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Culture of Silkworm *(Bombyx Mori)* in Present Scenario: A Review

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Abstract: ***Today, China and India are the two main producers of silk, with more than 60% of the world's annual production. India has the unique distinction of being the only country producing all the five known commercial silks, namely mulberry, tropical tasar, oak tasar, eri and muga, of which muga with its golden yellow glitter is unique and prerogative of India. Mulberry sericulture is mainly practiced in five states namely; Karnataka, Andhra Pradesh, Assam and Bodoland, West Bengal, Jharkhand and Tamil Nadu are major silk producing states in the country. North East has the unique distinction of being the only region producing all the varieties of silk viz., Mulberry, Oak, Tasar, Muga and Eri.***

Keywords: Silks, Mulberry, Sericulture, *Bombyx mori* and cocoons

1. Introduction

Sericulture is one of the agro based industries in India. India occupies second place of Mulberry raw silk production in the world. Mulberry silk comes from the cocoons of *Bombyx mori (L).* It is well documented that all insects require proper environmental conditions for normal life. Environment influences the activities of the organism directly or indirectly **(Ahsan, 2006).** Due to continuous domestication for many years, the silkworm has lost many of its natural activities as sense of smell, flight etc and it is completely under the protection of the silkworm growers **(Itushi, 2007).** Though the number of generations in a year is controlled genetically in the silkworm, environmental conditions like photoperiod, temperature, humidity etc., are known to influence during the entire life cycle of the silkworm **(Biram and Gowda, 2001).** Studies on the effects of environmental factors, especially temperature on the physiology are sporadic **(Barlow, 2008).** Mulberry silkworm is an economically important domesticated insect for luxuriant silk production, extensive studies on growth rates associated with photoperiod **(Cotes, 2002).** Photoperiodic mechanism has been demonstrated to be mostly influenced by the other environmental factors such as temperature and humidity. Developmental events that occur once in the life cycle of an individual insect have long been known to express at a specific part of the day to manifest a population rhythm **(Kirsur and Krishna, 2008).**

The silkworm is the larvae or caterpillar of the domesticated silk moth, *Bombyx mori*. Being a primary producer of silk, it is an economically important insect. A silkworm´s preferred food is mulberry leaves **(Krishnaswamy, 2011).** It is mainly dependent on humans for its reproduction. Mulberry leaves are fed by silkworm larvae and after the fourth moult, they climb a twig placed near them and spin their silken cocoons. This process is achieved by the worm through a dense fluid secreted from its structural glands, resulting in the fiber of the cocoon **(Rahmathulla, 2014).**

The silk is a continuous-filament fiber consisting of fibroin protein, secreted from two salivary glands in the head and a gum called sericin, which cements the two filaments together. The sericin is removed by placing the cocoons in hot water, which frees the silk filaments and readies them for reeling **(Jordan, 2004).** This is known as degumming process. Silk gland of *B. mori* is a typical exocrine gland secreting large amount of silk proteins. It is a paired organ consisting of modified labial/salivary glands located at the two lateral sides under the alimentary canal. Each gland is basically a tube made of glandular epithelium with two rows of cells surrounding the lumen. In sericulture, it is established fact that several factors contribute in the growth and development of silkworm for the production of quality eggs. Quality silkworm depends on the management practices i.e., rearing temperature, humidity, nutrition, and photoperiod. The better rearing conditions, environment and nutrition during larval period may leads to higher fecundity by silkworm moths (**Narashimhanna, 2014; Malik and Reddy, 2012).** The silk worm (*Bombyx mori* L.) is domesticated insect, which feeds exclusively on mulberry leaves to produce raw silk in the form of cocoon. The silkworm has been extensively utilized as model organism in biological studies as well as for economic gains. Commercial rearing of silkworms has been in practice for over 5000 years in different parts of the world **(Sidhu, 2013)** and an estimated 4310 silkworm germplasm strains are being reared worldwide. The life cycle of silk worm is greatly influenced by environmental stress and nutrition particularly during larval period. Temperature, photoperiod, nutrition and Relative humidity (RH) affects all stages of the insect. Deviations in temperature and humidity levels below and above certain critical limits affect larval growth and development.

2. Related Work

Jyothi (2004) studied the toxicity evaluation of neem oil and metacid on the development of the silk worm, *Bombyx Mori L.* LC 50 dose for an organophosphorous pesticide, metacid and plant based pesticide neem oil was estimated and the pesticide metacid was found to inhibit the developmental stages of *Bombyx mori* at a high level when compared with neem oil. The larval and pupal duration increased in pesticide treated worms. Retardation of larval

growth and variation in larval pupal index depend on the concentrations of the pesticide.

Mahalingam and Murugesh (2005) studied the spraying of aqueous leaf extract of *T. terrestri*s on silkworm during third, fourth and fifth instars resulted in higher cocoon and shell weights, silk productivity and shell ratio. They also studied the silk productivity of silkworm, *B. mori* through the use of botanicals. They found higher larval weight and effective rate of rearing when the larvae were topically applied with aqueous extracts of plants, than control. **Kamalakannan *et al*. (2005)** reported that the application of petroleum ether extract of *C. longa* stems on 24, 48, 72, 90 and 120h old fifth instar multivoltine larva resulted in increased cocoon and shell weight, shell ratio and silk filament length. **Pratheeshkumar *et al.* (2006)** have reported that feed supplementation of 5% concentration (v/v) of *T. terrestris* and *W. somnifera* has contributed for improvement of reproductive parameters *viz.*, higher fecundity and egg recovery in silkworms.

Rahmathulla (2013) studied the growth rate pattern of fifth instar silkworm after the administration of folic acid directly as diet and with the folic acid treated mulberry leaves. It was reported that administration of folic acid as treated mulberry leaves or as diet to the mulberry silkworm substantially improves the biological growth parameters of silkworm including larval weight, silk gland weight and growth rate which subsequently enhances the economic growth parameters like cocoon weight, shell weight and shell ratio.

Development and silk production by silkworm larvae after topical application of methoprene was experimented by **Ahmad and Rahayu (2007).** Methoprene was topically applied 48h after the fourth larval ecdysis, on the dorsal integument of the 2nd thoracic segment of the insects, at seven rates between 0 and 20 ng. Methoprene influenced positively the duration of the fifth instar and the weight gain of the insects. The application of 1ng methoprene resulted in the heaviest silk glands, cocoons, shell cocoons and pupae weights. Comparatively to the control, the increment on silk production (approximately 24%) by the use of 1ng methoprene was more accentuated than the corresponding negative effects on the cocooning rate (approximately 12%).

Juvenile hormone analogues, methoprene and fenoxycarb dose-dependently enhance certain enzyme activities in the silkworm *Bombyx Mori (L).* Use of Juvenile Hormone Analogues (JHA) in sericulture practices has been shown to boost good cocoon yield; their effect has been determined to be dose-dependent. The impact of low doses of JHA compounds such as methoprene and fenoxycarb on selected key enzymatic activities of the silkworm *Bombyx mori* was studied. Methoprene and fenoxycarb at doses of 1.0 µg and 3.0fg/larvae/48 hours showed enhancement of the 5th instar *B. mori* larval muscle and silk gland protease, aspartate aminotransaminase (AAT) and alanine aminotransaminase (ALAT), adenosine triphosphate synthase (ATPase) and cytochrome-c-oxidase (CCO) activity levels, indicating an upsurge in the overall oxidative metabolism of the *B. mori* larval tissues according to the study of **Cohly and More (2008).**

Isolation and purification of juvenile hormone of *Bombyx mori* was experimented by **Maragathavalli (2009).** The study was concentrated on the unrevealed mysterious of the Juvenile hormone biosynthesis and their indirect effect on the silk production. It throws light on the darker sides of the following aspects. The purification and isolation of Juvenile hormone from *Bombyx mori* upto 4000 fold by employing the methods of extraction such as methanol, saponification, silic acid chromatographyI, silic acid chromatographyII, succinoylation, crystallization and gas liquid chromatography. The GLC results show peaks at 12.9min in F and M model Instrument with hydrogen flame ionization detector.

The effect of a juvenile hormone (JH) mimic R394 (ethyl 9-cyclohexyl-3, 7-dimethy l-2, 4-nonadienoate) applied topically on the abdominal tergum of silkworm (*Bombyx mori* L.) after the fourth ecdysis has been studied. JH R394 ranging from 1.0, 0.1, 0.01 µl / larva was applied at 48, 72 and 96 hours of V instar larva that was improved the cocoon weight, shell weight and shell ratio etc. The most effective dose observed 0.01 µl / larva, when applied at 48 and 72 hours after resumption of the last moult. It was observed that the development of the silk gland takes place up to a particular period, after that the larval development increases due to the increase of the feeding period without any significant increase in silk and silk ratio **(Gangwar, 2009).**

Nair *et al.* (2001) studied the phyto-juvenile hormones and mimics, w-formyl longifolene oxime propargylether (NL13) and bakuchiol, mainly used as biopesticides, and their response on the growth factors of silkworm *B. mori.* Both compounds in different concentrations (NL13 in 2.5, 5 and 10 ppm; Bakuchiol in 0.625, 1.25 and 2.5 ppm; @ the rate of 12.5ml/100 larvae) were administered to the fifth instar larvae in different groups at 24, 48, 72 and 96 hrs and were observed. It was observed that NL13 (5 ppm) and bakuchiol (1.25 ppm) administered at 48 hrs showed maximum improvement in larval weight and cocoon characteristics about 10-15% including cocoon weight, yield, shell weight and filament length.

Isaiarasu *et al.* (2011) recorded the influence of herbal tonic *Alloe* on the overall performance of the mulberry silkworm, *B. mori*. They found the mean larval weight, relative growth rate, effective rearing rate, larval consumption index of the final instar larvae of *B. mori* increased with this supplementation of *A. vera*.

Radjabi (2010) demonstrated the efficacy of amino acid treated mulberry leaves on growth and economic characteristics of silkworm, *B. Mori.* Amino acid, aspargine (0.1, 0.2 and 0.5% concentrations) and alanine (0.1, 0.2 and 0.5% concentrations) were used for the treatment of leaves. Treated mulberry leaves were fed once daily from beginning of the first instar until fifth instar phase and biological and economic growth parameters were observed. It was demonstrated that treatment of mulberry leaves with amino acids constituents did not

significantly affect the silkworm growth and the economic parameters.

Phyto-Juvenile hormone for augmentation in cocoon yield in silkworm, *Bombyx mori L* was explained by **Jolly (2009).** The compounds elicited notable positive response in silkworm in terms of improved economic traits such as larval and cocoon characters. In the case of NL13, 5 ppm and in the case of bakuchiol, 1.25 ppm of the compounds at 48 h of 5th instar showed the maximum improvement in the cocoon traits in the range of 10~15%. The physiological impact of the compounds on silkworm growth and development and the resultant impact on the commercial traits are discussed.

Influence of juvenile hormone analogue, methoprene on the biochemical changes and economic characters of silkworm *Bombyx mori* was observed by **Collins and Weast (2005)**. The methoprene administration prolonged the larval period and increased the cocoon characters in silkworm hybrids. The differential behavior of trehalose and glycogen content suggested that these disaccharides might play distinct physiological roles during course of development.

Mishra and Upadhaya (2011) quoted the significance of foliar nutrients on sericulture productivity. Continuous research and studies have revealed that the mulberry plant is treated with various foliar nutrients including macro and microelements, extract of medicinal plants, stimulants, plant hormones, and botanicals. Foliar spray on mulberry leaves enhanced the crop and yield quality, enhances the silkworm growth and cocoon parameters without being toxic. This technique was proved beneficial for silkworm disease management.

The influence of juvenile hormone analogue, fenoxycarb on the midgut remodeling in *Bombyx mori* (Lepidoptera: Bombycidae) during larval-pupal metamorphosis was studied by **Maragathavalli (2009).** Study indicates that, programmed cell death of larval midgut has morphologic characteristics of apoptosis and caspase activation occurs during this period and juvenile hormone analogue fenoxycarb inhibits or delays remodeling process in dose dependent manner. **Uranli *et al.* (2011)** also investigated the influence of the juvenile hormone analogue fenoxycarb on major hemolymph proteins of the silkworm *Bombyx mori* during the last larval instar.

Parimi *et al.* (2012) synthesized diamino substituted thiadiazole compound and studied its effect on the various growth parameters of *Bombyx mori* silkworms. Mulberry leaves was supplemented with the synthesized compound and was fed to the *Bombyx mori* silkworms from the day one of the fifth instar stage. Observations showed that addition of diamino substituted thiadiazole compound has a positive effect on the growth of silkworms as silk worm weight, silk gland weight and cocoon weight increased in comparison with the controlled silkworms.

Prasad and Nagaraju (2013) determined the effect of food supplementation with silver nanoparticles on feed efficacy of *Bombyx mori*. Morus sinensis (MR_2) leaves were treated with different concentrations of silver nanoparticles (25%, 50%, 75% and 100%) and fed to silkworm larvae at fifth instar phase. Feed efficacy parameters like Food Consumption (FC), Food Utilization (FU), Approximate Digestion (AD), Food Consumption Index and Coefficient of Food Utilization (CFU) of treated and control group were evaluated. It was observed that 25% silver nanoparticles treated larval group showed enhanced feed efficacy as compared to treated and control groups.

Kamada (2000) investigated the effect of treatment of mulberry leaves with certain trace elements like Zn, Vitamin B_6 and Methoprene on various economic parameters of silkworm cocoon. It was observed that various growth factor significantly enhanced on addition of Zn, vitamin B_6 and methoprene. Based on the experimental results, it was concluded that use of trace element, vitamin and hormone in lower doses or in combination can be recommended for enhancing the quality and silk yield.

Sivaprakasam *et al.* (2013) concluded that the disinfection of bamboo mountages followed by application of sericulture after each moult and feeding of mulberry leaves treated with aqueous extract of *P. corylifolia* at 800 ppm once during third, fourth and fifth instar of silkworm reduced the grasserie disease besides enhancing the larval and cocoon parameters.

Konala *et al.* (2013) studied the effect of bovine milk on the growth of *Bombyx mori.* They observed that the larvae gained 82.5% more weight by the end of fifth instar larval when fed with mulberry leaves dipped in milk than when fed with fresh mulberry leaves without milk. The larvae fed with milk-treated leaves gained 310% weight from day 1 to day 7 of the fifth instar, while the larvae fed with fresh leaves gained 153% weight in the same timespan. In addition, cocoon weight increased by 8% when milk was added compared to when it was not. These results suggest that *B. mori* larvae can be fed mulberry leaves treated with bovine milk for better growth rate and increased silk production.

Patil *et al.* (2005) reported that *Parthenium* root extract induced silkworms resulting in higher cocoon and pupal weights and better survival**.** He also tested the efficacy of leaf extracts of seven plants, *viz., P. corylifolia, T. terrestris, C. nucifera, A. indicum, B. diffusa, P. niruri* and *S. vulgare pers*. They also observed that the botanicals did not show any toxic impact. On the contrary marginal increase in the larval, pupal and shell weights, shell ratio and silk filament length were also noticed.

The influence of some plant growth regulators on larval growth and cocoon traits of silkworm, *B. mori* was observed by **Ramesha *et al.* (2013)**. They observed that the fifth instar larval duration was reduced and maximum larval weight, spinning percentage, cocoon weight; shell weight, shell percentage and silk productivity were enhanced due to topical application of plant growth regulators.

Mahesha (2014) studied the Oroxylum extract of botanicals on larval, cocoon and egg parameters of *B. mori.* Increase in the concentration of Oroxylum extract used for topical application was found reflected into improvement in the weight of cocoon shell followed by the shell ratio and denier scale of silk filament. Efficient use of acetone herbal extractives, like Oroxylumindicum (L) may open a new avenue in the silk yield.

Prasad and Nagaraju (2013) reported a comparative phylogenetic analysis of full length mariner elements isolated from the Indian mulberry silk moth, *A. mylitta* and also studied the effect of aqueous neem seed kernel extract and neem oil on development and survival of silkworm, *B. mori*.

The effects of juvenile hormone analogue, fenoxycarb on degeneration of midgut in silkworm *bombyx mori* linnaeus (lepidoptera: bombycidae) was studied by **Selek *et al.* (2014).** It has been observed that fenoxycarb has direct effect on degeneration of the midgut in *Bombyx mori.* The animals which were treated with juvenile hormone analogue fenoxycarb have been compared with control animals, considering degeneration of midgut.

Savanurmath *et al.* (2014) explored a new variety of microsporidian spores causing Pebrine disease in silkworm, which differ significantly from the known standard strain *Nosema bombycis.* The discovered microsporidian strains were studied for their morphological characteristics, pathogenicity and the transmission. The new microsporidian strains were ovo-cylindrical in shape and measured 4.03 ± 0.24 µm in length and 2.30 ± 0.14 µm in width with 1: 0.57 length width ratios. The pathogenicity of the discovered spores was less virulent than *N. bombycis*. The infection rate of new microsporidians was found to be 3.00% at moth stage as compared to 8.67% by *N. bombycis* at the inoculation doses of 1×10^3 and 1×10^4 spore/ml. It was also indicated that infection by the new microsporidian in mother moth did not impact the larval health and cocoon parameters in the next generation. There was no crop loss observed in any sericulture area or Basic Seed Farms due to the new microsporidian by thorough mother moth examination at each generation and using layings laid by spore-free moths.

Manimuthu *et al.* (2014) recorded the influence of herbal tonic *Alloe* on the overall performance of the mulberry silkworm, *B. mori*. They found the mean larval weight, relative growth rate, and effective rearing rate; larval consumption index of the final instar larvae of *B. mori* increased with this supplementation of *A. vera.* and studied the silk productivity of silkworm, *B. mori* through the use of botanicals. They found higher larval weight and effective rate of rearing when the larvae were topically applied with aqueous extracts of plants, than control.

Raman *et al.* (2014) observed that the relative effects of methoprene on the improvement of fecundity in different races of mulberry silkworm, *B. mori*. Application of methoprene caused significant (P< 0.05) increase in trehalose and glycogen contents, both in haemolymph and fat body tissues. The increase in trehalose was about 48% and 37% in haemolymph after 72 hrs of treatment in CSR2 x CSR4 and PM x CSR2 respectively. In the fat body 25 & 26 % increased trehalose content was observed after 96 hours of treatment in CSR2 x CSR4 and PM x CSR2 respectively.

Sisodia and Gaherwal (2017a) studied that Juvenile hormone analogues have been tested as insect growth regulators in silkworm (*Bombyx mori*), seeking an increment of silk production. These chemical products, when applied in small or moderate rates, promote the extension of the last larval instar. To understand the physiologic consequences on silk production by the silkworm strain CSR2 × CSR4.The application of fenoxycarb, a juvenile hormone analogue was performed to evaluate its effects on larval development and silk production. Fenoxycarb was topically applied 48h after the fourth larval ecdysis, on the dorsal integument of the 2nd thoracic segment of the insects, between 1 and 1.5 µg fenoxycarb influenced positively the duration of the fifth instar and the weight gain of the insects. The application of 1µg fenoxycarb resulted in the heaviest silk glands, cocoons, shell cocoons and pupae weights. Comparatively to the control, the increment on silk production by the use of 1µg fenoxycarb was more accentuated than the corresponding negative effects on the cocooning rate.

Sisodia and Gaherwal (2017b) reported that Silk is considered to be queen of textiles which is proteinecious in nature. Rearing of silkworm for the production of silk fibre is called sericulture. Present investigation was carried out to evaluate the best environmental conditions for commercial cocoon production of Bombyx mori. Temperature and R.H. % (Relative Humidity) plays vary vital role on silkworm growth and development and it leads to cocoon quality. In the present investigation the appropriate temperature for silkworm rearing was 25º C and appropriate R.H. % was 75-80%. Bi-voltine silkworm is registered for best grades and high quality cocoon production. Present study was carried out to see the influence of varying temperature on development of pupa from larvae of silkworm Bombyx mori. It is observed that mortality rate is less at temperature 25ºC. Rearing is suggested in suitable environmental conditions.

Sisodia and Gaherwal (2019a) reported that Sericulture or silk farming is the rearing of silkworms for the production of raw silk. The mulberry silkworm, Bombyx mori is a domesticated and monophagous insect which feeds only on the leaves of mulberry for its nutrition. In this study we investigated the growth and economic parameters of Silkworm, Bombyx mori (Lepidoptera: Bombycidae) by dietary supplementation of thiadiazole. Thiadiazoles are heterocyclic compounds containing oxygen and nitrogen. 1, 3, 4, thiadiazoles are extensively studied and are known to play diverse biological activities. Diamines or polyamines are found in various biological fluids and are necessary for optimal growth, replication and metabolism of every cell in the body. This report describes the synthesis of diamino substituted thiadiazole and its effect on the growth parameters of Bombyx mori silkworm. Results show that the thiadiazole resulted in

increased worm weight, silk gland weight and cocoon weight. We conclude that the thiadiazole can be fed to Bombyx mori silk worms for improving their economic parameters.

Sisodia and **Gaherwal** (2018). Reported the effect of Juvenile Analogue (Methoprene) on Development of Silkworm Larvae and Silkworm Production. Sisodia and **Gaherwal** (2019b). observed the effect of Bovine Milk on the growth and economic traits of silkworm *Bombyx Mori.*

Sisodia and **Gaherwal** (2019c). Studied the effect of amla extract on food intake and utilization were studied in Cross Breed race of Silkworm Bombyx mori. Mulberry leaves Morus alba treated with amla extract at (25°C) and constant relative humidity (75-80%). It has been observed that the amla treated group plays a significant role with an increase in growth and better food intake as compared to the control group. During silkworm Bombyx mori rearing, larvae frequently acquire various infections leading to mortality. Growing infection needs to be controlled in order to increase the silk production. In a view, an induced flacherie by Bacillus subtilis infection was controlled by amla extract showing antibacterial action in both in vitro and in vivo experiments. Suggestively, 10% amla extract in an intermittent period during rearing resulted in an improved defensive mechanism as evidenced from the study to improve silk productivity.

Sisodia *et al.* (2019d) observed the different disease and preventive measures of mulberry silkworm, (Bombyx mori). Epizootiology, development of immunodiagnostic kit, fluorescent antibody technique and use of ideal disinfectant, chemotherapy and thermo-therapy techniques and management strategies have been addressed for identification, destruction, prevention and control of disease causing micro-organisms. Three years survey was conducted on the incidence of silkworm diseases namely, Grasserie, Flacherie, Muscardine and pebrine, the data revealed that grasserie and flacherie incidence were maximum in summer season and minimum in winter season whereas muscardine was observed high in winter.

Pal and Sisodia (2014) explained the influence of varying temperature on pupation from larvae of silkworm *Bombyx Mori.* The study shows that the development of larvae was better obtained at low temperature. It is also observed that average weight of pupa and weight of shell was more at low temperature.

Acceleration of pupal-adult development by fenoxycarb in the silkworm, *Bombyx mori* was studied by **Dedos and Fugo (2015).** There study suggests that fenoxycarb, a potent juvenile hormone mimic, can imitate the developmental effects of excess 20E and behave as an ecdysteroid mimic after its application during the short developmental period of the pharate pupal stage of *B. mori.* These results shed light on the timely and coordinated increase of endogenous juvenile hormone titer before pupal ecdysis.

The influence of the leaf, flower and pod extracts of *Moringa oleiofera* on the growth and reproductive parameters of *B. mori* was observed by **Isaiarasu *et al.* (2011)**. The mean larval weight and the weight and size of cocoon increased significantly as a result of this supplementation.

Shakhawat *et al.* (2015) studied the effect of Cow Milk on the Growth and Economic Traits of Silkworm (*Bombyx mori* L.). The result showed that the larvae fed with milk treated leaves gained 208% weight from day 1 to 5, while the larvae fed with fresh leaves gained 188% weight in the same span. Cocoon weight in-creased by 18% and shell percentage by 11% when compared to the control. These result suggested feed silkworm larvae with mulberry leaves dipped in cow milk at fifth instar for better larval weight and reeling performances.

Suryanarayana and Shrivastava (2014) prepared a monograph on tropical mulberry silkworm under which India's wild silkmoth biodiversity consists of 47 species, 15 genera, 3 tribes and 2 sub - families of the family Saturniidae and also studied the spraying of aqueous leaf extract of *T. terrestri*s on silkworm during third, fourth and fifth instars resulted in higher cocoon and shell weights, silk productivity and shell ratio.

Rao (2014) observed the influence of the leaf, flower and pod extracts of *Moringa oleiofera* on the growth and reproductive parameters of *B. mori*. The mean larval weight and the weight and size of cocoon increased significantly as a result of this supplementation.

The symptoms of bacterial toxicosis in silkworm are sudden cessation of feeding, lifting of head, spasms and tremors, paralysis, distress, sudden collapse and death, it was revealed by **Robertson (2014).** The flacherie affected larvae become semi-transparent in the anterior part of the body in early stages and digestive juice, which is initially yellow in colour and turns blackish brown colour.

Sridevi *et al.* (2014) studied the effect of Ocimum sanctum L. extract on the economic parameters of silkworm, *Bombyx mori*. Fifth instar *B. mori* larvae were fed to the enriched mulberry leaves (1, 2and 3% of *Ocimum sanctum* L. extract) and were observed. At the therapeutic concentration of 2%, there was remarkable increase in larval weight, cocoon weight, pupal weight, shell weight and shell ratio in comparison with control and other treated groups. It was also observed that cocoon quantity and quality, and silk characteristics were significantly improved with the treatment.

The benefits of fortification of mulberry leaves with number of nutritional supplements such as, amino acids, royal jelly, vitamins, and dietary proteins for the biological and economic growth of mulberry silkworm, B*ombyx mori* was outlined by **Etebari *et al.* (2004).** It was concluded that addition of supplements to mulberry enhanced the characteristics of silkworm as well as of silk fibres.

Zah *et al.* (2016) studied the dietary supplement (amla extract) in the muga silkworm and changes in total haemocyte counts in relation to sex, development, ecdysis and hot water fixation in muga silkworm. They found

there is no difference in the total haemocyte counts of the two sexes, the total haemocyte counts differes in the immature stages and adults. There is a gradual increase in counts during metamorphosis. The fixation of insects in hot water before withdrawal of haemolymph abruptly affects the total haemocyte counts shows a significant increase in the number of haemocytes. Their studies made in relation to ecdysis showed that the total haemocyte counts slightly decreases 24 hour before ecdysis, whereas after ecdysis it abruptly falls and then rises again during the middle part of the instar.

3. Conclusion

Above mention literature showed that lot of work was carried out on the temperature, humidity, drugs and nutrition to enhance silkworm production. Since the dawn of human civilization, silkworm plays an important role for human being for providing enchanting textile and dress material. The silkworm (*Bombyx mori)* was selected for the proposed study. It has commercial value because it is used to make silk. If appropriate temperature, humidity, nutrition and drugs are provided to silkworm (*Bombyx mori)* then there will be rise in silk production.

Conclusively, use of synthetic (Methoprene, fenoxycarb and thiadiazole) and herbal drugs (bovine milk and amla extract) proves to be an growth promoter, growth enhancer and prolong the larval period of silkworm which results in the high quality of silk and good reeling performance as compared to the control ones.

The domesticated silkworm *Bombyx mori,* a lepidopteran molecular model and an important economic insect that are emerging as an ideal molecular genetic resource for solving a broad range of biological problems. The silkworm, *B. mori* produces massive amount of silk proteins during the final stage of larval development. These proteins are stored in the middle silk gland and they are discharged through the anterior duct and spinneret, at the end of the fifth instar.

Temperature has a direct effect on various physiological activities. The temperature has a direct correlation with the growth of silkworm; wide fluctuation of temperature is harmful to the development of silkworm Temperature plays a vital role on the growth of the silkworms. As silkworms are cold-blooded animals. Temperature increases the basal metabolic rate and inner body temperature in small-bodied insects. The influence of temperature and humidity on the growth and development of a bivoltine *B. mori* hybrid, least significant difference (5°C) temperature exceeds 35°C, metabolic function become erratic, resulting in poor growth of silkworm, which affects the growth of the silk gland and health status of the larvae and resulting into less production of silk.

Use of Juvenile Hormone Analogues (JHA) and other drugs in sericulture practices has shown good cocoon yield; their effect has been determined to be dose-dependent. The impact of low doses of JHA compounds such as methoprene and fenoxycarb on silkworm *Bombyx mori* show enhancement of the 5th instar *B. mori* larval muscle and silk gland protease and adenosine triphosphate synthase (ATPase) indicating an upsurge in the overall oxidative metabolism of the *B. mori* larval tissues.

The control and prevention of various infections during silkworm rearing helps to increase the silk productivity by preventing the mortality to a great extent. In a view, use of amla extract during rearing improve the larval survival by preventing the infections and also improves the productivity of the silk

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