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RESEARCH ARTICLE

FOLIAR CONSTITUENTS OF *TERMINALIA ARJUNA ROXB.* (FAMILY: COMBRETACEAE): AN ALTERNATE HOST PLANT OF WILD TEMPERATE TASAR SILKWORM, *ANTHERAEA FRITHI,* MOORE

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ABSTRACT

The quality of food has got a direct influence on the health, growth, development and survival of silkworm. Most of the food plants may contain all the nutritional requirements but the quantity of each nutrient may not be well balanced for proper growth and development of silkworm. The nutritional status as well as growth and development of insect varied on different host plants. The present investigation deals with rearing of *Antheraea frithi* M. and foliar constituents of *Terminalia arjuna* Roxb., a newly reported host plant for *A. frithi*. The foliar constituents of *Terminalia arjuna*, viz. total nitrogen (2.88 ± 0.04 %), total soluble protein (12.77 ± 0.38 %), crude protein (18 ± 0.70 %), phosphorous (22.02 ± 0.36 ppm/gm), potassium (18.8 ± 0.46 ppm/gm), crude fiber (33 ± 0.59 %), cellulose (12.33 ± 0.40 %), total ash content (12.33 ± 0.40 %) moisture content (68 ± 0.71 %) were recorded during the rearing season i.e. July-August. Although *A. frithi* is a wild temperate tasar silkworm and so far not commercially exploited, hence, there is an ample scope to introduce *Terminalia arjuna* as a new host plant along with other host plants and it will accomplished the conservation of silkworm as well as host plant at significant level.

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INTRODUCTION

Terminalia arjuna Roxb. (Family: Combretaceae), is an indigenous multipurpose tree having various medicinal values and widely distributed throughout the Indian sub continent. It is a perennial evergreen tree with spreading branches that form canopy at the crown. The branches drop downwards with simple leaves and racemose inflorescence hanging from the branches while flowering. Leathery, woody fruit is a one seeded drup with glabrous angled or winged pericarps. It is cultivated for rearing of tasar silk worm *Antheraea mylitta* in tribal inhabitant areas in India (Rai *et al.,* 2009) and also reported to feeds on *Antheraea paphia***.** Different food plants may influence differently on food intake, efficiency of digestion and conservation of food to body biomass and finally on growth and development of insect (Waldbauer 1968; Bhattacharya and Pant 1976). Slansky and Scriber (1985) critically reviewed these aspects of nutrition ecology of insect and concluded that the nutritional indices as well as growth and development of insect varied on different host plants.

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The nutritive value of the host plants and their seasonal variability are closely related to that of the silkworm. The quality of food has got a direct influence on the health, growth and survival of silkworm. Most of the food plants may contain all the nutritional requirements but the quantity of each nutrient may not be well balanced for proper growth and development of silkworm. Quantitative requirements for each nutrient and the required balance of nutrients for optimum nutrition may vary within and between species owing to many factors including synthetic ability of the insect and metabolic activities involving specific interrelations between certain nutrients (House 1974a). Thus, studies on quantitative and qualitative aspects of insect nutrition is quite essential for better understanding of the insect-plant relationship and is of great importance for improvement of diet of the silkworm. Besides, ecological factors also have great influence in determining the quality of the host plant leaves as well as nutrition, growth and development of silkworm. A good number of studies on foliar constituents of the food plants of non-mulberry silkworm i.e. Tropical tasar, Oak tasar, Muga and Eri silkworm have been reported from different parts of India (Chowdhury, 1981; Kohli *et al*., 1986; Sinha *et al*., 1993; Yadav and Goswami 1992; Banerjee *et al.,* 1993; Dutta *et al*., 1997; Sharma and Devi

1997). Rai *et al.* (2009) give a comparative analysis of nitrogen content, moisture content, carbohydrate, tannin content, soluble protein and phenolic content for pollarded and unpollarded *T. arjuna* for evaluation of growth and development of *Antheraea mylitta.* However, no information is available on foliar constituents of *T. arjuna* to evaluate the biology and rearing performance of *Antheraea frithi* Moore. from North Eastern region of India. Hence, a study has been undertaken to evaluate different biochemical aspects of *T. arjuna*, a newly reported food plant of *A. frithi* from this region.

MATERIALS AND METHODS

Fresh leaves of *Terminalia arjuna* were collected, shed dried and powdered for the estimation of nutritional status. Biochemical parameters namely, moisture, crude fiber, total nitrogen, potassium, phosphorous, total soluble sugar, total carbohydrate, reducing sugar, crude protein, cellulose and total ash content were estimated following standard procedures. Moisture content, crude fiber, crude protein, total nitrogen, potassium and phosphorous were determined by using the method of AOAC (1970). Total soluble protein was determined following the methods described by Lowry *et al.* (1951). Total soluble sugar and total carbohydrate were determined by Anthrone method (Yemm and Willis 1954). Reducing sugar was estimated by the method described by Burner (1964). The total ash percentage of the leaf sample was estimated by using muffle furnace at 600^0C. Cellulose was estimated by following the methods described by Sadasivam and Manikam (2005). Altogether five replications were conducted for each parameter. The mean value and standard deviation were calculated from the computed value.

RESULTS AND DISCUSSION

The quality of food has got a direct influence on the health, growth, development and survival of silkworm. Most of the food plants may contain all the nutritional requirements but the quantity of each nutrient may not be well balanced for proper growth and development of silkworm. The nutritional status as well as growth and development of insect varied on different host plants. Foliar constituents of leaf are the most important determining factor during the growth and development of different stages of silkworm and it also differ significantly among themselves in different food plants. The present investigation of the foliar constituents of *T. arjuna,* like total nitrogen (2.88 ± 0.04 %), total soluble protein (12.77 ± 0.38 %), crude protein (18 ± 0.70 %), Phosphorous (22.02 ± 0.36 ppm/gm), potassium (18.8 ± 0.46 ppm/gm), crude fiber (33 ± 0.59 %), carbohydrate (7.38 ± 0.41 %), cellulose (12.33 ± 0.40 %), total ash content (12.33 ± 0.40 %) moisture content (68 ± 0.71 %) were recorded during the rearing season i.e. July-August which are found to be *at par* other silkworm host plants. The data depicted in the Table: 1 is the mean values of 10 different biochemical constituents are discussed in the light of earlier works in following paragraphs.

Total Nitrogen: Nitrogen is the most distinguishing element present in protein which in turn is the most ubiquitous organic nitrogenous compound in food staff and in all living matter. The total nitrogen content of different leaves differs

Table 1. Folliar constituents of *T. arjuna*

Parameters	Mean ± SD
Total Nitrogen (%)	2.88 ± 0.04
Crude Protein (%)	18 ± 0.70
Total Soluble Protein (%)	12.77 ± 0.38
Phosphorus (ppm/gm)	22.02 ± 0.36
Potassium (ppm/gm)	18.8 ± 0.46
Crude Fibre (%)	33 ± 0.59
Cellulose (%)	12.33 ± 0.40
Total Ash content (%)	12.33 ± 0.40
Moisture content (%)	68 ± 0.71
Total carbohydrate (%)	7.38 ± 0.41

significantly from different plants. Yadav and Goswami (1992) reported that *Litsaea polyantha* leaves possessed higher total nitrogen than *Persea bombycina*, but variation between the leaf types for nitrogen was not significant. In our investigation total nitrogen was estimated at 2.88 ± 0.04 %, which is within the range of other silk worm host plants reported by Dutta *et al.* (1997) in Mejankari (3.08%), Som (2.36%), Soalu (2.02%) and Dighloti (1.39%).

Total soluble Protein: The green leaves of plants are good source of protein and may supply most of the essential amino acids. Nitrogen as protein and non-protein nitrogenous matter present in food plant leaves are responsible for healthy growth of silkworms as silk substance consist of proteins. The role of protein in silkworm nutrition has been emphasized by Takeuchi (1960) and Fukuda *et al.* (1959). In the present study total soluble protein content was estimated as 12.77±0.38 which is comparable to the protein contents of Soalu (*Litsea citrata*) as 13.42 (Charkavorty *et al.,* 2004) and Som (*Persea bombycina*) as 12.25 (Dutta *et al.,* 1977). However, Rai *et al.* (2009) reported a lower protein content (8.7-9.1 mg/gm) in *T. arjuna* from pollarded and unpollarded leaves.

Crude protein: Crude protein is considered as a desirable nutritional parameter in silkworm diet. Agarwal *et al.* (1980) recorded lower levels of crude protein content in *Lagerstroemia indica* (9.7%), *Dalbergia sisoo* (15.5%), *Terminalia paniculata* (8.37%), *Lagerstroemia speciosa* (13.95%) and *Careya arborea* (8.27%), while Pathak (1988) observed higher crude protein in *Ricinus communis* (23.80%) followed by *Heteropanax fragrans* (20.7%) and *Manihot utilissima* (19.8%). Yadava and Goswami (1992) observed that mean value of crude protein was significantly higher in Soalu leaves than that of Som. However, Dutta *et al*. (1997) recorded highest amount of protein in Mejankori (15.53%) followed by Som (12.25%), Soalu (10.36%) and Digloti (7.50%). In the present study, 18 ± 0.70 % crude protein was estimated in *T. arjuna***.** This observation is in agreement with the findings of previous studies.

Phosphorous: Phosphorus is an important component of numerous cellular structures, including membrane phospholipids, ATP, phosphocreatine, DNA and RNA. Phosphorus-limitation was evident in a phosphorus-poor herbivore consuming a phosphorus-rich host (Perkins *et al.* 2004). However, increasing dietary phosphorus has been shown to increase growth rates in caterpillars (Clancy and King 1993) and crickets (McFarlane 1991). The present observation registered 22.02 ± 0.36 ppm/gm of phosphorous content in

T. arjuna which is in conformity with the findings of Chandrashekhar *et al.* (2013).

Potassium: Potassium, in the form of potassium cations, is essential to life, being a constituent of all cells. It is also predicted that the mechanical properties of the muscles of a herbivorous insect will be found to be subject to fairly marked changes if the blood potassium rises or falls to an appreciable extent (Hoyel 1953). Further, El-Shaarawy *et al.* (1975) recorded higher potassium content with bloomy red variety of castor than the bloomy green variety, confirming that this content varied with varieties. Similarly, Chandrashekhar *et al.* (2013) also noticed significant variation of potassium content among leaves of selected castor genotypes. In the present study notable potassium content (18.8 ± 0.46 ppm/gm) was recorded in the leaves of *T. arjuna.*

Crude fiber: Crude fibre is not considered as nutrient, as larvae of silkworm cannot digest crude fibre. But, its intake has impact in maintaining peristaltic movement of intestine. Vasuki and Basanava (1969) reported reduction of fibre content is advantageous for better yield of silkworm. While Charkavorty *et al*. (2004) reported that the average crude fibre contents of leaves of Som, Digloti and Soalu were found as 26.60%, 23.65% and 16.52% respectively. In the present study, the crude fibre is recorded as 33±0.59 % which is found to be suitable for rearing of silkworm.

Carbohydrate: Carbohydrates are very important for growth of silkworms. These are utilized by the silkworm as energy source and for synthesis of lipids and amino acids (Horie 1978). Carbohydrates, particularly reducing sugars are essential nutrients for insect behvioury (Lindroth 1993). Chakravorty *et al*. (2004) found the average value of total carbohydrate from 10.61% to 19.31% in mulberry leaves. In the present investigation the total carbohydrate content was estimated at 7.38± 0.41% which is akin with the findings of Banerjee *et al.* (1993). They reported 10.61%-15.10% of total carbohydrate in the food plants of temperate tasar silkworm.

Cellulose: Cellulose is a major component in crude fiber content. Further it is often treated simply as inert, indigestible diluents of insect diets (Simpson & Abisgold 1985, Timmins *et al.* 1988). It is also worth mentioned that, increase in crude fiber content of leaves in autumn season is more than in spring season that may be attributed due to thickening of cell wall and higher cellulose in leaves of spring season. 12.33 ± 0.40 % cellulose was recorded from the leaves of *T. arjuna* during summer season.

Total ash content: Ash, the inorganic constituents are the total amount of the non-combustible substances present in the plants. The quantity of ash in a feed or in some biological products lack information about any specific minerals that may present in a food. Chutia (2009) reported highest mean total ash (%) in *Quercus acutissima* (9.66 ± 4.54) and lowest in *Alnus nepalensis* (4.97 ± 0.25). Further, in summer season, maximum of total ash was recorded in *Heteropanax fragrans* (9.67 ± 0.35) and minimum in *Litsaea citrata* (3.78 ± 0.06), while in spring season maximum and minimum was recorded in *Quercus acutissima* (13.90 ± 8.82) and *Litsaea citrata* (3.70 ± 0.11) respectively. In our present study total ash content was recorded as 12.33 ± 0.40 % which is in conformity with the above findings.

Moisture: Leaf moisture increases the amount of nitrogen and digestion capacity of silkworm. Moisture acts as an olfactory and gustatory stimulant (Ito 1967). Dietary water affects the nutritional efficiency of insects since higher water content affects both edibility and assimilability of leaves in silkworm (Parpiev 1968), while a low water content affects energy expenditure, nutritional efficiency and the growth of herbivorous insects (VantHof and Martin 1989). Jolly and Dandin (1986) reported that 70% or more leaf moisture content is optimum for mulberry silkworm rearing. Paul *et al*. (1992) observed that the 5th instar larva of *Bombyx mori* reared on mulberry leaves containing 76.62% moisture exhibited absolute consumption and the growth rate of larva per day is increased with the increasing percentage of leaf moisture. Dutta *et al.* (1997) recorded highest moisture content in *Litsaea polyantha* (71.84%) followed by *Litsaea salicifolia* (69.98%) and *Litsaea citrata* (69.55%) and the lowest in *Persaea bombycina* (67.02%). In the present investigation, 68 ± 0.71 % leaf moisture content is recorded from leaves of *T. arjuna* that may be considered as optimum compared to earlier report.

Conclusion: Rearing of *A. frithi* was performed successfully on *T. arjuna* during the period of study. Therefore, there is a prospect to introduce *T. arjuna* as a new alternate host plant of *A. frithi* with other host plants. Although *A. frithi* is a wild temperate tasar silkworm and so far not commercially exploited, hence, there is an ample scope to introduce this sericigenous species for commercial utilization on *T. arjuna* as a new host plant. The preliminary result of the study also supports that the plant could be also blended for commercial utilization and rearing of *A. frithi* on *Terminalia arjuna* will additionally help in conservation of both silkworm as well as host plant at significant level.

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