21.57**	90.67	19.57**
	330	90	21.93**	91.33	24.48**	87.33	18.79**	86.67	17.54**
	420	86.67	19.86**	89.33	22.87**	84	17.23**	82.67	15.88**
FS-3	Control	88	---	90	---	85.33	---	83.33	---
	60	89.33	21.48**	91.33	24.48**	87.33	18.79**	84	16.40**
	150	90	21.93**	92	25.07**	88	19.14**	85.33	16.95**
	240	91.33	22.90**	93.33	26.37**	89.33	19.88**	86.67	17.54**
	330	88.67	21.05**	90.67	23.92**	86.67	18.46**	83.33	16.13**
	420	84.67	18.81**	86.67	21.07**	81.33	16.15**	80	14.93**

FS- 1: Feeding Schedule-1, Fed every day in 1st feeding of 3rd to 5th instar larvae
FS- 2: Feeding Schedule- 2, Fed in 1st and 5th feeding of 3rd to 5th instar larvae
FS- 3: Feeding Schedule-3, Fed only in 1st feeding of 3rd to 5th instar larvae

S-1: Season-1, Agrahyani
S-2: Season-2, Chaita
S-3: Season-3, Jaista
S-4 : Season-4 , Baduri

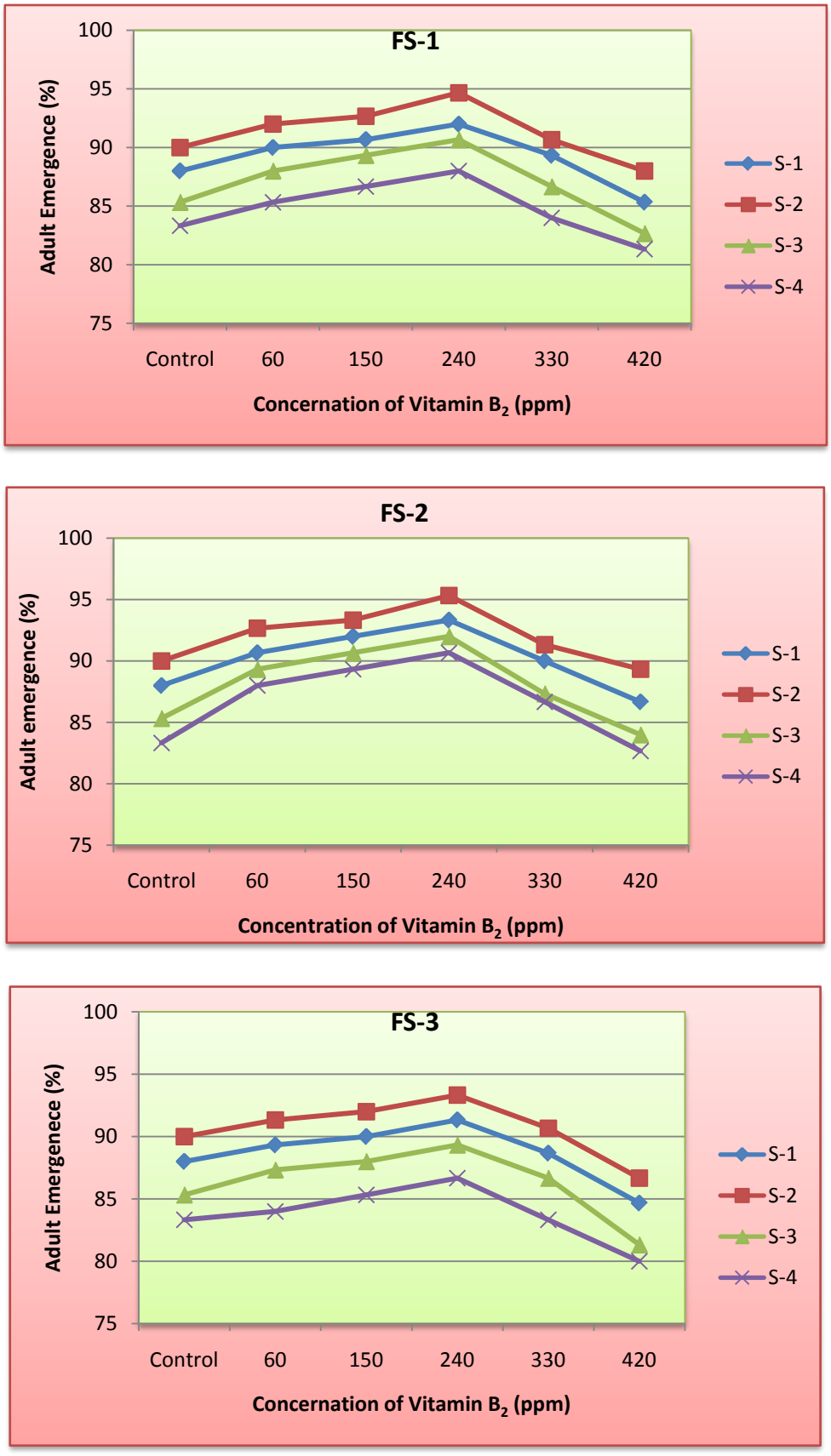


Figure 11.AE (%) line of vit-B_2 supplemented food against *B. mori* L. at different feeding schedules.

Table 12. Effect of vit-B_2 under different feeding schedules, seasons and doses on the larval period (days) of *B. mori*L.

Feeding Schedule	Dose (ppm)	Mean ± SE			
		S-1	S-2	S-3	S-4
FS-1	Control	23.450±0.017	23.383±0.033	23.500±0.012	23.530±0.010
	60	23.410±0.021	23.367±0.017	23.470±0.010	23.507±0.007
	150	23.367±0.017	23.277±0.015	23.440±0.010	23.487±0.007
	240	23.333×0.017	23.260±0.010	23.393±0.007	23.413±0.007
	330	23.433±0.017	23.383±0.020	23.493±0.007	23.513±0.007
	420	23.487±0.007	23.460±0.010	23.523±0.015	23.570±0.010
FS-2	Control	23.450±0.017	23.383±0.033	23.500±0.012	23.530±0.010
	60	23.383±0.017	23.317±0.017	23.460±0.010	23.493±0.007
	150	23.340±0.010	23.250±0.017	23.407±0.007	23.460±0.010
	240	23.300±0.012	23.210±0.021	23.360±0.010	23.407±0.007
	330	23.377±0.015	23.330±0.010	23.477±0.015	23.490±0.021
	420	23.477±0.015	23.400±0.029	23.507±0.007	23.560±0.010
FS-3	Control	23.450±0.017	23.383±0.033	23.500±0.012	23.530±0.010
	60	23.437±0.019	23.393±0.013	23.487±0.013	23.520±0.012
	150	23.427±0.007	23.387±0.013	23.460±0.020	23.507±0.007
	240	23.377±0.015	23.340±0.010	23.413±0.007	23.460±0.010
	330	23.450±0.017	23.410±0.021	23.500±0.012	23.523±0.015
	420	23.500±0.017	23.480±0.033	23.540±0.012	23.580±0.010

FS- 1: Feeding Schedule-1, Fed every day in 1st feeding of 3rd to 5th instar larvae
FS- 2: Feeding Schedule- 2, Fed in 1st and 5th feeding of 3rd to 5th instar larvae
FS- 3: Feeding Schedule-3, Fed only in 1st feeding of 3rd to 5th instar larvae

S-1: Season-1, Agrahyani
S-2: Season-2, Chaita
S-3: Season-3, Jaista
S-4 : Season-4 , Baduri

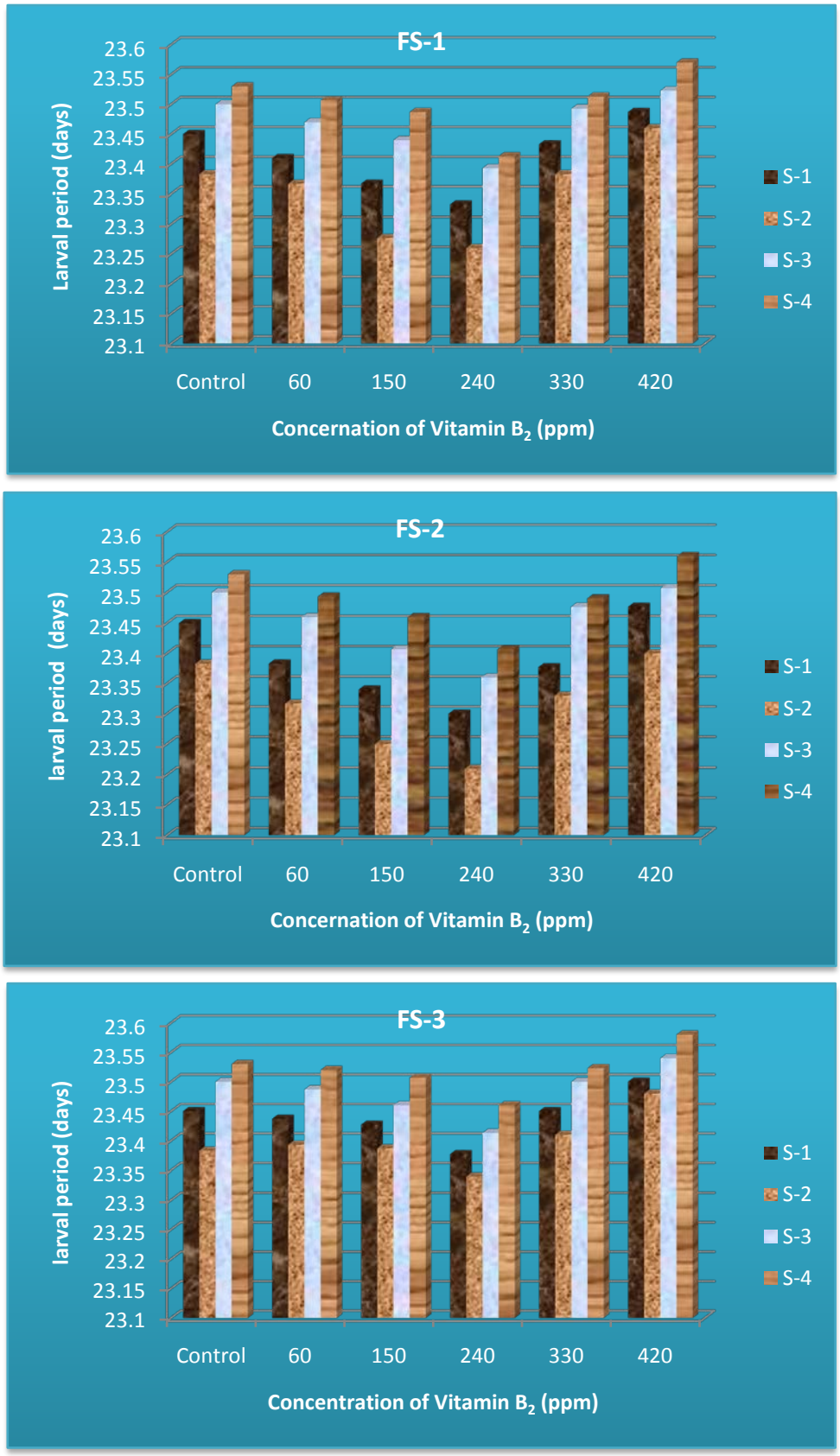


Figure 12.Effect of vit-B_2 supplemented food on LP(days) of *B. mori* L. at different feeding schedules.

Table 13. Effect of vit-B_2 under different feeding schedules, seasons and doses on the pupal period (days) of *B. mori*L.

Feeding Schedule	Dose (ppm)	Mean ± SE			
		S-1	S-2	S-3	S-4
FS-1	Control	9.500±0.029	9.450±0.029	9.550±0.029	9.600±0.029
	60	9.450±0.029	9.410±0.021	9.510±0.021	9.550±0.029
	150	9.400±0.029	9.340±0.010	9.467±0.017	9.500±0.029
	240	9.350±0.029	9.290±0.021	9.417±0.017	9.450±0.029
	330	9.460±0.023	9.413±0.007	9.523±0.015	9.567±0.024
	420	9.520±0.007	9.480±0.030	9.600±0.030	9.650±0.021
FS-2	Control	9.500±0.029	9.450±0.029	9.550±0.029	9.600±0.029
	60	9.427±0.027	9.383±0.020	9.460±0.010	9.543±.023
	150	9.360±0.010	9.323±0.015	9.407±0.007	9.460±0.010
	240	9.283±0.020	9.257±0.023	9.323±0.015	9.387±0.007
	330	9.430±0.010	9.403±0.023	9.473±0.007	9.550±0.017
	420	9.513±0.007	9.460±0.017	9.570±0.013	9.623±0.015
FS-3	Control	9.500±0.029	9.450±0.029	9.550±0.029	9.600±0.029
	60	9.477±0.026	9.430±0.010	9.527±0.012	9.557±0.023
	150	9.470±0.010	9.400±0.000	9.480±0.000	9.523±0.015
	240	9.460±0.010	9.313±0.007	9.467±0.007	9.507±0.007
	330	9.490±0.020	9.437±0.009	9.540±0.010	9.567±0.017
	420	9.550±0.017	9.500±0.017	9.620±0.015	9.680±0.010

FS- 1: Feeding Schedule-1, Fed every day in 1st feeding of 3rd to 5th instar larvae
FS- 2: Feeding Schedule- 2, Fed in 1st and 5th feeding of 3rd to 5th instar larvae
FS- 3: Feeding Schedule-3, Fed only in 1st feeding of 3rd to 5th instar larvae

S-1: Season-1, Agrahyani
S-2: Season-2, Chaita
S-3: Season-3, Jaista
S-4 : Season-4 , Baduri

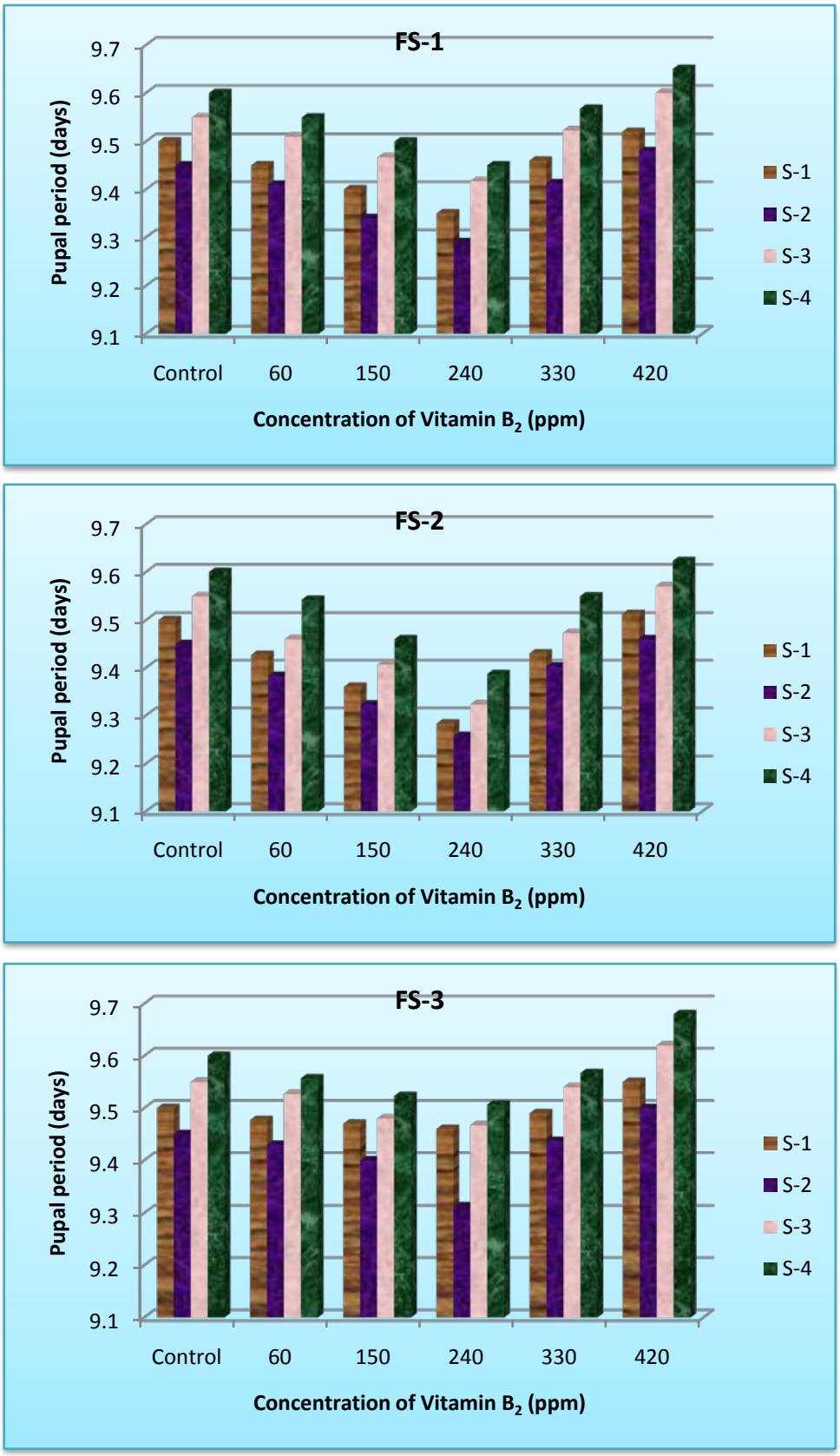


Figure 13. Effect of vit-B_2 supplemented food on PP(days) of *B. mori* L. at different feeding schedules.

Table 14. Effect of vit-B_2 under different feeding schedules, seasons and doses on the total number of eggs laid (TEL)of *B. mori*L.

Feeding Schedule	Dose (ppm)	Mean ± SE			
		S-1	S-2	S-3	S-4
FS-1	Control	299.59±0.51	303.18±1.62	298.61±0.19	298.03±0.12
	60	389.07±2.54	390.68±2.38	388.76±3.20	387.31±2.42
	150	402.38±1.47	403.61±1.93	401.34±0.67	399.96±0.60
	240	406.56±0.58	408.59±0.95	404.83±0.57	403.01±1.08
	330	388.43±1.36	392.26±0.86	385.41±2.36	384.28±2.04
	420	297.07±0.85	298.54±0.20	296.69±0.79	296.68±0.14
FS-2	Control	299.59±0.51	303.18±1.62	298.61±0.19	298.03±0.12
	60	394.36±0.81	395.61±0.18	393.50±0.77	391.99±0.77
	150	403.18±1.32	405.34±0.27	402.52±1.21	401.71±0.86
	240	407.25±0.38	409.93±1.04	405.27±0.64	404.28±0.77
	330	390.57±1.30	394.84±0.14	389.17±1.39	387.92±1.76
	420	298.35±0.88	299.87±0.50	297.49±0.83	297.34±0.41
FS-3	Control	299.59±0.51	303.18±1.62	298.61±0.19	298.03±0.12
	60	385.68±0.51	388.70±1.20	381.36±0.46	376.55±1.06
	150	389.19±0.53	395.28±0.98	391.34±0.75	384.85±1.31
	240	395.51±0.28	398.34±0.13	394.39±0.81	390.80±0.09
	330	367.02±1.57	369.44±0.73	380.43±0.91	379.23±0.88
	420	296.95±0.98	297.77±0.31	295.25±0.13	294.41±0.11

FS- 1: Feeding Schedule-1, Fed every day in 1st feeding of 3rd to 5th instar larvae
FS- 2: Feeding Schedule- 2, Fed in 1st and 5th feeding of 3rd to 5th instar larvae
FS- 3: Feeding Schedule-3, Fed only in 1st feeding of 3rd to 5th instar larvae

S-1: Season-1, Agrahyani
S-2: Season-2, Chaita
S-3: Season-3, Jaista
S-4 : Season-4 , Baduri

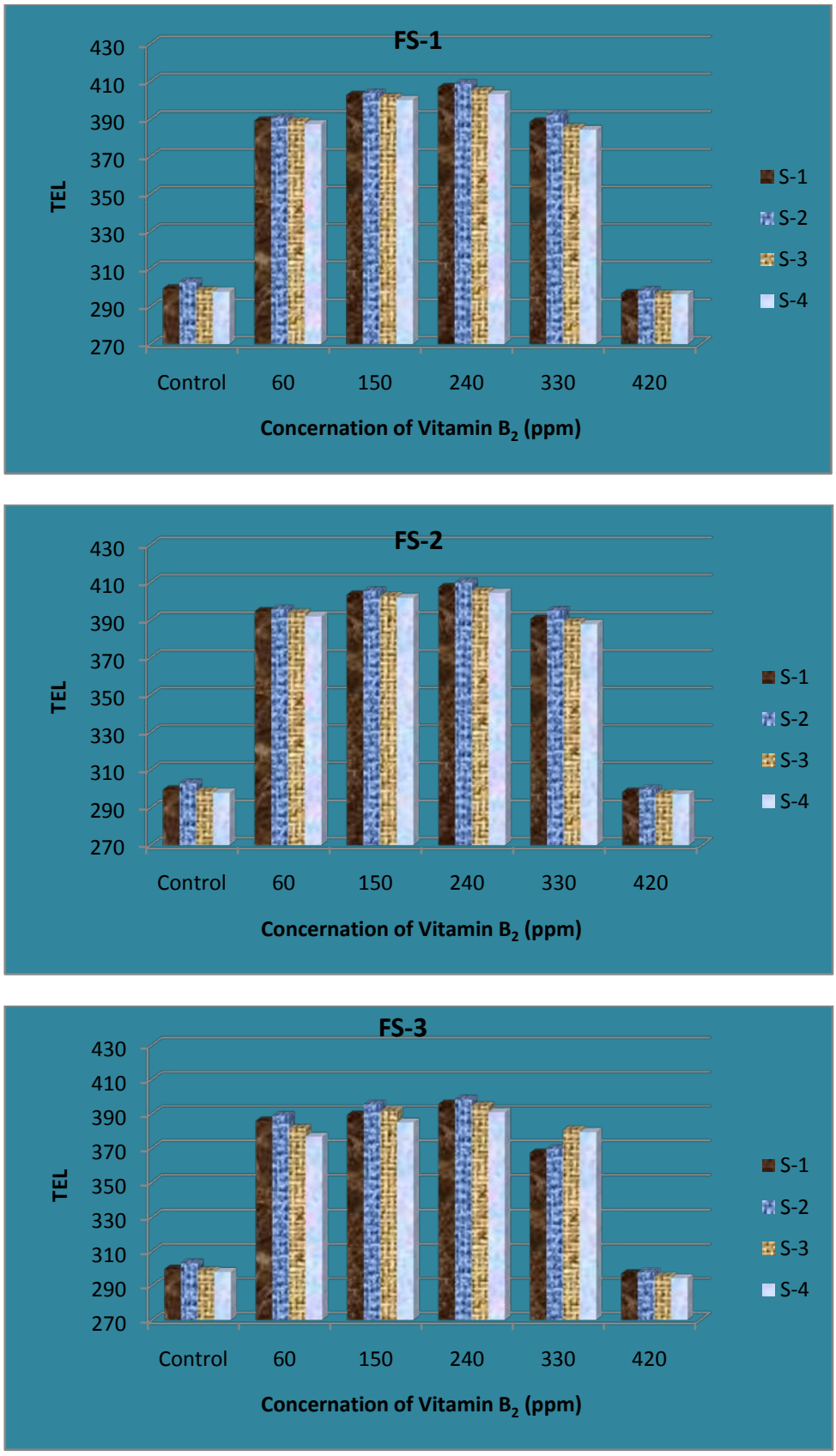


Figure 14. Effect of vit-B_2 supplemented food on TEL of *B. mori* L. at different feeding schedules.

Table 15. Effect of vit-B_2 under different feeding schedules, seasons and doses on the egg hatching percentage (EHP) of *B. mori*L.

Feeding Schedule	Dose (ppm)	Mean ± SE			
		S-1	S-2	S-3	S-4
FS-1	Control	94.38±0.03	94.61±0.05	94.27±0.02	94.22±0.01
	60	95.61±0.04	95.67±0.02	95.47±0.04	95.36±0.03
	150	95.68±0.02	95.77±0.02	95.59±0.02	95.50±0.02
	240	95.81±0.02	95.88±0.01	95.69±0.02	95.57±0.01
	330	95.55±0.04	95.67±0.04	95.43±0.03	95.28±0.01
	420	94.22±0.05	94.55±0.06	94.14±0.02	94.11±0.01
FS-2	Control	94.38±0.03	94.61±0.05	94.27±0.02	94.22±0.01
	60	95.67±0.04	95.70±0.03	95.56±0.04	95.44±0.02
	150	95.72±0.03	95.82±0.02	95.63±0.04	95.54±0.02
	240	95.83±0.05	96.06±0.04	95.73±0.06	95.64±0.03
	330	95.60±0.04	95.68±0.04	95.47±0.02	95.36±0.03
	420	94.32±0.03	94.58±0.07	94.21±0.04	94.16±0.03
FS-3	Control	94.38±0.03	94.61±0.05	94.27±0.02	94.22±0.01
	60	94.92±0.02	94.99±0.01	94.78±0.01	94.65±0.02
	150	95.25±0.02	95.41±0.02	95.12±0.01	94.88±0.02
	240	95.38±0.02	95.62±0.02	95.28±0.01	95.13±0.01
	330	94.70±0.01	94.83±0.02	94.65±0.02	94.55±0.02
	420	94.05±0.02	94.50±0.03	94.09±0.01	94.07±0.01

FS- 1: Feeding Schedule-1, Fed every day in 1st feeding of 3rd to 5th instar larvae
FS- 2: Feeding Schedule- 2, Fed in 1st and 5th feeding of 3rd to 5th instar larvae
FS- 3: Feeding Schedule-3, Fed only in 1st feeding of 3rd to 5th instar larvae

S-1: Season-1, Agrahyani
S-2: Season-2, Chaita
S-3: Season-3, Jaista
S-4 : Season-4 , Baduri

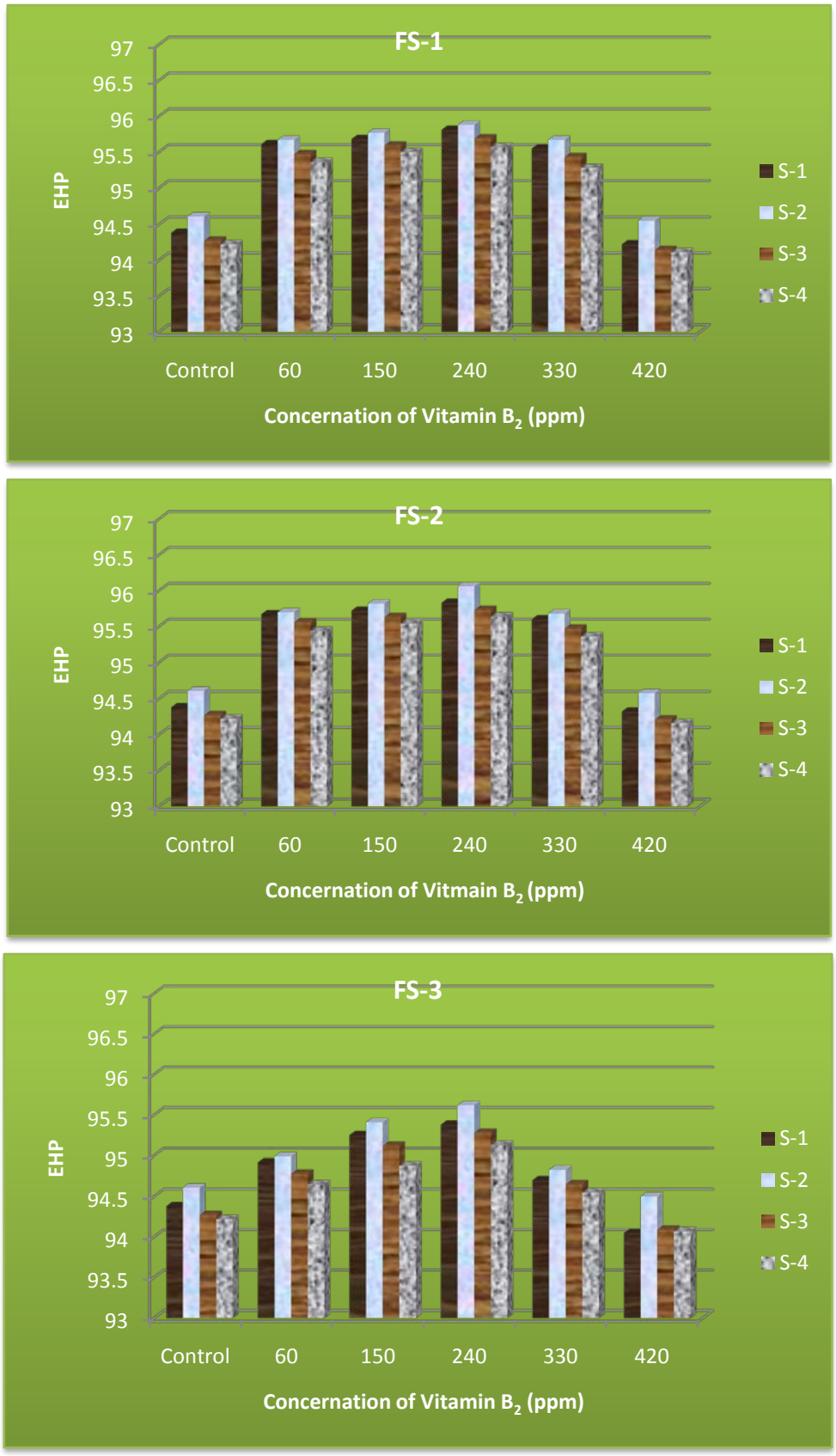


Figure 15. Effect of vit-B_2 supplemented food on EHP of *B. mori* L. at different feeding schedules.

Table 16. Effect of vit-B_2 under different feeding schedules, seasons and doses on the mortality (%) of *B. mori*L.

Feeding Schedule	Dose (ppm)	S-1		S-2		S-3		S-4	
		mortality (%)	d-value	mortality (%)	d-value	mortality (%)	d-value	mortality (%)	d-value
FS-1	Control	19.62	---	16.7	---	21.11	---	28.71	---
	60	13.81	0.63	12.38	0.51	18.17	0.84	22.61	1.29
	150	12.38	0.58	10.96	0.46	15.24	0.72	19.62	1.15
	240	9.57	0.47	6.78	0.31	12.38	0.61	16.69	1.00
	330	14.91	0.67	13.81	0.56	19.62	0.89	25.64	1.43
	420	22.61	0.94	21.11	0.78	28.71	1.22	31.86	1.72
FS-2	Control	19.62	---	16.7	---	21.11	---	28.71	---
	60	12.38	0.58	9.57	0.41	16.7	0.78	19.62	1.15
	150	10.96	0.52	8.17	0.36	13.81	0.67	16.7	1.00
	240	6.78	0.35	4.04	0.20	10.96	0.55	12.38	0.78
	330	13.81	0.63	12.38	0.51	18.17	0.84	21.11	1.22
	420	21.11	0.89	19.62	0.74	25.64	1.11	28.71	1.58
FS-3	Control	19.62	---	16.7	---	21.11	---	28.71	---
	60	16.7	0.74	13.81	0.56	19.62	0.89	25.64	1.43
	150	15.24	0.68	12.38	0.51	18.17	0.84	22.61	1.29
	240	13.81	0.63	9.57	0.41	16.7	0.78	19.62	1.15
	330	18.17	0.79	15.24	0.60	21.11	0.95	27.17	1.51*
	420	25.64	1.04	24.11	0.87	31.86	1.33	35.05	1.87*

FS- 1: Feeding Schedule-1, Fed every day in 1st feeding of 3rd to 5th instar larvae
FS- 2: Feeding Schedule- 2, Fed in 1st and 5th feeding of 3rd to 5th instar larvae
FS- 3: Feeding Schedule-3, Fed only in 1st feeding of 3rd to 5th instar larvae

S-1: Season-1, Agrahyani
S-2: Season-2, Chaita
S-3: Season-3, Jaista
S-4 : Season-4 , Baduri

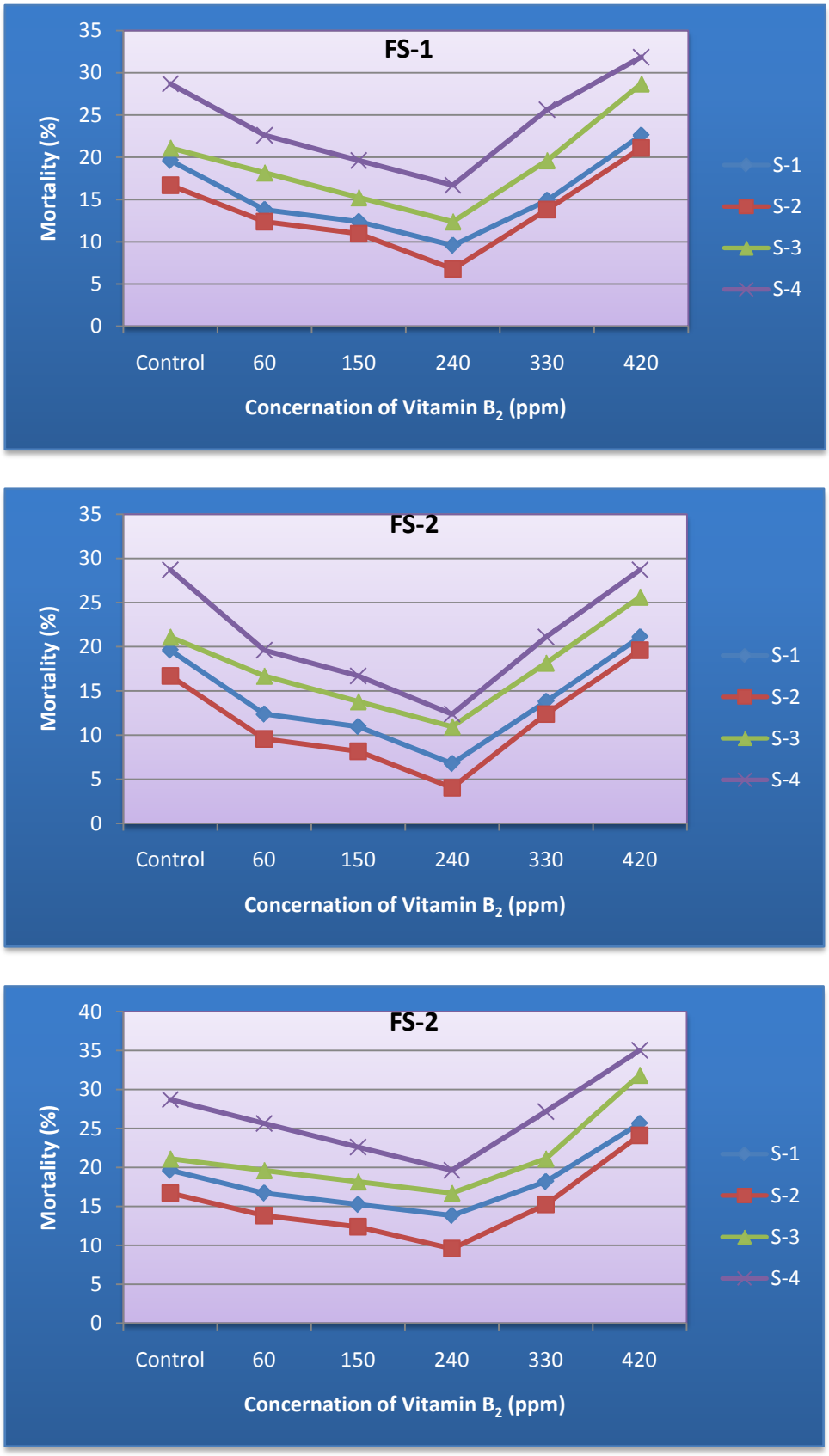


Figure 16. . Mortality (%) line of vit-B_2 supplemented food against *B. mori* L. at different feeding schedules.

Table 17. Effect of vit-B_2 under different feeding schedules, seasons and doses on the food consumption (gm) of *B. mori*L.

Feeding Schedule	Dose (ppm)	Mean ± SE			
		S-1	S-2	S-3	S-4
FS-1	Control	45.45 ±0.58	46.56±0.60	44.97±0.09	44.60±0.09
	60	46.69±0.07	47.33±0.07	46.43±0.03	45.48±0.08
	150	47.62±0.06	47.87±0.04	47.14±0.02	46.45±0.04
	240	48.43±0.08	48.91±0.06	48.14±0.08	47.67±0.07
	330	46.32±0.08	46.89±0.06	46.24±0.03	45.12±0.06
	420	45.24±0.08	45.92±0.05	44.52±0.02	44.27±0.02
FS-2	Control	45.45±0.58	46.56±0.60	44.97±0.09	44.60±0.09
	60	47.25±0.13	47.65±0.09	46.75±0.05	45.70±0.07
	150	47.70±0.12	48.17±0.28	47.25±0.15	46.58±0.08
	240	49.13±0.27	50.47±0.16	48.31±0.07	47.90±0.06
	330	47.04±0.04	47.23±0.39	46.50±0.01	45.50±0.09
	420	45.36±0.11	46.24±0.25	44.70±0.06	44.46±0.05
FS-3	Control	45.45±0.58	46.56±0.60	44.97±0.09	44.60±0.09
	60	46.45±0.09	46.97±0.10	46.12±0.07	45.22±0.04
	150	47.33±0.07	47.58±0.04	46.82±0.05	46.32±0.03
	240	48.03±0.12	48.40±0.03	47.75±0.06	47.42±0.04
	330	46.08±0.06	46.71±0.06	45.87±0.09	45.01±0.05
	420	44.98±0.07	45.58±0.10	44.22±0.07	43.99±0.08

FS- 1: Feeding Schedule-1, Fed every day in 1st feeding of 3rd to 5th instar larvae
FS- 2: Feeding Schedule- 2, Fed in 1st and 5th feeding of 3rd to 5th instar larvae
FS- 3: Feeding Schedule-3, Fed only in 1st feeding of 3rd to 5th instar larvae

S-1: Season-1, Agrahyani
S-2: Season-2, Chaita
S-3: Season-3, Jaista
S-4 : Season-4 , Baduri

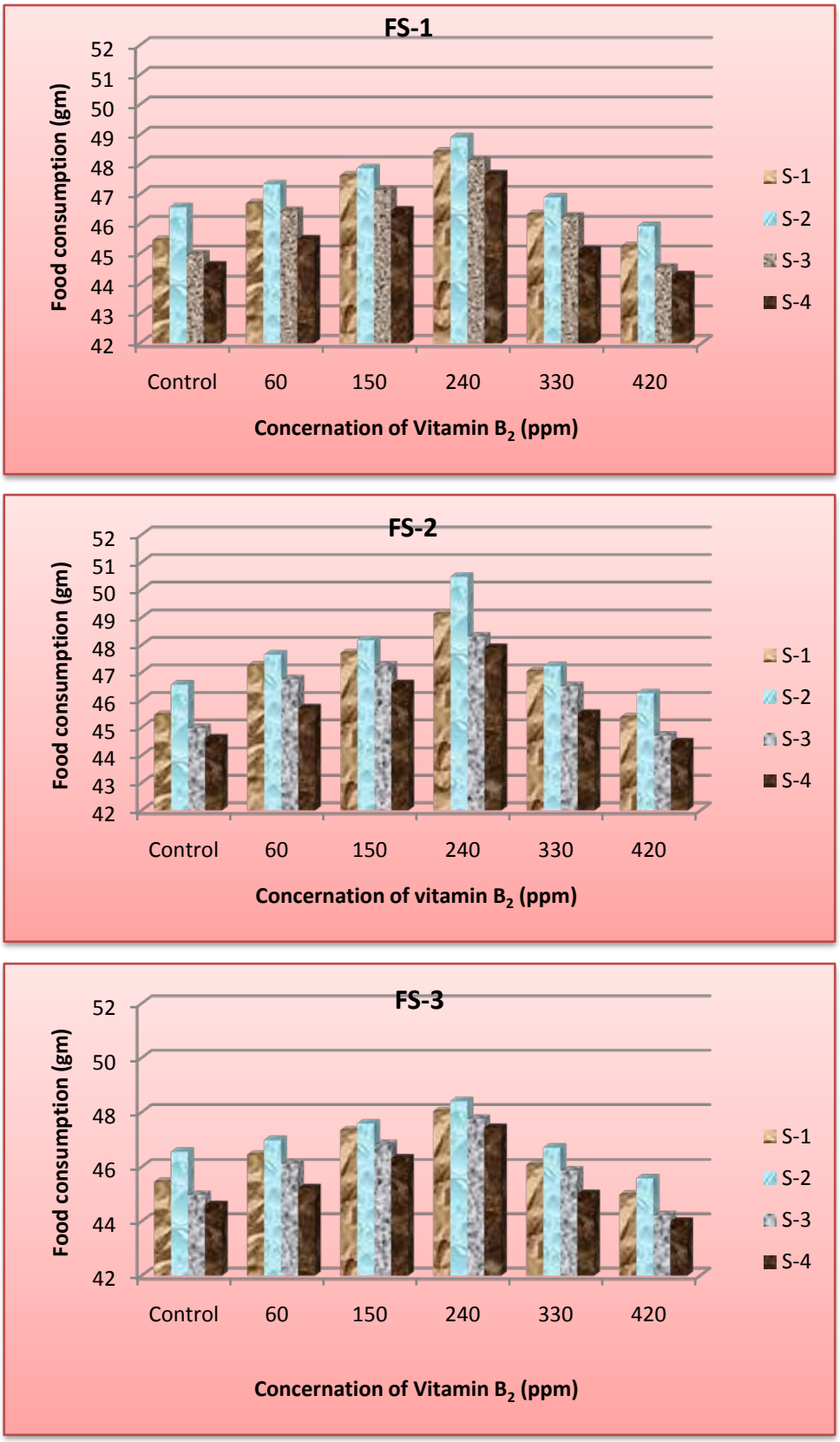


Figure 17.Effect of vit-B_2 supplemented food on FC(gm) of *B. mori* L. at different feeding schedules.

Table 18. Effect of vit-B_2 under different feeding schedules, seasons and doses on the food utilizations (gm) of *B. mori*L.

Feeding Schedule	Dose (ppm)	Mean ± SE			
		S-1	S-2	S-3	S-4
FS-1	Control	60.06±0.03	60.55±0.03	59.52±0.05	59.11±0.06
	60	64.69±0.07	65.33±0.07	64.40±0.03	64.02±0.04
	150	65.64±0.07	65.87±0.04	65.34±0.06	64.83±0.02
	240	67.43±0.08	67.91±0.06	66.57±0.04	65.79±0.05
	330	64.32±0.08	64.83±0.04	64.20±0.04	63.69±0.05
	420	59.37±0.08	60.07±0.04	58.96±0.02	58.66±0.04
FS-2	Control	60.06±0.03	60.55±0.03	59.52±0.05	59.11±0.06
	60	65.30±0.05	65.63±0.06	64.82±0.02	64.47±0.04
	150	66.22±0.07	66.48±0.08	65.75±0.05	65.56±0.08
	240	67.80±0.09	68.58±0.10	66.82±0.08	66.43±0.04
	330	65.06±0.03	65.28±0.03	64.50±0.01	64.25±0.03
	420	59.78±0.05	60.40±0.03	59.37±0.02	59.02±0.02
FS-3	Control	60.06±0.03	60.55±0.03	59.52±0.05	59.11±0.06
	60	64.33±0.06	64.98±0.07	63.88±0.02	63.38±0.02
	150	65.28±0.04	65.59±0.04	64.82±0.05	64.32±0.03
	240	67.03±0.06	67.39±0.02	65.78±0.05	65.40±0.03
	330	64.03±0.03	64.67±0.04	63.42±0.04	63.09±0.05
	420	59.07±0.04	59.76±0.03	58.75±0.03	58.27±0.03

FS- 1: Feeding Schedule-1, Fed every day in 1st feeding of 3rd to 5th instar larvae
FS- 2: Feeding Schedule- 2, Fed in 1st and 5th feeding of 3rd to 5th instar larvae
FS- 3: Feeding Schedule-3, Fed only in 1st feeding of 3rd to 5th instar larvae

S-1: Season-1, Agrahyani
S-2: Season-2, Chaita
S-3: Season-3, Jaista
S-4 : Season-4 , Baduri

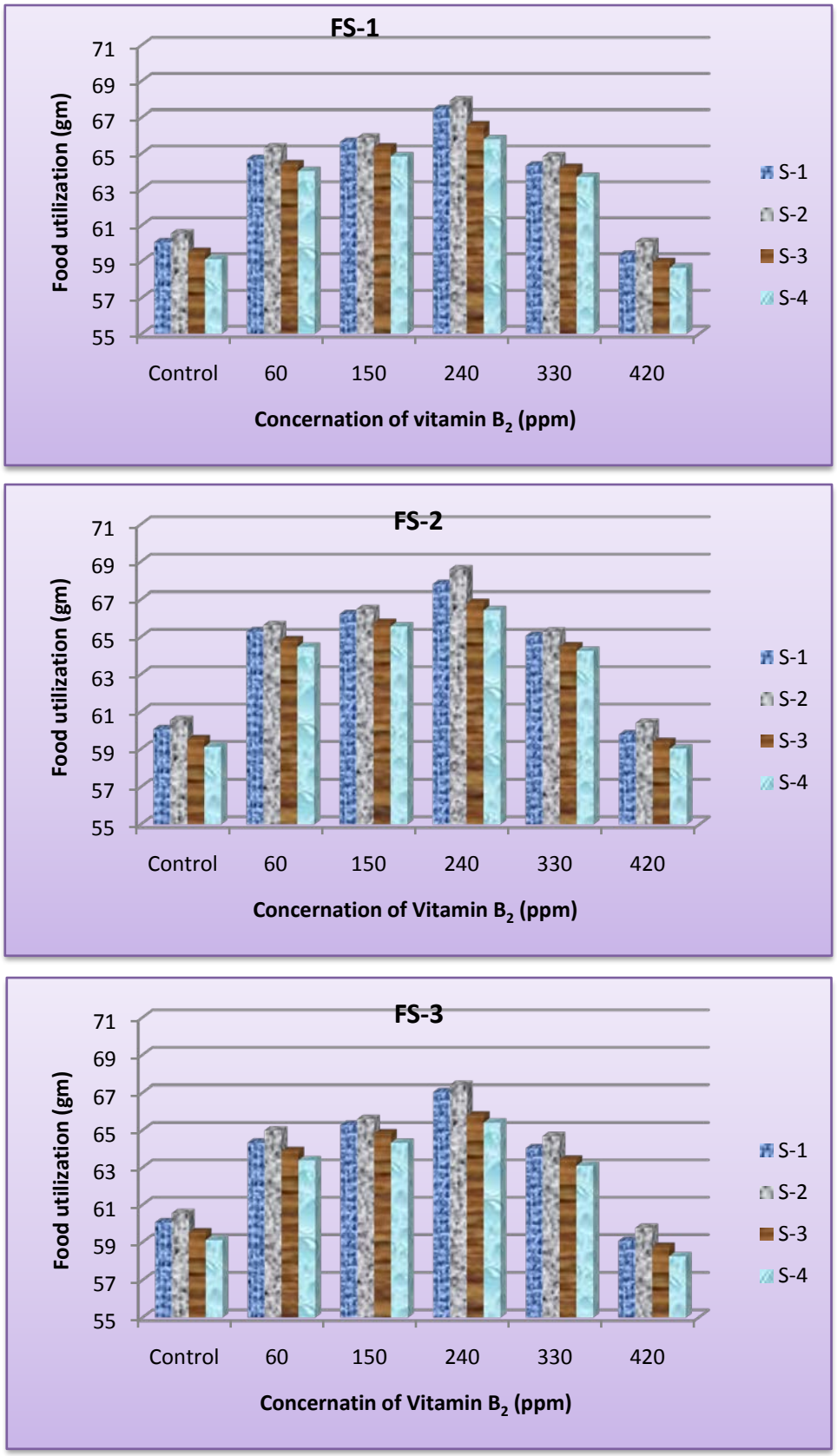


Figure 18. Effect of vit-B_2 supplemented food on FU(gm) of *B. mori* L. at different feeding schedules.

Table 19. Effect of vit-B_2 under different feeding schedules, seasons and doses on the approximate digestibility(%) of *B. mori* L.

Feeding Schedule	Dose (ppm)	Mean ± SE			
		S-1	S-2	S-3	S-4
FS-1	Control	62.08±0.04	62.57±0.04	61.78±0.02	60.50±0.03
	60	66.86±0.05	67.70±0.02	66.40±0.03	65.99±0.04
	150	67.67±0.07	68.17±0.04	67.34±0.06	66.76±0.02
	240	68.43±0.05	68.96±0.10	67.88±0.04	67.77±0.05
	330	66.35±0.06	67.52±0.03	66.17±0.03	65.55±0.04
	420	61.46±0.04	62.07±0.04	60.96±0.02	60.05±0.04
FS-2	Control	62.08±0.04	62.57±0.04	61.78±0.02	60.50±0.03
	60	67.54±0.06	68.14±0.03	67.38±0.04	66.72±0.04
	150	68.18±0.02	68.52±0.05	67.82±0.02	67.31±0.05
	240	68.88±0.03	70.48±0.03	68.43±0.05	68.10±0.06
	330	67.27±0.04	67.82±0.03	67.06±0.03	66.39±0.02
	420	61.75±0.04	62.19±0.02	61.50±0.02	60.25±0.04
FS-3	Control	62.08±0.04	62.57±0.04	61.78±0.02	60.50±0.03
	60	66.47±0.04	67.00±0.06	66.23±0.04	65.39±0.04
	150	67.17±0.04	67.77±0.04	66.87±0.04	66.27±0.04
	240	68.02±0.07	68.38±0.02	67.37±0.02	66.86±0.03
	330	66.03±0.02	66.81±0.04	65.96±0.04	65.09±0.05
	420	61.07±0.04	61.87±0.03	60.76±0.03	59.71±0.02

FS- 1: Feeding Schedule-1, Fed every day in 1st feeding of 3rd to 5th instar larvae
FS- 2: Feeding Schedule- 2, Fed in 1st and 5th feeding of 3rd to 5th instar larvae
FS- 3: Feeding Schedule-3, Fed only in 1st feeding of 3rd to 5th instar larvae

S-1: Season-1, Agrahyani
S-2: Season-2, Chaita
S-3: Season-3, Jaista
S-4 : Season-4 , Baduri

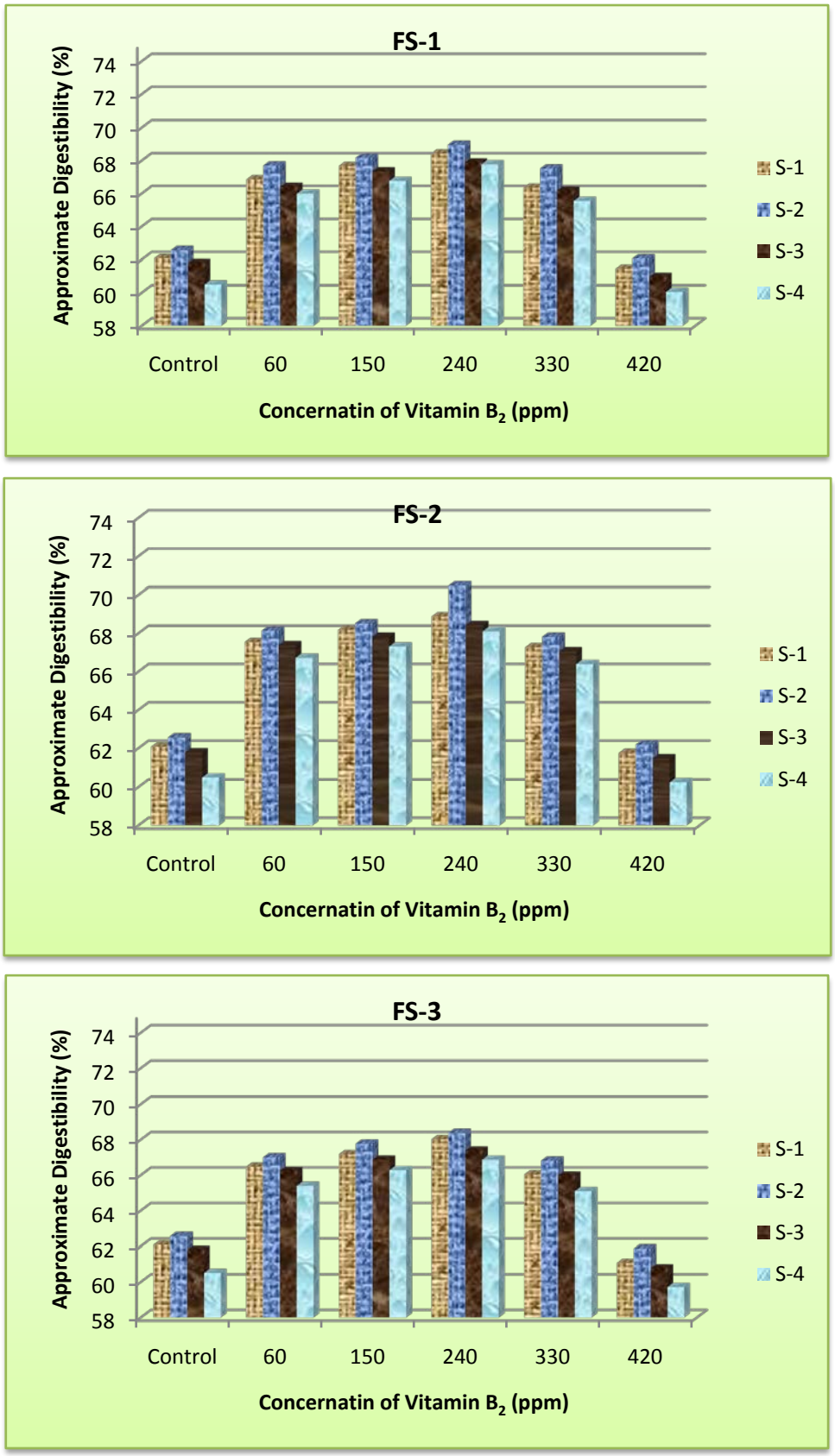


Figure 19. Effect of vit-B_2 supplemented food on AD(%) of *B. mori* L. at different feeding schedules.

Table 20. Effect of vit-B_2 under different feeding schedules, seasons and doses on the food consumption index of *B. mori*L.

Feeding Schedule	Dose (ppm)	Mean ± SE			
		S-1	S-2	S-3	S-4
FS-1	Control	56.30±0.03	56.60±0.03	55.77±0.04	55.63±0.03
	60	60.12±0.04	60.35±0.06	58.47±0.05	58.24±0.06
	150	64.41±0.05	64.52±0.05	62.46±0.03	62.27±0.05
	240	66.38±0.06	66.47±0.03	64.46±0.05	64.22±0.04
	330	59.87±0.04	60.16±0.02	58.27±0.04	57.82±0.05
	420	55.87±0.03	56.38±0.02	55.29±0.03	54.86±0.02
FS-2	Control	56.30±0.03	56.60±0.03	55.77±0.04	55.63±0.03
	60	60.33±0.02	60.55±0.04	58.79±0.03	58.50±0.03
	150	64.57±0.05	64.72±0.03	62.75±0.04	62.51±0.04
	240	66.52±0.05	66.76±0.04	64.70±0.03	64.44±0.03
	330	60.17±0.03	60.45±0.04	58.66±0.02	58.32±0.02
	420	56.10±0.03	56.53±0.04	55.45±0.02	55.25±0.04
FS-3	Control	56.30±0.03	56.60±0.03	55.77±0.04	55.63±0.03
	60	58.42±0.04	58.76±0.05	57.51±0.02	57.32±0.02
	150	62.30±0.03	62.52±0.05	61.76±0.03	61.42±0.04
	240	63.60±0.03	63.86±0.03	63.30±0.03	62.89±0.02
	330	58.16±0.02	58.63±0.02	57.40±0.03	56.75±0.03
	420	55.70±0.03	56.29±0.02	54.87±0.02	54.52±0.02

FS- 1: Feeding Schedule-1, Fed every day in 1st feeding of 3rd to 5th instar larvae
FS- 2: Feeding Schedule- 2, Fed in 1st and 5th feeding of 3rd to 5th instar larvae
FS- 3: Feeding Schedule-3, Fed only in 1st feeding of 3rd to 5th instar larvae

S-1: Season-1, Agrahyani
S-2: Season-2, Chaita
S-3: Season-3, Jaista
S-4 : Season-4 , Baduri

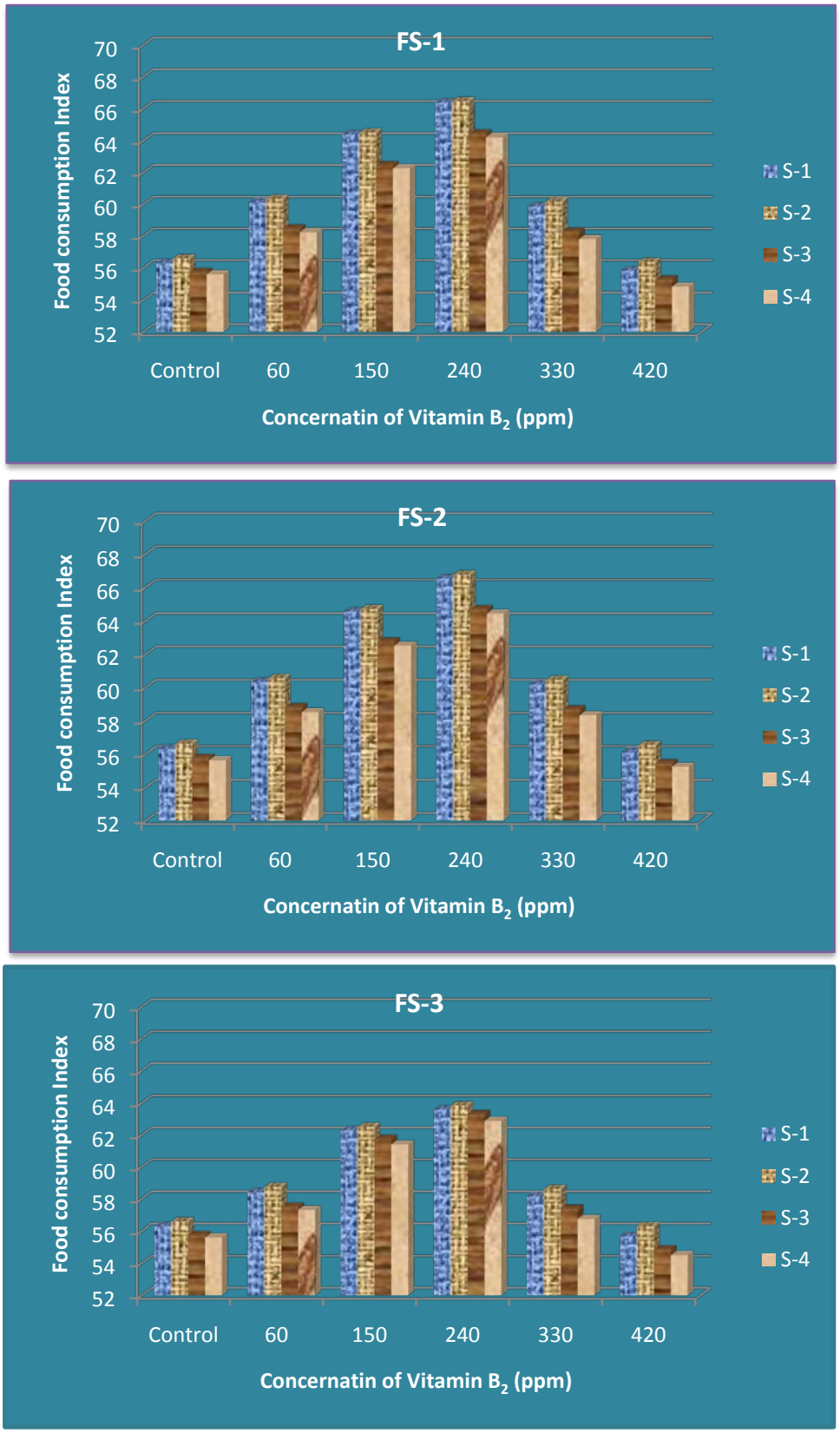


Figure 20. Effect of vit-B_2 supplemented food on FCI(gm) of *B. mori* L. at different feeding schedules.

Table 21. Effect of vit-B_2 under different feeding schedules, seasons and doses on the co-efficientof food utilization (%) of *B. mori*L.

Feeding Schedule	Dose (ppm)	Mean ± SE			
		S-1	S-2	S-3	S-4
FS-1	Control	46.30±0.03	46.60±0.02	45.80±0.03	45.46±0.03
	60	48.11±0.02	48.35±0.06	47.47±0.05	47.25±0.04
	150	54.21±0.03	54.51±0.04	52.48±0.04	52.25±0.03
	240	56.28±0.04	56.47±0.04	55.37±0.02	55.22±0.04
	330	47.78±0.05	48.16±0.02	47.23±0.03	46.82±0.05
	420	45.87±0.02	46.12±0.04	45.27±0.02	44.86±0.02
FS-2	Control	46.30±0.03	46.60±0.02	45.80±0.03	45.46±0.03
	60	48.33±0.02	48.52±0.03	47.75±0.03	47.50±0.03
	150	54.48±0.04	54.77±0.02	52.64±0.03	52.41±0.04
	240	56.49±0.06	56.75±0.05	55.71±0.03	55.42±0.04
	330	48.16±0.02	48.41±0.03	47.64±0.02	47.31±0.02
	420	46.10±0.03	46.32±0.02	45.45±0.03	45.26±0.03
FS-3	Control	46.30±0.03	46.60±0.02	45.80±0.03	45.46±0.03
	60	47.40±0.03	47.74±0.04	47.20±0.03	46.71±0.03
	150	52.72±0.04	54.33±0.04	52.63±0.04	51.82±0.03
	240	55.82±0.03	56.22±0.02	55.20±0.03	54.89±0.01
	330	47.16±0.02	47.62±0.02	46.87±0.02	46.51±0.05
	420	45.70±0.03	45.86±0.03	44.75±0.03	44.65±0.04

FS- 1: Feeding Schedule-1, Fed every day in 1st feeding of 3rd to 5th instar larvae
FS- 2: Feeding Schedule- 2, Fed in 1st and 5th feeding of 3rd to 5th instar larvae
FS- 3: Feeding Schedule-3, Fed only in 1st feeding of 3rd to 5th instar larvae

S-1: Season-1, Agrahyani
S-2: Season-2, Chaita
S-3: Season-3, Jaista
S-4 : Season-4 , Baduri

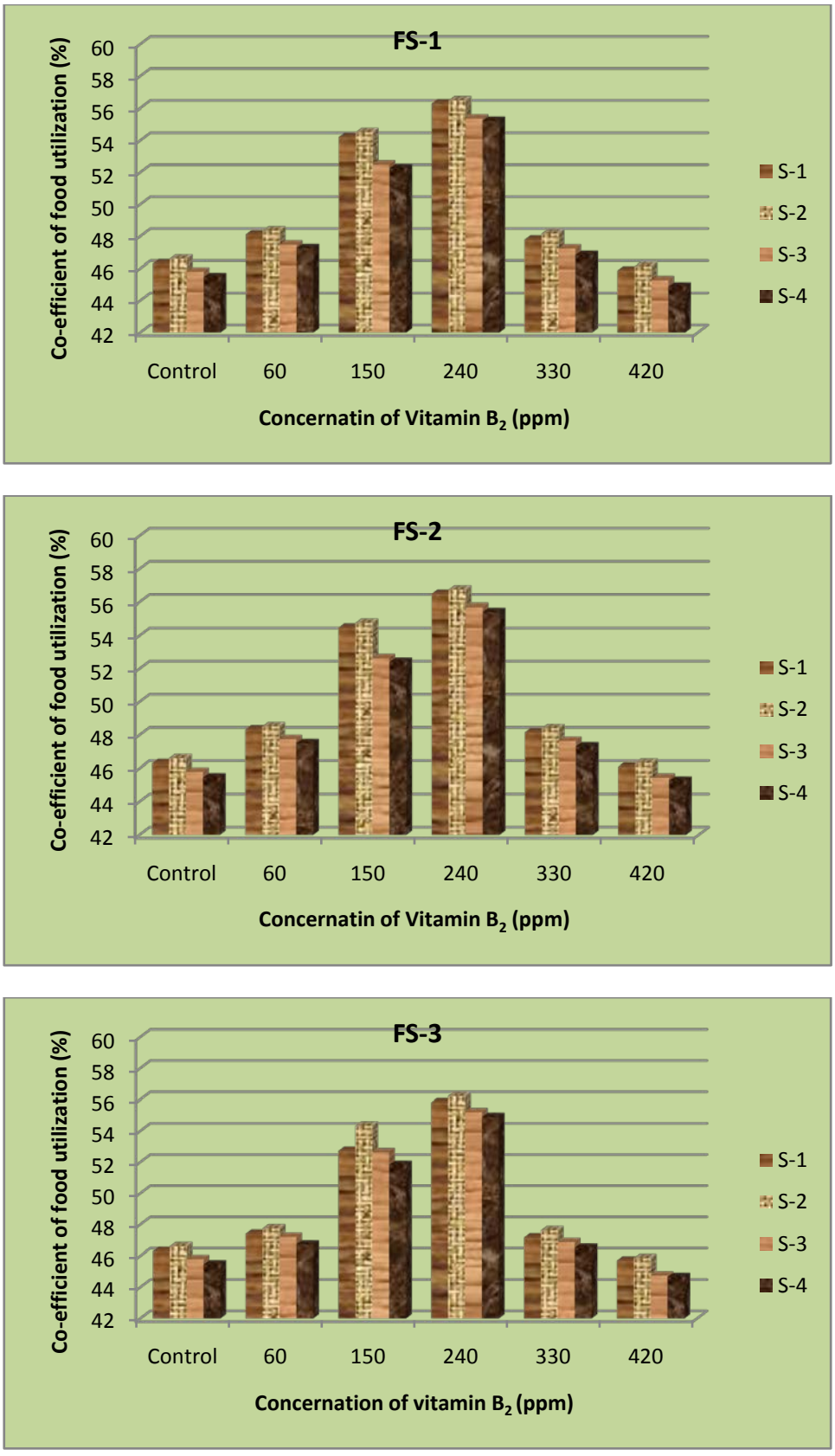


Figure 21. Effect of vit-B_2 supplemented food on CFU(%) of *B. mori* L. at different feeding schedules.

4.2. Effect of ascorbic acid supplementation with mulberry leaves on *Bombyxmori*L.

Results on the effect of thesupplementation of vitamin Cduring different seasons, viz. S-1, S-2, S-3 and S-4 on *B.mori* at different feeding schedules, viz. fed every day in 1st feeding of 3rdto 5thinstar larvae (FS-1), fed in 1st to 5th feeding of 3rdto 5thinstar larvae (FS-2), fed only in 1st feeding of 3rdto 5thinstar larvae (FS-3) were evaluated and are presented in Tables 22-37 and the graphical presentation are showed in Figures22-37. The data of different characters were subjected to analysis of variance to determine the variations among concentrations, seasons and feeding schedules are presented in Appendices Table XX-XXXIII. The results obtained in the present investigation are discussed as follows:

4.2.1 Effect of ascorbic acid on the larval growth of *B. mori*

The results ofvit- C supplementation on the larval growth of*B.mori*under different seasons anddifferent feeding schedules are given bellow:

Weight of mature larvae (WML):

The effect of vit- C supplementation on the WML of *B.mori*under different seasons, viz. S-1, S-2, S-3 and S-4 at different feeding schedules, viz. FS-1, FS-2, FS-3 are shown inTable22, the graphical presentation are showed in Figure 22 and their statistical analysis is presented in Appendix Table XX.

The mean values of WML were increased in S-1 under different dosesof vit- C except 30000ppm compared to the control while fed according to FS-1. The highest and lowest mean values of WML were found at 15000ppm(1.83±0.02gm) and 30000ppm(1.65±0.01gm)respectively. While maintaining FS-2, the highest and lowestmean values of WML wereobserved at 15000ppm(1.91±0.02gm)and 30000ppm(1.68±0.01gm)respectively. In case of FS-3,the WML werealso increased under different doses, viz. at 10000ppm(1.75±0.00gm), 15000ppm(1.80±0.01gm), 20000ppm(1.79±0.01gm), 25000ppm(1.71±0.02gm) compared to

the control(1.70±0.01gm) but the mean value of WML was decreased at 30000ppm(1.63±0.01gm).

The supplementation of vit- C significantly increasedthe mean values of WML of *B. mori*inS-2under different concentrations and at different feeding schedules. While fed according to FS-1, the highest and the lowestmean of WML were seenat 15000ppm (1.96±0.02gm) and at 30000ppm(1.76±0.01gm)respectively. In case of FS-2,the WML were increased under different concentrations, viz. at 10000ppm(1.96±0.01gm), 15000ppm(2.03±0.02gm), 20000ppm(2.03±0.02gm), 25000ppm(1.94±0.01gm) compared to the control(1.78±0.01gm) but the mean value of WML was decreased at 30000ppm(1.77±0.01gm). At FS-3, the highest and the lowest mean values of WML were observed at 15000ppm (1.92±0.01gm)and at 30000ppm(1.73±0.01gm)respectively.

The mean values of WML were significantly increased atvarious feeding schedules under different doses ofvit- C in S-3. The highest and lowest mean of WML were found at 15000ppm (1.71±0.02gm) and at 30000ppm (1.56±0.01gm) for FS-1, at 15000ppm (1.82±0.02gm)and at 30000ppm (1.58±0.02gm) for FS-2 and at 15000ppm (1.68±0.02gm)and at 30000ppm(1.56±0.02gm)for FS-3.

The mean of WML were significantly increased inS-4under different concentrations and atvarious feeding schedules. While fed according to FS-1, the highest and the lowestmean of WML were observed at 15000ppm (1.64±0.01gm) and at 30000ppm(1.42±0.02gm)respectively. In case of FS-2,the WML wereincreased under different doses, viz. at 10000ppm (1.60±0.01gm), 15000ppm(1.72±0.01gm), 20000ppm(1.71±0.01gm), 25000ppm(1.58±0.01gm) compared to the control(1.49±0.02gm) but the mean value of WML was decreased at 30000ppm(1.44±0.03gm). While maintaining FS-3, the highest and the lowest mean values of WML were noticed at 15000ppm (1.62±0.01gm)and at 30000ppm (1.40±0.02gm) respectively.

The Results of analyses of variance have been presented in Appendix Table XX. All of the items viz. feeding schedules (F=52.43), seasons (F=492.06), doses (F=91.75)showed highly significant differences at 1% level of significance.

The effectiveness of different concentrations ofvit- C under different seasons on WML followed the order S-2>S-1>S-3 > S-4 and in respect of feeding schedule FS-2> FS-1> FS-3. The most effective dose of the vit- Cwas found to be 15000ppm followed by 20000ppm, 10000ppm and 25000ppm.

Length of mature larvae (LML):

The result of vit- C supplementationunder different seasons on LML of *B.mori* at different feeding schedules, viz. FS-1, FS-2, FS-3 are shown in Table 23, the graphical presentation are showed in Figure 23 and their statistical analysis is presented in Appendix Table XXI.

The mean values of LML were increased under different doses compare to the control in S-1 while fed FS-1. The highest and the lowest mean of LML were observed at 15000ppm (62.87±0.02mm) and at 30000ppm(61.15±0.03mm) respectively. While maintaining FS-2, the highest and the lowest LML were observed at 15000 ppm (62.94±0.03mm) and at 30000ppm(61.18±0.04mm) respectively. On FS-3,the LML were also increased under different doses viz. at 10000ppm (62.42±0.02mm), 15000ppm (62.75±0.03mm), 20000ppm (62.67±0.02mm), 25000ppm (62.33±0.02mm) compared to the control (61.28±0.02mm).

The supplementation of vit- Csignificantly increased the LML in S-2under different concentrations at different feeding schedules. While fed according to FS-1, the highest and the lowest LML were recorded at 15000ppm (62.97±0.03mm) and at 30000ppm (62.95±0.03mm) respectively. In case of FS-2, the LML were alsoincreased under different doses, viz. at 10000ppm (62.87±0.09mm), 15000ppm (63.20±0.06mm), 20000ppm (63.17±0.09mm), 25000ppm (62.73±0.06mm) comparedto thecontrol (61.40±0.06mm) but the lowest mean

value of LML at 30000ppm (61.35±0.05mm). The highest and the lowest mean of LML were observed at 15000ppm (62.88±0.01mm) and at 30000ppm (61.27±0.02mm) respectively while fed according to FS-3.

At different feeding schedules, the mean values of LML were significantly increased under different concentrations ofvit- Cin S-3. The highest and the lowest mean of LML were observed at 15000ppm (62.80±0.03mm) and at 30000ppm (60.95±0.03mm) for FS-1, at 15000ppm (62.85±0.03mm) and at 30000ppm (61.05±0.05mm) for FS-2 and at 15000ppm (62.63±0.02mm) and at 30000ppm (60.91±0.01mm) for FS-3 respectively.

In S-4, the mean values of LML under different doses at different feeding schedules were increased. While fed according to FS-1, the highest and the lowestmean of LML were found at 15000ppm (62.68±0.01mm) and at 30000ppm(60.82±0.01mm) respectively. At FS-2, the LML were increased under different doses, viz. at 10000ppm (62.27±0.04mm), 15000ppm(62.80±0.01mm), 20000ppm(62.63±0.04mm), 25000ppm(62.20±0.01mm) compared to the control(61.13±0.02mm) but the LML was decreased at 30000ppm(61.03±0.03mm). The highest and the lowest mean values ofLML were observed at 15000ppm (62.54±0.02mm) and at 30000ppm (60.77±0.02mm)respectively at FS-3.

The results of ANOVA have been presented in Appendix TableXXI. The items, viz. feeding schedules (F=177.83), seasons (F=756.31), doses (F=2321.41) and dose ×season (F= 2.78) revealed significant results ($P<0.01$).

The efficacy of vit- C under different seasons on LML followed the order S-2>S-1>S-3> S-4 and ondifferent feeding schedule the effectiveness in this regard was FS-2 > FS-1> FS-3. The most effective dose ofvit- C in most of the cases was 15000ppm followed by 20000ppm, 10000ppm and 25000ppm.

Breadth of mature larvae (BML):

The effect of vit- C supplementation under different seasons, viz. S-1, S-2, S-3 and S-4 on BML of *B.mori* at different feeding schedules, viz. FS-1, FS-2, FS-3 are shown in Table 24, the graphical presentation are showed in Figure 24 and their statistical analysis is presented in Appendix Table XXII.

In S-1,results were showed that the BML were increased under different concentrations in comparison to the control while fed at FS-1. The highest and the lowest mean of BML were observed at 15000ppm (12.46±0.01mm) and at 30000ppm (11.41±0.01mm) respectively. While fed according to FS-2, the highest and the lowest BML were recorded at 15000ppm (12.49±0.01mm) and at 30000ppm (11.43±0.02mm) respectively. In case of FS-3, the BML were also increased under different concentrations, viz. at 10000ppm (11.86±0.01mm), 15000ppm (12.33±0.02mm), 20000ppm (12.17±0.02mm), 25000ppm (11.73±0.03mm) comparedtothe control (11.47±0.03mm) but the mean value of BML was decreased at 30000ppm(11.28±0.02mm).

DuringS-2, the mean values of BML were increasedsignificantlyunder different concentrations and at different feeding schedules. At FS-1, the highest and the lowestBML were recorded at 15000ppm (12.50±0.02mm) and at 30000ppm(11.45±0.08mm) respectively. At FS-2,the BML were increased under different concentrations, viz. at 10000ppm (12.13±0.09mm), 15000ppm(12.55±0.08mm), 20000ppm(12.35±0.03mm), 25000ppm(11.92±0.04mm) compared to the control(11.60±0.12mm) but the mean value of BML was decreased at 30000ppm(11.50±0.08mm). The highest and the lowest mean values ofBML were observed at 15000ppm (12.42±0.02mm) and at

30000ppm (11.38±0.03mm)respectively while fed according to FS-3.

On different feeding schedules, the mean values of BML were significantly increased under different concentrations ofvit- Cin S-3. The highest and the lowest mean values of BML were observed at 15000ppm (12.41±0.02mm) and at 30000ppm (11.32±0.01mm) for FS-1, at 15000ppm (12.47±0.02mm) and at 30000ppm(11.38±0.01mm) for FS-2 and at 15000ppm (12.23±0.02mm) and at 30000ppm (11.25±0.03mm) for FS-3 respectively.

The mean values of BML under different concentrations at different feeding schedules were increasedsignificantly inS-4. While fed according to FS-1, the highest and the lowestBML were observed at 15000ppm (12.30±0.03mm) and at 30000ppm(11.27±0.02mm) respectively. At FS-2, the BML were increased under different doses, viz. at 10000ppm (11.73±0.02mm), 15000ppm(12.38±0.02mm), 20000ppm(12.12±0.02mm), 25000ppm(11.72±0.02mm) compared to the control(11.33±0.02mm) but the mean value of BML was decreased at 30000ppm(11.30±0.01mm). The highest and the lowest BML were observed at 15000ppm (12.18±0.02mm) and at 30000ppm (11.23±0.02mm)respectively at FS-3.

Analysis of variance showed highly significant differences among feeding schedules (F=232.15),seasons (F=651.16), doses (F=1201.99) at 1% level of significance but dose× seasons (F=2.34) showed significant results at 5%in Appendix Table XXII.

The effectiveness of vit- C with respect to different seasons on BML followed the order S-2>S-1>S-3> S-4 and while in respect of different feeding schedule this trend was FS-2 > FS-1> FS-3.In most of the cases for both seasons and feeding schedule effective doses of vit-Cfollowed the order 15000ppm >20000ppm >10000ppm >25000ppm.

4.2.2. Effect of ascorbic acid on the pupal growth of *B. mori*

The results ofvit- C supplementation on the growth of pupae of*B.mori*under different seasons and different feeding schedules are given bellow:

Pupalweight (PW):

The effect of vit- C supplementation under different seasons, viz. S-1, S-2, S-3 and S-4 on PW of *B.mori* at different feeding schedules, viz. FS-1, FS-2, FS-3 are

shown in Table 25, the graphical presentation are showed inFigure 25 and their statistical analysis is presented in Appendix Table XXIII.

The mean values of PW were increased in S-1 under different doses when compared to the control while fed according to FS-1. The highest and the lowest mean of PW were observed at 15000ppm (0.78±0.01gm) and at 30000ppm (0.65±0.01gm) respectively. While maintaining FS-2, the highest and the lowest PW were observed at 15000ppm (0.85±0.01gm) and at 30000ppm(0.67±0.00gm) respectively. Incase of FS-3, the PW also increased under different concentrations, viz. at 10000ppm (0.72±0.00gm), 15000ppm (0.76±0.00gm), 20000ppm (0.74±0.02gm) and 25000ppm (0.70±0.01gm) compared to the control (0.69±0.01gm) but the mean value of BML was decreased at 30000ppm (0.63±0.02gm).

The supplementation of vit- C significantly increasedthe mean values of PW under different concentrations and atvarious feeding schedulesinS-2. While fed according to FS-1, the highest and the lowest PW were recorded at 15000ppm (0.80±0.01gm) and at 30000ppm (0.66±0.00gm) respectively. In case of FS-2, the PW were increased under different doses, viz. at 10000ppm (0.80±0.01gm), 15000ppm (0.91±0.03gm), 20000ppm (0.87±0.02gm) and 25000ppm (0.78±0.01gm) compared to control(0.71±0.02gm). While maintaining FS-3, the highest and the lowest mean of PW were observed at 15000ppm (0.78±0.01gm) and at 30000ppm (0.64±0.02gm) respectively.

On different feeding schedules, the mean values of PW were significantly increased under different concentrations ofvit- C in S-3. The highest and the lowest PW were observed at 15000ppm (0.75±0.01gm) and at 30000ppm(0.62±0.01gm) for FS-1, at 15000ppm (0.81±0.01gm) and at 30000ppm (0.64±0.01gm) for FS-2 and at 15000ppm (0.72±0.01gm) and at 30000ppm (0.60±0.01gm) for FS-3 respectively.

The mean values of PWwere significantly increased under different concentrations and at different feeding schedules inS-4. While fed according to FS-1, the highest and the lowestmean of PW observed at 15000ppm (0.74±0.01gm) and at 30000ppm(0.55±0.01gm) respectively. In case of FS-2, the PW were increased at different doses, viz. at 10000ppm (0.72±0.01gm), 15000ppm(0.77±0.02gm), 20000ppm(0.74±0.02gm), 25000ppm(0.70±0.01gm) compared to control(0.61±0.01gm) but the mean value of PWwas decreased at 30000ppm(0.60±0.01gm). The highest and the lowest mean values ofPW were observed at 15000ppm (0.70±0.01gm) and at 30000ppm (0.52±0.01gm)respectively at FS-3.

Analysis of variance showed highly significant differences among feeding schedules (F=72.30),seasons (F=51.08), doses (F=109.74) at 1% level of significance but in this case dose× seasons (F=0.69) showed insignificant result in Table XXIII.

The effectiveness of vit- Cwith respect to different seasons on PW followed the order S-2>S-1>S-3 > S-4 and while in respect of different feeding schedule this trend was FS-2 > FS-1> FS-3.In most of the cases for both seasons and feeding schedule effective doses of vit- Cfollowed the order 15000ppm >20000ppm >10000ppm >25000ppm.

4.2.3. Effect of ascorbic acid on the cocoon characters of *B. mori*

The results of vit- C supplementation under different seasons anddifferent feeding schedules on the growth of cocoon characters of *B.mori* are given bellow:

Cocoonweight (CW):

The effect of vit- C supplementation under different seasons, viz. S-1, S-2, S-3 and S-4 on CW of *B.mori* at different feeding schedules, viz. FS-1, FS-2 and FS-3 is shown in Table26, the graphical presentation are showed in Figure 26 and their statistical analysis is presented in Appendix Table XXIV.

The mean values of CW were increased under different doses comparetothe control maintaining FS-1in S-1. The highest and the lowest mean of CW were observed at 15000ppm (0.92±0.01gm) and at 30000ppm (0.75±0.01gm) respectively. While fed according to FS-2, the highest and the lowest CW were noticed at 15000ppm (1.00±0.01gm) and at 30000ppm (0.78±0.00gm) respectively. In case of FS-3, the CW also increased under different doses, viz. at 10000ppm (0.84±0.00gm), 15000ppm (0.90±0.00gm), 20000ppm (0.87±0.01gm) and 25000ppm (0.82±0.01gm) compared to the control (0.80±0.01gm) but the mean value of CWwas decreased at 30000ppm(0.73±0.02gm).

The supplementation of vit- Csignificantly increased the mean values of CWin S-2under different concentrations and different feeding schedules. While fed according to FS-1, the highest and the lowest CW were observed at 15000ppm (0.95±0.01gm) and at 30000ppm (0.78±0.00gm) respectively. In case of FS-2, the CW was increased under different concentrations, viz. at 10000ppm (0.93±0.01gm), 15000ppm (1.07±0.03gm), 20000ppm (1.01±0.02gm) and 25000ppm (0.91±0.01gm) compared to the control (0.84±0.02gm). While maintaining FS-3,the highest and the lowest mean of CW were recorded at 15000ppm (0.92±0.01gm) and at 30000ppm (0.75±0.02gm) respectively.

On different feeding schedules, the mean values of CW were significantly increased under different concentrations ofvit- C in S-3. The highest and the lowest mean of CW were observed at 15000ppm (0.89±0.01gm) and at 30000ppm (0.71±0.01gm) for FS-1, at 15000ppm (0.95±0.01gm) and at 30000ppm (0.74±0.01gm) for FS-2 and at 15000ppm (0.85±0.01gm) and at 30000ppm (0.69±0.01gm) for FS-3 respectively.

In S-4, the mean values of CW were significantly increased under different concentrations and at different feeding schedules. While fed according to FS-1, the highest and the lowestmean of CW were observed at 15000ppm (0.86±0.01gm) and at 30000ppm (0.64±0.01gm) respectively. In case of FS-2, the CW were

increased under different doses, viz. at 10000ppm (0.83±0.01gm), 15000ppm (0.91±0.01gm), 20000ppm (0.87±0.01gm), 25000ppm (0.81±0.01gm) compared to control (0.71±0.01gm) but the mean value of CW was decreased at 30000ppm (0.69±0.01gm). The highest and the lowest mean values of CW were observed at 15000ppm (0.82±0.01gm) and at 30000ppm (0.63±0.01gm) respectively at FS-3.

Analysis of variance showed highly significant differences among feeding schedules (F=97.36),seasons (F=147.24) anddoses (F=132.78) at 1% level of significance in Appendix Table XXIV.

The effectiveness of vit- Cwith respect to different seasons on CW followed the order S-2 > S-1 > S-3 > S-4 and while in respect of different feeding schedule this trend was FS-2 > FS-1 > FS-3. In most of the cases for both seasons and feeding schedule effective doses of vit- Cfollowed the order 15000ppm >20000ppm >10000ppm >25000ppm.

Cocoon length (CL):

The effect of vit- Con CL of *B.mori*under different seasons at different feeding schedules, viz. FS-1, FS-2, FS-3 is shown in Table27, the graphical presentation are showed in Figure 27 and their statistical analysis is presented in appendix Table XXV.

In S-1, the mean values of CLwere increased under different doses compare to the control while fed according to FS-1. The highest and the lowest mean of CL were observed at 15000ppm (41.12±0.02mm) and at 30000ppm (39.38±0.02mm) respectively. While maintaining FS-2, the highest and the lowest CL were seen at 15000ppm (41.39±0.02mm) and at 30000ppm (39.42±0.01mm) respectively. In case of FS-3,the CL wasalso increased under different concentrations viz. at 10000ppm (39.56±0.02mm), 15000ppm (40.95±0.03mm), 20000ppm (40.83±0.02mm), 25000ppm (39.48±0.01mm) compared to the control (39.46±0.02mm).

The mean values of CLwere significantly increased in S-2 under different concentrations and different feeding schedules. At FS-1, the highest and the lowest CL were recorded at 15000ppm (41.25±0.03mm) and at 30000ppm (39.53±0.03mm) respectively. In case of FS-2, the CLwas also increased under different doses, viz. at 10000ppm (39.92±0.01mm), 15000ppm (41.46±0.03mm), 20000ppm (41.31±0.02mm), 25000ppm (39.81±0.02mm) compared to the control (39.62±0.04mm) but the lowest mean value of CL at 30000ppm (39.60±0.03mm). While maintaining FS-3, the highest and the lowest mean of CL were observed at 15000ppm (41.08±0.02mm) and at 30000ppm (39.55±0.02mm) respectively.

On different feeding schedules, the mean values of CL were significantly increased under different concentrations ofvit- Cin S-3. The highest and the lowest mean of CL were observed at 15000ppm (40.92±0.01mm) and at 30000ppm (39.14±0.01mm) for FS-1, at 15000ppm (41.24±0.02mm) and at 30000ppm (39.18±0.02mm) for FS-2 and at 15000ppm (40.88±0.01mm) and at 30000ppm (39.08±0.01mm) for FS-3 respectively.

The supplementation of vit- Csignificantly increasedthe mean values of CLin S-4under different concentrations and different feeding schedules. While fed according to FS-1, the highest and the lowestCL were noticed at 15000ppm (40.78±0.02mm) and at 30000ppm (38.89±0.03mm) respectively. In case of FS-2, the CL were increased undervarious concentrations, viz. at 10000ppm (39.59±0.02mm), 15000ppm (41.07±0.02mm), 20000ppm (40.92±0.02mm), 25000ppm (39.56±0.01mm) compared to the control (39.03±0.02mm) but the mean value of CL has been decreased at 30000ppm (38.97±0.03mm). AtFS-3, the highest and the lowest mean of CLwere observed at 15000ppm (40.74±0.01mm) and at 30000ppm (38.82±0.01mm) respectively.

The results of ANOVA have been presented in Appendix Table XXV. The items, viz. feeding schedules (F=318.82), seasons (F=647.64), doses (F=1164.42) revealed significant results ($P<0.01$).

The efficacy of vit- C under different seasons on CL followed the order S-2 > S-1 > S-3> S-4 and at different feeding schedule the effectiveness in this regard was FS-2 > FS-1 > FS-3. The most effective dose of vit- C in majority of the cases was 15000ppm followed by 20000ppm, 10000ppm and 25000ppm.

Cocoon breadth (CB):

The effect of vit- C supplementation on CB of *B.mori* under different seasons, viz. S-1, S-2, S-3, S-4 and at different feeding schedules, viz. FS-1, FS-2, FS-3 are shown in Table 28, the graphical presentation are showed in Figure 28 and their statistical analysis is presented in Appendix Table XXVI.

The results were showed that the CBwas increased under different dosesandat different feeding schedules compare to the controlin S-1. While maintaining FS-1,the highest and the lowest mean of CB were observed at 15000ppm (22.01±0.02mm) and at 30000ppm (21.12±0.01mm) respectively. At FS-2 the highest and the lowest CB were recorded at 15000ppm (22.18±0.01mm) and at 30000ppm (21.20±0.01mm) respectively. In case of FS-3, the BML were also increased under different concentrations, viz. at 10000ppm (21.84±0.01mm), 15000ppm (21.97±0.01mm), 20000ppm (21.86±0.01mm), 25000ppm (21.80±0.01mm) compared to thecontrol (21.30±0.01mm) but the mean value of CB has been decreased at 30000ppm(21.10±0.01mm).

The mean values of CBwere significantly increased under different concentrations and different feeding schedulesin S-2. At FS-1, the highest and the lowest CB were recorded at 15000ppm (22.10±0.01mm) and at 30000ppm (21.35±0.00mm) respectively. While fed according to FS-2, the CB were increased under different doses, viz. at 10000ppm (22.09±0.02mm), 15000ppm (22.25±0.03mm), 20000ppm (22.18±0.02mm), 25000ppm (21.95±0.02mm) compared to the control (21.42±0.01mm) but the mean value of CB has been decreased at 30000ppm (21.40±0.01mm). The highest and the lowest mean values of CB were observed at 15000ppm (22.07±0.02mm) and at 30000ppm (21.28±0.01mm) respectively while maintaining FS-3.

The supplementation ofvit- C significantly increased the mean values of CB under different concentrations and different feeding schedules in S-3. The highest and the lowest mean values of CB were observed at 15000ppm (21.88±0.02mm) and at 30000ppm (21.04±0.04mm) for FS-1, at 15000ppm (22.01±0.03mm) and at 30000ppm (21.07±0.02mm) for FS-2 and at 15000ppm (21.84±0.01mm) and at 30000ppm (21.00±0.03mm) for FS-3 respectively.

In S-4, the mean values of CBwere significantly increased under different concentrations andvarious feeding schedules. While fed according to FS-1, the highest and the lowestCB were noticed at 15000ppm (21.78±0.01mm) and at 30000ppm (20.84±0.01mm) respectively. At FS-2, the CB were increased under different concentrations, viz. at 10000ppm (21.75±0.01mm), 15000ppm (21.93±0.02mm), 20000ppm (21.78±0.04mm), 25000ppm (21.69±0.01mm) compared to the control (20.92±0.01mm) but the CB has been decreased at 30000ppm (20.86±0.01mm). At FS-3, the highest and the lowest mean values of CBwere observed at 15000ppm (21.74±0.01mm) and at 30000ppm (20.78±0.01mm) respectively.

Analysis of variance showed highly significant differences among feeding schedules (F=171.49), seasons (F=1177.02), doses (F=1010.90) anddose × seasons (F=3.47) at 1% level of significance in Appendix Table XXVI.

The effectiveness of vit- C with respect to different seasons on CB followed the order S-2 > S-1 > S-3 > S-4 and while in respect of different feeding schedule this trend was FS-2 > FS-1 > FS-3. In most of the cases for both seasons and feeding schedule effective doses of vit- Cfollowed the order 15000ppm >20000ppm >10000ppm >25000ppm.

Shell weight (SW):

Effect of vit- C supplementation under different seasons, viz. S-1, S-2, S-3 and S-4 on SW of *B.mori* at different feeding schedules, viz. FS-1, FS-2, FS-3 in shown

in the Table 29, the graphical presentation are showed in the Figure 29 and their statistical analysis is presented in Appendix Table XXVII.

Vit- C supplementation increased the SW under different doses compare to the control while fed according to FS-1in S-1. The highest and the lowest mean of SW were observed at 15000ppm (0.143±0.003gm) and at 30000ppm (0.103±0.003gm) respectively. While fed according to FS-2, the highest and the lowest SW were noticed at 15000ppm (0.153±0.003gm) and at 30000ppm (0.107±0.003gm) respectively. In case of FS-3, the SW wasalso increased under different doses, viz. at 10000ppm (0.120±0.000gm), 15000ppm (0.137±0.003gm), 20000ppm (0.127±0.003gm), 25000ppm (0.117±0.003gm) compared to the control (0.110±0.000gm). But the mean value of SW has been decreased at 30000ppm(0.100±0.000gm).

In S-2, the mean values of SW significantly increased under different concentrations and at different feeding schedules. While fed according to FS-1, the highest and the lowest SW were observed at 15000ppm (0.147±0.003gm) and at 30000ppm (0.117±0.003gm) respectively. At FS-2, the SW were increased under different doses, viz. at 10000ppm (0.130±0.000gm), 15000ppm (0.157±0.003gm), 20000ppm (0.147±0.003gm) and 25000ppm (0.133±0.003gm) compared to the control (0.123±0.003gm). The highest and the lowest mean of SW were noticed at 15000ppm (0.140±0.000gm) and at 30000ppm (0.110±0.000gm) respectively at FS-3.

The mean values of SW were significantly increased under different concentrations ofvit- C at different feeding schedulesin S-3. The highest mean of SW was observed at 15000ppm (0.133±0.003gm) at FS-1, at 15000ppm (0.143±0.003gm) for FS-2 and at 15000ppm (0.130±0.000gm) for FS-3 and the lowest at 30000ppm for all of the cases,viz. (0.093±0.003gm) for FS-1, (0.100±0.000gm) for FS-2 and (0.090±0.000gm) for FS-3 respectively.

The supplementations ofvit- C increased the mean values of SW under different concentrations and at different feeding schedules in S-4. While fed according to FS-1, the highest and the lowest larvae were recorded at 15000ppm (0.127±0.003gm)and at 30000ppm (0.087±0.003gm)) respectively. In case of FS-2, the SW were increased under different doses, viz. at 10000ppm (0.113±0.003gm), 15000ppm (0.133±0.003gm), 20000ppm (0.123±0.003gm), 25000ppm (0.110±0.000gm)compared to the control (0.093±0.003gm)but the mean value of SW has been decreased at 30000ppm (0.090±0.000gm). While maintaining FS-3,the highest and the lowest mean values of SW were observed at 15000ppm (0.120±0.000gm)and at 30000ppm (0.083±0.003gm)respectively.

Analysis of variance showed highly significant differences among feeding schedules (F=133.93),seasons(F=495.05), doses (F=285.26)at 1% level of significance in AppendixTable XXVII.

The effectiveness of vit- Cwith respect to different seasons on SW followed the order S-2 > S-1 > S-3 > S-4 and while in respect of different feeding schedule this trend was FS-2 > FS-1 > FS-3. In majority of the cases for both seasons and feeding schedule effective doses of vit- Cfollowed the order 15000ppm >20000ppm >10000ppm >25000ppm.

Shell ratio (%)

The effect of vit- C on SR% of *B.mori* under different seasons at different feeding schedules, viz. FS-1, FS-2, FS-3 is shown in Table30, the graphical presentation are showed in Figure 30 and their statistical analysis is presented in Appendix Table XXVIII.

In S-1, the mean values of SR% were increasedunder different doses in comparison to the control while fed according to FS-1. The highest and the lowest mean of SR% were observed at 15000ppm (15.58±0.31%)and at control (13.76±0.20%) respectively. In case of FS-2, the highest and lowest mean of SR%

were found at 15000ppm (15.33±0.20%) and at 30000ppm (13.68±0.43%) respectively. While maintaining FS-3, the results were the same as FS-2.

The mean values of SR% were significantly increasedinmajority cases except 30000 ppm compared to the control under different feeding schedules in S-2. At FS-1, the highest and the lowest SR% were recorded at 15000ppm (15.44±0.40%) and at 10000ppm (14.23±0.20%) respectively. While maintaining FS-2, the highest and lowest SR% was recorded at control (14.74±0.32%) and 10000ppm (14.03±0.10%). For FS-3, the highest and the lowest SR% were observed at 15000ppm (15.22±0.19%) and at 25000ppm (14.40±0.12%) respectively.

In different feeding schedules, the mean values of SR% were significantly increasedunder different concentrations except 30000ppm in S-3. The highest and the lowest mean of SR% were observed at 15000 ppm and at 30000ppm for all the feeding schedules.

In majority of the cases, the supplementation of vit- Csignificantly increasedthe mean values of SR% in S-4 under different concentrations and different feeding schedules. While fed according to FS-1, the highest and the lowest SR% were noticed at 15000ppm (14.67±0.29%) and at 10000ppm (13.12±0.47%) gradually. In case of FS-2, the SR% were increased under various concentrations, viz. at 10000ppm (13.61±0.51%), 15000ppm (14.72±0.59%), 20000ppm (14.25±0.61%), 25000ppm (13.53±0.11%) compared to the control (13.21±0.55%) but the mean value of SR% was decreased at 30000ppm (13.11±0.13%). At FS-3, the highest and the lowest mean of SR% were observed at 15000ppm (14.64±0.21%) and at control (13.21±0.55%) respectively.

The results of ANOVA have been presented in Appendix Table XXVIII. The items, viz. seasons (F=23.99), doses (F=91.40) and dose × season (F=6.41) revealed significant results ($P<0.01$). But the result was insignificant for the feeding schedules (F=0.16).

The efficacy of vit- C under different seasons on SR% followed the order S-2 > S-1 > S-3> S-4 and at different feeding schedule the effectiveness in this regard was not followed the same trend in different seasons. The most effective dose of vit- C in majority of the cases was 15000ppm followed by 20000ppm, 25000ppm and 10000ppm.

4.2.4. Effect of ascorbic acid on the survival percentage (SP) and adult emergence(%)of *B. mori*

The cocoon yield is significantly dependent on the production of various stages as well as the developmental period. The present work was initiated to determine the effect of various concentrations of vit- Con the survival percentage (SP)and adult emergence % of *B. mori.*under different seasons andvarious feeding schedules. The results are given bellow:

Survival percentage (SP):

Effect of vit- C supplementation under different seasons, viz. S-1, S-2, S-3, S-4 on SP of *B.mori* at different feeding schedules, viz. FS-1, FS-2, FS-3 are shown inTable 31, the graphical presentation are showed in Figure 31 and their statistical analysis is presented in Appendix Table XXIX.

The results were showed that the SP was increased under different doses in comparison to control while fed according to FS-1during S-1. The highest and the lowest mean of SPwere observed at 15000ppm (93.33±0.10%) and at 30000ppm (84.00±0.13%) respectively. While maintaining FS-2, the highest and the lowest SPwere recorded at 15000ppm (95.33±0.05%) and at 30000ppm (85.33±0.07%) respectively. At FS-3, the SPwere also increased under different concentrations, viz. at 10000ppm (89.33±0.17%), 15000ppm (92.00±0.094%), 20000ppm (90.67±0.03%),25000ppm (88.00±0.10%) comparedto thecontrol (86.67±0.05%) but the mean value of SP has been decreased at 30000ppm(83.33±0.07%).

The supplementation ofvit- Cincreasedthe mean values of SPin S-2under different concentrations and various different feeding schedules. While fed according to FS-1, the highest and the lowest SP were recorded at 15000ppm (95.33±0.05%) and at 30000ppm (85.33±0.07%) respectively. At FS-2, the SPwas increased under different doses, viz. at 10000ppm (93.33±0.10%) 15000ppm (96.67±0.03%), 20000ppm (94.67±0.08%), 25000ppm(92.00±0.17%) compared to the control (88.67±0.01%) but the mean value of SP has been decreased at 30000ppm (86.67±0.05%). The highest and the lowest mean values of SP were observed at 15000ppm (93.33±0.10%) and at 30000ppm (84.94±0.83%) respectively while maintaining FS-3.

On different feeding schedules, the mean values of SP were significantly increased under different concentrations ofvit- C in S-3. The highest and the lowest mean values of SPwere observed at 15000ppm (92.00±0.17%) and at 30000ppm (83.33±0.07%) for FS-1, at 15000ppm (94.00±0.06%) and at 30000ppm (84.00±0.13%) for FS-2 and at 15000ppm (90.67±0.03%) and at 30000ppm (81.33±0.05%) for FS-3 respectively.

In S-4, the mean values of SPwere significantly increasedunder different concentrations and at different feeding schedules. While fed according to FS-1, the highest and the lowestSP were recorded at 15000ppm (90.67±0.03%) and at 30000ppm (81.33±0.05%) respectively. In case of FS-2, the SP were increased under various concentrations, viz. at 10000ppm (89.33±0.17%), 15000ppm (92.00±0.17%), 20000ppm (90.67±0.03%), 25000ppm (88.00±0.10%) compared to the control (83.33±0.07%) but the mean value of SP has been decreased at 30000ppm (82.67±0.03%). The highest and the lowest mean values of SP were observed at 15000ppm (90.00±0.14%) and at 30000ppm (80.00±0.12%) respectively at FS-3.

The results of ANOVA have been presented in Table XXIX. It indicated highly significant differences among feeding schedules (F=417.31), seasons (F=859.69)

and doses (F=409.48) at 1% level of significance. The results was insignificant for the interaction itemdose × seasons (F=0.42).

The effectiveness of vit- C with respect to different seasons on SP followed the order S-2 > S-1 > S-3 > S-4 and while in respect of different feeding schedule this trend was FS-2 > FS-1 > FS-3. In most of the cases for both seasons and feeding schedule effective doses of vit- Cfollowed the order 15000ppm >20000ppm >10000ppm >25000ppm.

Adult emergence (%)

The effect of vit- C supplementation on AE% of *B.mori*under different seasons, viz. S-1, S-2, S-3 and S-4 at different feeding schedules, viz. FS-1, FS-2, FS-3 are shown in Table 32, the graphical presentation are showed in Figure 32 and their deviate values (T-test) is presented in Table 32.

During S-1, the mean values of AE% were increased under different doses compared to the control while maintaining FS-1. The highest and the lowest mean of AE% were observed at 15000ppm (90.67%)and at 30000ppm (82.67%)respectively. While fed according to FS-2, the highest and the lowest AE% were recorded at 15000ppm (92.00%) and at 30000ppm (83.33%)respectively. In case of FS-3, the AE%was also increased under different doses, viz. at 10000ppm (86.67%), 15000ppm (89.33%), 20000ppm (88.00%) and 25000ppm (85.33%)compared to the control (84.67%). But the mean value of AE% was decreased at 30000ppm(81.33%).

The mean values of AE%were increased significantlyunder different concentrations of vit-Cat different feeding schedules in S-2. While fed according to FS-1, the highest and the lowest AE% were observed at 15000ppm (93.33%) and at 30000ppm (84.00%) respectively. In case of FS-2, the AE% was increased under different doses, viz. at 10000ppm (92%), 15000ppm (95.33%), 20000ppm (93.33) and 25000ppm (90.00%) compared to the control (86.67%). The highest

and the lowest mean of AE% were recorded at 15000ppm (92.00%)and at 30000ppm (83.33%)respectively while fed according to FS-3.

At different feeding schedules, the mean values of AE% were significantly increased under different concentrations ofvit- C in S-3. The highest and the lowest mean of AE% were observed at 15000ppm (89.33%) and at 30000ppm (81.33%)for FS-1, at 15000ppm (90.67%) and at 30000ppm (82.67%)for FS-2 and at 15000ppm (88.00%)and at 30000ppm (80.00%)for FS-3 respectively.

In S-4, the mean values of AE% under different concentrations at different feeding schedules were significantly increased. While fed according to FS-1, the highest and the lowestmean of AE% were observed at 15000ppm (88.00%)and at 30000ppm (78.67%)respectively. In case of FS-2, the AE% were increasedunder different doses, viz. at 10000ppm (86.67%), 15000ppm (89.33%), 20000ppm (88.00%), 25000ppm (85.33%)compared to the control (81.33%)but the mean value of AE% has been decreased at 30000ppm (80.00%). The highest and the lowest mean values of AE% were observed at 15000ppm (86.67%) and at 30000ppm (76.67%)respectively at FS-3.

The results of deviate values have been presented in Table 32. The items concentrations, seasons and feeding schedules revealed significant.

The effectiveness of vit- C with respect to different seasons on AE% followed the order S-2 > S-1 > S-3 > S-4 and while in respect of different feeding schedule this trend was FS-2 > FS-1 > FS-3. In most of the cases for both seasons and feeding schedule effective doses of vit- Cfollowed the order 15000ppm >20000ppm >10000ppm >25000ppm.

4.2.5.Effect of ascorbic acid on the developmental stages of *B. mori*

The results of vit- C supplementationon the developmental stages of *B.mori* under different seasons and different feeding schedules are given bellow:

Larval period (LP):

Effect of vit- C supplementation under different seasons, viz. S-1, S-2, S-3 and S-4 on LP of *B.mori* at different feeding schedules, viz. FS-1, FS-2, FS-3 are shown inTable 33, the graphical presentation are showed in Figure 33 and their statistical analysis is presented in Appendix Table XXX.

The supplementation of vit- C decreased the mean ofLP under different dosesin comparison to the control while maintaining FS-1 in S-1. The highest and the lowest mean of LP were noticed at 30000ppm (23.607±0.007 days) and at 15000ppm (23.470±0.010 days) respectively. While fed according to FS-2 the highest and the lowest LP were recorded at 30000ppm (23.593±0.007 days) and at 15000ppm (23.460±0.012 days) respectively. In case of FS-3, the LP were also decreased under various concentrations, viz. at 10000ppm (23.540±0.012 days), 15000ppm (23.507±0.007 days), 20000ppm (23.533±0.007 days), 25000ppm (23.557±0.003 days) comparedto thecontrol (23.587±0.007 days). But the mean value of LP has been increased at 30000ppm (23.633±0.007 days).

The mean values of LP were significantly decreased in S-2 under different concentrations and different feeding schedules. According to FS-1, the highest and the lowest LP were recorded at 30000ppm (23.540±0.010 days) and at 15000ppm (23.433±0.007 days) respectively. At FS-2, the LP were decreased under different doses, viz. at 10000ppm (23.457±0.012 days), 15000ppm (23.413±0.007 days), 20000ppm (23.440±0.010 days), 25000ppm (23.480±0.012 days) compared to the control (23.523±0.015 days). But the mean value of LP has been increased at 30000ppm (23.537±0.009 days). While maintaining FS-3, the highest and the lowest LP were observed at 30000ppm (23.550±0.000 days) and at 15000ppm (23.477±0.015 days) respectively.

In different feeding schedules, the mean values of LP were significantly decreased under different concentrations ofvit- C in S-3. The highest and the lowest mean values of LP were observed at 30000ppm (23.700±0.012 days), at 15000ppm

(23.577±0.015 days) for FS-1, at 30000ppm (23.677±0.015 days), at 15000ppm (23.550±0.017 days) for FS-2 and at 30000ppm (23.720±0.012 days) and at 15000ppm (23.613±0.007 days) for FS-3 respectively.

The supplementations of vit- Csignificantly decreased the mean values of LPin S-4under different concentrations and different feeding schedules. While maintaining FS-1 the highest and the lowestLP were recorded at 30000ppm (23.760±0.010 days) and at 15000ppm (23.620±0.015 days) respectively. In case of FS-2, the LP were decreased under different doses, viz. at 10000ppm (23.640±0.010 days), 15000ppm (23.600±0.012 days), 20000ppm (23.633±0.007 days), 25000ppm (23.660±0.010 days) compared to the control (23.723±0.015 days). But the mean value of LP has been increased at 30000ppm (23.740±0.010 days). The highest and the lowest mean values of LP were observed at 30000ppm (23.773±0.007 days) and at 15000ppm (23.640±0.012 days) respectively at FS-3.

The results of ANOVA have been presented in Appendix Table XXX. It indicated highly significant differences among feeding schedules (F=172.84), seasons (F=3520.73) and doses (F=225.41) at 1% level of significance. The results was insignificant for the interaction item dose × seasons (F=1.06).

The effectiveness of vit- C under different seasons on LP followed the order S-4> S-3> S-1> S-2 and while in respect of different feeding schedules this trend was FS-3 > FS-1 > FS-2. In most of the cases for both seasons and feeding schedule effective doses of vit- C followed the order 15000ppm >20000ppm >10000ppm >25000ppm.

Pupalperiod (PP):

The effect of vit- Cunder different seasons on PP of *B.mori* at different feeding schedules, viz. FS-1, FS-2, FS-3 are shown in Table34, the graphical presentation are showed in Figure 34 and their statistical analysis is presented in Appendix Table XXXI.

The supplementations ofvit- C in S-1decreased the mean values of PPunder different doses compare to the control while fed according to FS-1. The highest and the lowest mean ofPP were observed at 30000ppm (09.613±0.007 days) and at 15000ppm(09.470±0.010 days) respectively. While maintaining FS-2, the highest and the lowest PP were observed at 30000ppm (09.593±0.007 days) and at 15000ppm(09.467±0.017 days) respectively. In case of FS-3, the PPwasalso decreased under different concentrations viz. at 10000ppm (09.550±0.006 days), 15000ppm (09.507±0.007 days), 20000ppm (09.533±0.007 days) and25000ppm (09.553±0.020 days) compared to the control (09.580±0.012 days).But the highest mean value of PP were observed at 30000ppm (09.633±0.007 days).

The mean values of PPwere significantly decreasedin S-2under different concentrations and different feeding schedules. While fed according to FS-1, the highest and the lowest PP were recorded at 30000ppm (09.563±0.009 days) and at 15000ppm (09.433±0.007days) respectively. In case of FS-2, the PPwas alsodecreased at different doses, viz. at 10000ppm (09.440±0.012 days), 15000ppm (09.413±0.007 days), 20000ppm (09.427±0.007 days), 25000ppm (09.450±0.006 days) comparedto thecontrol (09.420±0.012 days). But the highest mean value of PP were seen at 30000ppm (09.533±0.017 days). The highest and the lowest mean ofPP were noticed at 30000ppm (09.580±0.012 days) and at 15000ppm (09.447±0.003 days) respectively while fed according to FS-3.

The supplementations of vit- C decreased the mean values of PP in S-3 under different concentrations and different feeding schedules. The highest and the lowest mean of PP were observed at 30000ppm (09.693±0.013 days and at 15000ppm (09.550±0.000 days) for FS-1, at 30000ppm (09.680±0.012 days) and at 15000ppm (09.537±0.009 days) for FS-2 and at 30000ppm (09.710±0.021 days) and at 15000ppm (09.567±0.007 days) for FS-3 respectively.

In S-4, the mean values of PP were significantly decreasedunder different concentrations and different feeding schedules. According to FS-1, the highest and

the lowestPP were noticed at 30000ppm (09.773±0.007 days) and at 15000ppm(09.600±0.012 days) respectively. In case of FS-2, the PP weredecreased under different concentrations, viz. at 10000ppm (09.643±0.003 days), 15000ppm(09.577±0.015 days), 20000ppm(09.627±0.007 days), 25000ppm(09.653±0.003 days) compared to the control(09.750±0.017 days) but the mean value of PP has been increased at 30000ppm(09.757±0.003 days). While maintaining FS-3, the highest and the lowest mean values ofPP were observed at 30000ppm (09.780±0.000 days) and at 15000ppm (09.613±0.013 days)respectively.

The results of ANOVA have been presented in Appendix TableXXXI. The items, viz. feeding schedules (F=110.95), seasons (F=2802.01), doses (F=453.54) and dose × season (F=4.33) revealed significant results (P<0.01).

The efficacy of vit- Cunder different seasons on PP followed the order S-4>S-3>S-1> S-2 and at different feeding schedule the effectiveness in this regard was FS-3> FS-1> FS-2. The most effective dose ofvit- Cin most of the cases was 15000ppm followed by 20000ppm, 10000ppm and 25000ppm.

4.2.6. Effect of ascorbic acid on thetotal number of eggs laid (TEL) and egg hatching percentage (EHP) of *B. mori*

In the present experimenttotal number of eggs laid was evaluated on the basis of egg laying potential, *i.e.* total number of eggs laid by individual female moth of *B. mori*and for fertility parameter egg hatching percentage was computed.

The results ofvit- C supplementation on the total number of eggs laid (TEL) and egg hatching percentage (EHP) of*B.mori*under different seasons anddifferent feeding schedules are given bellow:

Total number of eggs laid (TEL): The effect of vit- C supplementation on the TEL of *B.mori*under different seasons, viz. S-1, S-2, S-3 and S-4 at different feeding schedules, viz. FS-1, FS-2

and FS-3 are shown in Table35, the graphical presentation are showed in Figure 35 and their statistical analysis is presented in Appendix Table XXXII.

The supplementation of vit- C increased the TEL in S-1 under different doses compare to the control while fed according to FS-1. The highest and lowest mean values of TEL were observed at 15000ppm (365.35±0.51) and 30000ppm (262.27±1.47) respectively. While maintaining FS-2, the highest and lowest mean of TEL were seen at 15000ppm (375.59±0.61) and 30000ppm (261.41±1.72) respectively. At FS-3, the mean of TEL were also increasedundervariousconcentrations, viz. at 10000ppm(303.12±1.36), 15000ppm(352.83±1.38), 20000ppm(313.61±1.08), 25000ppm(296.70±0.84) compared to the control(270.59±1.08)but the mean value of TEL has been decreased at 30000ppm(256.56±0.95).

InS-2, the mean values of TELwere significantly increasedunder different concentrations and different feeding schedules. While fed according to FS-1, the highest and the lowestTEL were viewedat 15000ppm (374.81±0.93) and at 30000ppm (270.61±1.12) respectively. At FS-2, the mean ofTELwere increased under different doses, viz. at 10000ppm (327.93±1.61), 15000ppm(382.92±1.43), 20000ppm(336.43±2.29), 25000ppm(323.58±0.97) compared to the control(276.73±0.99) but the mean value of TEL has been decreased at 30000ppm(373.03±0.47).While maintaining FS-3, the highest and the lowest mean values ofTEL were observed at 15000ppm (360.53±1.09)and at 30000ppm(265.29±0.99) respectively.

The mean values of TEL were significantly increased underdifferent concentrations andvarious feeding schedules in S-3. The highest and lowest mean of TEL were observed at 15000ppm (360.37±0.14) and at 30000ppm (252.59±1.16) for FS-1, at 15000ppm(366.26±1.32) and at 30000ppm(259.27±0.63) for FS-2 and at 15000ppm(346.25±1.29)and at 30000ppm (247.55±1.11) for FS-3.

The supplementation of vit- C increasedthe mean values of TELduringS-4undervarious concentrations and different feeding schedules. While fed according to FS-1, the highest and the lowestmean of TEL were observed at 15000ppm (351.24±0.64) and at 30000ppm (248.68±0.70) respectively. In case of FS-2, the TEL were increased under different doses, viz. at 10000ppm (312.97±1.55), 15000ppm(255.99±1.90), 20000ppm(318.61±0.18), 25000ppm(306.89±1.04) compared to the control(257.03±0.69) but the mean value of TEL has been decreased at 30000ppm(253.50±0.98). At FS-3, the highest and the lowest mean values ofTEL were observed at 15000ppm (340.58±1.17) and at 30000ppm (243.01±1.28) respectively.

The results of ANOVA have been presented in Appendix TableXXXII. The items, viz. feeding schedules (F=2004.76), seasons (F=2089.08), doses (F=920.34) revealed significant results ($P<0.01$).

The effectiveness of different concentrations of vit- Cunder different seasons on TEL followed the order S-2>S-1>S-3 > S-4 and in respect of feeding schedule FS-2> FS-1> FS-3. The most effective doses of the vit- C was found to be 15000ppm followed by 20000ppm, 10000ppm and 25000ppm.

Egg hatching percentage (EHP):

The effect of vit- C supplementation on EHP of *B.mori*under different seasons viz. S-1, S-2, S-3 and S-4 andat different feeding schedules, viz. FS-1, FS-2, FS-3 are shown in Table 36, the graphical presentation are showed in Figure 36 and their statistical analysis is presented in Appendix Table XXXIII.

During S-1 the mean values of EHP were increased under different doses compared to the control while fed according to FS-1. The highest and the lowest mean of EHP were observed at 15000ppm (94.81±0.02%) and at 30000ppm (93.17±0.09%) respectively. While maintaining FS-2, the highest and the lowest EHP were observed at 15000ppm (94.83±0.05%)and at 30000ppm (93.32±0.01%)

respectively. At FS-3, the EHPwasalso increased under different concentrations viz. at 10000ppm (93.92±0.02%), 15000ppm (94.38±0.02%), 20000ppm (94.25±0.02%), 25000ppm (93.70±0.01%)compared to control (93.38±0.03%).

The mean values of EHPwere increased significantly during S-2 under different concentrations andat different feeding schedules. While fed according to FS-1, the highest and the lowest EHP were recorded at 15000ppm (94.88±0.01%)and at 30000ppm (93.55±0.06%)respectively. In case of FS-2, the mean ofEHP were also increased under different doses, viz. at 10000ppm (94.70±0.03%), 15000ppm(95.06±0.04%), 20000ppm (94.82±0.02%), 25000ppm (94.68±0.04%)compared to the control (93.61±0.05%). But the lowest mean value of EHP at 30000ppm (93.58±0.07%). While fed according to FS-3, the highest and the lowest mean of EHP were noticed at 15000ppm (94.58±0.02%)and at 30000ppm (93.48±0.03%)respectively.

On different feeding schedules, the mean values of EHP were significantly increased under different concentrations ofvit- Cin S-3. The highest and the lowest mean of EHP were observed at 15000ppm (94.69±0.02%) and at 30000ppm (93.14±0.02%)for FS-1, at 15000ppm (94.73±0.06%)and at 30000ppm(93.21±0.04%)for FS-2 and at 15000ppm (94.28±0.01%) and at 30000ppm(93.09±0.01%) for FS-3 respectively.

The supplementation of vit- Csignificantly increasedthe mean values of EHP in S-4under different concentrations andat different feeding schedules. While fed according to FS-1, the highest and the lowestEHP were recorded at 15000ppm (94.57±0.01%)and at 30000ppm (93.11±0.01%)respectively. In case of FS-2, the EHPwas increased under different doses, viz. at 10000ppm (94.44±0.02%), 15000ppm (94.64±0.02%), 20000ppm (94.54±0.03%), 25000ppm (94.36±0.03%) compared to the control (93.22±0.01%)but the mean value of EHP has been decreased at 30000ppm (93.16±0.03%). At FS-3, the highest and the lowest mean

values of EHP were observed at 15000ppm (94.13±0.01%) and at 30000ppm (93.07±0.01%)respectively.

The results of ANOVA have been presented in Appendix Table XXXIII. The items, viz. feeding schedules (F=1295.42), seasons (F=381.00), doses (F=114.67) revealed significant results (P<0.01).

The efficacy of vit- C on EHPunder different seasons followed the order S-2 > S-1 > S-3> S-4 and at different feeding schedule the effectiveness in this regard was FS-2 > FS-1 > FS-3. The most effective doses of vit- C in majority of the cases was 15000ppm followed by 20000ppm, 10000ppm and 25000ppm.

4.2.7. Effect of ascorbic acid on the Mortality % of *B. mori*

The purpose of the following investigation is to find out the effect of vit-C supplementation on the Mortality of *B. mori*under different seasons and different feeding schedules.The results are given bellow:

Mortality (%)

The effect of vit- C on Mortality% of *B.mori* under different seasons, viz. S-1, S-2, S-3, S-4 and at different feeding schedules, viz. FS-1, FS-2, FS-3 are shown in Table 37, the graphical presentation are showed in Figure 37 and their deviate values (T-test) is presented in Table 37.

The mean values of Mortality% were decreased under different doses compared to the control maintaining scheduled FS-1during S-1. The highest and the lowest mean of Mortality% were observed at 30000ppm (35.05%) and at 15000ppm (13.81%) respectively. While fed according to FS-2, the highest and the lowest Mortality%were recorded at 30000ppm (31.86%) and at 15000ppm (9.57%) respectively. At FS-3, the Mortality% also decreased under different concentrations, viz. at 10000ppm (22.61%), 15000ppm (16.70%), 20000ppm (19.62%) and 25000ppm (25.64%) compared to the control (28.71%). But the mean value of AD% has been increased at 30000ppm (36.67%).

The mean values of Mortality%under different doses of vit-Cat different feeding schedules in S-2were decreased significantly. While fed according to FS-1, the highest and the lowest Mortality% were observed at 30000ppm (31.86%) and at 15000ppm (9.57%) respectively. At FS-2, the Mortality% was decreased under different doses, viz. at 10000ppm (13.81%), 15000ppm (6.78%), 20000ppm (11.00%) and 25000ppm (17.40%) compared to the control (24.11%). The highest and the lowest mean of Mortality% were recorded at 30000ppm (35.05%) and at 15000ppm (13.81%) respectively while fed according to FS-3.

At different feeding schedules, the mean values of Mortality% were significantly decreased under different concentrations ofvit- C in S-3. The highest and the lowest mean of Mortality% were observed at 30000ppm (36.67%) and at 15000ppm (16.00%) for FS-1, at 30000ppm (35.04%) and at 15000ppm (12.38%) for FS-2 and at 30000ppm (41.62%) and at 15000ppm (19.62%) for FS-3 respectively.

During S-4 the mean values of Mortality% under different concentrations at different feeding schedules were significantly decreased. While fed according to FS-1, the highest and the lowestmean of Mortality% were observed at 30000ppm (41.62%) and at 15000ppm (19.62%) respectively. In case of FS-2, the Mortality% were decreasedunder different doses, viz. at 10000ppm (22.61%), 15000ppm (16.70%), 20000ppm (19.62%), 25000ppm (25.64%) compared to the control (36.67%) but the mean value of Mortality%wasincreased at 30000ppm (38.03%). The highest and the lowest mean values of Mortality% were observed at 30000ppm (45.00%) and at 15000ppm (21.11%) respectively at FS-3.

The results of deviate values have been presented in Table 37. The items concentrations and feeding schedules revealed insignificant.

The effectiveness of vit- Cwith respect to different seasons on Mortality% followed the order S-4> S-3> S-1> S-2 and while in respect of different feeding schedule this trend was FS-3> FS-1 > FS-2. In most of the cases for both seasons

and feeding schedule effective doses of vit- Cfollowed the order 15000ppm >20000ppm >10000ppm >25000ppm.

4.2.8. Effect of ascorbic acid on feed efficacy of *B. mori*L.

The results of physiological parameters like food consumption, food utilization, food digestibility, food consumption index and co-efficient offoof utilization of 5th instar larvae of *B. mori* fed with control mulberry leaves and different concentrations of vitamin B_2 treated mulberry leaves under different seasons and at various feeding schedule are showedin Tables38-42, graphical presentation are showed in Figures38-42 and their statistical analysis is presented in Appendix Table XXXIV-XXXVIII.

Food consumption (FC):

The effect of vit- C supplementation on the FC of *B.mori*under different seasons, viz. S-1, S-2, S-3 and S-4 and at different feeding schedules, viz. FS-1, FS-2, FS-3 are shown in Table38, the graphical presentation are showed in Figure 38 and their statistical analysis is presented in Appendix Table XXXIV.

The mean values ofFC were increased in S-1 under different dosesof vit- C compared to the control while fed according to FS-1. The highest and lowest mean values of FC were found at 15000ppm(47.43±0.04gm) and 30000ppm(44.77±0.06gm) respectively. While fed according to FS-2 the highest and lowest of FC were observed at 15000ppm(47.77±0.05gm)and 30000ppm(44.91±0.06gm)respectively. In case of FS-3, the FC werealso increased under different doses, viz. at 10000ppm(45.46±0.09gm), 15000ppm(47.04±0.11gm), 20000ppm (46.32±0.06gm), 25000ppm(45.13±0.03gm)compared to the control(45.03±0.10gm)but the mean value of FC has been decreased at 30000ppm(44.57±0.04gm).

InS-2, the mean values of FCwere increasedsignificantlyunder different concentrations and at different feeding schedules. While fed according to FS-1,

The highest and the lowestmean of FCwere noticed at 15000ppm (47.85±0.08gm) and at 30000ppm(45.07±0.04gm) respectively. In case of FS-2, the FCwere increased under different concentrations, viz. at 10000ppm (46.55±0.04gm), 15000ppm(48.44±0.03gm), 20000ppm(47.45±0.04gm), 25000ppm (45.18±0.04gm) compared to the control (45.65±0.08gm) but the mean value of FC has been considerably decreased at 30000ppm (45.37±0.04gm). The highest and the lowest mean values ofFC were observed at 15000ppm(47.40±0.03gm)and at 30000ppm (44.86±0.03gm)respectively at FS-3.

The mean values of FC were increasedsignificantly at different feeding schedules under different doses ofvit- C in S-3. The highest and lowest mean of FC were found at 15000ppm (47.01±0.08gm) and at 30000ppm (44.52±0.02gm) for FS-1, at 15000ppm (47.39±0.07gm)and at 30000ppm (44.58±0.09gm)for FS-2 and at 15000ppm (46.75±0.03gm) and at 30000ppm (44.26±0.05gm) for FS-3.

The mean values of FC were significantly increased inS-4under different concentrations and atvarious feeding schedules. While fed according to FS-1, the highest and the lowestmean of FC were observed at 15000ppm (46.45±0.04gm)and at 30000ppm(43.92±0.06gm)) respectively. In case of FS-2, the FCwasincreased under different doses, viz. at 10000ppm (45.26±0.07gm), 15000ppm(46.89±0.06gm),20000ppm(46.41±0.05gm), 25000ppm(45.12±0.07gm) compared to the control(44.17±0.09gm) but the mean value of FC has been decreased at 30000ppm(44.08±0.04gm). The highest and the lowest mean values ofFC were viewed at 15000ppm (46.22±0.07gm)and at 30000ppm (43.78±0.04gm) respectively at FS-3.

Analysis of variance showed highly significant differences among feeding schedules (F=35.52),seasons (F=359.72), doses (F=363.89) at 1% level of significance in Appendix Table XXXIV.

The effectiveness of vit- Csupplementationunder different seasons on FC followed the order S-2>S-1>S-3 > S-4 and in respect of feeding schedule FS-2>

FS-1> FS-3. The most effective doses of vit- C was found at15000ppm followed by 20000ppm, 10000ppm and 25000ppm.

Food utilization (FU):

The effects of the supplementation ofvit- C on the FU of *B.mori* under different seasons and various feeding schedules are shown in Table39, the graphical presentation are showed in Figure 39 and their statistical analysis is presented in Appendix TableXXXV.

The supplementation ofvit- Cin S-1 under different doses while feeding FS-1increased the mean values of FU of *B mori*. The highest and the lowest mean ofFU were found at 15000ppm (67.53±0.08gm) and at 30000(59.61±0.04gm) respectively. While maintaining FS-2, the highest and the lowest FU were observed at 15000ppm (67.81±0.06gm) and at 30000ppm(59.76±0.04gm) respectively. On FS-3, the FUwere also increased under different concentrations viz. at 10000ppm (64.42±0.05gm), 15000ppm (67.28±0.04gm), 20000ppm (65.60±0.06gm), 25000ppm (64.41±0.04gm) compared to the control (60.22±0.05gm).

The mean values of FU in S-2under different concentrations at different feeding schedules were increasedsignificantly. While fed according to FS-1, the highest and the lowest FU were recorded at 15000ppm (68.26±0.03gm) and at 30000ppm (60.14±0.06gm) respectively. In case of FS-2, the FU were also increased at various concentrations, viz. at 10000ppm (65.52±0.03gm), 15000ppm (68.51±0.06gm),20000ppm (66.52±0.10gm), 25000ppm (65.32±0.04gm) comparedto thecontrol (60.66±0.03gm). But the lowest mean value of FU at 30000ppm (60.45±0.03gm). The highest and the lowest mean ofFU were observed at 15000ppm (67.86±0.06m) and at 30000ppm (59.82±0.03gm) respectively while fed according to FS-3.

At different feeding schedules, the mean values of FU were significantly increased under different concentrations ofvit- C in S-3. The highest and the lowest mean of

FU were observed at 15000ppm (67.15±0.08gm) and at 30000ppm (58.39±0.05gm) for FS-1, at 15000ppm (67.33±0.07gm) and at 30000ppm (58.45±0.06gm) for FS-2 and at 15000ppm (63.82±0.08gm) and at 30000ppm (58.25±0.03gm) for FS-3 respectively.

In S-4, the mean values of FU under different concentrations at different feeding schedules were significantly increased. While fed according to FS-1, the highest and the lowestmean of FU were found at 15000ppm (66.69±0.04gm) and at 30000ppm(57.72±0.04gm) respectively. At FS-2, the FU were increased under different doses, viz. at 10000ppm (64.42±0.04gm), 15000ppm(66.86±0.06gm), 20000ppm(65.47±0.04gm), 25000ppm(65.22±0.04gm) compared to the control(58.23±0.05gm) but the mean value of FU has been decreased at 30000ppm(58.14±0.07gm). The highest and the lowest mean values ofFU were observed at 15000ppm (66.47±0.04gm) and at 30000ppm (57.56±0.03gm)respectively at FS-3.

The results of ANOVA have been presented in Appendix TableXXXV. The items, viz. feeding schedules (F=121.46), seasons (F=853.99), doses (F=7504.48) and dose× seasons (F=20.04) showed significant result at 1% level of significance.

The efficacy of vit- C under different seasons on FU followed the order S-2>S-1>S-3> S-4 and ondifferent feeding schedule the effectiveness in this regard was FS-2 > FS-1> FS-3. The most effective dose ofvit- C in most of the cases was 15000ppm followed by 20000ppm, 10000ppm and 25000ppm.

Approximate digestibility (AD %)

The results of vit- C supplementation on AD% of *B.mori*under different seasons and different feeding schedules are shown in Table 40, the graphical presentation is showed in Figure 40 and their statistical analysis is presented in Appendix Table XXXVI.

In S-1,results were showed thatAD%was increased under different concentrations in comparison to the control while fed at FS-1. The highest and the

lowest mean of AD% were observed at 15000ppm (70.29±0.04%) and at 30000ppm (60.15±0.04%) respectively. While fed according to FS-2 the highest and the lowest AD% were recorded at 15000ppm (70.51±0.04%) and at 30000ppm (62.42±0.04%) respectively. In case of FS-3, the AD%was also increased under different concentrations, viz. at 10000ppm (66.10±0.05%), 15000ppm (70.01±0.06%), 20000ppm (68.02±0.07%), 25000ppm (65.81±0.04%) comparedtothe control (60.59±0.04%) but the mean value of AD% has been decreased at 30000ppm(60.02±0.02%).

The mean values of AD%under different concentrations and at different feeding schedules were increasedsignificantlyinS-2. At FS-1, the highest and the lowestAD% were recorded at 15000ppm (70.49±0.05%) and at 30000ppm(60.36±0.03%) respectively. While maintaining FS-2, the AD% were increased under different concentrations, viz. at 10000ppm (66.76±0.03%), 15000ppm(70.74±0.03%), 20000ppm(68.75±0.04%), 25000ppm(66.61±0.04%) compared to the control(60.80±0.05%) but the mean value of AD% has been decreased at 30000ppm(60.68±0.04%). The highest and the lowest mean values ofAD% were observed at 15000ppm (70.26±0.02%) and at 30000ppm (60.17±0.04%)respectively while fed according to FS-3.

On different feeding schedules, the mean values of AD% were significantly increased under different concentrations ofvit- C in S-3. The highest and the lowest mean values ofAD% were observed at 15000ppm (68.57±0.05%) and at 30000ppm (58.50±0.05%) for FS-1, at 15000ppm (68.86±0.04%) and at 30000ppm (58.68±0.05%) for FS-2 and at 15000ppm (68.31±0.04%) and at 30000ppm (58.28±0.04%) for FS-3 respectively.

The mean values of AD% under different concentrations and at different feeding schedules were increasedsignificantly inS-4. While fed according to FS-1, the highest and the lowest larvae were observed at 15000ppm (66.68±0.05%) and at 30000ppm(58.30±0.03%) respectively. At FS-2, the AD% were increased under

different doses, viz. at 10000ppm (64.73±0.04%), 15000ppm(66.86±0.02%), 20000ppm(65.74±0.05%), 25000ppm(64.62±0.07%) compared to the control(58.62±0.07%) but the mean value of AD% has been decreased at 30000ppm(58.43±0.06%). The highest and the lowest mean values ofAD% were noticed at 15000ppm (66.27±0.04%) and at 30000ppm (58.08±0.04%)respectively at FS-3.

Analysis of variance showed highly significant differences among feeding schedules (F=263.26),seasons (F=6518.96), doses (F=17043.78) and dose× seasons (F=52.49) at 1% level of significance in Appendix Table XXXVI.

The effectiveness of vit- Cwith respect to different seasons on AD% followed the order S-2>S-1>S-3 > S-4 and while in respect of different feeding schedule this trend was FS-2 > FS-1> FS-3.In most of the cases for both seasons and feeding schedule effective doses of vit- Cfollowed the order 15000ppm >20000ppm >10000ppm >25000ppm.

Food consumption index (FCI)

The effect of vit- C supplementation under different seasons, viz. S-1, S-2, S-3 and S-4 on FCI of *B.mori* at different feeding schedules, viz. FS-1, FS-2, FS-3 are shown in Table41, the graphical presentation are showed inFigure 41 and their statistical analysis is presented in Appendix Table XXVII.

In S-1, the mean values of FCI of *B mori*were increased at different doses when compared to control in respect of FS-1. The highest and the lowest mean ofFCI were observed at 15000ppm (66.27±0.04%) and at 30000ppm (55.85±0.04%) respectively. While maintaining scheduled FS-2, the highest and the lowest FCI were observed at 15000ppm (66.53±0.07%) and at 30000ppm(56.15±0.03%) respectively. In case of FS-3, the FCI also increased at different doses, viz. at 10000ppm (59.42±0.04%), 15000ppm (66.05±0.05%), 20000ppm (63.95±0.09%) and 25000ppm (59.27±0.04%) compared to control (56.31±0.05%). But the mean value of FCIwas decreased at 30000ppm(55.66±0.04%).

The mean values of FCI of *B mori*under different concentrations and at different feeding schedules were significantly increasedinS-2. While fed according to FS-1, the highest and the lowest FCI were recorded at 15000ppm (66.48±0.05%) and at 30000ppm (56.42±0.02%) respectively. In case of FS-2, the FCI were increased at different doses, viz. at 10000ppm (60.47±0.04%), 15000ppm (66.70±0.03%), 20000ppm (64.67±0.05%) and 25000ppm (60.32±0.04%) compared to the control(56.73±0.03%). The highest and the lowest mean ofFCI were observed at 15000ppm (66.30±0.08%) and at 30000ppm (56.22±0.04%) respectively while fed according to FS-3.

In different feeding schedules, the mean values of FCI were increased significantly under different concentrations of vit- C in S-3. The highest and the lowest mean ofFCI were observed at 15000ppm (65.43±0.04%) and at 30000ppm (55.25±0.03%) for FS-1, at 15000ppm (65.67±0.04%) and at 30000ppm (55.50±0.03%) for FS-2 and at 15000ppm (65.26±0.04%) and at 30000ppm (54.90±0.02%) for FS-3 respectively.

InS-4, the supplementationof vit- Csignificantly increased theFCIunder different concentrations and at different feeding schedules. While fed according to FS-1, the highest and the lowestmean of FCI observed at 15000ppm (64.52±0.04%) and at 30000ppm(54.82±0.05%) respectively. In case of FS-2, the FCI were increased at different doses, viz. at 10000ppm (58.45±0.06%), 15000ppm(64.78±0.05%), 20000ppm(62.71±0.02%), 25000ppm(58.30±0.03%) compared to control(55.52±0.04%) but the mean value of FCIwas decreased at 30000ppm(55.25±0.04%). The highest and the lowest mean values ofFCI were observed at 15000ppm (64.32±0.05%) and at30000ppm (54.57±0.02%)respectively at FS-3.

Analysis of variance showed highly significant differences among feeding schedules (F=147.67), seasons (F=1437.70), doses (F=10183.94) and dose × seasons (F=12.51) at 1% level of significance results in Appendix Table XXXVII.

The effectiveness of vit- C with respect under different seasons on FCI followed the order S-2>S-1>S-3 > S-4 and while in respect of different feeding schedule this trend was FS-2 > FS-1> FS-3.In most of the cases for both seasons and feeding schedule effective doses of vit- C followed the order 15000ppm >20000ppm >10000ppm >25000ppm.

Co-efficient of food utilization:

The effect of vit- Con co-efficient of food utilization of *B.mori*under different seasons, viz. S-1, S-2, S-3 and S-4 and at different feeding schedules, viz. FS-1, FS-2, FS-3 are shown in Table 42, the graphical presentation are showed in Figure 42 and their statistical analysis is presented in Appendix Table XXXVIII.

The mean values of co-efficient of food utilization were increased in S-1at different doses compared to control maintaining scheduled FS-1. The highest and the lowest mean of co-efficient of food utilization were observed at 15000 ppm (56.26±0.04%) and at 30000ppm (45.10±0.05%) respectively. While fed according to FS-2, the highest and the lowest co-efficient of food utilization were recorded at 15000ppm (56.47±0.06%) and at 30000ppm (45.29±0.03%) respectively. In case of FS-3, the co-efficient of food utilization also increased at different doses, viz. at 10000ppm (47.45±0.03%), 15000ppm (55.59±0.02%), 20000ppm (54.15±0.04%) and 25000ppm (47.23±0.02%) compared to the control (45.39±0.03%). But the mean value of co-efficient of food utilizationwas decreased at 30000ppm (44.80±0.03%).

The supplementation of vit- Cincreased co-efficient of food utilization in S-2 under different concentrations and feeding schedules. The highest and the lowest co-efficient of food utilization were observed at 15000ppm (56.44±0.03%) and at 30000ppm (45.46±0.04%) respectivelywhile fed according to FS-1. In case of FS-2, the co-efficient of food utilization was increased under different doses, viz. at 10000ppm (48.49±0.03%), 15000ppm (56.73±0.05%), 20000ppm (54.75±0.02%) and 25000ppm (48.39±0.03%) compared to the control (45.71±0.04%). The highest and the lowest mean of co-efficient of food utilization were recorded at

15000ppm (55.74±0.03%) and at 30000ppm (45.32±0.01%) respectively while fed according to FS-3.

In different feeding schedules, the mean values of co-efficient of food utilization were significantly increased under different concentration ofvit- C in S-3. The highest and the lowest mean of co-efficient of food utilization were observed at 15000ppm (55.41±0.05%) and at 30000ppm (44.25±0.02%) for FS-1, at 15000ppm (55.70±0.03%) and at 30000ppm (44.45±0.03%) for FS-2 and at 15000ppm (55.20±0.03%) and at 30000ppm (43.80±0.03%) for FS-3 respectively.

During S-4 the mean values of co-efficient of food utilization of *B mori*were significantly increased under different concentrations andat various feeding schedules. While fed according to FS-1, the highest and the lowestmean of co-efficient of food utilization were observed at 15000ppm (55.20±0.03%) and at 30000ppm (44.02±0.06%) respectively. In case of FS-2, the co-efficient of food utilization were increased under different doses, viz. at 10000ppm (47.50±0.03%), 15000ppm (55.40±0.04%), 20000ppm (53.38±0.04%), 25000ppm (47.30±0.03%) compared to control (44.42±0.04%) but the mean value of co-efficient of food utilizationwas decreased at 30000ppm (44.25±0.03%). The highest and the lowest mean values of co-efficient of food utilizationwere observed at 15000ppm (54.83±0.03%) and at 30000ppm (43.65±0.03%) respectively at FS-3.

The Results of analyses of variance have been presented in Appendix Table XXXVIII. All of the items viz. feeding schedules (F=256.18), seasons (F=882.18) and doses (F=8638.90)showed highly significant differences at 1% level of significance.

The effectiveness of vit- Cwith respect to different seasons on co-efficient of food utilization followed the order S-2 > S-1 > S-3 > S-4 and while in respect of different feeding schedule this trend was FS-2 > FS-1 > FS-3. In most of the cases for both seasons and feeding schedule effective doses of vit- Cfollowed the order 15000ppm >20000ppm >10000ppm >25000ppm.

Table 22. Effect of vit-C under different feeding schedules, seasons and doses on the larval weight (gm) of *B. mori*L.

Feeding Schedule	Dose (ppm)	Mean ± SE			
		S-1	S-2	S-3	S-4
FS-1	Control	1.70±0.01	1.78±0.01	1.60±0.01	1.49±0.02
	10000	1.76±0.01	1.88±0.01	1.67±0.02	1.57±0.01
	15000	1.83±0.02	1.96±0.02	1.71±0.02	1.64±0.01
	20000	1.81±0.02	1.91±0.02	1.70±0.01	1.64±0.01
	25000	1.73±0.02	1.85±0.01	1.61±0.01	1.59±0.01
	30000	1.65±0.01	1.76±0.01	1.56±0.01	1.42±0.02
FS-2	Control	1.70±0.01	1.78±0.01	1.60±0.01	1.49±0.02
	10000	1.82±0.01	1.96±0.01	1.72±0.02	1.60±0.01
	15000	1.91±0.02	2.03±0.02	1.82±0.02	1.72±0.01
	20000	1.90±0.01	2.03±0.02	1.81±0.01	1.71±0.01
	25000	1.78±0.01	1.94±0.01	1.71±0.01	1.58±0.01
	30000	1.68±0.01	1.77±0.01	1.58±0.02	1.44±0.03
FS-3	Control	1.70±0.01	1.78±0.01	1.60±0.01	1.49±0.02
	10000	1.75±0.00	1.84±0.01	1.63±0.02	1.55±0.02
	15000	1.80±0.01	1.92±0.01	1.68±0.02	1.62±0.01
	20000	1.79±0.01	1.88±0.01	1.67±0.01	1.59±0.01
	25000	1.71±0.02	1.82±0.00	1.59±0.01	1.54±0.01
	30000	1.63±0.01	1.73±0.01	1.56±0.02	1.40±0.02

FS- 1: Feeding Schedule-1, Fed every day in 1st feeding of 3rd to 5th instar larvae
FS- 2: Feeding Schedule- 2, Fed in 1st and 5th feeding of 3rd to 5th instar larvae
FS- 3: Feeding Schedule-3, Fed only in 1st feeding of 3rd to 5th instar larvae

S-1: Season-1, Agrahyani
S-2: Season-2, Chaita
S-3: Season-3, Jaista
S-4 : Season-4 , Baduri

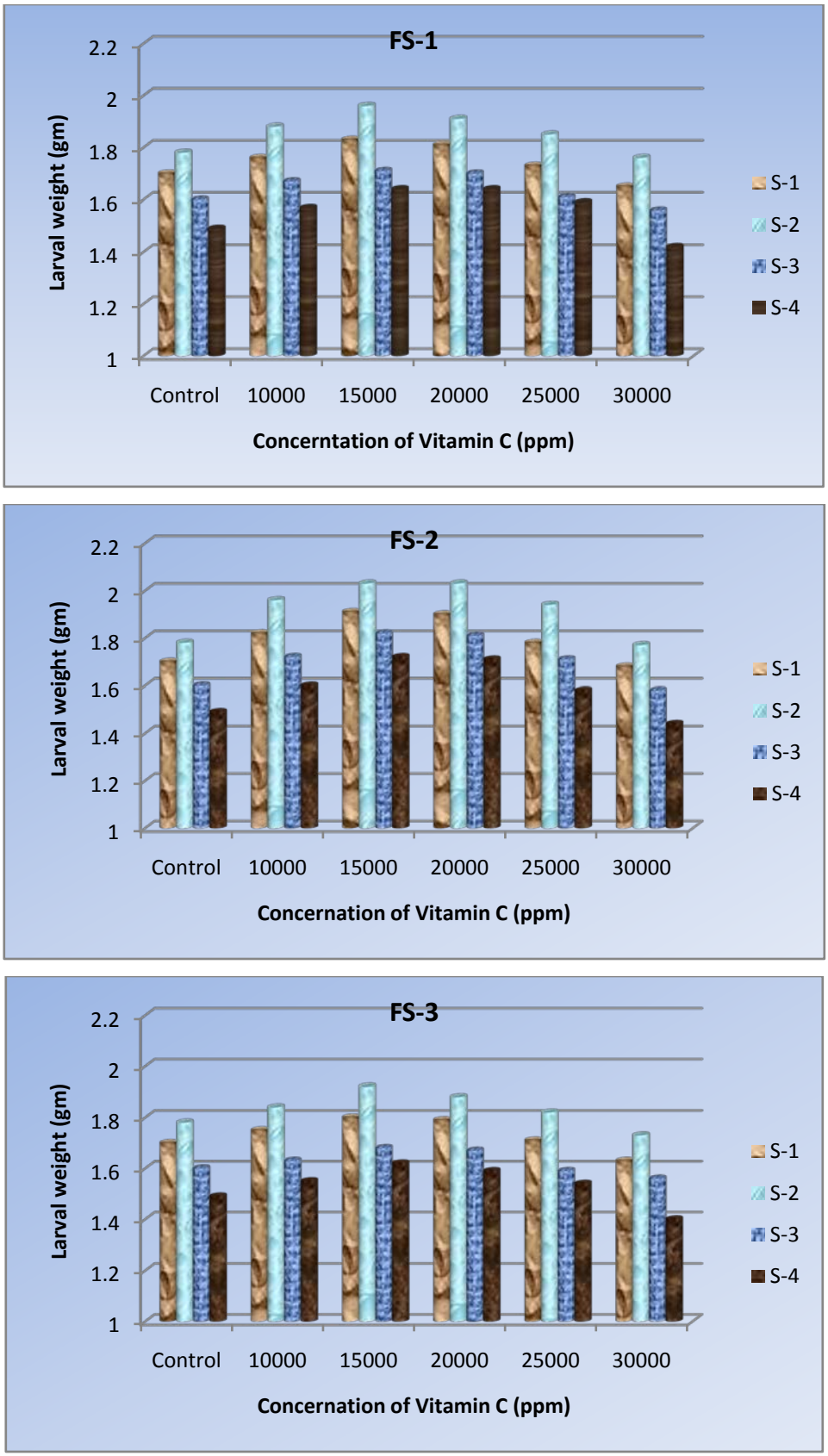


Figure 22.Effect of vit- C supplemented food on LW(gm) of *B. mori* L. at different feeding schedules.

Table 23. Effect of vit-C under different feeding schedules, seasons and doses on thelarval length (mm) of *B. mori*L.

Feeding Schedule	Dose (ppm)	Mean ± SE			
		S-1	S-2	S-3	S-4
FS-1	Control	61.28±0.02	61.40±0.06	61.22±0.02	61.13±0.02
	10000	62.50±0.03	62.78±0.04	62.35±0.03	62.20±0.03
	15000	62.87±0.02	62.97±0.03	62.80±0.03	62.68±0.01
	20000	62.80±0.03	62.95±0.03	62.63±0.03	62.56±0.03
	25000	62.37±0.03	62.64±0.03	62.15±0.03	62.13±0.02
	30000	61.15±0.03	61.30±0.03	60.95±0.03	60.82±0.01
FS-2	Control	61.28±0.02	61.40±0.06	61.22±0.02	61.13±0.02
	10000	62.60±0.05	62.87±0.09	62.40±0.03	62.27±0.04
	15000	62.94±0.03	63.20±0.06	62.85±0.03	62.80±0.01
	20000	62.89±0.04	63.17±0.09	62.76±0.03	62.63±0.04
	25000	62.47±0.03	62.73±0.06	62.30±0.03	62.20±0.01
	30000	61.18±0.04	61.35±0.05	61.05±0.05	61.03±0.03
FS-3	Control	61.28±0.02	61.40±0.06	61.22±0.02	61.13±0.02
	10000	62.42±0.02	62.67±0.04	62.31±0.01	62.15±0.02
	15000	62.75±0.03	62.88±0.01	62.63±0.02	62.54±0.02
	20000	62.67±0.02	62.85±0.02	62.54±0.02	62.42±0.01
	25000	62.33±0.02	62.56±0.03	62.10±0.01	62.09±0.02
	30000	61.12±0.02	61.27±0.02	60.91±0.01	60.77±0.02

FS- 1: Feeding Schedule-1, Fed every day in 1st feeding of 3rd to 5th instar larvae
FS- 2: Feeding Schedule- 2, Fed in 1st and 5th feeding of 3rd to 5th instar larvae
FS- 3: Feeding Schedule-3, Fed only in 1st feeding of 3rd to 5th instar larvae

S-1: Season-1, Agrahyani
S-2: Season-2, Chaita
S-3: Season-3, Jaista
S-4 : Season-4 , Baduri

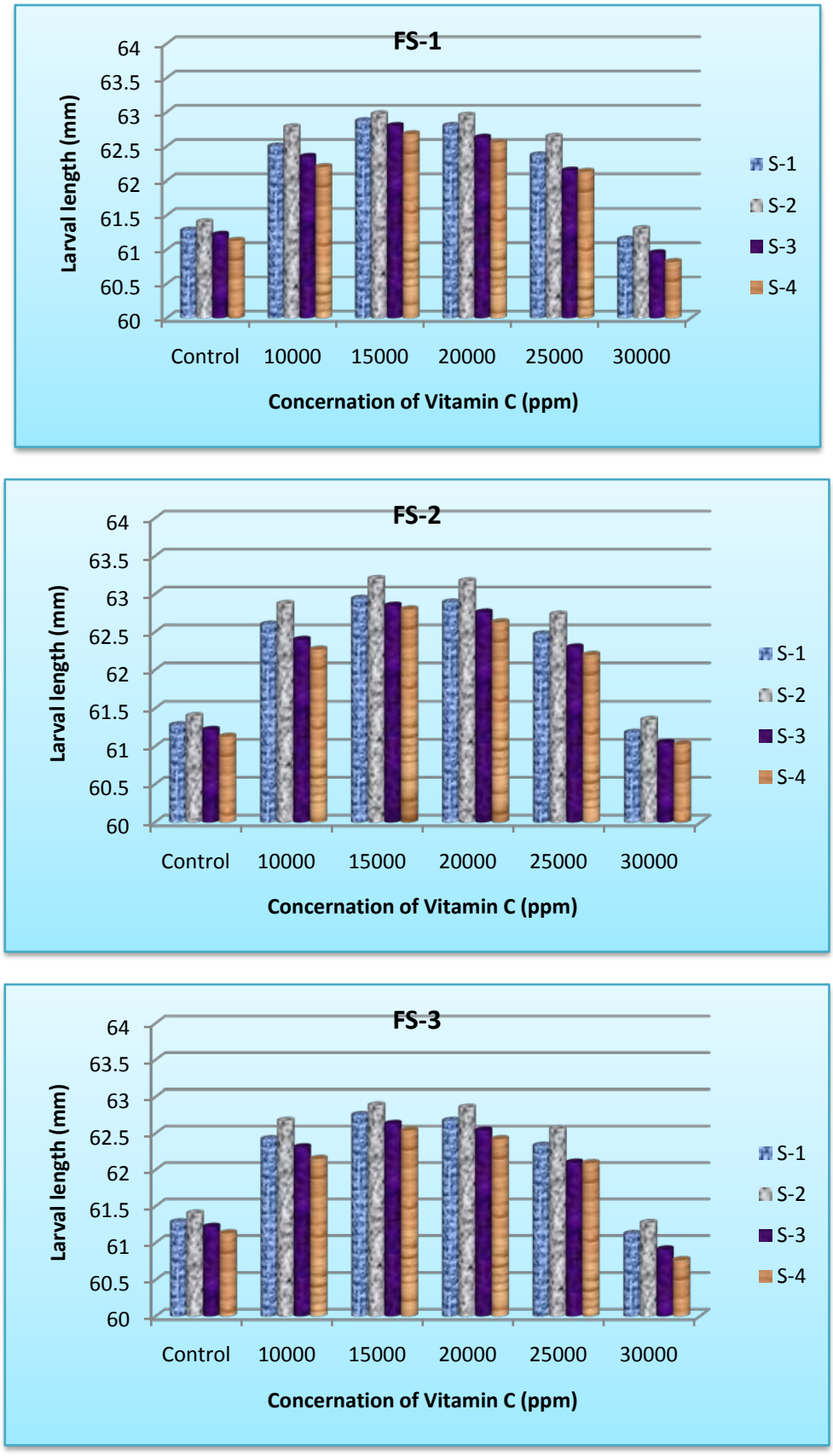


Figure 23.Effect of vit-C supplemented food on LL(mm) of *B. mori* L. at different feeding schedules.

Table 24. Effect of vit-C under different feeding schedules, seasons and doses on the larval breath (mm) of *B. mori*L.

Feeding Schedule	Dose (ppm)	Mean ± SE			
		S-1	S-2	S-3	S-4
FS-1	Control	11.47±0.03	11.60±0.12	11.42±0.06	11.33±0.02
	10000	11.90±0.01	12.08±0.06	11.81±0.02	11.71±0.01
	15000	12.46±0.01	12.50±0.02	12.41±0.02	12.30±0.03
	20000	12.20±0.03	12.30±0.03	12.12±0.02	11.98±0.02
	25000	11.81±0.02	11.82±0.04	11.71±0.01	11.55±0.03
	30000	11.41±0.01	11.45±0.08	11.32±0.01	11.27±0.02
FS-2	Control	11.47±0.03	11.60±0.12	11.42±0.06	11.33±0.02
	10000	12.00±0.00	12.13±0.09	11.82±0.02	11.73±0.02
	15000	12.49±0.01	12.55±0.08	12.47±0.02	12.38±0.02
	20000	12.27±0.02	12.35±0.03	12.18±0.02	12.12±0.02
	25000	11.87±0.02	11.92±0.04	11.78±0.02	11.72±0.02
	30000	11.43±0.02	11.50±0.08	11.38±0.01	11.30±0.01
FS-3	Control	11.47±0.03	11.60±0.12	11.42±0.06	11.33±0.02
	10000	11.86±0.01	12.02±0.04	11.80±0.03	11.62±0.02
	15000	12.33±0.02	12.42±0.02	12.23±0.02	12.18±0.02
	20000	12.17±0.02	12.22±0.02	12.08±0.02	11.95±0.03
	25000	11.73±0.03	11.77±0.04	11.63±0.02	11.48±0.02
	30000	11.28±0.02	11.38±0.03	11.25±0.03	11.23±0.02

FS- 1: Feeding Schedule-1, Fed every day in 1st feeding of 3rd to 5th instar larvae
FS- 2: Feeding Schedule- 2, Fed in 1st and 5th feeding of 3rd to 5th instar larvae
FS- 3: Feeding Schedule-3, Fed only in 1st feeding of 3rd to 5th instar larvae

S-1: Season-1, Agrahyani
S-2: Season-2, Chaita
S-3: Season-3, Jaista
S-4 : Season-4 , Baduri

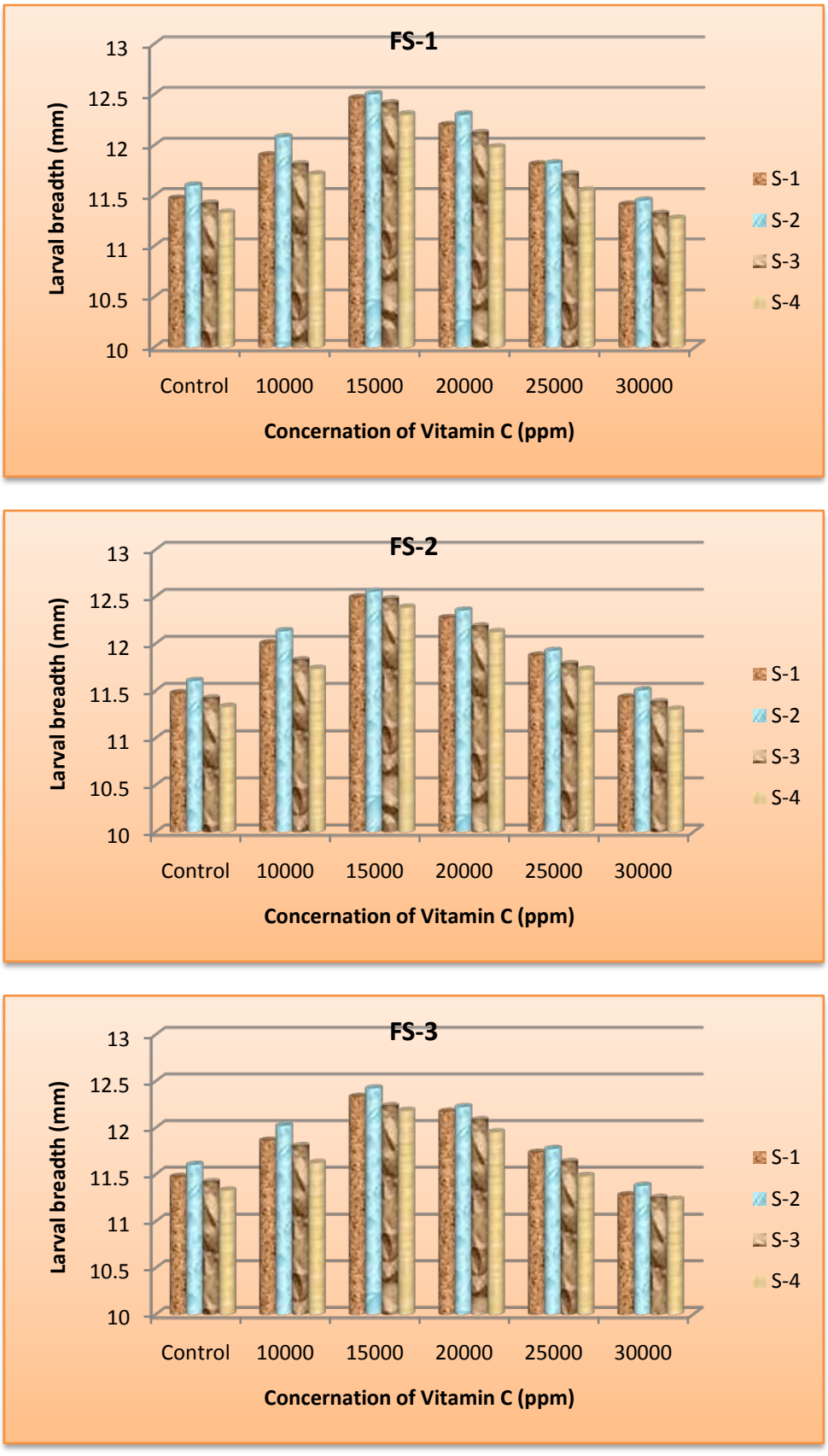


Figure 24. Effect of vit-C supplemented food on LB(mm) of *B. mori* L. at different feeding schedules.

Table 25. Effect of vit-C under different feeding schedules, seasons and doses on the pupal weight (gm) of *B. mori*L.

Feeding Schedule	Dose (ppm)	Mean ± SE			
		S-1	S-2	S-3	S-4
FS-1	Control	0.69±0.01	0.71±0.02	0.66±0.01	0.61±0.01
	10000	0.74±0.02	0.76±0.01	0.72±0.01	0.71±0.01
	15000	0.78±0.01	0.80±0.01	0.75±0.01	0.74±0.01
	20000	0.75±0.01	0.77±0.01	0.73±0.00	0.72±0.00
	25000	0.72±0.01	0.73±0.00	0.70±0.01	0.66±0.01
	30000	0.65±0.01	0.66±0.00	0.62±0.01	0.55±0.01
FS-2	Control	0.69±0.01	0.71±0.02	0.66±0.01	0.61±0.01
	10000	0.78±0.01	0.80±0.01	0.75±0.01	0.72±0.01
	15000	0.85±0.01	0.91±0.03	0.81±0.01	0.77±0.02
	20000	0.81±0.01	0.87±0.02	0.77±0.01	0.74±0.02
	25000	0.78±0.00	0.78±0.01	0.73±0.01	0.70±0.01
	30000	0.67±0.00	0.70±0.01	0.64±0.01	0.60±0.01
FS-3	Control	0.69±0.01	0.71±0.02	0.66±0.01	0.61±0.01
	10000	0.72±0.00	0.73±0.01	0.69±0.01	0.68±0.00
	15000	0.76±0.00	0.78±0.01	0.72±0.01	0.70±0.01
	20000	0.74±0.02	0.76±0.01	0.70±0.01	0.69±0.01
	25000	0.70±0.01	0.71±0.01	0.67±0.01	0.61±0.01
	30000	0.63±0.02	0.64±0.02	0.60±0.01	0.52±0.01

FS- 1: Feeding Schedule-1, Fed every day in 1st feeding of 3rd to 5th instar larvae
FS- 2: Feeding Schedule- 2, Fed in 1st and 5th feeding of 3rd to 5th instar larvae
FS- 3: Feeding Schedule-3, Fed only in 1st feeding of 3rd to 5th instar larvae

S-1: Season-1, Agrahyani
S-2: Season-2, Chaita
S-3: Season-3, Jaista
S-4 : Season-4 , Baduri

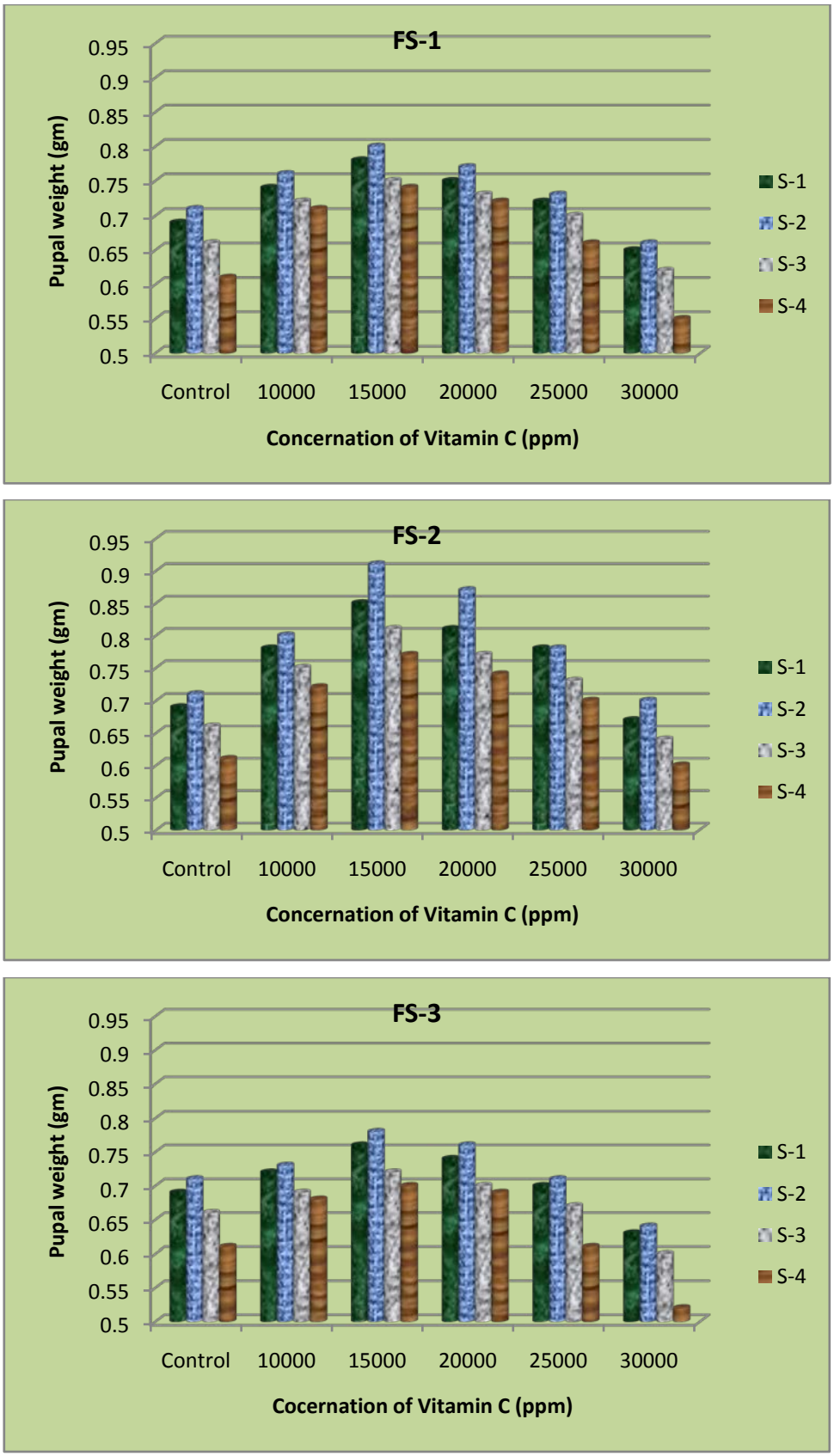


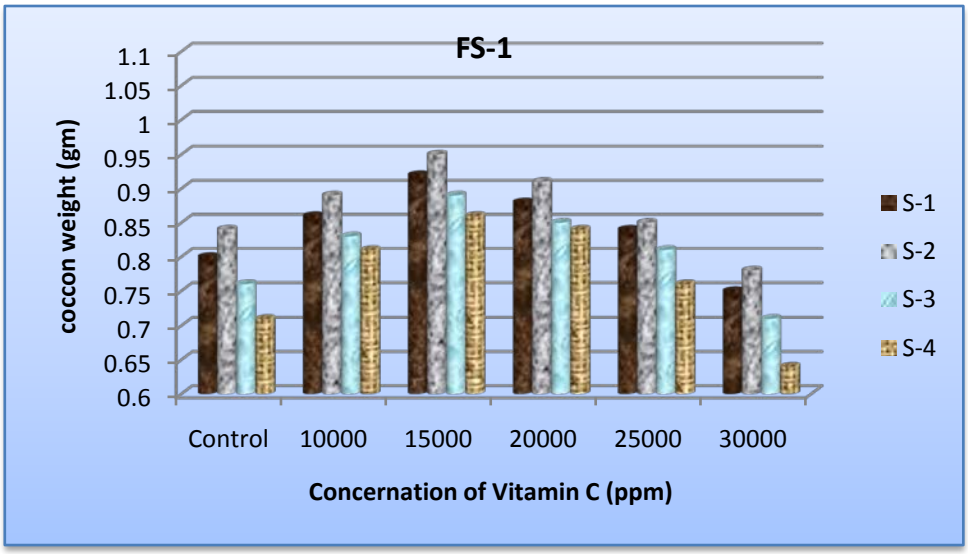
Figure 25. Effect of vit-C supplemented food on PW(gm) of *B. mori* L. at different feeding schedules.

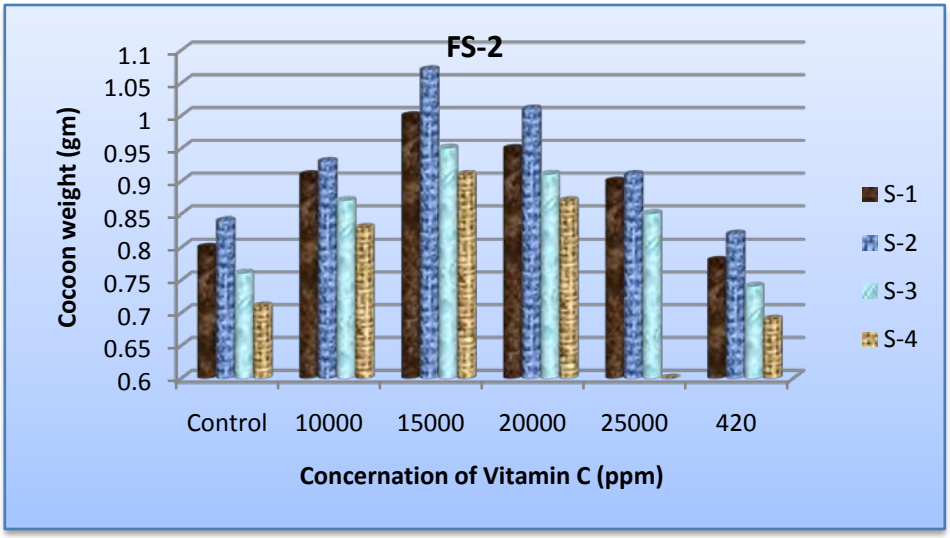
Table 26. Effect of vit-C under different feeding schedules, seasons and doses on the cocoon weight (gm) of *B. mori*L.

Feeding Schedule	Dose (ppm)	Mean ± SE			
		S-1	S-2	S-3	S-4
FS-1	Control	0.80±0.01	0.84±0.02	0.76±0.01	0.71±0.01
	10000	0.86±0.02	0.89±0.02	0.83±0.01	0.81±0.01
	15000	0.92±0.01	0.95±0.01	0.89±0.01	0.86±0.01
	20000	0.88±0.01	0.91±0.01	0.85±0.00	0.84±0.00
	25000	0.84±0.01	0.85±0.01	0.81±0.01	0.76±0.01
	30000	0.75±0.01	0.78±0.00	0.71±0.01	0.64±0.01
FS-2	Control	0.80±0.01	0.84±0.02	0.76±0.01	0.71±0.01
	10000	0.91±0.01	0.93±0.01	0.87±0.01	0.83±0.01
	15000	1.00±0.01	1.07±0.03	0.95±0.01	0.91±0.01
	20000	0.95±0.01	1.01±0.02	0.91±0.01	0.87±0.01
	25000	0.90±0.00	0.91±0.01	0.85±0.01	0.81±0.01
	30000	0.78±0.00	0.82±0.01	0.74±0.01	0.69±0.01
FS-3	Control	0.80±0.01	0.84±0.02	0.76±0.01	0.71±0.01
	10000	0.84±0.00	0.86±0.01	0.80±0.01	0.78±0.00
	15000	0.90±0.00	0.92±0.01	0.85±0.01	0.82±0.01
	20000	0.87±0.01	0.89±0.01	0.82±0.01	0.80±0.01
	25000	0.82±0.01	0.83±0.01	0.78±0.01	0.71±0.01
	30000	0.73±0.02	0.75±0.02	0.69±0.01	0.63±0.01

FS- 1: Feeding Schedule-1, Fed every day in 1st feeding of 3rd to 5th instar larvae
FS- 2: Feeding Schedule- 2, Fed in 1st and 5th feeding of 3rd to 5th instar larvae
FS- 3: Feeding Schedule-3, Fed only in 1st feeding of 3rd to 5th instar larvae

S-1: Season-1, Agrahyani
S-2: Season-2, Chaita
S-3: Season-3, Jaista
S-4 : Season-4 , Baduri





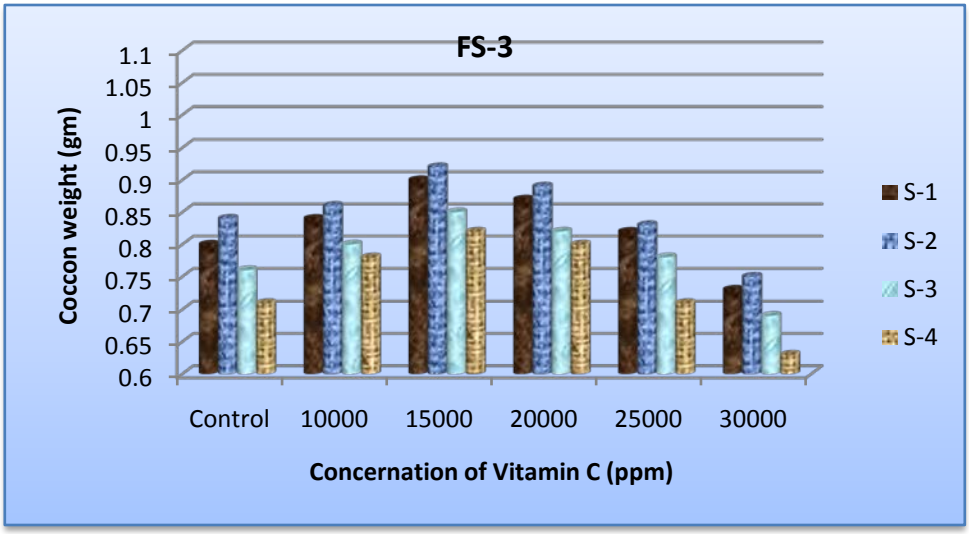


Figure 26. Effect of vit-C supplemented food on CW(gm) of *B. mori* L. at different feeding schedules.

Table 27. Effect of vit-C under different feeding schedules, seasons and doses on the cocoon length (mm) of *B. mori*L.

Feeding Schedule	Dose (ppm)	Mean ± SE			
		S-1	S-2	S-3	S-4
FS-1	Control	39.46±0.02	39.62±0.04	39.22±0.01	39.03±0.02
	10000	39.67±0.01	39.73±0.02	39.54±0.03	39.45±0.03
	15000	41.12±0.02	41.25±0.03	40.92±0.01	40.78±0.02
	20000	41.02±0.02	41.10±0.01	40.82±0.01	40.71±0.02
	25000	39.58±0.01	39.72±0.01	39.44±0.02	39.35±0.02
	30000	39.38±0.02	39.53±0.03	39.14±0.01	38.89±0.03
FS-2	Control	39.46±0.02	39.62±0.04	39.22±0.01	39.03±0.02
	10000	39.81±0.02	39.92±0.01	39.74±0.02	39.59±0.02
	15000	41.39±0.02	41.46±0.03	41.24±0.02	41.07±0.02
	20000	41.26±0.01	41.31±0.02	41.16±0.01	40.92±0.02
	25000	39.78±0.01	39.81±0.02	39.60±0.03	39.56±0.01
	30000	39.42±0.01	39.60±0.03	39.18±0.02	38.97±0.03
FS-3	Control	39.46±0.02	39.62±0.04	39.22±0.01	39.03±0.02
	10000	39.56±0.02	39.66±0.01	39.42±0.01	39.30±0.01
	15000	40.95±0.03	41.08±0.02	40.88±0.01	40.74±0.01
	20000	40.83±0.02	40.91±0.01	40.74±0.01	40.68±0.02
	25000	39.48±0.01	39.62±0.01	39.38±0.02	39.26±0.01
	30000	39.35±0.00	39.55±0.02	39.08±0.01	38.82±0.01

FS- 1: Feeding Schedule-1, Fed every day in 1st feeding of 3rd to 5th instar larvae
FS- 2: Feeding Schedule- 2, Fed in 1st and 5th feeding of 3rd to 5th instar larvae
FS- 3: Feeding Schedule-3, Fed only in 1st feeding of 3rd to 5th instar larvae

S-1: Season-1, Agrahyani
S-2: Season-2, Chaita
S-3: Season-3, Jaista
S-4 : Season-4 , Baduri

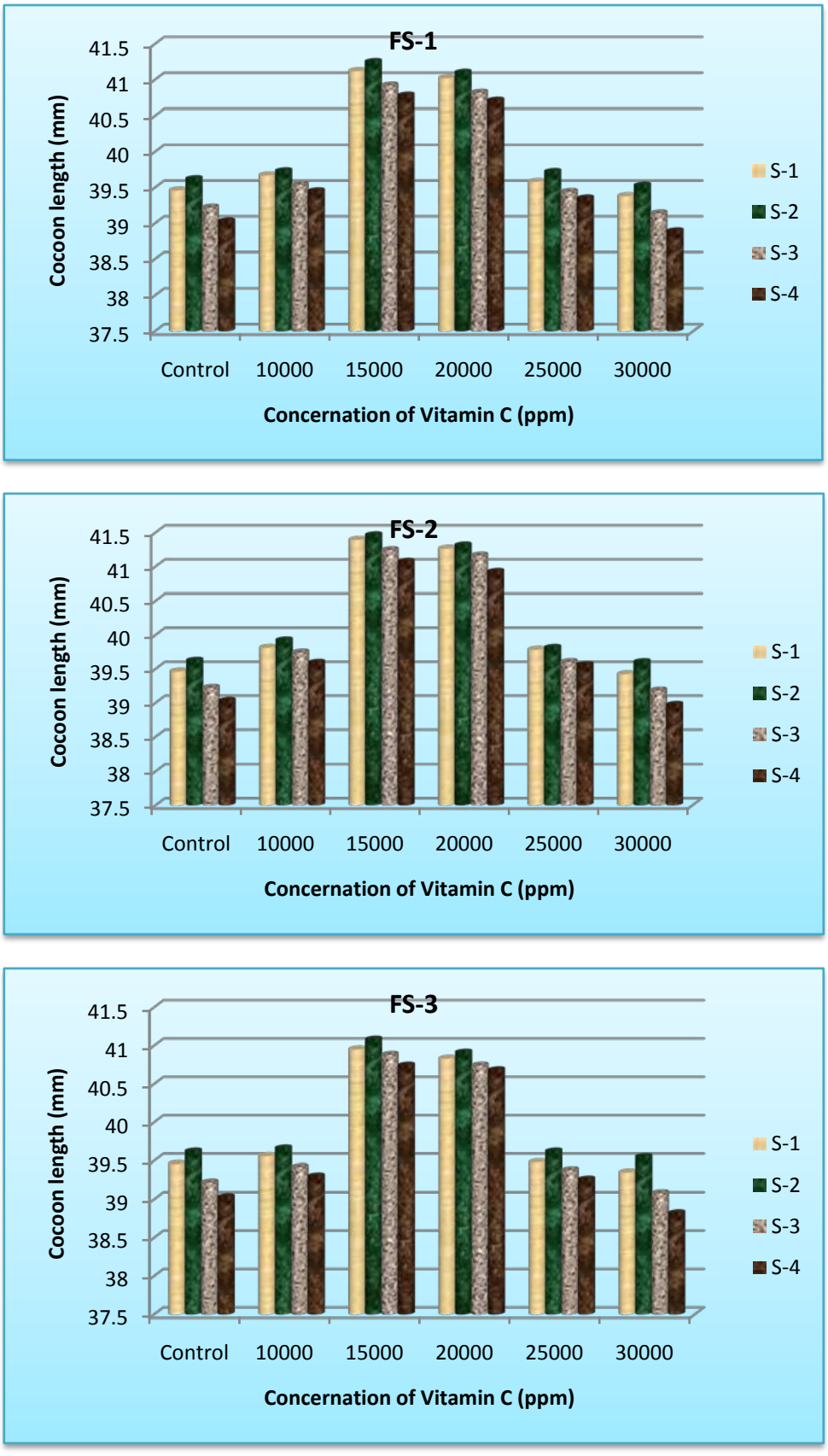


Figure 27. Effect of vit-C supplemented food on CL(mm) of *B. mori* L. at different feeding schedules.

Table 28. Effect of vit-C under different feeding schedules, seasons and doses on the cocoon breadth (mm) of *B. mori* L.

Feeding Schedule	Dose (ppm)	Mean ± SE			
		S-1	S-2	S-3	S-4
FS-1	Control	21.30±0.01	21.42±0.01	21.14±0.02	20.92±0.01
	10000	21.89±0.01	22.00±0.03	21.74±0.01	21.68±0.01
	15000	22.01±0.02	22.10±0.01	21.88±0.02	21.78±0.01
	20000	21.92±0.01	22.07±0.01	21.76±0.02	21.69±0.02
	25000	21.82±0.01	21.91±0.02	21.72±0.01	21.63±0.02
	30000	21.12±0.01	21.35±0.00	21.04±0.04	20.84±0.01
FS-2	Control	21.30±0.01	21.42±0.01	21.14±0.02	20.92±0.01
	10000	22.00±0.03	22.09±0.02	21.92±0.04	21.75±0.04
	15000	22.18±0.01	22.25±0.03	22.01±0.03	21.93±0.02
	20000	22.07±0.02	22.18±0.02	21.92±0.02	21.78±0.01
	25000	21.84±0.02	21.95±0.02	21.78±0.01	21.69±0.01
	30000	21.20±0.01	21.40±0.01	21.07±0.02	20.86±0.01
FS-3	Control	21.30±0.01	21.42±0.01	21.14±0.02	20.92±0.01
	10000	21.84±0.01	22.01±0.01	21.73±0.01	21.64±0.01
	15000	21.97±0.01	22.07±0.02	21.84±0.01	21.74±0.01
	20000	21.86±0.01	22.02±0.01	21.74±0.01	21.66±0.01
	25000	21.80±0.01	21.85±0.02	21.69±0.01	21.61±0.01
	30000	21.10±0.01	21.28±0.01	21.00±0.03	20.78±0.01

FS- 1: Feeding Schedule-1, Fed every day in 1st feeding of 3rd to 5th instar larvae
FS- 2: Feeding Schedule- 2, Fed in 1st and 5th feeding of 3rd to 5th instar larvae
FS- 3: Feeding Schedule-3, Fed only in 1st feeding of 3rd to 5th instar larvae

S-1: Season-1, Agrahyani
S-2: Season-2, Chaita
S-3: Season-3, Jaista
S-4 : Season-4 , Baduri

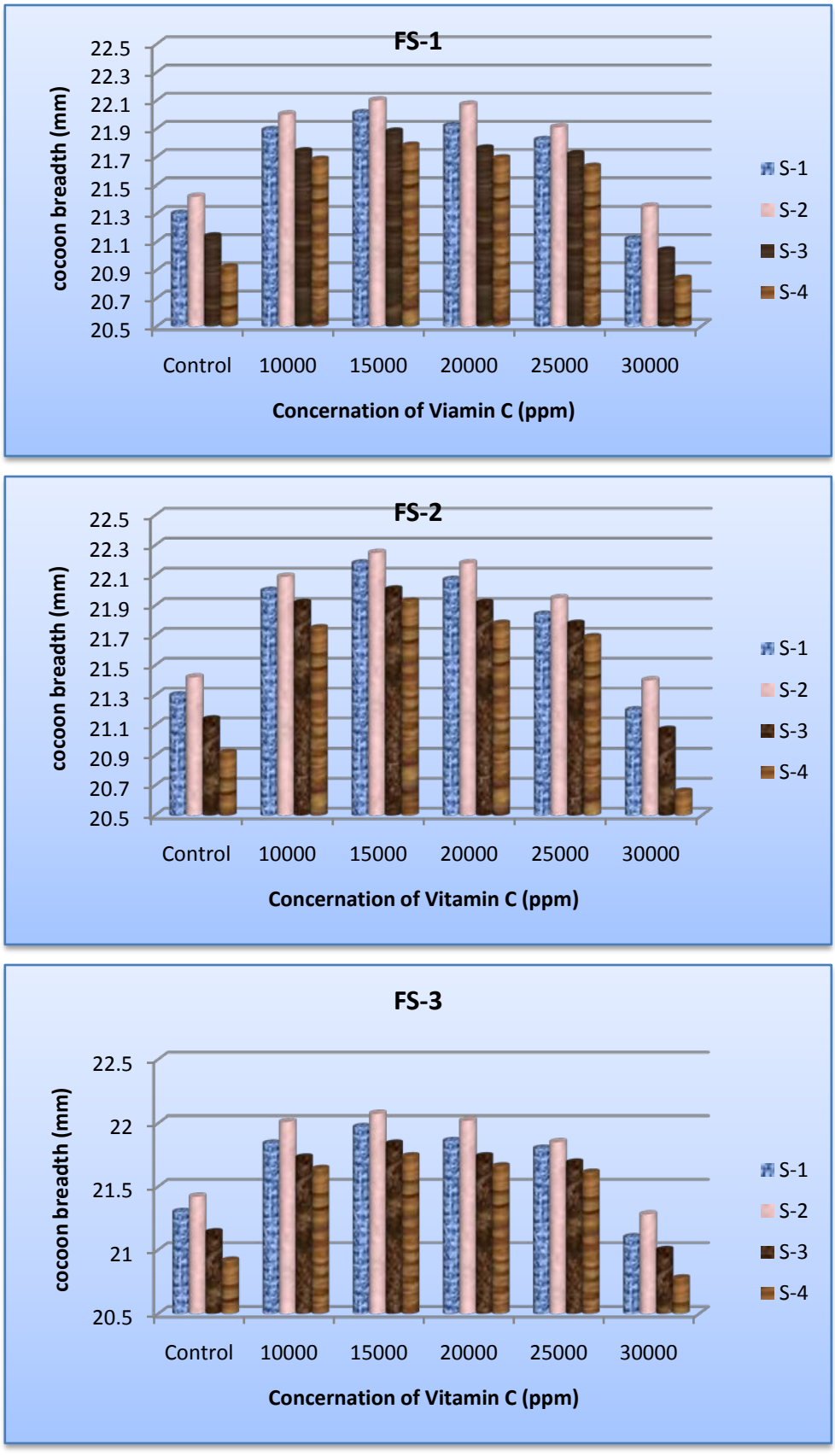


Figure 28. Effect of vit-C supplemented food on CB(mm) of *B. mori* L. at different feeding schedules.

Table 29. Effect of vit-C under different feeding schedules, seasons and doses on the shell weight (gm) of *B. mori*L.

Feeding Schedule	Dose (ppm)	Mean ± SE			
		S-1	S-2	S-3	S-4
FS-1	Control	0.110±0.000	0.123±0.003	0.103±0.003	0.093±0.003
	10000	0.123±0.003	0.127±0.003	0.113±0.003	0.107±0.003
	15000	0.143±0.003	0.147±0.003	0.133±0.003	0.127±0.003
	20000	0.130±0.000	0.137±0.003	0.123±0.003	0.117±0.003
	25000	0.120±0.000	0.123±0.003	0.110±0.000	0.103±0.003
	30000	0.103±0.003	0.117±0.003	0.093±0.003	0.087±0.003
FS-2	Control	0.110±0.000	0.123±0.003	0.103±0.003	0.093±0.003
	10000	0.127±0.003	0.130±0.000	0.123±0.003	0.113±0.003
	15000	0.153±0.003	0.157±0.003	0.143±0.003	0.133±0.003
	20000	0.137±0.003	0.147±0.003	0.133±0.003	0.123±0.003
	25000	0.123±0.003	0.133±0.003	0.120±0.000	0.110±0.000
	30000	0.107±0.003	0.120±0.000	0.100±0.000	0.090±0.000
FS-3	Control	0.110±0.000	0.123±0.003	0.103±0.003	0.093±0.003
	10000	0.120±0.000	0.127±0.003	0.110±0.000	0.103±0.003
	15000	0.137±0.003	0.140±0.000	0.130±0.000	0.120±0.000
	20000	0.127±0.003	0.133±0.003	0.120±0.000	0.113±0.003
	25000	0.117±0.003	0.120±0.000	0.107±0.003	0.100±0.000
	30000	0.100±0.000	0.110±0.000	0.090±0.000	0.083±0.003

FS- 1: Feeding Schedule-1, Fed every day in 1st feeding of 3rd to 5th instar larvae
FS- 2: Feeding Schedule- 2, Fed in 1st and 5th feeding of 3rd to 5th instar larvae
FS- 3: Feeding Schedule-3, Fed only in 1st feeding of 3rd to 5th instar larvae

S-1: Season-1, Agrahyani
S-2: Season-2, Chaita
S-3: Season-3, Jaista
S-4 : Season-4 , Baduri

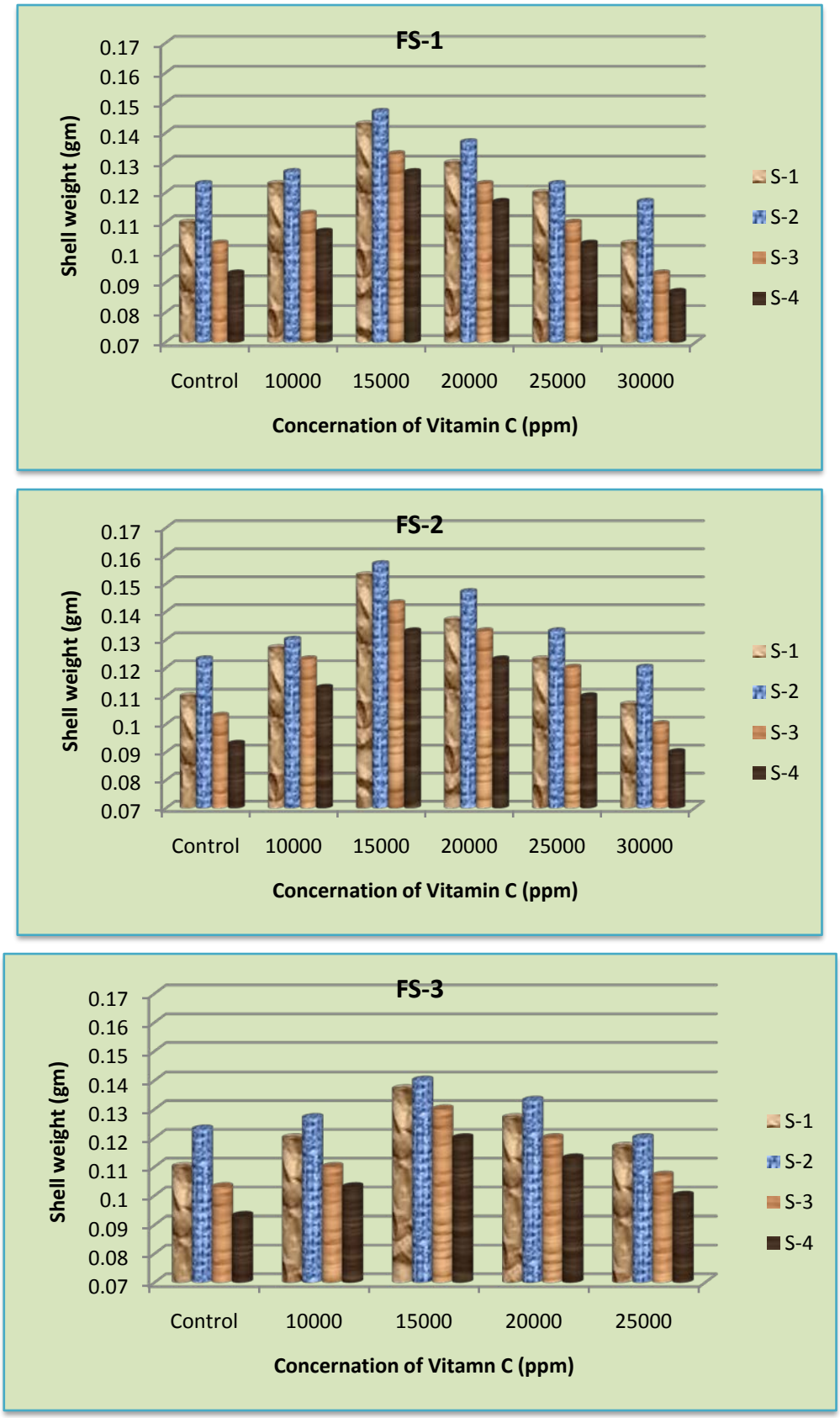


Figure 29. Effect of vit-C supplemented food on SW(gm) of *B. mori* L. at different feeding schedules.

Table 30. Effect of vit-C under different feeding schedules, seasons and doses on the shell ratio (%) of *B. mori*L.

Feeding Schedule	Dose (ppm)	Mean ± SE			
		S-1	S-2	S-3	S-4
FS-1	Control	13.76±0.20	14.74±0.32	13.61±0.55	13.21±0.55
	10000	14.28±0.09	14.23±0.20	13.60±0.36	13.12±0.47
	15000	15.58±0.31	15.44±0.40	15.04±0.32	14.67±0.29
	20000	14.78±0.19	15.07±0.33	14.45±0.33	13.94±0.34
	25000	14.35±0.20	14.51±0.31	13.64±0.11	13.53±0.29
	30000	13.78±0.46	14.96±0.43	13.10±0.60	13.53±0.31
FS-2	Control	13.76±0.20	14.74±0.32	13.61±0.55	13.21±0.55
	10000	13.98±0.47	14.03±0.10	14.12±0.34	13.61±0.51
	15000	15.33±0.20	14.71±0.49	15.09±0.36	14.72±0.59
	20000	14.39±0.43	14.48±0.26	14.71±0.32	14.25±0.61
	25000	13.70±0.37	14.60±0.32	14.17±0.11	13.53±0.11
	30000	13.68±0.43	14.64±0.21	13.52±0.19	13.11±0.13
FS-3	Control	13.76±0.20	14.74±0.32	13.61±0.55	13.21±0.55
	10000	14.29±0.00	14.73±0.44	13.76±0.20	13.25±0.43
	15000	15.24±0.32	15.22±0.19	15.30±0.10	14.64±0.21
	20000	14.63±0.54	14.92±0.33	14.64±0.21	14.10±0.20
	25000	14.22±0.26	14.40±0.12	13.68±0.48	14.03±0.26
	30000	13.67±0.44	14.68±0.34	12.98±0.13	13.22±0.31

FS- 1: Feeding Schedule-1, Fed every day in 1st feeding of 3rd to 5th instar larvae
FS- 2: Feeding Schedule- 2, Fed in 1st and 5th feeding of 3rd to 5th instar larvae
FS- 3: Feeding Schedule-3, Fed only in 1st feeding of 3rd to 5th instar larvae

S-1: Season-1, Agrahyani
S-2: Season-2, Chaita
S-3: Season-3, Jaista
S-4 : Season-4 , Baduri

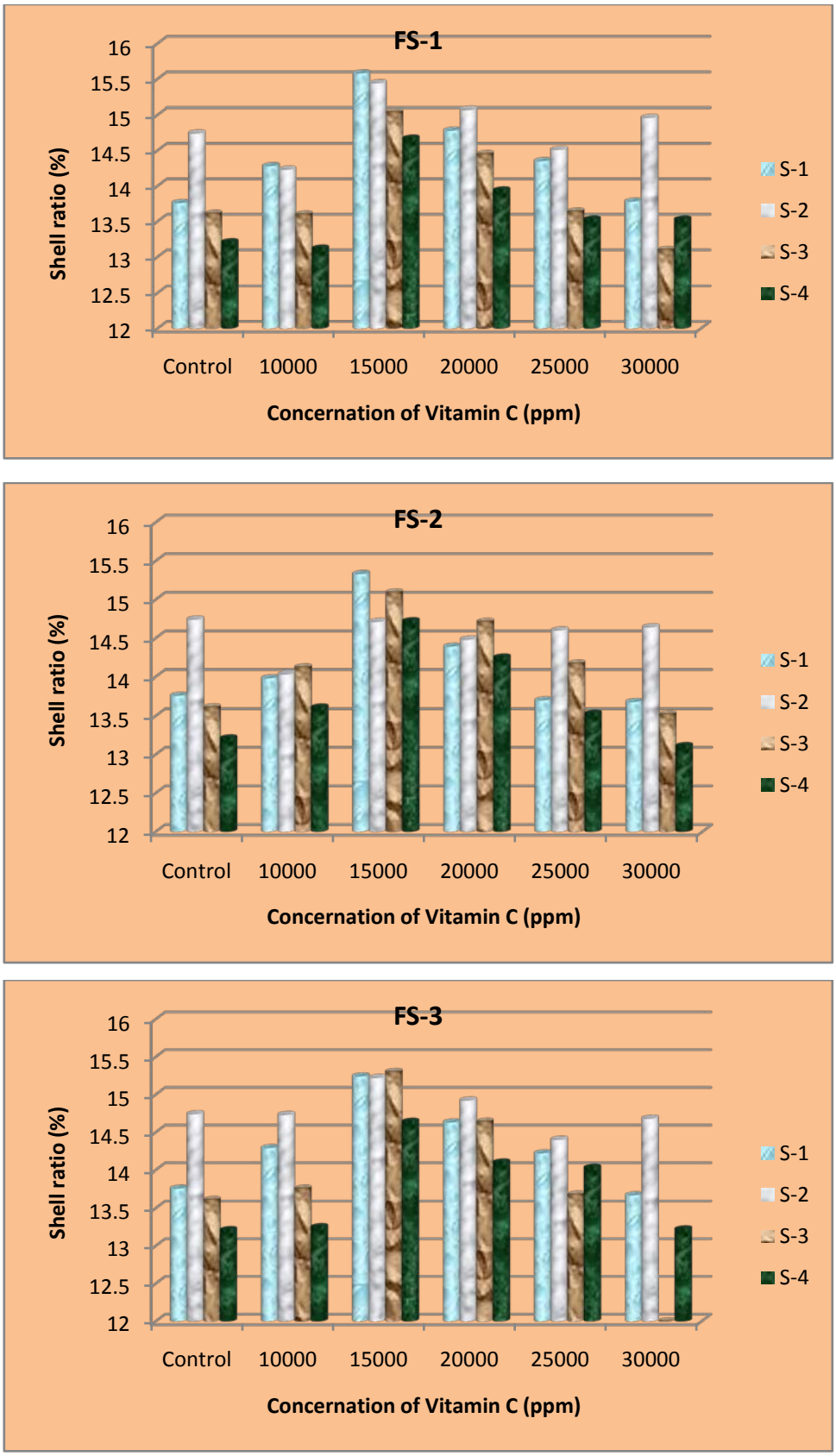


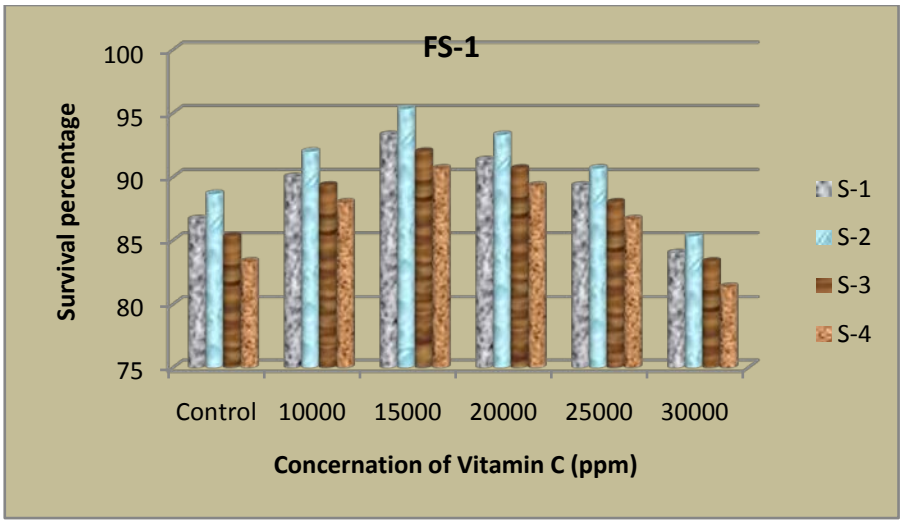
Figure 30. Effect of vit-C supplemented food on SR(%) of *B. mori* L. at different feeding schedules.

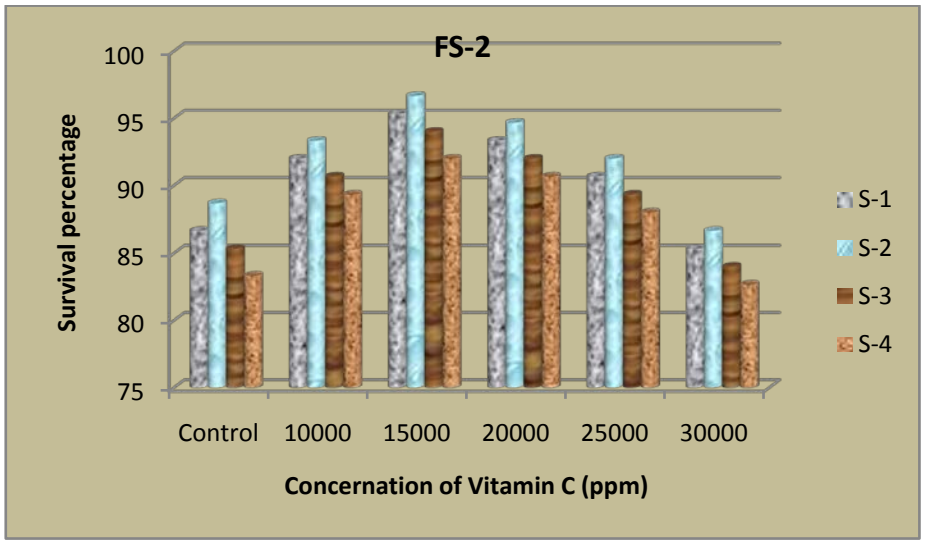
Table 31. Effect of vit-C under different feeding schedules, seasons and doses on the survival percentage of *B. mori*L.

Feeding Schedule	Dose (ppm)	Mean ± SE			
		S-1	S-2	S-3	S-4
FS-1	Control	86.67±0.05	88.67±0.01	85.33±0.07	83.33±0.07
	10000	90.00±0.08	92.00±0.17	89.33±0.17	88.00±0.10
	15000	93.33±0.10	95.33±0.05	92.00±0.17	90.67±0.03
	20000	91.33±0.07	93.33±0.10	90.67±0.03	89.33±0.17
	25000	89.33±0.17	90.67±0.03	88.00±0.10	86.67±0.05
	30000	84.00±0.13	85.33±0.07	83.33±0.07	81.33±0.05
FS-2	Control	86.67±0.05	88.67±0.01	85.33±0.07	83.33±0.07
	10000	92.00±0.17	93.33±0.10	90.67±0.03	89.33±0.17
	15000	95.33±0.05	96.67±0.03	94.00±0.06	92.00±0.17
	20000	93.33±0.10	94.67±0.08	92.00±0.17	90.67±0.03
	25000	90.67±0.03	92.00±0.17	89.33±0.17	88.00±0.10
	30000	85.33±0.07	86.67±0.05	84.00±0.13	82.67±0.03
FS-3	Control	86.67±0.05	88.67±0.01	85.33±0.07	83.33±0.07
	10000	89.33±0.17	90.67±0.03	88.00±0.10	86.67±0.05
	15000	92.00±0.09	93.33±0.10	90.67±0.03	90.00±0.14
	20000	90.67±0.03	92.00±0.09	89.33±0.17	88.00±0.10
	25000	88.00±0.10	89.33±0.17	86.67±0.05	85.33±0.07
	30000	83.33±0.07	84.94±0.83	81.33±0.05	80.00±0.12

FS- 1: Feeding Schedule-1, Fed every day in 1st feeding of 3rd to 5th instar larvae
FS- 2: Feeding Schedule- 2, Fed in 1st and 5th feeding of 3rd to 5th instar larvae
FS- 3: Feeding Schedule-3, Fed only in 1st feeding of 3rd to 5th instar larvae

S-1: Season-1, Agrahyani
S-2: Season-2, Chaita
S-3: Season-3, Jaista
S-4 : Season-4 , Baduri





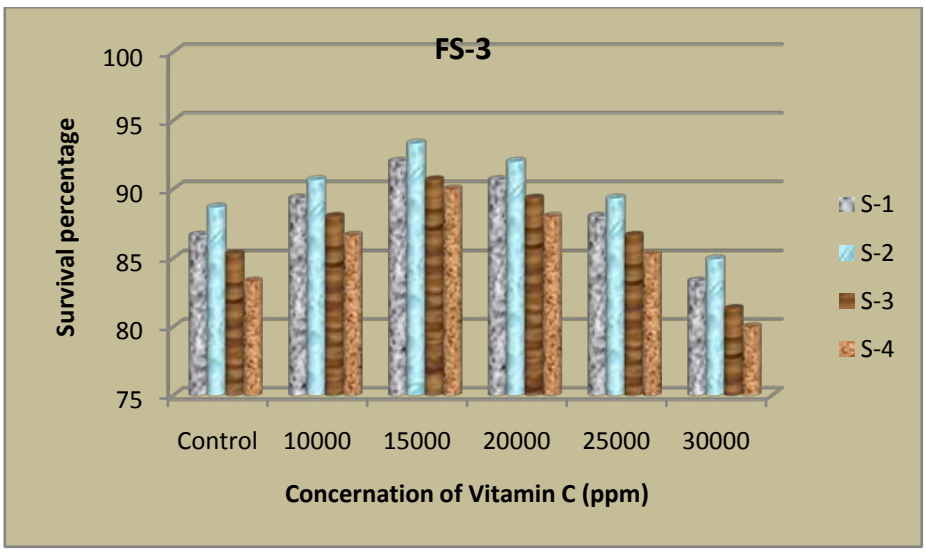


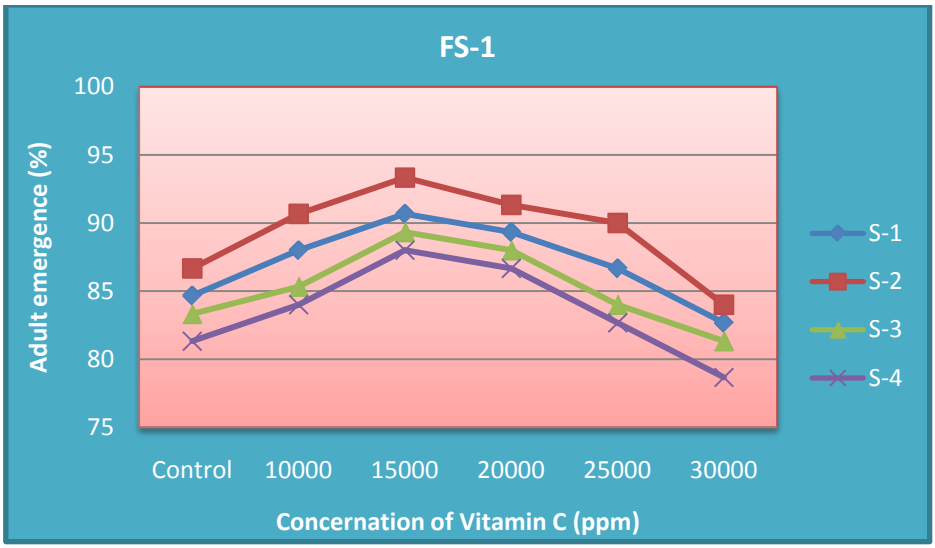
Figure 31. Effect of vit-C supplemented food on SP of *B. mori* L. at different feeding schedules.

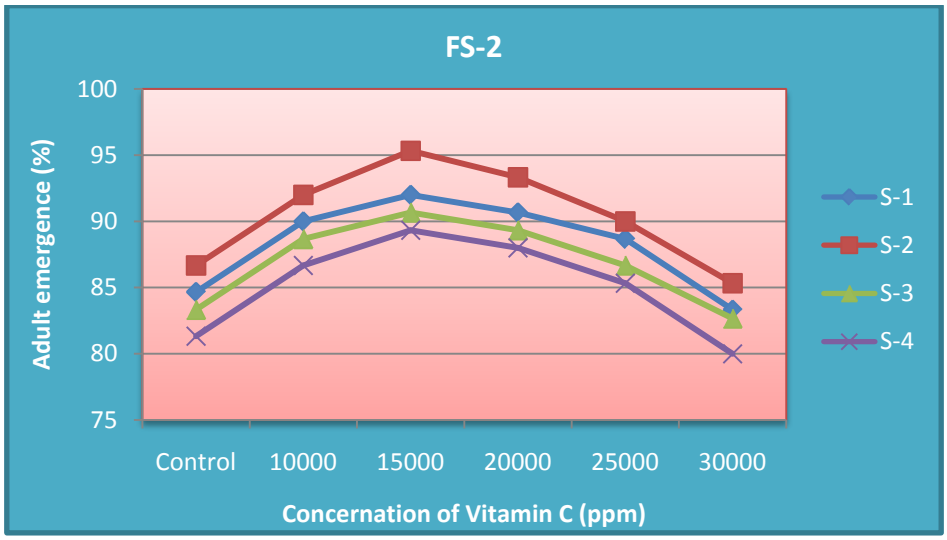
Table 32. Effect of vit-C under different feeding schedules, seasons and doses on the adult emergence (%) of *B. mori*L.

Feeding Schedule	Dose (ppm)	S-1		S-2		S-3		S-4	
		AE%	d-value	AE%	d-value	AE%	d-value	AE%	d-value
FS-1	Control	84.67	---	86.67	---	83.33	---	81.33	---
	10000	88	18.80**	90.67	21.51**	85.33	16.95**	84	15.64**
	15000	90.67	20.30**	93.33	23.50**	89.33	18.84**	88	17.28**
	20000	89.33	19.52**	91.33	21.97**	88	18.16**	86.67	16.70**
	25000	86.67	18.145**	90	21.07**	84	16.40**	82.67	15.16**
	30000	82.67	16.40**	84	17.83**	81.33	15.40**	78.67	13.86**
FS-2	Control	84.67	---	86.67	---	83.33	---	81.33	---
	10000	90	19.91**	92	22.45**	88.67	18.50**	86.67	16.70**
	15000	92	21.15**	95.33	25.29**	90.67	19.57**	89.33	17.90**
	20000	90.67	20.30**	93.33	23.50**	89.33	18.84**	88	17.28**
	25000	88.67	19.16**	90	21.07**	86.67	17.54**	85.33	16.15**
	30000	83.33	16.67**	85.33	18.46**	82.67	15.88**	80	14.27**
FS-3	Control	84.67	---	86.67	---	83.33	---	81.33	---
	10000	86.67	18.14**	89.33	20.65**	84	16.40**	83.33	15.40**
	15000	89.33	19.52**	92	22.45**	88	18.16**	86.67	16.70**
	20000	88	18.81**	90.67	21.51**	86.67	17.54**	85.33	16.15**
	25000	85.33	17.52**	88	19.86**	83.33	16.14**	81.33	14.70**
	30000	81.33	15.89**	83.33	17.54**	80	14.93**	76.67	13.28**

FS- 1: Feeding Schedule-1, Fed every day in 1st feeding of 3rd to 5th instar larvae
FS- 2: Feeding Schedule- 2, Fed in 1st and 5th feeding of 3rd to 5th instar larvae
FS- 3: Feeding Schedule-3, Fed only in 1st feeding of 3rd to 5th instar larvae

S-1: Season-1, Agrahyani
S-2: Season-2, Chaita
S-3: Season-3, Jaista
S-4 : Season-4 , Baduri





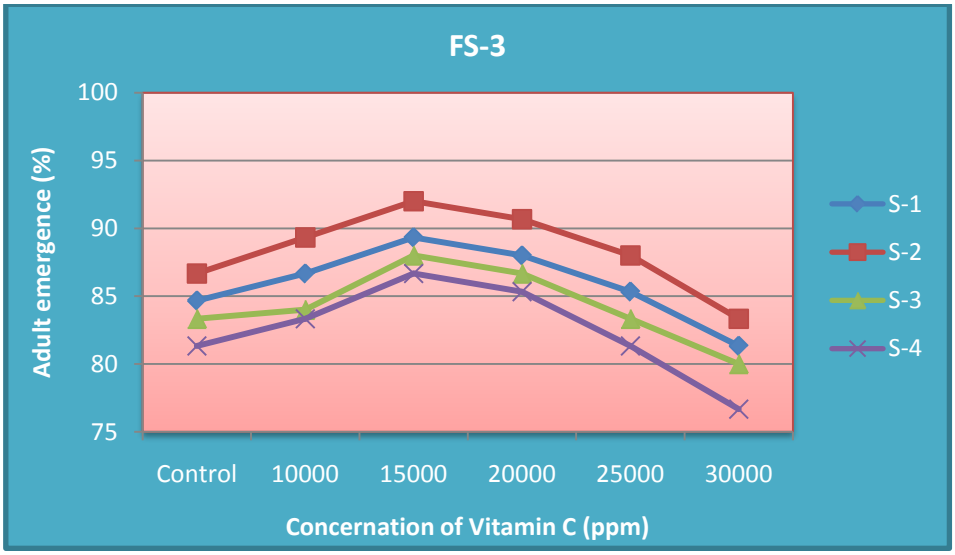


Figure 32. AE(%) line of vit-C supplemented food against *B. mori* L. at different schedules.

Table 33. Effect of vit-C under different feeding schedules, seasons and doses on the larval period (days) of *B. mori*L.

Feeding Schedule	Dose (ppm)	Mean ± SE			
		S-1	S-2	S-3	S-4
FS-1	Control	23.587±0.007	23.523±0.015	23.670±0.010	23.723±0.015
	10000	23.520±0.012	23.477±0.015	23.613±0.007	23.660±0.010
	15000	23.470±0.010	23.433±0.007	23.577±0.015	23.623±0.015
	20000	23.500±0.000	23.460±0.012	23.593±0.007	23.647±0.007
	25000	23.543±0.003	23.487±0.007	23.643±0.003	23.687±0.007
	30000	23.607±0.007	23.540±0.010	23.700±0.012	23.760±0.010
FS-2	Control	23.587±0.007	23.523±0.015	23.670±0.010	23.723±0.015
	10000	23.513±0.018	23.457±0.012	23.590±0.021	23.640±0.010
	15000	23.460±0.012	23.413±0.007	23.550±0.017	23.600±0.012
	20000	23.493±0.013	23.440±0.010	23.587±0.007	23.633±0.007
	25000	23.530±0.010	23.480±0.012	23.623±0.015	23.660±0.010
	30000	23.593±0.007	23.537±0.009	23.677±0.015	23.740±0.010
FS-3	Control	23.587±0.007	23.523±0.015	23.670±0.010	23.723±0.015
	10000	23.540±0.012	23.500±0.012	23.637±0.009	23.687±0.007
	15000	23.507±0.007	23.477±0.015	23.613±0.007	23.640±0.012
	20000	23.533±0.007	23.487±0.013	23.633±0.007	23.663±0.009
	25000	23.557±0.003	23.507±0.007	23.653±0.003	23.707±0.007
	30000	23.633±0.007	23.550±0.000	23.720±0.012	23.773±0.007

FS- 1: Feeding Schedule-1, Fed every day in 1st feeding of 3rd to 5th instar larvae
FS- 2: Feeding Schedule- 2, Fed in 1st and 5th feeding of 3rd to 5th instar larvae
FS- 3: Feeding Schedule-3, Fed only in 1st feeding of 3rd to 5th instar larvae

S-1: Season-1, Agrahyani
S-2: Season-2, Chaita
S-3: Season-3, Jaista
S-4 : Season-4 , Baduri

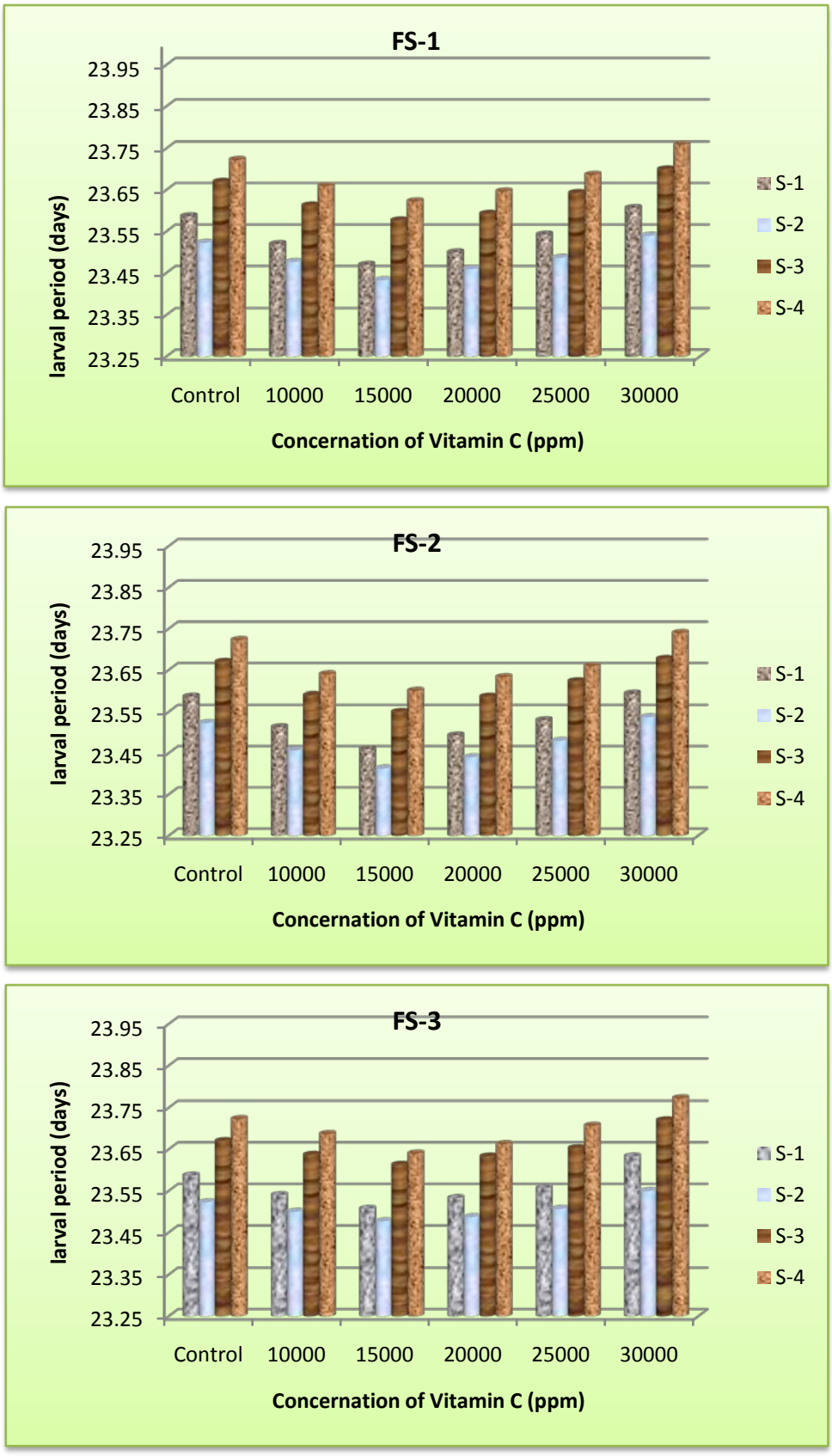


Figure 33. Effect of vit-C supplemented food on LP(days) of *B. mori* L. at different feeding schedules.

Table 34. Effect of vit-C under different feeding schedules, seasons and doses on the pupal period (days)of *B. mori*L.

Feeding Schedule	Dose (ppm)	Mean ± SE			
		S-1	S-2	S-3	S-4
FS-1	Control	9.580±0.012	9.520±0.012	9.663±0.009	9.750±0.017
	10000	9.530±0.010	9.460±0.010	9.587±0.007	9.653±0.003
	15000	9.470±0.010	9.433±0.007	9.550±0.000	9.600±0.012
	20000	9.507±0.007	9.450±0.006	9.567±0.007	9.643±0.003
	25000	9.547±0.003	9.473±0.007	9.600±0.020	9.667±0.007
	30000	9.613±0.007	9.563±0.009	9.693±0.013	9.773±0.007
FS-2	Control	9.580±0.012	9.520±0.012	9.663±0.009	9.750±0.017
	10000	9.507±0.018	9.440±0.012	9.570±0.010	9.643±0.003
	15000	9.467±0.017	9.413±0.007	9.537±0.009	9.577±0.015
	20000	9.500±0.000	9.427±0.007	9.567±0.013	9.627±0.007
	25000	9.537±0.009	9.450±0.006	9.583±0.017	9.653±0.003
	30000	9.593±0.007	9.533±0.017	9.680±0.012	9.757±0.003
FS-3	Control	9.580±0.012	9.520±0.012	9.663±0.009	9.750±0.017
	10000	9.550±0.006	9.480±0.012	9.613±0.007	9.673±0.018
	15000	9.507±0.007	9.447±0.003	9.567±0.007	9.613±0.013
	20000	9.533±0.007	9.463±0.009	9.593±0.007	9.653±0.003
	25000	9.553±0.007	9.500±0.012	9.633±0.007	9.687±0.024
	30000	9.633±0.007	9.580±0.012	9.710±0.021	9.780±0.000

FS- 1: Feeding Schedule-1, Fed every day in 1st feeding of 3rd to 5th instar larvae
FS- 2: Feeding Schedule- 2, Fed in 1st and 5th feeding of 3rd to 5th instar larvae
FS- 3: Feeding Schedule-3, Fed only in 1st feeding of 3rd to 5th instar larvae

S-1: Season-1, Agrahyani
S-2: Season-2, Chaita
S-3: Season-3, Jaista
S-4 : Season-4 , Baduri

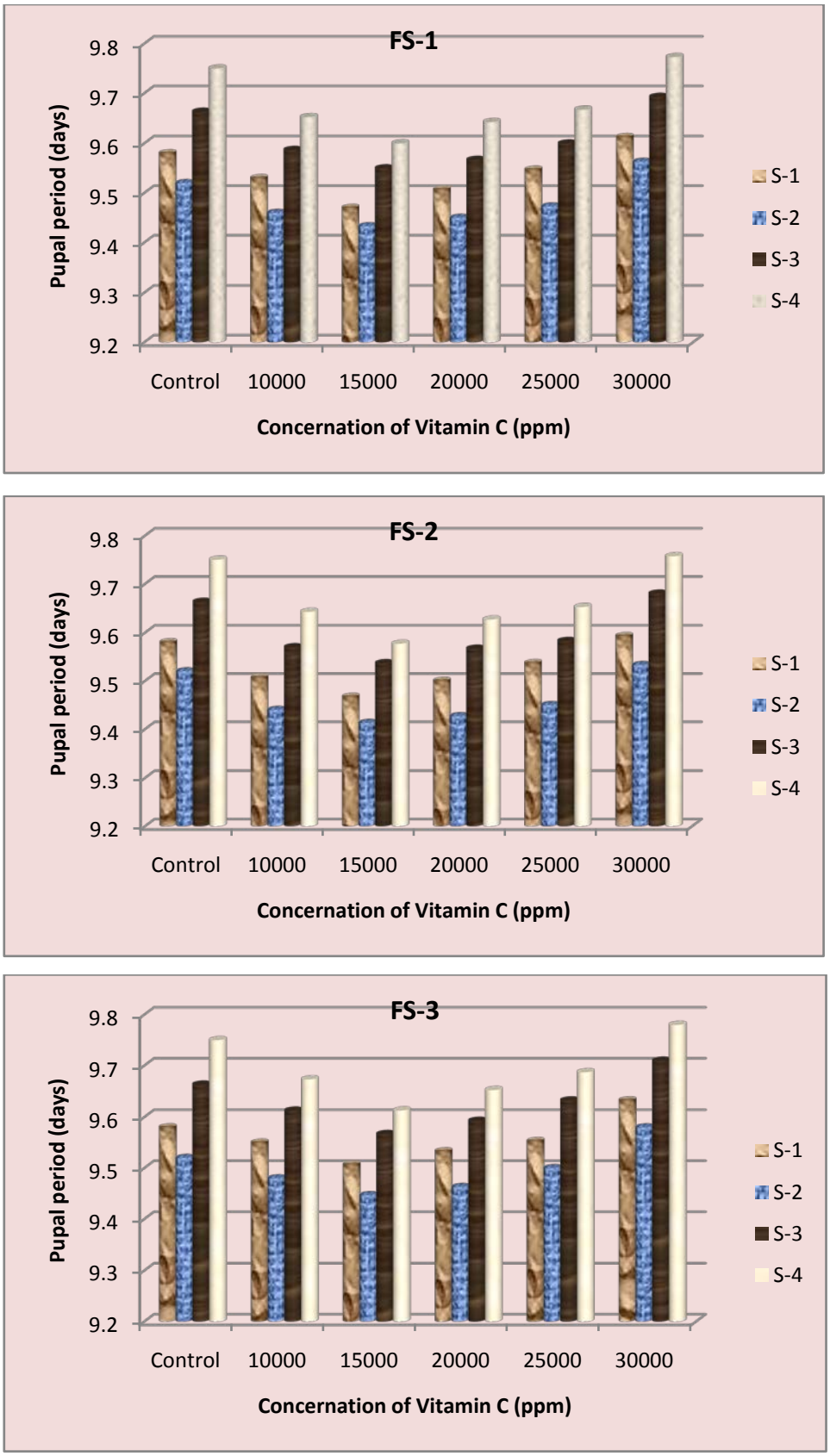


Figure 34. Effect of vit-C supplemented food on PP(days) of *B. mori* L. at different feeding schedules.

Table 35. Effect of vit-C under different feeding schedules, seasons and doses on the total eggs laid(TEL) of *B. mori*L.

Feeding Schedule	Dose (ppm)	Mean ± SE			
		S-1	S-2	S-3	S-4
FS-1	Control	270.59±1.08	276.73±0.99	265.21±0.15	257.03±0.69
	10000	316.18±0.31	322.83±1.54	311.73±0.60	304.47±0.46
	15000	365.35±0.51	374.81±0.93	360.37±0.14	351.24±0.64
	20000	324.47±0.96	329.91±1.83	316.61±0.92	310.49±1.06
	25000	312.62±1.47	318.16±1.45	306.84±0.92	299.56±0.46
	30000	262.27±1.47	270.61±1.12	252.59±1.16	248.68±0.70
FS-2	Control	270.59±1.08	276.73±0.99	265.21±0.15	257.03±0.69
	10000	321.87±0.51	327.93±1.61	316.17±1.04	312.97±1.55
	15000	375.59±0.61	382.99±1.43	366.26±1.32	355.99±1.90
	20000	331.54±2.12	336.43±2.29	322.07±0.61	318.61±0.18
	25000	316.99±0.66	323.58±0.97	313.52±0.92	306.89±1.04
	30000	265.41±1.72	273.03±1.47	259.27±0.63	253.50±0.98
FS-3	Control	270.59±1.08	276.73±0.99	265.21±0.15	257.03±0.69
	10000	303.12±1.36	312.76±1.59	297.15±1.42	291.69±0.62
	15000	352.83±1.38	360.53±1.09	346.25±1.29	340.58±1.17
	20000	313.61±1.08	319.95±0.56	309.71±0.68	301.75±0.64
	25000	296.70±0.84	303.35±1.54	291.95±1.46	286.47±0.97
	30000	256.56±0.95	265.29±0.99	247.55±1.11	243.01±1.28

FS- 1: Feeding Schedule-1, Fed every day in 1st feeding of 3rd to 5th instar larvae
FS- 2: Feeding Schedule- 2, Fed in 1st and 5th feeding of 3rd to 5th instar larvae
FS- 3: Feeding Schedule-3, Fed only in 1st feeding of 3rd to 5th instar larvae

S-1: Season-1, Agrahyani
S-2: Season-2, Chaita
S-3: Season-3, Jaista
S-4 : Season-4 , Baduri

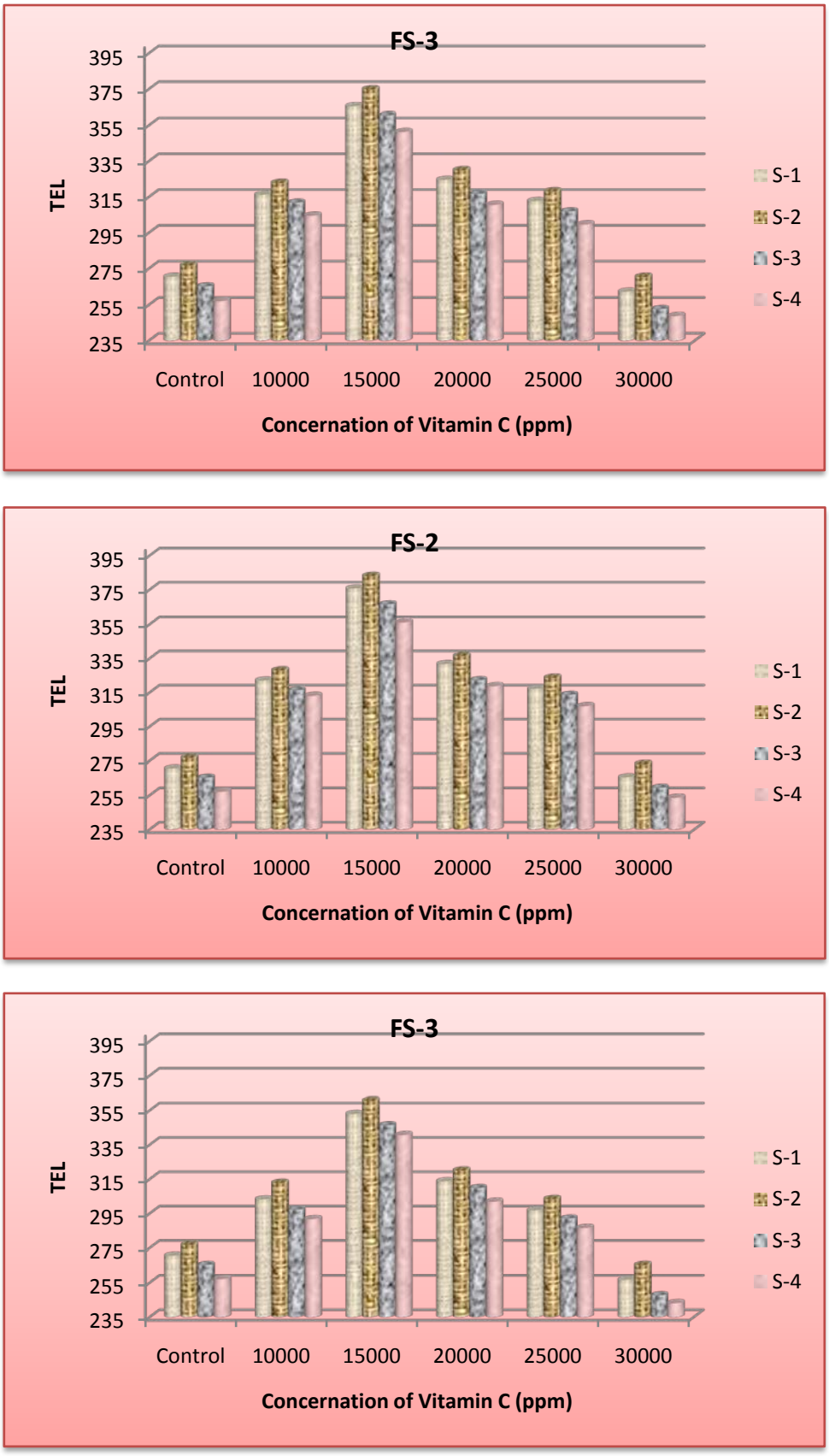


Figure 35. Effect of vit-C supplemented food on TEL of *B. mori* L. at different feeding schedules.

Table 36. Effect of vit-C under different feeding schedules, seasons and doses on the egg hatching percentage (EHP) of *B. mori*L.

Feeding Schedule	Dose (ppm)	Mean ± SE			
		S-1	S-2	S-3	S-4
FS-1	Control	93.38±0.03	93.61±0.05	93.27±0.02	93.22±0.01
	10000	94.61±0.04	94.67±0.01	94.47±0.04	94.36±0.03
	15000	94.81±0.02	94.88±0.01	94.69±0.02	94.57±0.01
	20000	94.68±0.02	94.77±0.02	94.59±0.02	94.50±0.02
	25000	94.56±0.03	94.67±0.04	94.43±0.03	94.28±0.01
	30000	93.17±0.09	93.55±0.06	93.14±0.02	93.11±0.01
FS-2	Control	93.38±0.03	93.61±0.05	93.27±0.02	93.22±0.01
	10000	94.67±0.04	94.70±0.03	94.56±0.04	94.44±0.02
	15000	94.83±0.05	95.06±0.04	94.73±0.06	94.64±0.03
	20000	94.72±0.03	94.82±0.02	94.63±0.04	94.54±0.02
	25000	94.60±0.04	94.68±0.04	94.47±0.02	94.36±0.03
	30000	93.32±0.01	93.58±0.07	93.21±0.04	93.16±0.03
FS-3	Control	93.38±0.03	93.61±0.05	93.27±0.02	93.22±0.01
	10000	93.92±0.02	93.99±0.01	93.78±0.01	93.67±0.01
	15000	94.38±0.02	94.58±0.02	94.28±0.01	94.13±0.01
	20000	94.25±0.02	94.41±0.02	94.12±0.01	93.88±0.03
	25000	93.70±0.01	93.83±0.02	93.65±0.02	93.55±0.02
	30000	93.03±0.02	93.48±0.03	93.09±0.01	93.07±0.01

FS- 1: Feeding Schedule-1, Fed every day in 1st feeding of 3rd to 5th instar larvae
FS- 2: Feeding Schedule- 2, Fed in 1st and 5th feeding of 3rd to 5th instar larvae
FS- 3: Feeding Schedule-3, Fed only in 1st feeding of 3rd to 5th instar larvae

S-1: Season-1, Agrahyani
S-2: Season-2, Chaita
S-3: Season-3, Jaista
S-4 : Season-4 , Baduri

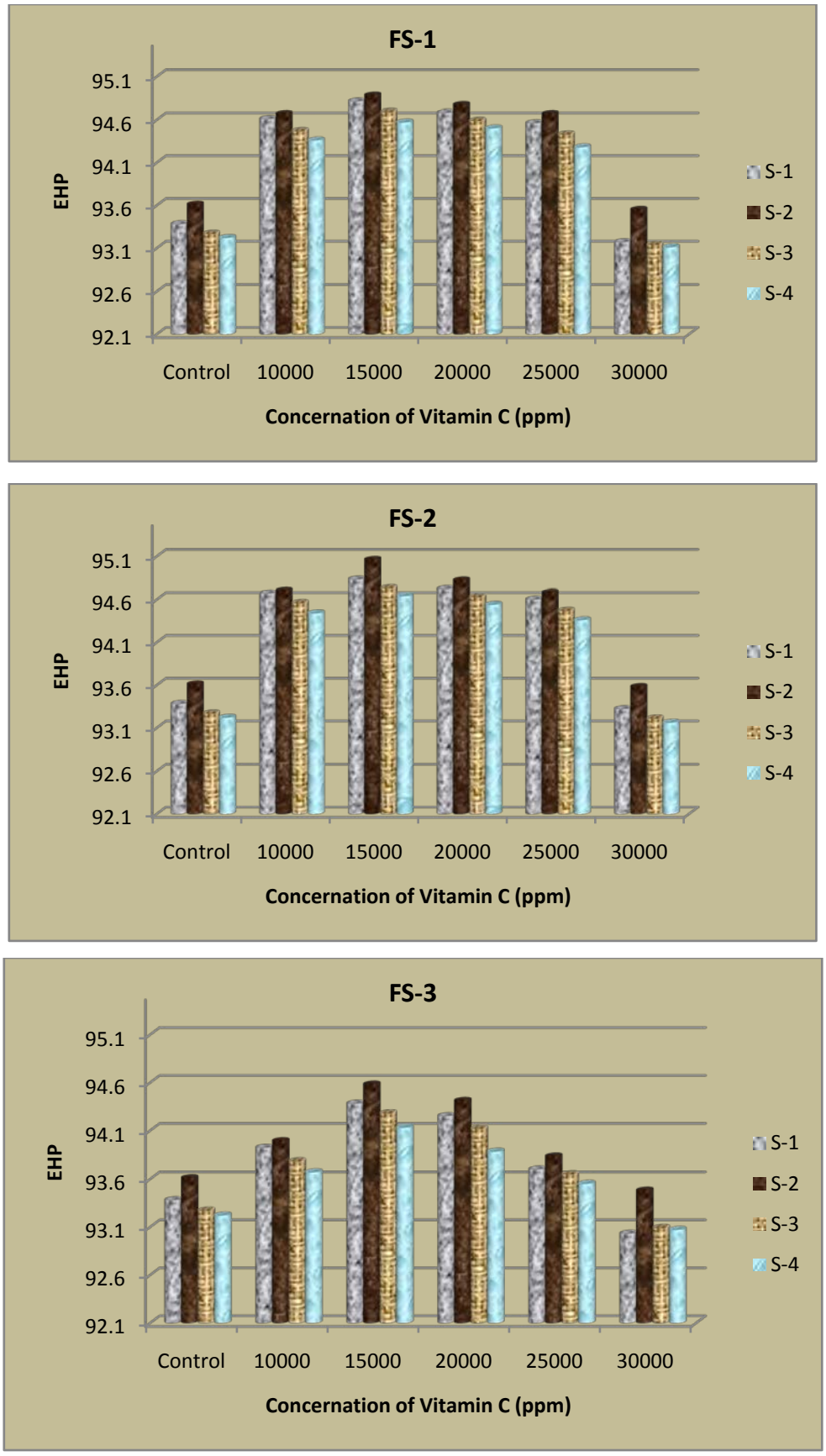


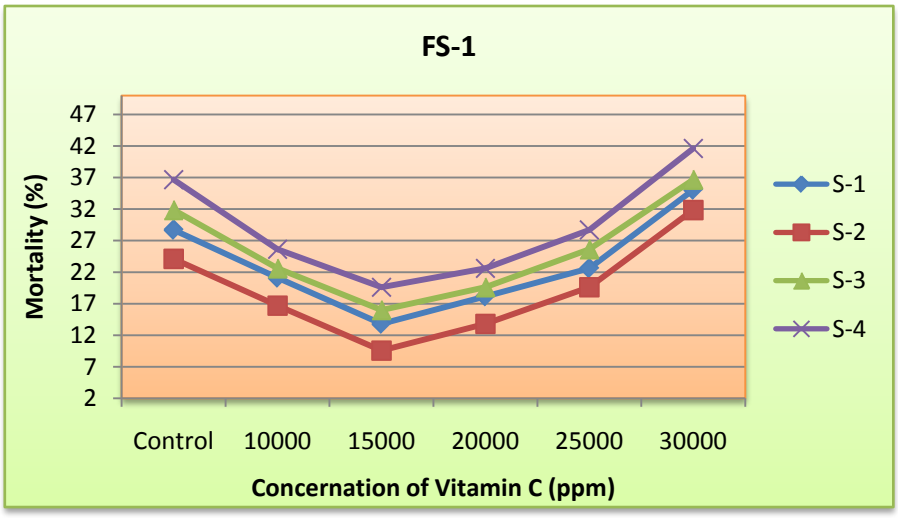
Figure 36. Effect of vit-C supplemented food on EHP of *B. mori* L. at different feeding schedules.

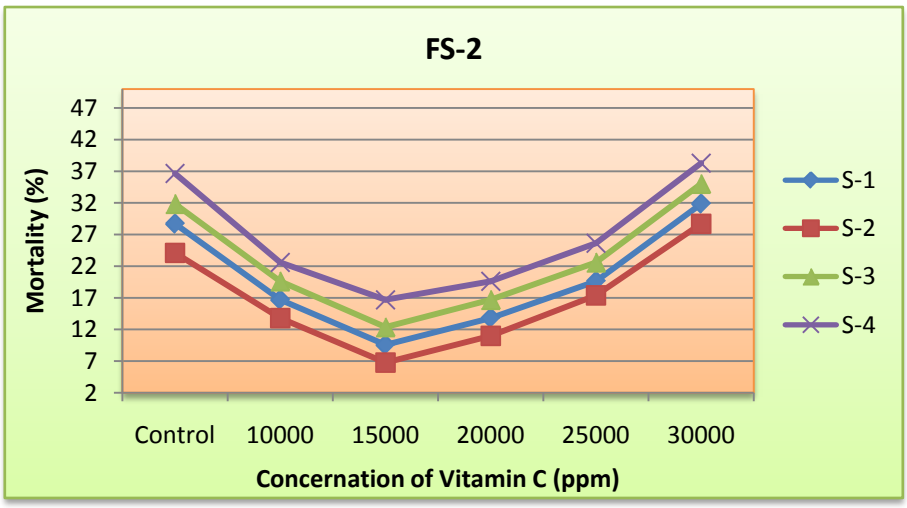
Table 37. Effect of vit-C under different feeding schedules, seasons and doses on the mortality (%) of *B. mori*L.

Feeding Schedule	Dose (ppm)	S-1		S-2		S-3		S-4	
		mortality (%)	d-value	mortality (%)	d-value	mortality (%)	d-value	mortality (%)	d-value
FS-1	Control	28.71	---	24.11	---	31.86	---	36.67	---
	10000	21.11	1.22	16.7	0.87	22.61	1.41	25.64	1.77
	15000	13.81	0.85	9.57	0.54	16	1.05	19.62	1.41
	20000	18.16	1.07	13.81	0.74	19.62	1.25	22.61	1.59
	25000	22.61	1.29	19.62	0.99	25.64	1.57	28.71	1.95
	30000	35.05	1.87	31.86	1.49	36.67	2.13	41.62	2.71
FS-2	Control	28.71	---	24.11	---	31.86	---	36.67	---
	10000	16.7	1.00	13.81	0.74	19.62	1.25	22.61	1.59
	15000	9.57	0.62	6.78	0.40	12.38	0.85	16.7	1.23
	20000	13.81	0.85	11	0.61	16.7	1.09	19.62	1.41
	25000	19.62	1.15	17.4	0.90	22.61	1.41	25.64	1.77
	30000	31.86	1.72	28.71	1.36	35.04	2.05	38.3	2.51
FS-3	Control	28.71	---	24.11	---	31.85	---	36.67	---
	10000	22.61	1.29	19.62	0.99	25.64	1.57	28.71	1.95
	15000	16.7	1.00	13.81	0.74	19.62	1.25	21.11	1.50
	20000	19.62	1.15	16.7	0.87	22.61	1.41	25.64	1.77
	25000	25.64	1.43	22.61	1.12	28.71	1.72	31.86	2.13
	30000	36.67	1.95	35.05	1.62	41.62	2.39	45	2.92

FS- 1: Feeding Schedule-1, Fed every day in 1st feeding of 3rd to 5th instar larvae
FS- 2: Feeding Schedule- 2, Fed in 1st and 5th feeding of 3rd to 5th instar larvae
FS- 3: Feeding Schedule-3, Fed only in 1st feeding of 3rd to 5th instar larvae

S-1: Season-1, Agrahyani
S-2: Season-2, Chaita
S-3: Season-3, Jaista
S-4 : Season-4 , Baduri





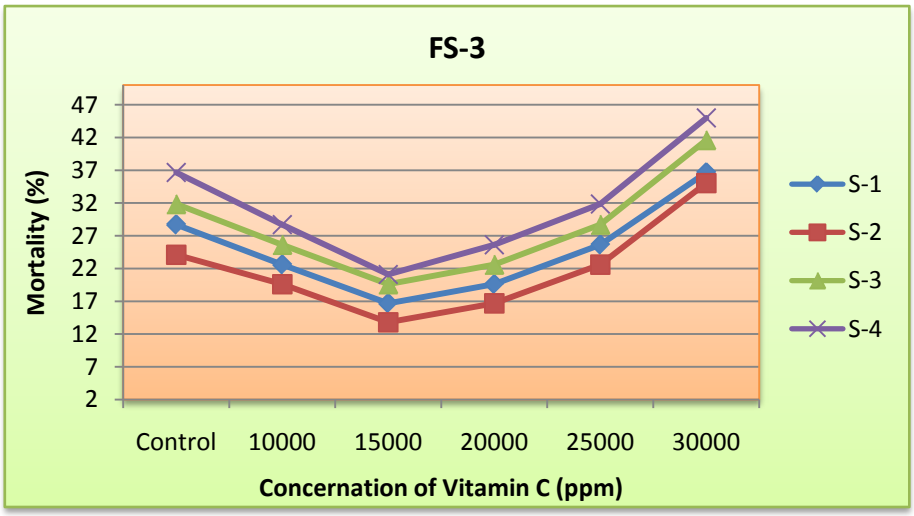


Figure 37. Mortality (%) line of vit-C supplemented food against *B. mori* L. at different schedules

Table 38. Effect of vit-C under different feeding schedules, seasons and doses on the food consumption (gm) of *B. mori*L.

Feeding Schedule	Dose (ppm)	Mean ± SE			
		S-1	S-2	S-3	S-4
FS-1	Control	45.03±0.10	45.65±0.08	44.68±0.07	44.17±0.09
	10000	45.77±0.04	46.33±0.07	45.47±0.05	44.89±0.06
	15000	47.53±0.04	47.85±0.08	47.01±0.08	46.45±0.04
	20000	46.46±0.06	46.95±0.03	46.17±0.09	45.92±0.04
	25000	45.34±0.06	45.85±0.08	45.21±0.01	44.33±0.04
	30000	44.77±0.06	45.07±0.04	44.52±0.02	43.92±0.06
FS-2	Control	45.03±0.10	45.65±0.08	44.68±0.07	44.17±0.09
	10000	46.31±0.03	46.55±0.04	45.68±0.05	45.26±0.07
	15000	47.77±0.05	48.44±0.03	47.39±0.07	46.89±0.06
	20000	47.25±0.03	47.45±0.04	46.64±0.07	46.41±0.05
	25000	45.94±0.03	46.18±0.04	45.40±0.03	45.12±0.07
	30000	44.91±0.06	45.37±0.04	44.58±0.09	44.08±0.04
FS-3	Control	45.03±0.10	45.65±0.08	44.68±0.07	44.17±0.09
	10000	45.46±0.09	45.95±0.08	45.20±0.04	44.59±0.07
	15000	47.04±0.11	47.40±0.03	46.75±0.03	46.22±0.07
	20000	46.32±0.06	46.54±0.04	45.83±0.03	45.49±0.05
	25000	45.13±0.03	45.71±0.05	44.85±0.08	44.22±0.05
	30000	44.57±0.04	44.86±0.03	44.26±0.05	43.78±0.04

FS- 1: Feeding Schedule-1, Fed every day in 1st feeding of 3rd to 5th instar larvae
FS- 2: Feeding Schedule- 2, Fed in 1st and 5th feeding of 3rd to 5th instar larvae
FS- 3: Feeding Schedule-3, Fed only in 1st feeding of 3rd to 5th instar larvae

S-1: Season-1, Agrahyani
S-2: Season-2, Chaita
S-3: Season-3, Jaista
S-4 : Season-4 , Baduri

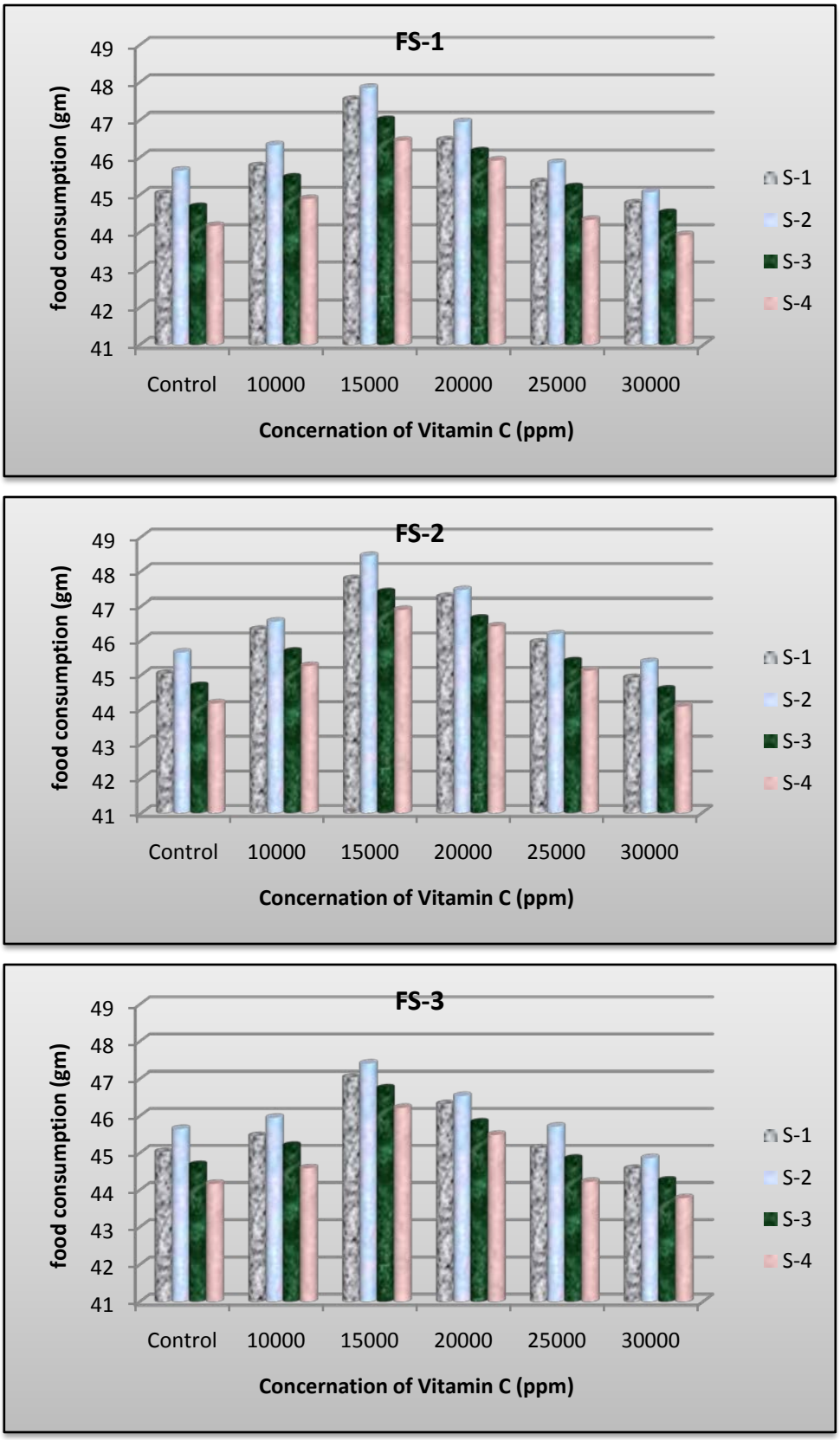


Figure 38. Effect of vit-C supplemented food on FC(gm) of *B. mori* L. at different feeding schedules.

Table 39. Effect of vit-C under different feeding schedules, seasons and doses on the food utilizations (gm) of *B. mori*L.

Feeding Schedule	Dose (ppm)	Mean ± SE			
		S-1	S-2	S-3	S-4
FS-1	Control	60.22±0.05	60.66±0.03	58.55±0.06	58.23±0.05
	10000	64.86±0.08	65.30±0.06	64.47±0.04	64.15±0.09
	15000	67.53±0.08	68.26±0.03	67.15±0.08	66.69±0.04
	20000	65.78±0.07	66.32±0.04	65.49±0.06	65.32±0.06
	25000	64.60±0.05	64.86±0.03	64.20±0.04	63.85±0.04
	30000	59.61±0.04	60.14±0.06	58.39±0.05	57.72±0.04
FS-2	Control	60.22±0.05	60.66±0.03	58.55±0.06	58.23±0.05
	10000	65.30±0.03	65.52±0.03	64.73±0.05	64.42±0.04
	15000	67.81±0.06	68.51±0.06	67.33±0.07	66.86±0.06
	20000	66.27±0.06	66.52±0.10	65.78±0.08	65.47±0.04
	25000	65.06±0.03	65.32±0.04	64.57±0.02	64.22±0.04
	30000	59.73±0.04	60.45±0.03	58.45±0.06	58.14±0.07
FS-3	Control	60.22±0.05	60.66±0.03	58.55±0.06	58.23±0.05
	10000	64.42±0.05	64.88±0.04	64.28±0.04	63.84±0.04
	15000	67.28±0.04	67.86±0.06	66.82±0.08	66.47±0.04
	20000	65.60±0.06	65.84±0.03	65.26±0.06	65.02±0.04
	25000	64.41±0.04	64.64±0.04	63.98±0.07	63.66±0.06
	30000	59.45±0.03	59.82±0.03	58.25±0.03	57.56±0.03

FS- 1: Feeding Schedule-1, Fed every day in 1st feeding of 3rd to 5th instar larvae
FS- 2: Feeding Schedule- 2, Fed in 1st and 5th feeding of 3rd to 5th instar larvae
FS- 3: Feeding Schedule-3, Fed only in 1st feeding of 3rd to 5th instar larvae

S-1: Season-1, Agrahyani
S-2: Season-2, Chaita
S-3: Season-3, Jaista
S-4 : Season-4 , Baduri

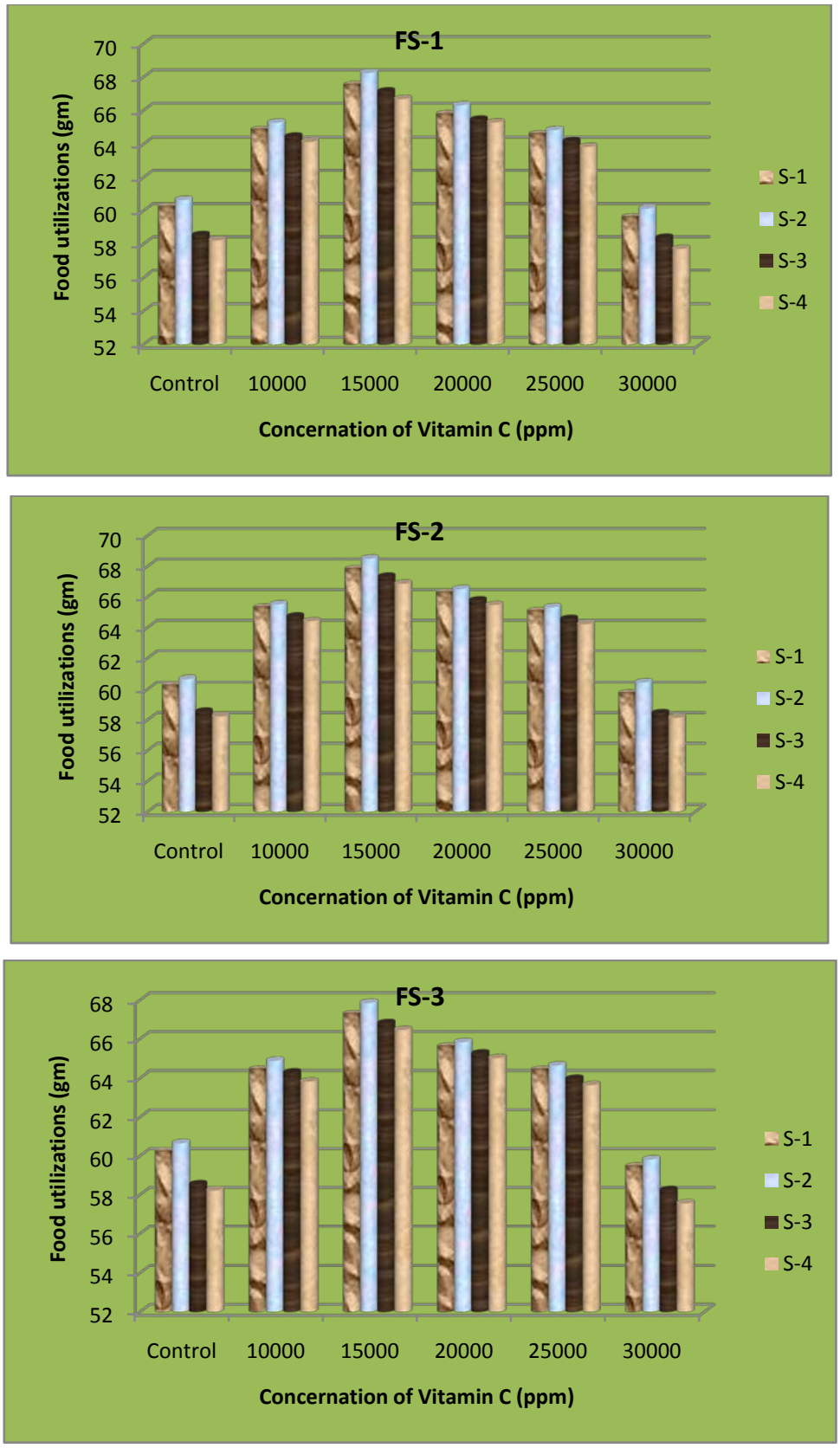


Figure 39. Effect of vit-C supplemented food on FU(gm) of *B. mori* L. at different feeding schedules.

Table 40. Effect of vit-C under different feeding schedules, seasons and doses on the approximate digestibility (%) of *B. mori*L.

Feeding Schedule	Dose (ppm)	Mean ± SE			
		S-1	S-2	S-3	S-4
FS-1	Control	60.59±0.04	60.80±0.05	58.80±0.03	58.62±0.07
	10000	66.33±0.04	66.52±0.03	65.47±0.04	64.60±0.03
	15000	70.29±0.04	70.49±0.05	68.57±0.05	66.68±0.05
	20000	68.23±0.04	68.46±0.02	67.52±0.05	65.54±0.04
	25000	66.11±0.05	66.32±0.03	65.29±0.02	64.47±0.03
	30000	60.15±0.04	60.36±0.03	58.50±0.05	58.30±0.03
FS-2	Control	60.59±0.04	60.80±0.05	58.80±0.03	58.62±0.07
	10000	66.53±0.05	66.76±0.03	65.78±0.05	64.73±0.04
	15000	70.51±0.04	70.74±0.03	68.86±0.04	66.86±0.02
	20000	68.55±0.04	68.75±0.04	67.84±0.03	65.74±0.05
	25000	66.40±0.06	66.61±0.04	65.56±0.03	64.62±0.07
	30000	60.42±0.04	60.68±0.04	58.68±0.05	58.43±0.06
FS-3	Control	60.59±0.04	60.80±0.05	58.80±0.03	58.62±0.07
	10000	66.10±0.05	66.32±0.04	65.22±0.02	64.34±0.05
	15000	70.01±0.06	70.26±0.02	68.31±0.04	66.27±0.04
	20000	68.02±0.07	68.27±0.04	67.30±0.04	65.23±0.04
	25000	65.81±0.04	66.10±0.06	65.05±0.05	64.10±0.04
	30000	60.02±0.02	60.17±0.04	58.28±0.04	58.08±0.04

FS- 1: Feeding Schedule-1, Fed every day in 1st feeding of 3rd to 5th instar larvae
FS- 2: Feeding Schedule- 2, Fed in 1st and 5th feeding of 3rd to 5th instar larvae
FS- 3: Feeding Schedule-3, Fed only in 1st feeding of 3rd to 5th instar larvae

S-1: Season-1, Agrahyani
S-2: Season-2, Chaita
S-3: Season-3, Jaista
S-4 : Season-4 , Baduri

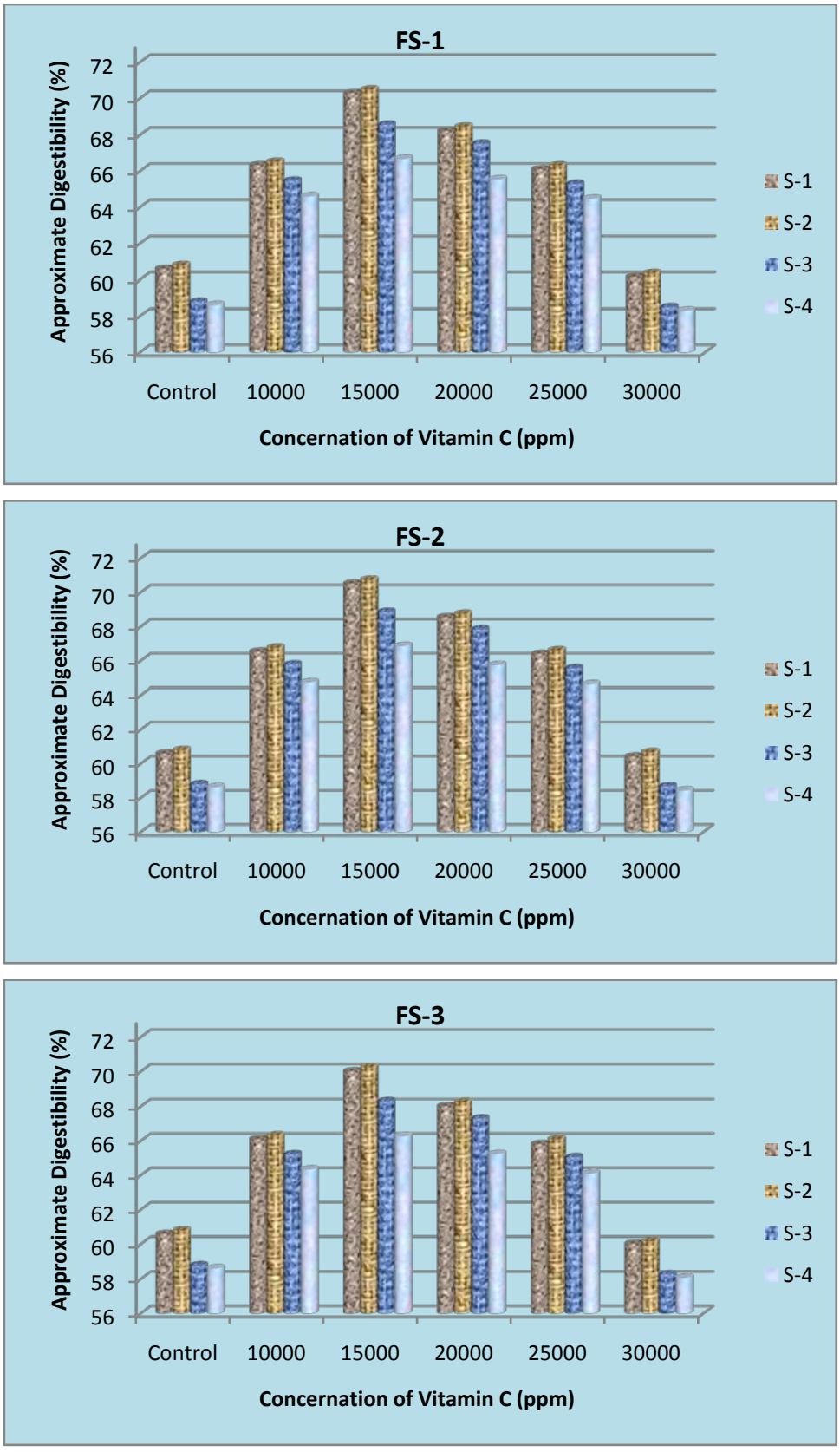


Figure 40. Effect of vit-C supplemented food onAD(%) of *B. mori* L. at different feeding schedules.

Table 41. Effect of vit-C under different feeding schedules, seasons and doses on the food consumption index of *B. mori*L.

Feeding Schedule	Dose (ppm)	Mean ± SE			
		S-1	S-2	S-3	S-4
FS-1	Control	56.31±0.05	56.73±0.03	55.82±0.04	55.52±0.04
	10000	60.07±0.07	60.25±0.04	58.41±0.02	58.24±0.06
	15000	66.27±0.04	66.48±0.05	65.43±0.04	64.52±0.04
	20000	64.19±0.04	64.41±0.04	63.80±0.03	62.46±0.06
	25000	59.85±0.03	60.17±0.01	58.25±0.03	57.84±0.04
	30000	55.85±0.04	56.42±0.02	55.25±0.03	54.82±0.05
FS-2	Control	56.31±0.05	56.73±0.03	55.82±0.04	55.52±0.04
	10000	60.23±0.04	60.47±0.04	58.68±0.04	58.45±0.06
	15000	66.53±0.07	66.70±0.03	65.67±0.04	64.78±0.05
	20000	64.41±0.06	64.67±0.05	64.10±0.06	62.71±0.02
	25000	60.11±0.06	60.32±0.04	58.48±0.04	58.30±0.03
	30000	56.15±0.03	56.65±0.03	55.50±0.03	55.25±0.04
FS-3	Control	56.31±0.05	56.73±0.03	55.82±0.04	55.52±0.04
	10000	59.42±0.04	59.74±0.06	58.22±0.05	58.09±0.05
	15000	66.05±0.05	66.30±0.08	65.26±0.04	64.32±0.05
	20000	63.95±0.09	64.26±0.03	63.53±0.02	62.30±0.04
	25000	59.27±0.04	59.59±0.04	57.98±0.05	57.70±0.03
	30000	55.66±0.04	56.22±0.04	54.90±0.02	54.57±0.02

FS- 1: Feeding Schedule-1, Fed every day in 1st feeding of 3rd to 5th instar larvae
FS- 2: Feeding Schedule- 2, Fed in 1st and 5th feeding of 3rd to 5th instar larvae
FS- 3: Feeding Schedule-3, Fed only in 1st feeding of 3rd to 5th instar larvae

S-1: Season-1, Agrahyani
S-2: Season-2, Chaita
S-3: Season-3, Jaista
S-4 : Season-4 , Baduri

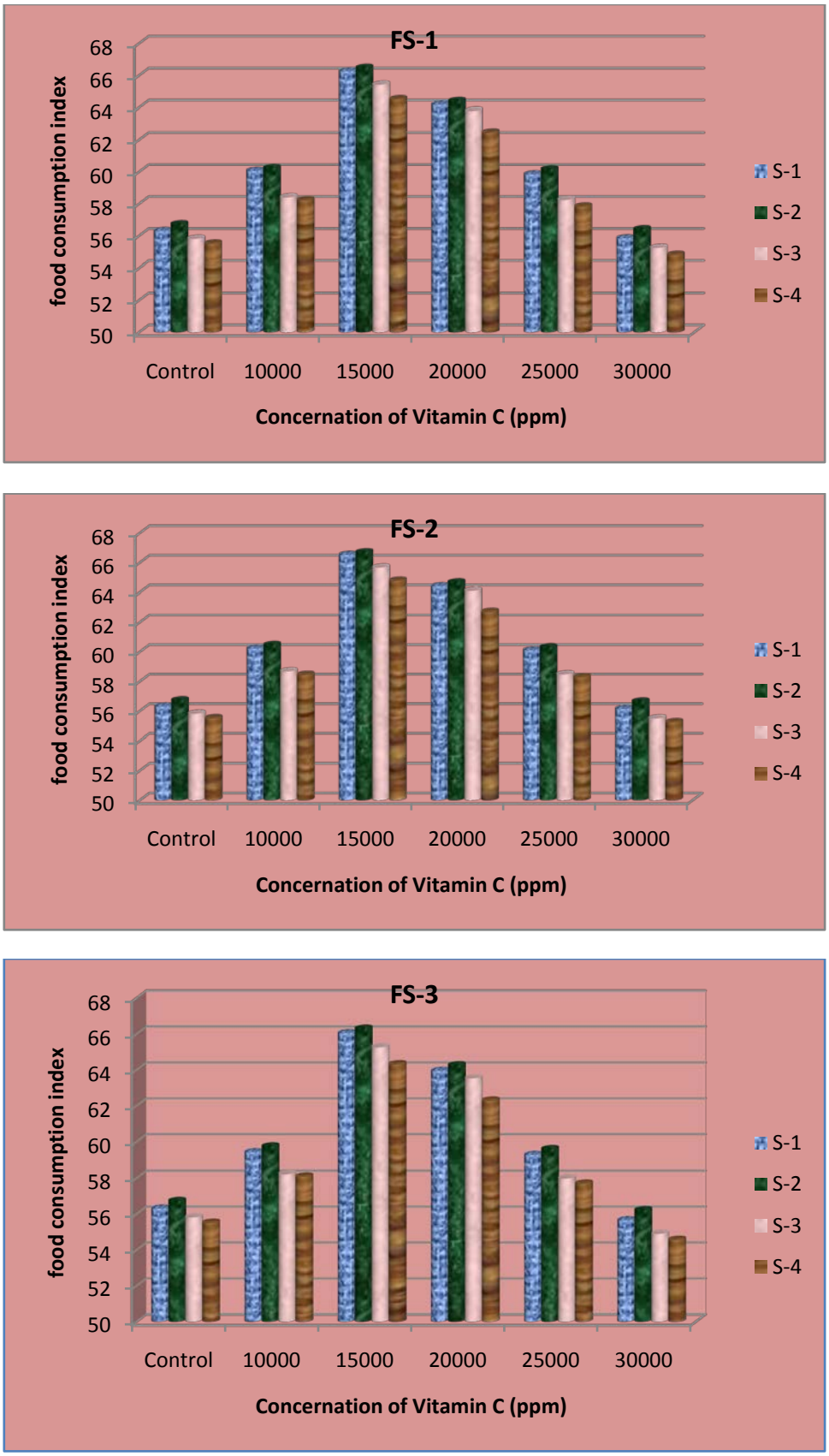


Figure 41. Effect of vit-C supplemented food on FCI of *B. mori* L. at different feeding schedules.

Table 42. Effect of vit-C under different feeding schedules, seasons and doses on the co-efficient of food utilization (%) of *B. mori*L.

Feeding Schedule	Dose (ppm)	Mean ± SE			
		S-1	S-2	S-3	S-4
FS-1	Control	45.39±0.03	45.71±0.04	44.76±0.03	44.42±0.04
	10000	48.08±0.05	48.32±0.06	47.45±0.04	47.22±0.03
	15000	56.26±0.04	56.44±0.03	55.41±0.05	55.20±0.03
	20000	54.19±0.03	54.48±0.04	53.45±0.03	53.22±0.02
	25000	47.76±0.04	48.14±0.02	47.27±0.03	47.04±0.04
	30000	45.10±0.05	45.46±0.04	44.25±0.02	44.02±0.06
FS-2	Control	45.39±0.03	45.71±0.04	44.76±0.03	44.42±0.04
	10000	48.31±0.03	48.49±0.03	47.75±0.03	47.50±0.03
	15000	56.47±0.06	56.73±0.05	55.70±0.03	55.40±0.04
	20000	54.44±0.02	54.75±0.02	53.62±0.03	53.38±0.04
	25000	48.14±0.02	48.39±0.03	47.63±0.02	47.30±0.03
	30000	45.29±0.03	45.65±0.02	44.45±0.03	44.25±0.03
FS-3	Control	45.39±0.03	45.71±0.04	44.76±0.03	44.42±0.04
	10000	47.45±0.03	47.69±0.05	47.27±0.03	46.74±0.09
	15000	55.59±0.02	55.74±0.03	55.20±0.03	54.83±0.03
	20000	54.15±0.04	54.30±0.05	53.23±0.04	53.02±0.07
	25000	47.23±0.02	47.58±0.05	46.90±0.01	46.54±0.03
	30000	44.80±0.03	45.32±0.01	43.80±0.03	43.65±0.03

FS- 1: Feeding Schedule-1, Fed every day in 1st feeding of 3rd to 5th instar larvae
FS- 2: Feeding Schedule- 2, Fed in 1st and 5th feeding of 3rd to 5th instar larvae
FS- 3: Feeding Schedule-3, Fed only in 1st feeding of 3rd to 5th instar larvae

S-1: Season-1, Agrahyani
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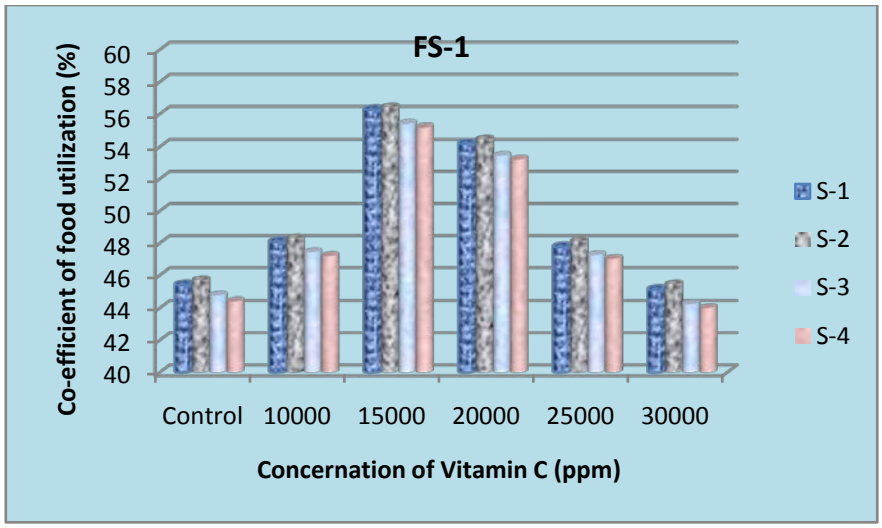
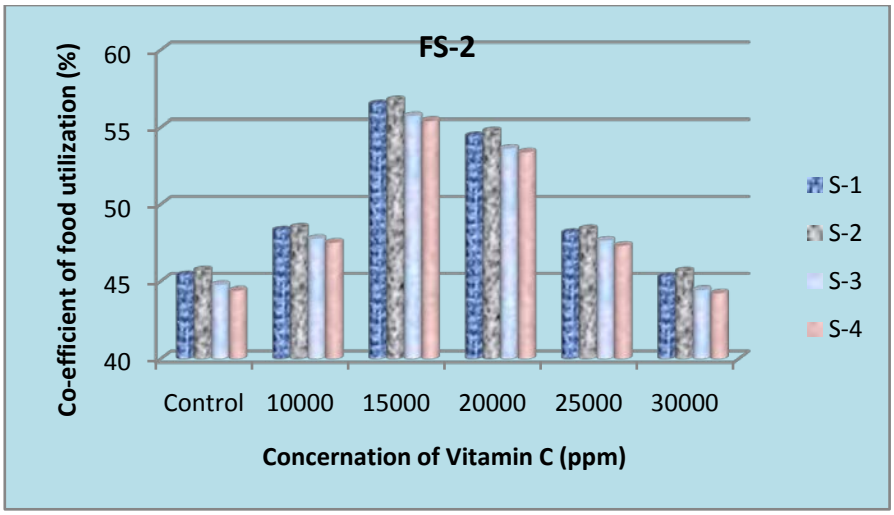
S-4 : Season-4 , Baduri





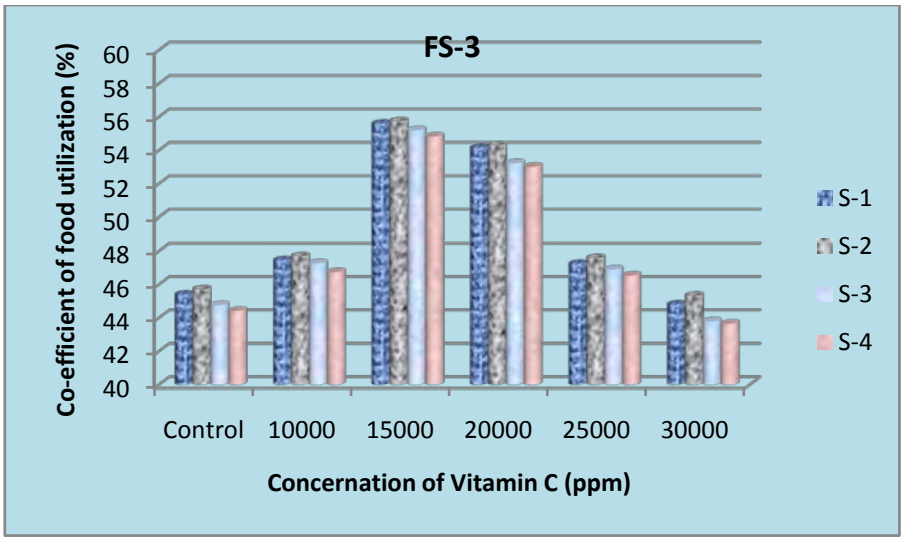


Figure 42. Effect of vit-C supplemented food on CFU(%) of *B. mori* L. at different feeding schedules.

Chapter 5

Discussion

The silkworm, *B. mori* L. is a beneficial insect producing the quality natural textile fiber. The growth of different stages of *B. mori* is of paramount importance because a successful cocoon crop in sericulture depends mostly on a healthy larval growth. Various factors are responsible for the growth of an organism, as in the silkworm. Vitamins are one of the most important growth-regulating factors, required in small quantity for the maintenance of vital metabolic functions. Nutritional background of the larval stage is significantly influences the status of the resulting pupae, adult and fiber (Etebari and Metindoost, 2004; Khan and Shah, 2003; Rahmathulla *et al*., 2002; Ahmed *et al*., 1998; Fukuda *et al*., 1963). Although the mulberry leaves constitute a complete diet for the mulberry silkworm, however, nutritional deficiencies occur due to different reasons.

In the present study, the effect of the supplementation of vitamin B_2 and C on different parameters, viz. larval growth, pupal growth, cocoon characters, developmental period, total egg laid, egg hatching percentage, mortality and feed efficacy of *B. mori* during different seasons, viz. S-1, S-2, S-3, S-4, and at different feeding schedules, viz. fed every day in 1^{st} feeding of 3^{rd} to 5^{th} instar larvae (FS-1), fed in 1^{st} to 5^{th} feeding of 3^{rd} to 5^{th} instar larvae (FS-2), fed only in 1^{st} feeding of 3^{rd} to 5^{th} instar larvae (FS-3) were assessed. In most of the cases supplementation of vitamin B_2 and C at various concentrations increased the growth and developmental parameters. The analysis of variance also indicated that there is a highly significant difference at various feeding schedules, seasons and doses.

Here it was observed that the larval growth were significantly increased in the treated lines (except at higher concentrations) in comparison to the control line.

These findings are in conformity with the studies of Balasundaram *et al*. (2008) where they stated that the larval length, width and weight have been improved

when the larvae fed with the supplementation of vitamin C treated mulberry leaves. Gomaa *et al.* (1977) observed that ascorbic acid significantly increased the weight of *B. mori* larvae. Similarly, it has been showed that thyroxin and vitamin B_{12} supplemented mulberry leaves caused a significant increase in body weight of silkworm larvae (Majumder and Medda, 1995). Nirwani and Kaliwal (1998) observed that the vitamin B_2 may have some stimulatory effect of metabolism of the silkworm larvae. The enrichment of mulberry leaves with riboflavin at 77ppm enhanced certain economic characters of silkworm, and improves silk production in the climatic conditions of Iran (Rajabi *et al.*, 2006a). Etebari *et al.* (2004) demonstrated that feeding on mulberry leaves enriched with ascorbic acid at 3% concentration decreased larval weight due to hypervitaminosis. Etebari *et al.* (2004) also reported the yield decrease, when ascorbic acid concentration is enhanced in silkworm diet. In the vitamin B-complex group, thiamin, riboflavin, nicotinic acid, pantothenic acid, pyridoxine, and cholinechloride are essential for larval growth in *Dacus cucurbitae* as shown by Srivastava and Pant (1977). Vitamin K_1 is beneficial in improving the growth of male and female nymphs of house cricket (Mcfarlane, 1983). Thianomin enhanced the growth of *B. mori* larvae (Faruki, 1998). Khan and Faruki (1990) reported that para- amino benzoic acid has significant effects on larval weight, length and head capsule width of *B. mori*. Zannoon, *et al*. (2008) recorded that the rearing with Kokuso-27 leaves with vitamin B and C, especially with the feeding schedule of four feeds per day, exhibited significantly increased larval fitness. Khan and Saha (1996) observed that citric acid supplementation increased the growth of *B. mori* larvae at lower concentrations. Again, Saha and Khan (1996) observed that vitamins and mineral significantly increased the growth of larvae when compared with the control worms. It has been reported that the growth of *B. mori* larvae was significantly influenced at lower doses when the worms were reared on Sinafort®-B supplemented diet (Saha and Khan, 1997). The oral supplementation of riboflavin resulted in significant increase in larval weight (Nirwani *et al.*, 1998). Similar results have been reported in locusts on feeding with carnitine, thioktic acid,

cobalanmin, glutathione, adenine, yeast and nucleic acid alone or in certain combinations in the artificial diet casein (Dadd, 1961). Nakamura (2000) reported that when silkworm larvae were reared on a vitamin B_2 deficient diet, their growth was gradually retarded and the total vitamin B_2 content in larval body was decreased rapidly. This decrease was mostly due to the fall of riboflavin content; FAD and FMN, the coenzyme forms of vitamin B_2. The growth of *B. mori* larvae was significantly enhanced when the worms were reared on artificial diets enriched with folic acid (Khalequzzaman and Ansary, 1982). However, according to Rahmathulla *et al.* (2007) the folic acid solution spraying on mulberry leaf and feeding to silkworm significantly improved larval weight and growth rate.

The current experiment also revealed that the pupal growth was significantly increased due to vitamin B_2 and C supplementation. These results are in close agreement with many previous studies (Ahsan *et al*., 2013; Balasundaram *et al*., 2013; Rahmathulla *et al.*, 2007; Etebari *et al.*, 2004; Khan and Saha, 2003; Nirwani *et al.*, 1998; Saha and Khan, 1997; Trivedy *et al*., 1993; Magadum *et al*., 1992; Qadar *et al*., 1994; Saha *et al*., 1994; Khan and Faruki, 1990; Saha and Khan, 1996; Islam and Khan, 1993; Magadum *et al.*, 1992). Etebari and Matindoost (2005) observed that feeding of silkworm on mulberry leaves enriched with multi-vitamins from 4^{th} instar increased female cocoon shell weight in 2.5% concentration, while female pupal weight increased in 1% concentration. It was observed that para-amino benzoic acid supplementation had significant effects on pupal weight, length, and breadth (Khan and Faruki, 1990). Fe-PLUS® supplementation significantly increased the weight of pupae when compared with that of the untreated control (Khan and Saha, 1996). Saha and Khan also found that vitamins and minerals significantly increased the growth of pupae compared to the controls. Citric acid supplementation increased the growth of *B. mori* pupae at lower concentrations (Khan and Saha, 1996). Thianomin® enriched mulberry leaves significantly increased the pupal weight and length in comparison to controls (Faruki, 1998). Talebi *et al.* (2001) observed that effect of multivitamins

on some traits of the silkworm showed significant result on pupal weight. Islam and Khan (1993) recorded that supplementation of mulberry leaves with lower concentrations of manganese sulphate significantly increased the pupal growth.

The cocoon characters viz. cocoon weight, length, breadth and shell weight except shell ratio were significantly increased in various concentrations except at 420ppm compared to the control.

These results are well supported with the findings of many researchers. Suprakash and Pal (2002) also found that vitamin B complex significantly improved growth and development, with beneficial effects on the economic characteristics of the cocoon. Nirwani and Kaliwal (1996) determined that folic acid has phagostimulatory effects with significant increase in female and male cocoon weight and shell weight. This is also supported by Sarker *et al*. (1995), who reported that supplementation of mulberry leaves offered to silkworm with ascorbic acid (1%) and vitamin B complex (0.5%) improved cocoon yield and silk filament quality. They reported that supplementation of ascorbic acid to silkworm larvae increased cocoon yield and filament length. It has been observed that vitamins plus minerals enhanced the cocoon characters, e.g. whole cocoon weight and shell weight in both the males and females (Saha and Khan, 1996). Babu *et al.,* (1992) observed that the first and second instar larvae reared on 1.5% ascorbic acid enriched mulberry leaves resulted in higher silk filament length, weight and denier values. Sengupta *et al.* (1972) have also recorded improvement of commercial characters in *B. mori* due to ascorbic acid supplementation. Vitamin B_{12} increased the shell weight in *B. mori* (Majumder and Medda, 1995). Khan and Faruki (1990) and Faruki and Khan (1992) observed that supplementation of para-amino benzoic acid slightly increased the cocoon characters of the mulberry silkworms at lower concentrations. The feeding of Fe-PLUS® relatively increased the cocoon and shell weight both in males and females and shell ratio (%) (Khan and Saha, 1996). Khan and Saha (1996a), and Saha and Khan (1996, 1997) reported that vitamins significantly increased the growth and economic characters

of *B. mori* at lower concentrations, but the higher concentrations produced detrimental effects on all the parameters. Khan and Saha (1996b, 1997) observed that citric acid and calcium lactateenriched mulberry leaves increased the growth and cocoon characters of *B. mori* significantly at all concentrations compared to the control. The cocoon characters such as cocoon weight, shell weight, shell length and breadth of *B. mori* was increased when the worms were reared on Thianomin® supplemented diet (Faruki, 1998). Supplementation of riboflavin significantly increased the male and female cocoon and shell weight in all treated groups as compared to the controls in *B. mori* (Nirwani *et al.*, 1998). Etebari and Matindoost (2005) reported that male and female shell ratio did not increase compared to the control. Hugar *et al.* (1998) found that lower concentration of nickel chloride supplementation significantly increased the silkgland weight, female and male cocoon weight and the length, weight and denier of the silk filament in all the treated groups. Rathinam *et al*. (1990) observed the enrichment of mulberry leaves with calcium chloride to increase the cocoon characters like cocoon weight, shell weight, shell ratio and silk proteins.

In the present study, it was observed that the survival and adult emergence percentage of *B. mori* were increased except at higher concentrations but the larval period and pupal period of *B. mori* were decreased in the treated lines compared to the control. Results on the effect of vitamin B and C at four feeding per day exhibited significantly shorter larval duration (Zannoon, *et al*., 2008). Khan and Faruki (1990) observed that low concentrations of para-amino benzoic acid produced detrimental effects on pupation and moth emergence. Rajabi *et al.*, (2006b) further reported that effective rate of rearing (ERR%) was higher (75.33%) at 100ppm concentration compared with other concentrations (10,500 and 1000ppm). Saha and Khan (1996) observed that the effect of dietary supplementation of vitamins and minerals was to increase the ERR(%) of *B. mori.* Similar results have also been recorded by Pai *et al.* (1988). It has been observed that feeding of minerals to the silkworms shortened the development periods in *B.*

mori in comparison to the control (Saha and Khan, 1996). Islam and Khan (1993) recorded that supplementation of mulberry leaves with lower concentrations of manganese sulphate significantly decreased the total developmental period of the mulberry silkworm. Sinafort® –B significantly reduced the larval and pupal periods in *B. mori* (Saha and Khan, 1997). Ascorbic acid is reported to enhance the larval survival rate (Ito and Niminura, 1966 a and b). Nirwani *et al*. (1998) observed that supplementation of riboflavin significantly decreased the larval period in all the treated groups.

In the present investigation it was observed that the total number of eggs laid (TEL) and egg hatching percentage (EHP) of *B. mori* was significantly increased due to vitamin supplementation but TEL and EHP were decreased at a higher concentration. Faruki (2005) observed that higher concentration of vitamins reduced the fecundity and fertility of silkworm. The reproductive success in lower concentrations was prominent compared to effect of the higher concentrations (Faruki 2005; Etebari and Matindoost, 2005). It has been reported that supplementation of ascorbic acid to silkworm larvae increased the fecundity (Chauhan and Singh, 1992), and cocoon yield and filament length (Sarker *et al.*, 1995). Nirwani *et al.* (1998) observed no significant effect on the reproductive potential of *B. mori* due to riboflavin supplementation. Rahman *et al.* (1990), on the other hand, observed that silkworms reared on ascorbic acid-enriched mulberry leaves produced more eggs than did in the untreated controls. There was a progressive increase in the fecundity and egg viability in the *B. mori* females resulting from vitamin plus mineral enriched mulberry leaves at lower concentrations (Saha and Khan, 1996). Sinafort®-B showed a significant increase in the reproductive potential of the treated female moths (Saha and Khan, 1997). The reproductive potential of the females reared on the citric acid enriched diet was significantly increased when compared to the untreated controls (Khan and Saha, 1996). Talebi *et al.* (2001) observed that effect of multi-vitamins on egg production of silkworm showed significant result. The dietary supplementation

with B complex to silkworm larvae resulted in a significant increase of female fecundity (Sarker *et al*., 1995). However, a high concentration of potassium iodide decreased fecundity (Bhattacharya and Medda, 1981a,b; 1983).

The supplementation of vitamin B_2 and C significantly reduced the mortality%. The results of the present work corroborate with the findings of Ahsan *et al*. (2013). They observed that vitamin supplementation slightly reduced the larval and pupal mortalities in *B. mori* at some concentrations as compared to the control. Etebari and Matindoost (2004) found that the high mortality of larvae occurs during molting and they cannot complete this process normally due to the effect of hypervitaminosis of vitamin B_3. It has been observed that at higher concentrations, viz. 0.80 and 1.60%, citric acid produced significantly higher mortalities in *B. mori* (Khan and Saha, 1996). The high concentrations of nicotinamide (10, 20 and 30g/l) could cause intensive mortality in the larval stage (Etebari, 2002). Majumdar (1982) recorded that a high concentration of potassium iodide produced higher larval and pupal mortalities in the Nistari race of *B. mori.*

This study has been indicated that the vitamin B_2 and C increased the feed efficacy parameters like, food consumption, food utilization, digestibility rate, food consumption index and co-efficient of food utilization of *B. mori.* In general, the present result is in agreement with the observations of earlier researchers (Ganesh Prabu *et al*., 2012; Ponraj Ganesh Prabu *et al*., 2011; Balasundaram *et al*., 2008; Chenthilnayaki *et al*., 2004; Ramadevi *et al*., 1992). Moisture content in the leaves enhances the feed efficacy of the larvae which increase the growth rate (Ueda and Suzuki, 1967). Food ingestion and digestibility and growth in the larval stages are interrelated and the rate of digestion in silkworm increase with the advance of instar, which is the highest, about 65% in the fifth instar (Ueda, 1982). These findings are in accordance with Balasundaram *et al.* (2013) who have investigated that the feed efficacy and growth rate of silkworm larvae (5^{th} instar), enhanced by 0.2% vitamin C treated group than control and other vitamin C treated groups (0.1%, 0.4% and 0.8%). The study of Balasundaram *et al*. (2013) has been also

indicated that the vitamin C exhibits the presence of certain growth stimulant activity and can be used to increase the feed efficacy in commercial silkworm rearing with reference to sericulture. Similar observations have also been made in the investigation of Thilagavathi *et al*. (2013).

From the preceding discussion it is evident that vitamins are the richest source of supplemented food in silkworm. In the present study the treatment of riboflavin at concentration of 240ppm and ascorbic acid at 15000ppm may have beneficial effects on the feed efficacy, growth of the silkworm larva and pupa, increasing the cocoon characters, influencing the egg production and reducing the mortality% and developmental period. So, this supplementation could be prescribed to the farmers to get more quantity and quality silk.

Chapter 6

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Appendices

Appendix I. ANOVA of B_2 under different feeding schedules, seasons and doses on the LW(gm) of *B. mori* L.

Source	df	SS	MS	F
FS	2	0.4043583	0.20217917	10.06**
S	3	2.9914012	0.99713374	49.63**
Error-1	6	0.12054	0.02009069	
Dose	5	1.1829648	0.23659296	64.69**
Dose*S	15	0.0367451	0.00244967	0.66
Error-2	40	0.146275	0.00365688	
Total	71	4.8822889		

LW = Larval weight, df=Degree of freedom, **SS**=Sum of squares, **MS**=Mean sum of square, **F**=Variance ratio

Appendix II. ANOVA of B_2 under different feeding schedules, seasons and doses on LL(mm) of *B. mori* L.

Source	df	SS	MS	F
FS	2	38.9411028	19.4705514	1567.71**
S	3	8.0153498	2.67178328	215.12**
Error-1	6	0.07452	0.0124197	
Dose	5	196.14669	39.2293377	70.05**
Dose*S	15	1.1553974	0.07702649	0.13
Error-2	40	22.398364	0.5599591	
Total	71	266.73142		

LW = Larval length, df=Degree of freedom, **SS**=Sum of squares, **MS**=Mean sum of square, **F**=Variance ratio

Appendix III. ANOVA of B_2 under different feeding schedules, seasons and doses on the LB(mm) of *B. mori* L.

Source	df	SS	MS	F
FS	2	1.9752985	0.98764923	29.24**
S	3	1.9586895	0.6528965	19.33**
Error-1	6	0.20263	0.03377166	
Dose	5	42.801888	8.56037765	273.46**
Dose*S	15	0.1362512	0.00908342	0.29
Error-2	40	1.252123	0.03130309	
Total	71	48.326881		

LW = Larval breadth, df=Degree of freedom, **SS**=Sum of squares, **MS**=Mean sum of square, **F**=Variance ratio

Appendix IV. ANOVA of B_2 under different feeding schedules, seasons and doses on the PW(gm) of *B. mori* L.

Source	df	SS	MS	F
FS	2	0.1163614	0.05818071	20.18**
S	3	0.3323486	0.11078287	38.44**
Error-1	6	0.01729	0.00288194	
Dose	5	2.143936	0.42878719	164.66**
Dose*S	15	0.0538338	0.00358892	1.37
Error-2	40	0.104162	0.00260404	
Total	71	2.7679332		

PW = Pupal weight, df=Degree of freedom, **SS**=Sum of squares, **MS**=Mean sum of square, **F**=Variance ratio

Appendix V. ANOVA of B_2 under different feeding schedules, seasons and doses on the CW(gm) of *B. mori* L.

Source	df	SS	MS	F
FS	2	0.1096410	0.05482052	101.97**
S	3	0.4588498	0.15294995	284.50**
Error-1	6	0.00323	0.0005376	
Dose	5	2.4425693	0.48851386	572.85**
Dose*S	15	0.02694	0.001796	2.10*
Error-2	40	0.034111	0.00085278	
Total	71	3.0753369		

CW = Cocoon weight, df=Degree of freedom, **SS**=Sum of squares, **MS**=Mean sum of square, **F**=Variance ratio

Appendix VI. ANOVA of B_2 under different feeding schedules, seasons and doses on the CL(mm) of *B. mori* L.

Source	df	SS	MS	F
FS	0.9888244	0.49441219	136.99**	0.9888244
S	1.8225123	0.60750412	168.33**	1.8225123
Error-1	0.02165	0.0036089		0.02165
Dose	301.36535	60.2730706	5055.16**	301.36535
Dose*S	0.1458802	0.00972535	0.81	0.1458802
Error-2	0.476922	0.01192306		0.476922
Total	304.82115			304.82115

CL = Cocoon length, df=Degree of freedom, **SS**=Sum of squares, **MS**=Mean sum of square, **F**=Variance ratio

Appendix VII. ANOVA of B_2 under different feeding schedules, seasons and doses on the CB(mm) of *B. mori* L.

Source	df	SS	MS	F
FS	2	0.7370614	0.36853071	543.85**
S	3	3.8688796	1.28962654	1903.16**
Error-1	6	0.00407	0.00067762	
Dose	5	173.41355	34.6827091	5663.36**
Dose*S	15	0.0134704	0.00089802	0.14
Error-2	40	0.244962	0.00612404	
Total	71	178.28198		

CB = Cocoon breadth, df=Degree of freedom, **SS**=Sum of squares, **MS**=Mean sum of square, **F**=Variance ratio

Appendix VIII. ANOVA of B_2 under different feeding schedules, seasons and doses on the SW(gm) of *B. mori* L.

Source	df	SS	MS	F
FS	2	0.0013892	0.0006946	43.98**
S	3	0.0073043	0.00243477	154.17**
Error-1	6	0.00009	1.5792E-05	
Dose	5	0.0114883	0.00229765	188.94**
Dose*S	15	0.0002957	1.9712E-05	1.62
Error-2	40	0.000486	1.216E-05	
Total	71	0.0210586		

SW = Shall weight, df=Degree of freedom, **SS**=Sum of squares, **MS**=Mean sum of square, **F**=Variance ratio

Appendix IX. ANOVA of B_2 under different feeding schedules, seasons and doses on the SR(%) of *B. mori* L.

Source	df	SS	MS	F
FS	2	0.6173224	0.30866121	5.50**
S	3	2.7777267	0.9259089	16.51**
Error-1	6	0.33648	0.05607971	
Dose	5	15.259405	3.05188098	64.11**
Dose*S	15	1.8886072	0.12590714	2.64**
Error-2	40	1.904073	0.04760183	
Total	71	22.783613		

SR= Shall ratio, df=Degree of freedom, **SS**=Sum of squares, **MS**=Mean sum of square, **F**=Variance ratio

Appendix X. ANOVA of B_2 under different feeding schedules, seasons and doses on the SP of *B. mori* L.

Source	df	SS	MS	F
FS	2	43.4801466	21.7400733	95.73**
S	3	225.79425	75.2647508	331.43**
Error-1	6	1.36253	0.22708894	
Dose	5	331.74109	66.3482177	221.43**
Dose*S	15	6.0732438	0.40488292	1.35
Error-2	40	11.984935	0.29962336	
Total	71	620.4362		

SP = Survival percentage**, df**=Degree of freedom, **SS**=Sum of squares, **MS**=Mean sum of square, **F**=Variance ratio

Appendix XI. ANOVA of B_2 under different feeding schedules, seasons and doses on the LP (days) of *B. mor* L.

Source	df	SS	MS	F
FS	2	0.0293398	0.01466991	15.35**
S	3	0.2269177	0.07563925	79.17**
Error-1	6	0.00573	0.0009553	
Dose	5	0.1656384	0.03312769	98.92**
Dose*S	15	0.0048535	0.00032357	0.96
Error-2	40	0.013395	0.00033488	
Total	71	0.4458764		

LP = Larval peirod, **df**=Degree of freedom, **SS**=Sum of squares, **MS**=Mean sum of square, **F**=Variance ratio

Appendix XII. ANOVA of B_2 under different feeding schedules, seasons and doses on the PP(days) of *B. mori* L.

Source	df	SS	MS	F
FS	2	0.0303494	0.01517469	37.37**
S	3	0.2209461	0.07364871	181.41**
Error-1	6	0.00244	0.00040597	
Dose	5	0.2338471	0.04676941	68.70**
Dose*S	15	0.0019363	0.00012908	0.18
Error-2	40	0.027230	0.00068074	
Total	71	0.5167443		

PP = Pupal period, **df**=Degree of freedom, **SS**=Sum of squares, **MS**=Mean sum of square, **F**=Variance ratio

Appendix XIII. ANOVA of B_2 under different feeding schedules, seasons and doses on the TEL of *B. mori* L.

Source	df	SS	MS	F
FS	2	1103.7176086	551.858804	243.09**
S	3	201.7648992	67.2549664	29.62**
Error-1	6	13.62104	2.27017305	
Dose	5	146564.9184	29312.9837	1570.67**
Dose*S	15	61.59778688	4.10651913	0.22
Error-2	40	746.505049	18.6626262	
Total	71	148692.1247		

TEL = Total number of Egg laid**, df**=Degree of freedom, **SS**=Sum of squares, **MS**=Mean sum of square, **F**=Variance ratio

Appendix XIV. ANOVA of B_2 under different feeding schedules, seasons and doses on the EHP of *B. mori* L.

Source	df	SS	MS	F
FS	2	2.9667522	1.48337608	893.58**
S	3	1.3452153	0.44840509	270.11**
Error-1	6	0.00996	0.00166003	
Dose	5	20.95726	4.19145201	113.79**
Dose*S	15	0.102169	0.00681127	0.18
Error-2	40	1.473354	0.03683386	
Total	71	26.854711		

EHP = Egg hatching percentage, **df**=Degree of freedom, **SS**=Sum of squares, **MS**=Mean sum of square, **F**=Variance ratio

Appendix XV. ANOVA of B_2 under different feeding schedules, seasons and doses on the FC (gm) of *B. mori* L.

Source	df	SS	MS	F
FS	2	3.5485176	1.7742588	34.03**
S	3	28.13285	9.37761662	179.87**
Error-1	6	0.31281	0.05213513	
Dose	5	93.023509	18.6047018	350.74**
Dose*S	15	1.5016215	0.1001081	1.88
Error-2	40	2.121746	0.05304364	
Total	71	128.64105		

FC = Food consumption**, df**=Degree of freedom, **SS**=Sum of squares, **MS**=Mean sum of square, **F**=Variance ratio

Appendix XVI. ANOVA of B_2 under different feeding schedules, seasons and doses on the FU (gm) of *B. mori* L.

Source	df	SS	MS	F
FS	2	6.9376000	3.4688	148.48**
S	3	21.224065	7.07468822	302.83**
Error-1	6	0.14017	0.02336152	
Dose	5	583.76954	116.753908	2534.24**
Dose*S	15	1.4366548	0.09577699	2.07*
Error-2	40	1.842816	0.0460704	
Total	71	615.35084		

FU = Food utilization, **df**=Degree of freedom, **SS**=Sum of squares, **MS**=Mean sum of square, **F**=Variance ratio

Appendix XVII. ANOVA of B_2 under different feeding schedules, seasons and doses on the AD (%) of *B. mori* L.

Source	df	SS	MS	F
FS	2	8.9076470	4.45382352	299.93**
S	3	28.407859	9.46928637	637.70**
Error-1	6	0.08909	0.01484905	
Dose	5	570.88328	114.176656	1327.92**
Dose*S	15	1.4529515	0.09686344	1.12
Error-2	40	3.439259	0.08598148	
Total	71	613.18009		

AD = Approximate Digestibility, **df**=Degree of freedom, **SS**=Sum of squares, **MS**=Mean sum of square, **F**=Variance ratio

Appendix XVIII. ANOVA of B_2 under different feeding schedules, seasons and doses on the FCI(gm) of *B. mori* L.

Source	df	SS	MS	F
FS	2	21.5826731	10.7913366	42.80**
S	3	36.978269	12.3260895	48.89**
Error-1	6	1.51255	0.25209151	
Dose	5	820.47148	164.094296	653.82**
Dose*S	15	2.4490907	0.16327272	0.65
Error-2	40	10.039022	0.25097556	
Total	71	893.03308		

FCI = Food consumption Index, **df**=Degree of freedom, **SS**=Sum of squares, **MS**=Mean sum of square, **F**=Variance ratio

Appendix XIX. ANOVA of B_2 under different feeding schedules, seasons and doses on the Co-efficient of food utilization (gm) of *B. mori* L.

Source	df	SS	MS	VR
FS	2	3.9428259	1.97141296	37.27**
S	3	21.193142	7.06438066	133.58**
Error-1	6	0.31730	0.05288374	
Dose	5	1069.6988	213.939757	4496.95**
Dose*S	15	2.5785043	0.17190029	3.61**
Error-2	40	1.902975	0.04757438	
Total	71	1099.6335		

CFU = Co-efficient of food utilization, **df**=Degree of freedom, **SS**=Sum of squares, **MS**=Mean sum of square, **F**=Variance ratio

Appendix XX. ANOVA of C under different feeding schedules, seasons and doses on the LW(gm) of *B. mori* L.

Source	df	SS	MS	VR
FS	2	0.0653003	0.03265015	52.43**
S	3	0.919342	0.30644733	492.06**
Error-1	6	0.00374	0.00062279	
Dose	5	0.3662198	0.07324395	91.75**
Dose*S	15	0.0063691	0.00042461	0.53
Error-2	40	0.031933	0.00079833	
Total	71	1.3929012		

LW = Larval weight, **df**=Degree of freedom, **SS**=Sum of squares, **MS**=Mean sum of square, **F**=Variance ratio

Appendix XXI. ANOVA of C under different feeding schedules, seasons and doses on the LL(mm) of *B. mori* L.

Source	df	SS	MS	VR
FS	2	0.2918398	0.14591991	177.83**
S	3	1.8617042	0.62056806	756.31**
Error-1	6	0.00492	0.00082052	
Dose	5	34.5224	6.90447991	2321.41**
Dose*S	15	0.124006	0.00826707	2.78**
Error-2	40	0.118970	0.00297426	
Total	71	36.923843		

LW = Larval length, **df**=Degree of freedom, **SS**=Sum of squares, **MS**=Mean sum of square, **F**=Variance ratio

Appendix XXII. ANOVA of C under different feeding schedules, seasons and doses on the LB(mm) of *B. mori* L.

Source	df	SS	MS	VR
FS	2	0.1569898	0.07849491	232.15**
S	3	0.6605056	0.22016852	651.16**
Error-1	6	0.00203	0.00033812	
Dose	5	9.7300259	1.94600519	1201.99**
Dose*S	15	0.0569074	0.00379383	2.34*
Error-2	40	0.064759	0.00161898	
Total	71	10.671217		

LW = Larval breadth, **df**=Degree of freedom, **SS**=Sum of squares, **MS**=Mean sum of square, **F**=Variance ratio

Appendix XXIII. ANOVA of C under different feeding schedules, seasons and doses on the PW(gm) of *B. mori* L.

Source	df	SS	MS	VR
FS	2	0.0411873	0.02059367	72.30**
S	3	0.077829	0.025943	91.08**
Error-1	6	0.00171	0.00028483	
Dose	5	0.194692	0.0389384	109.74**
Dose*S	15	0.0036784	0.00024523	0.69
Error-2	40	0.014193	0.00035481	
Total	71	0.3332883		

PW = Pupal weight, **df**=Degree of freedom, **SS**=Sum of squares, **MS**=Mean sum of square, **F**=Variance ratio

Appendix XXIV. ANOVA of C under different feeding schedules, seasons and doses on the CW(gm) of *B. mori* L.

Source	df	SS	MS	VR
FS	2	0.0550620	0.02753102	97.36**
S	3	0.1249486	0.04164954	147.24**
Error-1	6	0.00170	0.00028287	
Dose	5	0.2994292	0.05988583	132.78**
Dose*S	15	0.0042542	0.00028361	0.63
Error-2	40	0.018041	0.00045102	
Total	71	0.5034319		

CW = Cocoon weight**, df**=Degree of freedom, **SS**=Sum of squares, **MS**=Mean sum of square, **F**=Variance ratio

Appendix XXV. ANOVA of C under different feeding schedules, seasons and doses on the CL(mm) of *B. mori* L.

Source	df	SS	MS	VR
FS	2	0.6537398	0.32686991	318.82**
S	3	1.9919795	0.66399316	647.64**
Error-1	6	0.00615	0.00102526	
Dose	5	41.091972	8.21839435	1164.42**
Dose*S	15	0.1971511	0.01314341	1.86
Error-2	40	0.282316	0.0070579	
Total	71	44.22331		

CL = Cocoon length, **df**=Degree of freedom, **SS**=Sum of squares, **MS**=Mean sum of square, **F**=Variance ratio

Appendix XXVI. ANOVA of vit-C under different schedules of feeding and seasons on the CB(mm) of *B. mori* L.

Source	df	SS	MS	VR
FS	2	0.1449750	0.0724875	171.49**
S	3	1.4925259	0.49750864	1177.02**
Error-1	6	0.00254	0.00042269	
Dose	5	8.9165185	1.7833037	1010.90**
Dose*S	15	0.0917704	0.00611802	3.47**
Error-2	40	0.070563	0.00176407	
Total	71	10.718889		

CB = Cocoon breadth, **df**=Degree of freedom, **SS**=Sum of squares, **MS**=Mean sum of square, **F**=Variance ratio

Appendix XXVII. ANOVA of C under different feeding schedules, seasons and doses on the SW(gm) of *B. mori* L.

Source	df	SS	MS	VR
FS	2	0.0010059	0.00050293	133.93**
S	3	0.005577	0.001859	495.05**
Error-1	6	0.00002	3.7551E-06	
Dose	5	0.0116656	0.00233312	285.26**
Dose*S	15	0.0002202	1.4681E-05	1.79
Error-2	40	0.000327	8.179E-06	
Total	71	0.0188184		

SW = Shall weight, **df**=Degree of freedom, **SS**=Sum of squares, **MS**=Mean sum of square, **F**=Variance ratio

Appendix XXVIII. ANOVA of C under different feeding schedules, seasons and doses on the SR(%) of *B. mori* L.

Source	df	SS	MS	VR
FS	2	0.0425018	0.02125088	0.16
S	3	9.60171794	3.20057265	23.99**
Error-1	6	0.80033	0.13338776	
Dose	5	16.139474	3.22789481	91.40**
Dose*S	15	3.39468466	0.22631231	6.41**
Error-2	40	1.412689	0.03531722	
Total	71	31.3913935		

SR= Shall ratio, **df**=Degree of freedom, **SS**=Sum of squares, **MS**=Mean sum of square, **F**=Variance ratio

Appendix XXIX. ANOVA of C under different feeding schedules, seasons and doses on the SP(%) of *B. mori* L.

Source	df	SS	MS	VR
FS	2	58.8184651	29.4092326	417.310265
S	3	181.75513	60.5850434	859.687871
Error-1	6	0.42284	0.0704733	
Dose	5	723.46101	144.692203	409.476225
Dose*S	15	2.2183856	0.14789238	0.41853266
Error-2	40	14.134369	0.35335923	
Total	71	980.8102		

SP = Survival percentage**, df**=Degree of freedom, **SS**=Sum of squares, **MS**=Mean sum of square, **F**=Variance ratio

Appendix XXX. ANOVA of C under different feeding schedules, seasons and doses on the LP(days) of *B. mori* L.

Source	df	SS	MS	VR
FS	2	0.0134966	0.0067483	172.84**
S	3	0.4123819	0.13746065	3520.73**
Error-1	6	0.00023	3.9043E-05	
Dose	5	0.1236267	0.02472534	225.41**
Dose*S	15	0.0017468	0.00011645	1.06
Error-2	40	0.004388	0.00010969	
Total	71	0.5558739		

LP = Larval peirod, **df**=Degree of freedom, **SS**=Sum of squares, **MS**=Mean sum of square, **F**=Variance ratio

Appendix XXXI. ANOVA of C under different feeding schedules, seasons and doses on the PP(days) of *B. mori* L.

Source	df	SS	MS	VR
FS	2	0.0105361	0.00526806	110.95**
S	3	0.3991128	0.1330376	2802.01**
Error-1	6	0.00028	4.7479E-05	
Dose	5	0.1751866	0.03503731	453.54**
Dose*S	15	0.0050215	0.00033476	4.33**
Error-2	40	0.003090	7.7253E-05	
Total	71	0.5932319		

PP = Pupal period, **df**=Degree of freedom, **SS**=Sum of squares, **MS**=Mean sum of square, **F**=Variance ratio

Appendix XXXII. ANOVA of C under different feeding schedules, seasons and doses on the TEL of *B. mori* L.

Source	df	SS	MS	VR
FS	2	2472.4314123	1236.21571	2004.76**
S	3	3864.635929	1288.21198	2089.08**
Error-1	6	3.69984	0.61664054	
Dose	5	84065.87752	16813.1755	920.34**
Dose*S	15	67.92474877	4.52831658	0.25
Error-2	40	730.737907	18.2684477	
Total	71	91205.30736		

TEL = Total egg laid**, df**=Degree of freedom, **SS**=Sum of squares, **MS**=Mean sum of square, **F**=Variance ratio

Appendix XXXIII. ANOVA of C under different feeding schedules, seasons and doses on the EHP(%) of *B. mori* L.

Source	df	SS	MS	VR
FS	2	2.9905336	1.49526682	1295.42**
S	3	1.3193313	0.43977711	381.00**
Error-1	6	0.00693	0.00115427	
Dose	5	21.065338	4.21306756	114.67**
Dose*S	15	0.1102677	0.00735118	0.20
Error-2	40	1.469422	0.03673556	
Total	71	26.961818		

EHP = Egg hatching percentage, **df**=Degree of freedom, **SS**=Sum of squares, **MS**=Mean sum of square, **F**=Variance ratio

Appendix XXXIV. ANOVA of C under different feeding schedules, seasons and doses on the FC(gm) of *B. mori* L.

Source	df	SS	MS	VR
FS	2	4.0052707	2.00263534	135.52**
S	3	15.94668	5.31556008	359.72**
Error-1	6	0.08866	0.0147769	
Dose	5	59.981146	11.9962291	363.89**
Dose*S	15	0.3122605	0.02081737	0.63
Error-2	40	1.318660	0.03296651	
Total	71	81.652679		

FC = Food consumption, **df**=Degree of freedom, **SS**=Sum of squares, **MS**=Mean sum of square, **F**=Variance ratio

Appendix XXXV. ANOVA of C under different feeding schedules, seasons and doses on the FU(gm) of *B. mori* L.

Source	df	SS	MS	VR
FS	2	2.5743096	1.28715478	121.46**
S	3	27.149757	9.04991908	853.99**
Error-1	6	0.06358	0.01059717	
Dose	5	712.94948	142.589896	7504.48**
Dose*S	15	5.712627	0.3808418	20.04**
Error-2	40	0.760026	0.01900065	
Total	71	749.20979		

FU = Food utilization**, df**=Degree of freedom, **SS**=Sum of squares, **MS**=Mean sum of square, **F**=Variance ratio

Appendix XXXVI. ANOVA of C under different feeding schedules, seasons and doses on the AD(%) of *B. mori* L.

Source	df	SS	MS	VR
FS	2	2.0022355	1.00111775	263.26**
S	3	74.369492	24.7898307	6518.96**
Error-1	6	0.02282	0.00380273	
Dose	5	972.64771	194.529542	17043.78**
Dose*S	15	8.986421	0.59909473	52.49**
Error-2	40	0.456541	0.01141352	
Total	71	1058.4852		

AD = Approximate Digestibility**, df**=Degree of freedom, **SS**=Sum of squares, **MS**=Mean sum of square, **F**=Variance ratio

Appendix XXXVII. ANOVA of C under different feeding schedules, seasons and doses on the Food consumption index(%) of *B. mori* L.

Source	df	SS	MS	VR
FS	2	2.4419176	1.2209588	147.67**
S	3	35.661028	11.8870093	1437.70**
Error-1	6	0.04961	0.00826806	
Dose	5	990.11505	198.02301	10183.94**
Dose*S	15	3.6497148	0.24331432	12.51**
Error-2	40	0.777785	0.01944463	
Total	71	1032.6951		

FCI = Food consumption index**, df**=Degree of freedom, **SS**=Sum of squares, **MS**=Mean sum of square, **F**=Variance ratio

Appendix XXXVIII. ANOVA of vit-C under different schedules of feeding and seasons on the Co-efficient of food utilization(%) of *B. mori* L.

Source	df	SS	MS	VR
FS	2	3.3589225	1.67946127	256.18**
S	3	17.349889	5.78329645	882.17**
Error-1	6	0.03933	0.00655571	
Dose	5	1286.5266	257.305323	8638.89**
Dose*S	15	0.5611264	0.03740843	1.25
Error-2	40	1.191380	0.02978451	
Total	71	1309.0273		

CFU = Co-efficient of food utilization (%)**, df**=Degree of freedom, **SS**=Sum of squares, **MS**=Mean sum of square, **F**=Variance ratio