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Comparative biochemical study of improved mulberry (*Morus indica*) cultivars

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Abstract
Mulberry (*Morus* spp.) is an important plant in sericulture industry as foliage constitutes the essential feed for mulberry silkworm (*Bombyx mori* L.). Investigation was carried out to evaluate the best mulberry variety (V1, MR2, G4, S36) from the locally available and based on the biochemical parameters in terms of leaf moisture, carbohydrates, lipids, protein, crude fibre and ash content. The nutritional status of different mulberry varieties is ascertained by its biochemical constituents. The results indicated that V1 and G4 mulberry varieties have recorded highest biochemical constituents and suitable for silkworm rearing to getting maximum cocoon related parameters.

Keywords: Mulberry, biochemical, variety, Tamil Nadu

Introduction
The mulberry, a perennial woody plant having fast growth and short proliferation period, belongs to family Moraceae and genus Morus (Yang *et al*., 2010) [21]. In general, 10-16 species of genus Morus are found in subtropical, warm and temperate regions of Asia, Africa and North America (Pérez-Gregorio *et al*., 2011) [17]. Some of these are preferred due to foliage yield, delicious fruit, while few have ornamental importance and others are used due to their strong environmental adaptability (Pan and Lou, 2008) [15]. In sericulture industry, more than 60% of total cost of cocoon production goes towards mulberry production alone. Hence, in recent years maximum attention has been given for the improvement of mulberry both in terms parameter of quality and quantity. Growth and development of silkworm *Bombyx mori* L. and cocoon crop are mainly influenced by yield and nutritional quality of mulberry leaf used as feed (Vijaya *et al*., 2009) [20]. Quality of mulberry leaf was highly influenced by varieties, cultivation practices, preservation techniques, age and position of leaf and leaf quality was determined based on moisture content. Nutritive value of mulberry (*Morus* spp.) leaf is a key factor besides environment and technology adoption for better silkworm cocoon crop (Yogananda Murthy *et al*., 2013) [22]. Higher moisture content of mulberry leaves has a direct effect on growth and development of silkworm by favouring the ingestion, digestion and assimilation of nutrients. Mulberry leaves containing more water, total sugar and soluble carbohydrate and less mineral are best relished by silkworms. Nutritive requirement of silkworm larvae vary with the maturity of leaves fed. The plant is a very good source of ascorbic acid of which over 90% is present in a reduced form, and also contains carotene, vitamin b1, folic acid, folinic acid, isoquercetin, quercetin, tannins, flavonoids and saponins (Mahesh *et al*., 2017) [12]. Therefore, the present investigation was conducted to evaluate biochemical composition in leaves of improved commercial mulberry varieties.

Materials and methods
Collection of mulberry leaf samples
Mulberry leaf samples preparation: The four varieties (MR2, S36, V1 and G4) of mulberry leaves were collected from mulberry plants (*Morus indica*) in Department of Sericulture, Forest College and Research Institute, Tamil Nadu Agricultural University, Mettupalayam. The leaves were dried in oven and then made into fine powder using mortar and pestle. The powdered samples were preserved in butter paper/polythene cover and stored for further use.
Proximate Composition:
The proximate composition (ash, moisture, lipid, and fiber) of fresh leaf samples was determined using AOAC protocol (1995) [2]. Briefly, ash content was determined by dry ashing

method *i.e.*, placing the sample in furnace. Lipids were extracted from powdered samples in soxhlet extractor. The extract obtained was left for overnight drying at 80°C and contents of lipids were determined gravimetrically. Crude fibre content was determined by titrimetric method of analysis. Kjeldhal apparatus was used for the estimation of nitrogen content and protein content was calculated as N×6.25.

Determination of total carbohydrate: The total carbohydrate was estimated by anthrone method (Hedge and Hofreiter, 1962) [6].

Protein content (%): The protein content was estimated by using the procedure of Lowry *et al*. (1951) [10].

To evaluate the effect of different mulberry varieties on rearing performance and economic traits of silk worm (*B. mori*) Krishnaswami (1978) [8] described the improved technology of silkworm rearing and it was adopted in this investigation. The observations were recorded on weight of 10 matured larvae, single cocoon weight, single shell weight, and shell ratio. The data thus collected were statistically analyzed and the results were recorded.

Results Discussion

The mean values of proximate composition for the leaves of three different varieties of mulberry are summarized in Table 1 and the varieties were found to be statistically different ($P < 0.05$) in the context of ash (11.0%), moisture (78.5%), carbohydrate (18.3%), lipid (4.0%), crude fiber (8.8%) and protein (24.8%) contents in V1 mulberry variety wheras minimum biochemical content recorded in MR2. The maximum observations were made in V1 and G4 mulberry variety on four economically important traits of *viz*., larval weight (3.5 & 3.4g), single cocoon weight (1.7&1.5 g), single shell weight (0.29 & 0.26g) and shell ratio percentage (17.05 &17.33%), respectively in Figure 1. Similarly, Thirumalaisamy *et al*. (2009) reported that V1 mulberry variety containing highest total sugar (16.72%) and total protein (26.72%) content compare to other five mulberry varieties and which is highly recommendable feed for during the silkworm rearing to increase their cocoon productivity.

Mulberry improvement is also aimed at bringing qualitative improvement of leaves and a survey of the available literature reveals that extensive studies have been carried out on the varietal response, effect of agronomical inputs, seasons and related aspects on biochemical composition of leaves. Matsumara *et al.* (1955), Tangamani and Vivekanandan (1984) [18], Lie and Sano (1984) [9], Fotadar *et al*. (1989) [5] and Chaluvachari and Bongale (1995) [4] discussed the importance of quality of mulberry leaves used as a source of feed to silkworm larvae. Carbohydrates particularly the sugar content in mulberry leaves in closely related to the health of the silkworm. Mulberry leaves with high sugar content field's good results of rearing (Kichisaburo Minamizawa, 1970). The presence of higher protein level in these plants pointed towards their possible increased food value. Machii and Katagiri (1991) [11] opined that increased protein content beyond the optimal level in mulberry leaves leads to a marginal improvement in cocoon productivity. Protein and amino acids are of particular importance for the silkworm larvae because of their active utilization for the synthesis of silk proteins. Carbohydrates are estimated based on the amount of sugar and starch content available in leaves (Bose and Bindroo, 2001) [3]. If the leaves have high carbohydrate content, silkworms gain more energy and in turn may enhance the synthesis of silk protein. Leaf moisture content and moisture retention are reported to positive influence on the growth of silkworm larvae. Paul *et al.* (1992) [16] reported that absolute consumption of feed and growth rate of larvae increased with increasing levels of leaf moisture content. The post cocoon parameters like larval weight (g), number of cocoons harvested, cocoon weight (g), cocoon shell weight (g), cocoon shell percentage (%) was recorded in silkworm rearing through V1 mulberry variety (Manjula and Vijaya Kumari 2017) [13].

Table 1: Biochemical composition of improved mulberry varieties

Biochemical parameters	Mulberry varieties			
	V1	MR2	G4	S36
Moisture	78.5±2.50	74±2.41	75.0±3.10	80.3±3.10
Carbohydrate	18.3±0.40	16.8±0.51	16.3±0.45	21.3±0.45
Lipids	4.0±0.49	3.6±0.47	3.8±0.21	3.9±0.51
Proteins	24.8±0.22	20.0±0.25	24.6±0.50	24.2±0.25
Crude fibre	8.8±0.20	8.6±0.32	8.8±0.33	8.1±0.35
Ash	11.0±0.45	9.9±0.30	11.2±0.38	12.2±0.40

*Mean±SD

The difference between mean values between the columns followed by the same letter are not significant at 5% level ($p<0.05$) by one-way ANOVA.

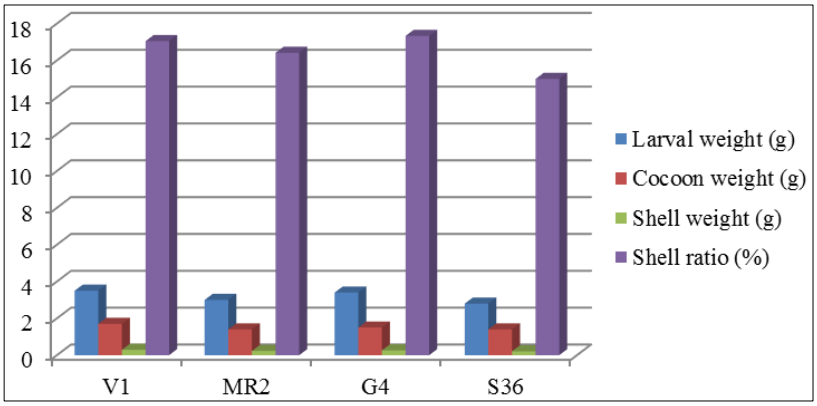

Fig 1: Larval and cocoon parameters performance of mulberry varieties

Conclusion

Improved mulberry varieties like V1 and G4 presently can be cultivated largest area in India particularly if South India not only for rearing of chawki and late age silkworms. But also it will open the way to corporate sericulture system through which these varieties can be explored by herbal druggists as health supplements in pharmaceutical industry thereby making commercial mulberry cultivation as profitable enterprise in future.

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