GENERAL INTRODUCTION
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Sericulture is a multi disciplinary cottage industry, which involves cultivation of mulberry, the food plant of silkworm, rearing of silkworm, its reeling, weaving and marketing. It is mainly an agrobased industry, which involves skilled labour and has higher income generation potential. It is remarkable for its low investment, quick and high returns which fits well into the socio-economic fabric of India. Sericulture is highly recommended by planners and administrators as one of the most effective tools for rural reconstruction (Lakshmanan et al., 1996). Nutrition in the silkworm, improved by dietary managements, directly influences the quantity and quality of silk production (Legay, 1957; Benchamin and Jolly, 1986).

India is the second largest silk producing country in the world, with a total silk production of 15,857 tones, ranking next to the People’s Republic of China, with a total production of 60,000 tones during 2000 – 2001. India has a share of 20% in the world silk production. People’s Republic of China and other countries like Brazil, CIS countries, Thailand, Vietnam and Korea account for 75% and the rest account for 5% (Khoday et al., 2001). India is one of the largest agrarian economy in the world. About 70% of total population live in the rural segment and is dependent on agriculture and its allied sectors for their livelihood (Rajan et al., 1991). In recent years, there have been crucial changes at the global level in production states, technology, trade and commercialization in agriculture and trade of silk. There are some constraints, which affect large-scale technology and commercial oriented
farming. It is largely due to the diversified social, cultural and economic factors prevailing in the rural areas that demand higher investment and commercial farming. These factors have forced peasants, small and marginal landholders to choose minimum investment oriented cropping. Sericulture activities are considered to be well suited to bring about economic transformation in the rural areas (Hanumappa and Erappa, 1988). It not only prevents rural migration but also has an added advantage of low capital requirement with assured remunerative returns within a short period.

India has the distinction of producing all the four types of silk viz, mulberry, tasar, muga and eri. It occupies second place in the global silk production, the major share is contributed by mulberry silk, which is produced in Karnataka state. Silk export by India has been registering a steady growth rate above 30% annually. India has the glorious heritage in silk production on par with rich tradition and culture. Silk is one of the most beautiful natural fibers and is acclaimed as the queen of textiles. It has been identified as one of the fastest growing foreign exchange corner of the country. Besides being a precious fiber, silk is also used for making parachutes, tyre linings, electrical insulators, artificial blood vessels and surgical sutures. Silkworm pupae have been used for the preparation of oil from which soap, plasticizers, hydrolyzed protein amino acids and vitamin B₁₂ can be obtained.

The production of mulberry raw silk (provisional) during the year 2000-2001 was 14,432 tones out of which bivoltine silk production was about 300 tones. The major mulberry silk producing states viz. Karnataka, Andhra Pradesh, Tamil Nadu,
West Bengal and Jammu and Kashmir accounts for about 98.7% of the country's raw silk production. Mulberry sericulture, because of its special features such as small initial investment, labour intensiveness, short gestation period and above all employment opportunities and regular income generation, is an important agro-based cottage industry in India. Presently mulberry is cultivated in about 2,15,921 ha providing full and part time employment to about 6 million people in mulberry cultivation, silkworm seed production, silkworm rearing, cocoon reeling, weaving and related activities (Mahadevappa, 2001).

In Karnataka, the area under mulberry cultivation has declined from 1,26,567 ha in the year 1984-85 to about 1,12,537 ha in the year 2000-2001. Mulberry cultivation under rainfed condition, which was 63,203 ha in the year 1983-85, has declined to 18,894 ha in the year 2000-2001 registering a decline by 70%. While during the same period mulberry cultivation under irrigated condition has increased to about 93, 663 ha, from about 63, 364 ha, registering an increase by 47.8%. Even an average 2,000 dfls per ha of irrigated mulberry and 800 dfls per ha of rainfed mulberry the laying requirement will be about 202 million as against the production of about 160 million. Production of cocoon and raw silk has increased from 40,588 and 4,059 tones to 66, 518 and 8,200 tones respectively. Average renditta has decreased from 10 to 8.11.

Many years of extensive research with silkworms has provided a considerable amount of knowledge in more or less every aspect of silkworm biology making them a
good laboratory tool (Tazima, 1978). But till now emphasis has been given to only two areas of silkworm research the silk protein synthesis and the neuroendocrinology. The “silk”, the material for which the silkworm has gained its economic importance is the product of silk gland of *B. mori*. A vast literature is available detailing different perspectives of silk proteins and their biosynthesis, silk gland and fiber spinning process (Lucas et al., 1958; Sciefler and Gallop, 1966; Fraser and Mac Rae, 1973; Tazima, 1978). The spinning of silk fiber in *B. mori* has been discussed from morphological, biophysical, biochemical and endocrinological points of view in the review (Shimura, 1983).

The silkworm, *Bombyx mori*, is being exploited largely for its economic importance and also as a tool for various scientific investigations (Tazima, 1978). It is know that *Bombyx mori* is very sensitive to changes in environment and food quality (Ueda and Lizuka, 1962; Benchamin and Jolly, 1986 Hanumappa, 1988; Asiya and Delvi, 1991; Krisnaswami, 1990). Leaf quality and temperature are known to play pivotal role in influencing the growth and productivity of insect (Bursell, 1974). The physiological activities in silkworm are influenced by body temperature (Benchamin and Nagaraj, 1987; Krishnaswami, 1994). All insect must maintain proper water balance (osmoregulation). The maintenance of water balance is keenly felt by terrestrial animals like the insects for they are constantly endagered by drying up (desiccation). Leaf feeders like lepidopterans satisfy their water requirements from their food (Ross, 1956), sanguivores get their water supply from the blood of the prey (Radhakrishnan, 1992).
It is reported that 70% of the silk protein produced by silkworm are directly derived from the protein of mulberry leaves (Narayanan et al., 1967; Petkor and Dona, 1979). The silkworm, *Bombyx mori* L is a highly sensitive insect and responds sharply to changes in the feed quality. Variations in the quality of mulberry leaf and climatic conditions are many times reflected in the performance of the silkworm cocoon crops (Krishnaswami et al., 1970). Wyatt and Kalf (1956, 1957) reported that trehalose is the major blood sugar in insects. The energy requirement of the larva serves as a determinant factor for the normal growth and development of the larva, which ultimately determines the quality of the silk produced.

Potassium is one of the major nutrients and invariably applied to mulberry to obtain good yield of quality produce. Potassium is essential for metabolic functions related to enzymes activation, water relations, energy transformation, translocation of assimilates, nitrogen metabolism, protein synthesis and starch synthesis. After completion of various processes within the tender cells, potassium can be moved and utilized again in the newborn tender cells (Anonymous, 1988). Due to its high requirement by plants, important role in physiology, it has been termed as “master cation” in plants (Yadav, 1983). Shortage of potassium in a field result in soft branches and poor quality leaves in mulberry (Anonymous, 1988). Recommendations of potash fertilizers for mulberry gardens are carried out based on neutral ammonium acetate extractable potassium (referred as exchangeable potassium).
Decrease in the intake of potassium, magnesium, calcium and phosphorus by silkworms adversely affects their body weight, cocoon and silk characters. Healthy mulberry leaves containing magnesium, iron and manganese in proper proportion favourably influence the cocoon yield and shell percentage. Calcium and magnesium accelerate the growth of silkworm through orientation of physiological activities and reduce the larval duration. Zinc deficiency affects the pupal weight and filament length and is also useful in seed production (Patil, 2001). The requirement of different minerals in various insects has been investigated (Ito, 1978; Chapman, 1998). Minerals include almost 10% of mulberry leaves. It has been reported that 28% of the silkworm larval structure in different ages include the absorbed minerals (Ito, 1978). So, the minerals are one of the most important components of silkworm and other insects diet. Mineral salts include more than 40% of utilized compounds in these studies (Ito and Nominura, 1966a, b; Horie et al., 1967; Viswanath and Krishnamurthy, 1982; Loknath et al., 1986; Sabir, 1991; Hugar and Kaliwal, 2002; Bhattacharya and Kaliwal, 2004; 2005 a, b, c, d; Chakrabarty and Kaliwal, 2006). Khan and Saha (1997) have showed that treatment with calcium lactate resulted in higher fecundity and egg viability in the silkworm, B. mori. The total protein was significantly increased in all multi mineral treatments to the silkworm (Etebari and Fazilati; 2003; Etebari et al., 2004).

The carbohydrates, proteins and lipids play an important role in the biochemical process underlying growth and development of insects (Ito and Horie, 1959; Wyatt, 1961, 1967). Insect digestion has been studied for more than a century (Wigglesworth, 1972). In recent years, the insect gut has become an excellent model for studying gut
function, which acts as the major interface between the insect and its environment (Terra and Ferriera, 1994).

Nucleic acids are the most important macromolecules in the cells. DNA is known to be the genetic material and is most important of all macromolecules of cell. DNA carries all kinds of necessary biological information and is involved in gene action, which is essential in regulation of cell metabolism and expression of the characters within the organism. RNA being the other important nucleic acid synthesized in nucleus but mainly found in cytoplasm to carry out protein synthesis. RNA plays vital role in cell metabolism by producing various enzymes, which catalyses the various cellular reaction. Cholesterol has been shown to be essential for the normal growth, reproduction, larval moulting and metamorphosis in insects (Gilmour, 1961; Monroe et al., 1961; Gilbert, 1967; Robbins, 1971; Dadd, 1973; Svoboda et al., 1975; Svoboda and Thompson, 1985). Electrophoresis is also used to separate and characterize protein. Analysis and comparison of proteins in large number of samples is easily made on polyacrylamide gel slabs.

Enzymes are biocatalyst synthesized by living cells. They are protein in nature, colloidal and thermolabile in character and specific in their action. The enzymes are functional outside the cell (digestive enzymes) or enzymes are active within the cell (cellular enzymes). The digestive enzymes are mainly present in the midgut of insects helps in breakdown of complex form of nutrients present in the food into smaller and simpler forms, which can easily be absorbed in the alimentary canal (Applebaum,
The digestive enzymes are generally hydrolases, broadly classified into three types according to the specific macromolecules on which they act such as carbohydases, lipases and proteases.

Main studies on mulberry leaves supplementation with nitrogenous compounds and amino acids and evaluation of their effects on silkworm rearing have been obtained (Sarker and Absar, 1995; Yeasmin et al., 1995; Zaman et al., 1996; Basit and Ashfaq, 1999; Etebari 2002; Etebari and Fazilati, 2003). Amino acids have multiple metabolic functions in the living cells. Diversity in the amount of free amino acids of haemolymph is generally affected by diet. Variation in the type of amino acids occurs due to different reasons. Changes in these compounds cause different signs. In host plant of silkworm at different years and regions, type of irrigation and soil fertilizers many fluctuations are observed in the amount of amino acid, which can affect the rearing efficiency (Sharma et al., 1995). Silkworm absorbs 72-86% of amino acids from the mulberry leaves and in the females more than 60% of absorbed amount is consumed for silk production (Lu and Jiang, 1988). Intestine absorption of amino acids is one of the most important stages of nitrogen metabolism in insect body. Absorption of this compound in the midgut of moth larvae especially in silkworm in an active mechanism depended to potassium ion and alkaline pH of exogenous part of peritrophic membrane. The enrichment of leaves with amino acid could increase the efficiency relatively but it cannot be expected that always there is a positive correlation between the supplementation and biological efficiency. It has been reported that the supplementation of mulberry leaves with amino acids and nitrogenous

Therefore, the present investigation was undertaken to study the effect of different doses of minerals potassium carbonate, magnesium carbonate and their mixture and nitrogenous compounds arginine, histidine and their mixture on food budget, water utilization, economic traits and biochemical contents of the silkworm, *B. mori* L.