CHAPTER- 5

DISCUSSION

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The biochemical analysis of castor and tapioca leaves indicated that biochemical compositions varied greatly in various seasons as well as among different food plants (Table 1 and Table 2). The biochemical compositions investigated in the present study were regarded as vital components for the growth and development of the silkworms (Chandra, 1999). It is mainly due to the biochemical compositions that different food plants influence differently on food intake, efficiency of digestion and conversion of food to body biomass and finally on growth and development of insect so as to produce good quality of silks. House (1974) reported that for optimum nutrition in insects, some balance is needed between the main classes of nutrients such as proteins, carbohydrates, lipids, vitamins etc. Quantitative requirements for each nutrient and consequently the required balance of nutrients can vary within and between species owing to many factors including the synthetic abilities of the organisms and metabolic activities involving specific interrelations between certain nutrients.

A number of studies were carried out regarding the foliar constituents of the food plants of eri silkworms (Pathak, 1988 and Shaw, 1998). Merenjungla and Kakati (2013) investigated the seasonal variation of nutrient contents in tender, semi-tender and mature leaves of four host plants of eri silkworm in Nagaland. Chandrasekhar *et al.* (2013) reported the varietal variation of Castor in terms of nutrition to feed the eri silkworm. All these reports were correlated with the present report of this study.

The role of proteins and amino acids in silkworm nutrition has been emphasized broadly by Fukuda *et al*. (1959) and Takeuchi (1960). Nitrogen is the most distinguishing chemical element present in proteins which in turn are the most ubiquitous organic nitrogenous compound in food stuff and in all living cells. Moreover, they appear to be involved in practically all the structure and functions of all cells (Mallette *et al*., 1960). The green leaves of plants are good sources of protein and may supply most of the essential amino acids required by the growing cells (Chandrasekhar *et al.,* 2013). Nitrogen as protein and non-protein nitrogenous matter present in the food plant leaves is responsible for healthy growth of silkworm as silk substances consist mainly of protein. Kaleemurrahman and Gowri (1982) reported a higher total protein in castor than in borkesseru. Dutta (2000) also described similar content of crude protein in respect of different maturity and seasons. Sarmah *et al.,* (2011) also reported high amount of mean crude protein content in 8 different accessions of castor. Merenjungla and Kakati (2013) reported higher content of protein in castor than tapioca, payam and kesseru- the other food plants of eri silkworms.

Similarly in the present study, significantly higher crude protein was recorded in castor leaves than tapioca. Castor leaves showed highest crude protein in spring season while the lowest crude protein was obtained from tapioca leaves in winter season. Among the four seasons, spring showed highest crude protein percent followed by summer, autumn and winter. This is in conformity with the above reports. Free Amino acid content of castor leaves was higher than the tapioca leaves. Winter leaves showed highest amount of free amino acid as compared to other seasons.

Lipids play an important role in the biochemical process underlying growth and development of insects (Ito and Horie, 1959 and Wyatt, 1961, 1967). In our study, the lipid content of tapioca leaves was significantly lower than castor leaves. Castor leaves showed highest lipid content in autumn season while tapioca leaves showed lowest lipid content in spring. This indicated that castor leaves provide a better dietary lipid to the growing silkworms.

One of the most important constituent of leaf is the crude fibre. Crude fibre is the ash free material and reduction in the fibre content had been established as an advantage for better silkworm crop yield (Vasuki and Basavanna, 1969). Crude fibre comprises largely of cellulose and lignin and these substances belong to polymeric carbohydrates, which cannot be digested by silkworm larvae. So, lower the amount of crude fibre, better is the food plant. Fibre is not grouped under nutrients, however, its intake along with all diet is essential because of regulatory function and it helps to maintain the normal peristaltic movement of the intestine to remove waste product from the intestine. Neog *et al.* (2011) also emphasized on reduction in fibre content as an advantage for better silkworm crop yield. Merenjungla and Kakati (2013) reported that kesseru exhibited the highest content of crude fibre and cellulose. In our study, the crude fibre was lowest in spring season and highest in autumn. Tapioca leaves showed significantly lower amount of crude fibres as compared to castor, suggesting its role as a promising food plant for better yield of eri silks.

Moisture content (%) was found higher in tapioca leaves than castor, although the difference was non-significant. Spring represented highest moisture in the leaves whereas it was recorded lowest in winter. The results showed that moisture content (%) was higher in tapioca than castor, irrespective of season. Similar finding was put forward by Pathak (1988). Reports are also available regarding the favorable effect of high moisture content of the palatability and digestibility by silkworm which in turn play an important role in the growth and development of the silkworm as well as the quality of silk fibre produced (Ueda and Suzuki, 1967; Parpiev, 1968; Waldbauer, 1968; Kasiviswanathan *et al*., 1973 and Yokoyama, 1975). Delvi *et al*. (1988) was in the opinion that high moisture percentage of the food plant is one of the biting factors that improves the food quality, leading to increased food utilization.

Carbohydrates, particularly reducing sugars are very important for growth and development of silkworms. Carbohydrates are utilized by the silkworms for energy source and for synthesis of both lipid and amino acids (Neog *et al.*, 2011). These are very important for healthy growth of silkworm; especially they are effective for keeping healthy growth of early stage larvae. The carbohydrates are generally the most effective in increasing fat body glycogen. The rate of increase of fat body glycogen and haemolymph trehalose is also dependent on the content of carbohydrate in diet (Horie, 1978). Chandrasekhar *et al*. (2013) and Kaleemurrahman and Gowri (1982) also studied the total carbohydrate content in castor and borkesseru. The role of higher content of carbohydrate in the leaves of castor and borpat on rearing is manifested by the shorter larval duration, higher larval weight, cocoon weight and ERR. The present findings are in agreement with Kaleemurrahman and Gowri (1982) and the slight variations with other reports might be due to variations in location, soil and climatic conditions. Here, comparable results were obtained for total carbohydrate content between the leaves of castor and tapioca; although, it was found a little higher in tapioca than castor. Among the various seasons, the carbohydrate content was lowest in summer. Hiratsuka (1971) reported that the carbohydrate found in the food plant is converted to glycogen in the silkworm's body. He also opined that a large part of the carbohydrate is used by the silkworm for physiological combustion and making fat. In our present investigation, tapioca fed eri larvae revealed prolonged larval duration and lower larval size and weight. This is in conformity with Li and Sano (1984) who observed that high content of carbohydrate and lower level of water and protein in feed resulted in slower larval growth and less body weight of the silkworm. However, earlier workers (Kapil, 1967 and Pathak and Dutta, 1990) also revealed that tapioca can suitably be utilized for rearing of eri silkworm. In our study, the sugar content was significantly higher in castor leaves than tapioca leaves. The sugar content was highest in autumn season; however, there was no significant difference among other seasons.

It was reported that the anti-nutrients like, tannin, phenol etc. had negative impact on the economic traits of eri silkworm. These compounds have been represented to have multiple biological effects including antioxidant property. Hazarika *et al.* (1995) reported that good quality food plants showed higher total phenol content. However, high phenol content affects on feeding during larval stage as reported by Rao *et al*. (2009) and Anjani *et al*. (2010). Higher phenol was obtained in our study in castor leaves than tapioca leaves. Lowest phenol content was obtained in autumn season. There were no significant differences among the other seasons.

Tannins are secondary metabolites of plants, non-nitrogenous, phenolic in nature and are present in all plant materials. It gives immunity to seeds attack by birds and diseases; they on the other hand display impaired nutritional quality, lower digestibility and reduction of food consumption. The increased level of tannin could cause reduced intake of leaves and digestibility in silkworm as reported by earlier workers (Reed *et al*., 1982). In the present investigation, significantly lower amount of tannin content (1.46%) was obtained in castor leaves as compared to the tapioca leaves which showed a tannin content of 14.48%. Autumn showed lowest and spring showed the highest tannin content in both castor and tapioca leaves.

Fecundity of eri silkworm varied significantly in different seasons. Though the highest fecundity in castor was observed in spring season, it was found at par with summer crop. Fecundity is largely dependent on the resources accumulated during the larval stage (Bergstrom *et al*., 2002) because the moth is a non-feeding stage. Food shortage during larval development may therefore result in a reduction in fecundity which was also reported by Gibbs *et al*. (2004). Chakravorty and Neog (2006) appraised the suitability of castor in terms of fecundity.

Hatching of eri silkworm didn't vary significantly in different seasons. Though the highest hatching on castor was observed in spring season, it was found at par with autumn and summer. Hatching of eri silkmoth eggs were found highest in spring and autumn seasons whereas it was lowest in winter.

Larval duration varied significantly during different seasons in the present study. But the mean difference between castor and tapioca was not significant. Larval duration of eri silkworm was suitably lowest in spring and summer seasons whereas it was highest in winter. The relationship between quality parameters of castor leaves exhibited positive correlation with all economic traits except that of larval duration which decreased with increase in nutritional content of leaves. Same results were observed in case of tapioca leaves. According to Das and Das (2003), the amount and quality of food intake of larvae influenced the larval duration. Besides, the environmental temperature had direct influence on the larval duration which is negatively correlated (Verk *et al*., 2009 and Kumar and Elangovan, 2010).

The effects of season on the morphological and economical traits are evident from our findings. Irrespective of the treatments, almost all the characters are influenced by season. It is also seen that the overall performance of the winter crops are much better than the summer crops. Kokrajhar District showed high variation in temperature, humidity and rainfall (Table 16 to Table 19). Such unwanted fluctuations in weather conditions have deep impact on the overall performance of the silkworm growth and development. The larval duration was found minimum in summer and maximum in winter. This is in accordance with the findings of Reddy *et al.* (1989) who observed that the larval duration was minimum in summer.

Food plants played a significant role for silkworm rearing and acquiring commercially important characters *viz*. ERR, Silk ratio, larval growth pattern and fecundity of muga silkworm (Neog *et al.*, 2011). The shorter larval duration facilitated the less investment in rearing as well as more crops per annum.

The larval weight (full grown larvae and ripened larvae) is one of the indicative factors of the growth of the silkworm. In this study, larval weight on castor was not significantly different during different seasons. Earlier reports established the suitability of castor leaves for eri silkworms in terms of larval weight (Hajarika *et al.,* 2003; Chakravorty and Neog, 2006 and Manjunatha Naik *et al.,* 2010).

ERR was significantly higher in spring while it was at par in other seasons. Sarmah *et al.* (2011) opined that ERR of eri silkworm was influenced by biochemical compositions of leaves. The weight of larvae and cocoons were significantly influenced by nitrogen and crude protein content of the foliage. This is supported by the present study. According to Thangavelu and Phukan (1983), the ERR varied on different host plants. Singh (1994) concluded that eri silkworms reared on castor produced best quality cocoons with high ERR. This opinion was put forward by many other workers (Devaiah and Dayashankar, 1982; Pathak, 1988; Kumar *et al.,* 1993; Nangia *et al.,* 2000; Jayaramaiah and Sannappa, 2000; Govindan *et al.,* 2002; Sarmah *et al.,* 2002; Pandey, 2003; Hazarika *et al.,* 2003; Rao, 2004 and Chandrappa *et al.,* 2005).

No significant differences in cocoon weight of male eri silkworms was observed in the present study. Cocoon weight of female eri silkworm revealed no significant differences. Shell weight of male of eri silkworm revealed no significant difference. Shell weight of female of eri silkworm showed significant difference on castor. Many other workers reported the suitability of castor in terms of cocoon weight and shell weight (Devaiah and Dayashankar, 1982; Sharma *et al.,* 1988; Hajarika *et al.,* 2003; Chakravorty and Neog, 2006 and Kumar and Elangovan, 2010).

Shell ratio of male of eri silkworm reveals significant differences. Shell ratio of female of eri silkworm reveals no significant differences. According to Singh *et al.* (2012), the value of shell ratio was non-significant in terms of different seasons. Similar findings were also reported by Devaiah and Dayashankar (1982), Thangavelu and Phukan (1983), Pathak (1988) and Kumar *et al.* (1993). Shell ratio (male) and shell ratio (female) were highest in summer and autumn seasons in both castor and tapioca fed leaves. The lowest values were observed in winter and spring seasons.

In case of castor fed eri silkworms, the fecundity, larval weight, ERR, cocoon weight (Male), cocoon weight (Female), shell weight (male), shell weight (female) were highest in spring season and lowest in summer and/or winter season. In case of tapioca fed silkworms, both spring and summer seasons showed highest recorded data for the above parameters. However, the lowest values were found mostly in winter season, along with the summer, spring and autumn seasons.

The rearing performance suggested that eri silkworms reared on tapioca leaves produced healthy larvae as well as good quality cocoons. Host plants have significant effect on the shell weight. Significantly highest shell weight was recorded on castor. The results are comparable with the report of Reddy *et al.* (1989) who observed highest shell weight on castor. Kumar *et al.* (1993) observed the highest single shell weight on castor followed by kesseru and tapioca.

The suitability of host plants towards the silkworm larvae is an important factor. If reared on less-suitable food plants, most of the larvae starve. The starving larvae showed less growth and produced cocoons of low weight (Srivastava and Mishra, 1981).

The quality, rate and quantity of food ingested by an insect larva influence its growth rate, development, final body weight and survival (Slansky and Scriber, 1985). In muga silkworms, it was found that variety of food plant fed by the larvae have significant effect on grainage performance (Singh and Goswami, 2012). In our investigation, in most of the parameters, there is no significant difference between castor and tapioca. It suggests the suitability of tapioca plants as secondary host plant for eri culture in Kokrajhar District and other places. Moreover, tapioca is easily grown in Kokrajhar District and the local people use its tuber as a food. The tuber has a good market value.

It has been reported earlier that silkworms take the leaves of some particular food plants that are rich in amino acids, proteins, total sugars, reducing sugars and many more nutrients (Chandra, 1999). The nutritional quality of the leaves shows a positive effect on the growth and development of the silkworms and the economic characters of the cocoons produced by these silkworms (Krishnaswami *et al.*, 1971 and Sunder Raj *et al.*, 2000). Eri silkworms have been known to feed on castor, kesseru, borkesseru, tapioca leaves etc. But as a tradition, majority of the eri farmers depend solely on castor and kesseru leaves.

In the present study, the higher nutritional values and lower anti-nutrient contents (like tannin) in castor could be attributed to the superior economic traits including cocoon yield and silk percentage and found most suitable for eri culture whereas in tapioca the economic traits were recorded least which could be due to poor nutrient contents in leaves. It is also supported by earlier findings (Bongale *et al.*, 1991).

Therefore, although the castor leaves were found superior than the tapioca leaves in the present study, however, in some case of some nutrients, there was no significant differences between castor and tapioca leaves and also the cocoon yield and silk percentage, suggesting that tapioca is also a suitable food plant for eri silkworms.

Eri silk yarns obtained from silkworms reared on castor and tapioca leaves showed no significant differences in its count and tensile properties, viz. tenacity, per cent strain, toughness and Young's modulus. Results obtained in these studies are in conformity with the results reported by earlier workers (Rajkhowa, 1998 and Das *et al.*, 2005). Fineness is a very useful character in textile industry. From the results it is seen that the count values varied a little among the eri silk yarns obtained from cocoons of the silkworm larvae fed with different food plant leaves. Moreover, the fineness did not vary considerably in summer and winter season. Rajkhowa *et al.* (2000) reported that eri silks are finer than other silks which is an interesting characteristic of domesticated eri silks. Fine silk fibres are reported to possess high tensile strength than other non-mulberry silks (Hazarika *et al.*, 1998 and Rajkhowa *et al.*, 2000). Shenai (1980) reported that the fineness of silk yarns are related to the count of the yarn. When the count of a yarn increases, the fineness of it also increases.

In this study, the tenacity, strain percent, Young's modulus and toughness are found highest in castor treatment in both summer and winter seasons. The tensile properties are dependent upon the denier (fineness), as established by earlier workers (Iizuka, 1965). The breaking strain and toughness of silk fibres varied directly along with their breaking tenacity. The variation in the load-elongation curve also indicated the difference in tensile behavior of the variously treated silk fibres. Fibres produced by castor treated eri silkworms resulted in high tenacity. Young's modulus is related to tenacity and breaking strain (Booth, 1996). The high elasticity of eri silk fibres may have suitable use in many industrial purposes.

Promising tensile properties of eri silks obtained from feeding the larvae on castor and tapioca leaves revealed a good economic value of these fibres in national and international markets. Increased tensile properties of eri silk fibres may suitably find its use in many new and innovative fields where low cost but durable fibres are very much needed.

The area under eri plantation in Kokrajhar District was 45.6%; muga plantation covered 48% whereas mulberry plantation covers 6.4% of the total area under plantation. Most of the plantation for eri silkworms include castor and kesseru, tapioca being practiced recently in some places. Similar results were also obtained by Teotia and Bajpeyi (2009) and Brahma (2015). This attachment of the local farmers towards eri culture than culture of other silks make Kokrajhar District more promising area for innovative objectives of eri culture. However, Brahma (2015) reported that despite of the Kokrajhar District having large area of eri food plant plantation, it covers very less of systematic plantation than natural plantation, the rearers not utilizing it and still collect castor leaves from the wild or stray plantation from different places for conducting rearing and do not perform systematic plantation themselves.

It is also clear from the present study that, in Kokrajhar District, majority of the families were engaged in eri culture (93.5%); although a few were engaged in other silkworm rearing practices like, muga (4.1%) and mulberry (2.4%). These reflects that eri culture is highly popular than other sericultural practices like muga and mulberry cultures (Singh and Benchamin, 2001). The popularity of eri culture is due to the following factors-

- Suitable climatic conditions for the growth and development of eri silkworms (Vijayan *et al.*, 2005).
- The easy availability of food plants for eri silkworm in Kokrajhar District.
- Eri silkworms are reared indoor and it required very less care compared to other silkworms.
- They were found to conduct eri culture as supplementary avocation primarily for pupa, as a delicacy.
- Establishment of Cocoon Bank at Udalguri, Assam and Eri Spun Silk Mill at Kokrajhar have immense contribution towards the adaptability and popularization of eri culture amongst farmer of the BTAD due to its immense market value and product and design diversification (Brahma, 2015).
- There is remarkable income from selling the tubers of tapioca plant.

The study revealed that in Kokrajhar District, a large number of farmers have more than 5-15 years of experience in sericulture, so eri culture has been a lucrative endeavor for a long time in Kokrajhar District. Moreover, a promising number of farmers have newly adopted sericulture, it reflected the increased popularity of eri culture among new families.

As the males occupied the head position in a family, the male farmers outnumbered the female farmers. But from the point of view of involvement in eri culture, the female population was far more than the male population. Although the participations of women in host plant cultivation and management was not high, but the silkworm rearing, cocoon harvesting, marketing and spinning of spun yarn, weaving etc. were conducted mostly by female populace of all age categories. Moreover, most its operations did not require hard labour, except digging and ploughing (Uma Rani, 1998). In a society nearly half of the total population is female and as such they can take a decisive role not only in family but also economic development of the society as a whole. This is reported by earlier workers who studied the involvement of women in BTAD (Mech and Ahmed, 2012). Involvement of more female labours in eri culture was also reported in earlier studies (Tom, 1989; Karanth, 1995 and Gregory, 1997).

On an average, 3-4 members are present in the sericulture families. The division of labour helps in proper maintenance of the planation, grainage, rearing house, spinning, marketing etc. This is effective to increase the net output. The non-worker members in a family were be generally found to be children between the age group of 1-12 years and old people of more than 55 years of age who are generally considered as non-productive and dependent population. The present study has reported that female percentage in performing activities of eri culture was higher than male population. Involvement of more female labours in eri culture was also reported in earlier studies (Tom, 1989; Karanth, 1995 and Gregory, 1997).

Majority of the farmers in Kokrajhar District are Scheduled Tribes (ST). Scheduled Castes (SC) comprises of 6% of the farmers whereas other castes cover the rest 15%. Although Bodo covers the majority of eri farmers, other communities like Garo, tea tribes, Rabha, minorities are also engaged in eri culture. Similar involvement of Bodo and other tribal communities was reported in earlier studies by Chowdhury (1982, 1984).

In earlier days, the illiterate villagers took sericulture as a profession of livelihood. But recently the educated people have come forward to take eri culture as a lateral income source because it needs very less care and attention. Education also plays a vital role in growth of this sector because more the number of educated farmers more is the success rate of trainings/skill development programs conducted by Govt. or other organizations. A co-relation exists between education and economic and social development of a society. Generally educated people are skilled labour and they are able to avail all sorts of facilities including financial assistance given by government through banks, Panchayat etc. as compared to the illiterate people (Talukdar, 2012). The present study also reported various levels of education among the farmers.

Adherence to age-old traditional practices, non-adoption of improved technologies, absence of market infrastructure and supporting linkages in the areas are still the limiting factors which are required to be attended for exploiting the existing potential of sericulture in Kokrajhar District (Brahma, 2015). It was also reported in earlier studies that major quantities of eri cocoons were sold outside in a very poor return due to lack of an adequate marketing system. The rearing of eri culture was generally carried out by individuals in small quantities i.e., 10-20 dfls per crop, which was another reason for less productivity. The rearers were unaware about Male: Female (2:1) for coupling for high productivity and day-wise egg segregation to avoid irregularity and diseases in larvae. The proper sanitation measures like cleaning and disinfection of rearing bed regularly, selection of weak and diseased worms were not practiced. Moreover, the rearers were unable to recognize different diseases and conducted rearing using uncertified dfls.

The majority of the farmers practiced commercial silkworm rearing only, although, there are a number of sericultural facilities available, viz. graineurs (Seed), commercial silkworm rearing, spinning (manual), automatic spinning machine, weaving, dyeing, fabric processing etc. A few farmers are employed in graineurs (production of seed) which is otherwise a very profitable income source. It also helped in employment generation.

Majority of the farmers have 1-2 acres of land holding, which is used in various purposes like plantation area, setting of rearing house etc. Besides eri culture, some farmers are also involved in growing field crops and other horticultural crops. Various types of income sources of the farmers, especially the women in Bodo community in Kokrajhar District are as like agriculture, weaving, poultry, piggery business, service, traditional industries and wage labour. Among these activities traditional industries like handicraft, weaving, preparation of traditional wine, piggery and poultry are the most prestigious culture of the Bodo community which is prevailing mostly in the rural areas. Such types of activities are generating a respectable amount of income for the Bodo family but the rate of income generation is less as compared to modern farming activates (Talukdar, 2012).

There was large number of supports from various Organizations/departments in Kokrajhar District. Central Silk Board (CSB) and Dept. of Sericulture, Assam Govt. provide help through assistance in plantation and seeds to the farmers. They also conduct extensive hand in trainings/workshops. It is observed that only 10% of the households have separate rearing spaces for eri silkworm rearing. Therefore, rearing houses have been provided to some deserving farmers with the help of organizations like CSB, Dept. of Sericulture, Assam Govt. etc. Water motors are also provided to some selected farmers to help in the growth of the plantations.

New technologies regarding grainage, rearing, spinning, weaving etc. have been provided to the farmers and weavers. The farmers have gained benefits from such adoptions. This is reflected in the increase in their annual income. There is a gradual increase in the income of the farmers through sericulture. The income from pupa is also high because the pupa is used as a delicious food among the local people and sold in the market at a high price. Moreover, there is satisfactory income from the tapioca tubers. However there is a scope for improvement in its productivity. There is ample opportunity for value addition and employment generation in post-cocoon sector.

Recently, introduction of advanced machineries in Kokrajhar District for spinning of eri cocoons facilitating production of finer yarns paved the way to commercially attractive designs and merchandises which included blends with other natural silks, cotton, wool, synthetic materials etc. (Somashekar, 2004).

C2, a high productive eri silkworm breed has been developed by Central Muga Eri Research Training Institute, Lahdoigarh, Jorhat, Assam through hybridization programme at its subordinate unit Regional Eri Research Station, Mendipathar (Singha, 2010). C2 breed ensures productivity with higher shell weight and fecundity.

The cocoon bank in Kokrajhar is expected to channelize and organize the marketing of eri cocoons. Various promotional events like trade fairs, exhibitions were also expected to boost the marketing of clothes and products of eri silk and silkworm.

There are some requirements of infrastructure and training/skill development in Kokrajhar District. Advanced techniques of spinning, knitting, weaving etc. should be introduced more. Technically educated men and women in Kokrajhar District should be provided Govt. loans to set up their own business, like fashion designing, sewing and cutting units, tailoring etc. Income earned from such activities are impressively higher than traditional primitive economic activities. The farmers are required to be adapted with improved rearing technology like platform mountage etc. Separate rearing house is a basic requirement for every farmer to increase their productivity and proper management of eri products.

Eri silk has diversified fabric products viz. saree, ladies bag, footwear, cap, tie, file folder, quilt, shirt, jacket, eri naturally died fabric, blended fabric with cotton, eri, mulberry and many more. The Bodo women are expert weavers and known as born weaver in Assam. Endle (1975) opined that, the loom employed for weaving the eri silk among the Bodos is of very simple in construction, and most, it not all, the material needed for the purpose can be provided by the villagers themselves from local resources.

Besides, there is immense scope for food diversification. Different recipes like boiled pupa, fried pupa, chilli pupa, pupa masala from eri silk pupa has increasing demand in all the states of NE India. Chaoba Singh and Suryanarayana, 2003 reported that eri pupae is great delicacy and dietary staple for Rabhas, Bodos, Karbi, Mising, Kachari, Garos, Khasi, Naga, Adis, Mizos, Syntengs tribals of Tibeto Burman and Indo mongoloid origin of NE India. Sarmah, (2011) reported the preference of eri silkworm for human consumption in mature stage as well as prepupal form in the NE region of India. Same was also reported by Paul and Dey (2011).

There is no harm to eri culture if the pupa is consumed because unlike other silkworms, eri pupae can be isolated from cocoons without damaging the silk as the cocoons were opened at one end. Further, this processes facilitate smooth spinning of yarn in addition to the maintenance of cleanliness. Moreover, the pupa contains high nutritional values with good quantities of proteins, fats, carbohydrates, minerals and vitamins. Sahay *et al.* (1997) opined that the tribals consuming the eri pupae for their taste, were unknowingly consuming rich protein food material. Pupae contain crude protein (55-60%), total lipids (26%), and free amino acids (5-8%). 100 g of dried eri silkworm pupae can provide 75% daily protein requirement of human individual. The vitamins like pyridoxal, riboflavin, thiamine, ascorbic acid, folic acid and minerals like calcium, iron and phosphorus make the pupae more nutritive (Roychoudhury and Joshi, 1995). In terms of protein, fat, vitamins and calories the eri pupae are equal to meat, but for certain degree of indigestibility. However, the biochemical analysis reveals that the pupae are of highly nutritive value and found better than the protein of soya bean, fish or beef.

Silkworm pupae were eaten by Chinese as food (Roychoudhury and Joshi, 1995) and in Japan cakes are prepared and sold as silkworm pupal cakes due to their high nutritive value (Majumder, 1997). In Hong-Kong, China, Korea and Japan the healthy silkworm larvae are sterilized, vacuum dried and sold as commercial food (Ramakanth and Anantha Raman, 1997). In Africa, the mature larvae of Saturniids used as a garnish in raw, dried and powdered form for human consumption and the dried product of pupae, the peaggie and also the roasted pupae are consumed as food in Western United States.

In NE India, the eri pupa can be consumed in a variety of ways. In Meghalaya, Karbi Anglong areas of Assam, pupae are dried and smoked in ash and hot coal for consumption. In other areas, the boiled and semi dried pupae look like blackened pea nuts/cashew nuts, edible as peanut shells. The delicious food items like fry, pakori/chop and cake etc., can be prepared from pupae and in powder form this will be used in soups and sauce as protein source. The eri pupae are being used as poultry or fish feed in other states. Various reports (Shiva Prakash, 1988; Aruga, 1994 and Majumder, 1997) suggest that eri pupa has diversified use in various industries as raw materials.

The present study revealed castor seeds as a potential by-product of eri culture. Castor seeds has a good market value locally as well as outside. It can be used for the manufacture of soap, medicine, lubricant, detergent etc. The litter of eri silkworms can be used as manure. According to FAO, castor is cultivated in about 20 nations, India being the top producer of castor seed and oil followed by China and Brazil. Castor is a multipurpose crop of international interest because of its commercial importance and unique biochemistry and valuable biomaterials such as, castor oil, ricinoleic acid, ricinoleyl-sulfate, lithium grease (lithium hydroxystearate), 10-undecylenic acid, 11-amino-undecanoic acid (McKeon *et al*., 2016). Recently it has attained many promising scopes in modern research such as it is suitable for remediation of crude oil contaminated soil, castor bean is a wizard for phytoremediation etc. (Kiran *et al*., 2017).

The tubers on roots of tapioca are considered as a nutritive material. It is very popular and consumed by the local people. The nutritive value of tapioca has been reported by many earlier workers (Hudson and Ogunsua, 1974; Okigbo, 1980; Tewe and Lutaladio, 2004; Charles *et al.,* 2005; Shittu *et al.,* 2007 and Montagnac *et al.,* 2009). The tapioca plant is a valuable source of carbohydrate, protein and vitamins. Tapioca root is an energy-dense food. In sweet tapioca varieties, up to 17% of the root is sucrose with small amounts of dextrose and fructose (Okigbo, 1980 and Charles *et al*., 2005).

The results from tensile properties support the practical applicability of the yarn. It is evident that various clothes and garments made from eri silk yarn are in good demand in national and international market. Eri silk is a part and parcel of the tradition and custom of various local and ethnic groups of the NE region of India, especially Assam. Eri silk has been used traditionally for making garments especially for winter seasons. However, in recent times the scope and prospect of eri silk have reached a new dimension. But now, product diversification has opened a variety of uses for this silk. Eri silk is known for its excellent strength, soft-smooth feel, comfort and luster besides having good thermal behavior (Kulkarni and Bahuguni, 2011). Also the fineness, density, strength, cross-sectional shape, surface properties and dyeing characteristics of eri silk promises its excellent blending capability with wool fibre (Kulkarni, 2007; Kariyappa *et al.*, 2009 and Kariyappa *et al.*, 2014).

There exists substantial scope for enhancing the eri culture activities even at the existing level of technology and with little effort in the food leaves production and financial assistance, it may be expanded significantly that would generate further income and employment (De and Das, 2010 and Kakoti, 2012).

It is expected that the present study will provide a handful of authentic information on some important aspects related to production of eri silk by rearing the silkworms on castor and tapioca leaves found locally in Kokrajhar District. The local farmers will be highly benefitted from this report. They will get a proper route to boost their silk productivity. A major share of the rural economy of this State is dependent on eri culture. Thus this finding may be helpful to afford employment generation and sustainable economic development for the people of this State.