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# Analysis on the Effect of Different Mulberry Varieties on the Commercial Parameters of Mulberry Silkworm (*Bombyx mori*): A Review

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***Authors' contributions***

*This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.*

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## ABSTRACT

Sericulture is a commerce that involves the cultivation of mulberry plant species, the raising of silkworms, and the manufacture of silk. It is a sustainable, eco-friendly, and agricultural focused commerce. It is one of the largest employment industries, and it has played a significant role in rural opportunities and financial progress. The silkworm is the greatest mulberry assessor since different mulberry types differ in numerous characteristics. Criteria for assessment have been created using a bioassay of silkworm larvae. The impact of a specific mulberry variety on a certain silkworm hybrid may be assessed based on growth/development, survival, and eventually cocoon generation, which directly influences silk productivity.

*Keywords: Mulberry; moisture content; silkworm (Bombyx mori L.); economic parameters; commercial parameters.*

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## 1. INTRODUCTION

Mulberry (genus *Morus*), a perennial tree or shrub, is an economically important plant used yielding foliage and is the sole food source for the domesticated silkworm, *Bombyx mori* L. Mulberry is widely distributed in Asia, Europe, North and South America and Africa, and it is cultivated extensively in East, Central, and South Asia for silk production. Because its adaptability to different ecological conditions and easy hybridization, both naturally and artificially, abundant mulberry germplasm resources are available, making its genetic background rather complicated and highly heterozygous [1,2]. China and India, being the leading silk-producing countries, have developed a number of mulberry varieties suitable for a wide range of agro-climatic conditions. Most of these mulberry varieties were developed from a few species such as *Morus alba* L., *M. atropupurea* Roxb, *M.bombycis* Koidz, *M. indica* L., *M. latifolia* Poir and *M. multicaulis* Perr, through more than 150 species were cited in the Index Kewensis and nearly 68 species are recognized and received wide acceptance [3]. The major reasons for this restricted utilization of species are reported to be the lower leaf yield and the poor acceptability by silkworms as feed material. The reasons may be coarseness of the leaf, lower moisture content, lower moisture retention capacity in the harvested leaves and poor quality [4,5]. Thus, a good number of species are unutilized and remains in wild condition.

## 2. IDENTIFICATION AND EVALUATION OF SUPERIOR VARIETIES

Mulberry (Morus spp.) is an essential plant that provides the foundation of sericulture since it is the only source of nourishment for silkworm. Mulberry variants have been produced to suit various agro-climates and climatic conditions due to their relevance in silk generating locations. In the recent revelation, it is reported that the genetic pool of the domesticated species is shrinking [6] and the wild species such as *M. serrata, M. laevigata, Morus nigra* and *M. tartarica* hold genes for several important traits like abiotic and biotic response and may be suitable for exploitation. Some of the varieties and species are attaining threshold level in yield which needs to be broken by both conventional and unconventional breeding methods. Keeping this in view, several countries, including India, have taken strong initiatives for acquisition and utilization of wild relatives of mulberry genetic resources. Keeping in view the background, the present literature pertaining to study on the effect of different mulberry varieties on the economic parameters of silkworm hybrids have been reviewed and presented as follows:

## 3. ESTIMATION OF NUTRITIONAL TRAITS

High leaf moisture content and moisture retention capacity of the mulberry genotypes have a positive influence on the growth and development of silkworm. For successful rearing, the maintenance/retention of sufficient moisture content in the leaves for prolonged periods is of immense importance Legacy [7]. Hamamura et al. [8]. Mandal and Krishnaswami [9]. Different genotypes are said to influence the leaf moisture content and its retention in harvested leaf. Besides environmental factors, leaf anatomical parameters like stomatal size, stomatal frequency, mesophyll tissue, cuticle thickness and leaf thickness also influence the moisture content of the leaf and its retention capacity [1] Further Hamamura [10] and Waldbauer [11] have stated that silkworm *B. mori* being monophagus insect, consumes only mulberry leaves. Ueda and Suzuki [12] Paul et al. [13] reported that nutritional quality of the leaves play an important role in silkworm rearing. Higher moisture content is known to increase the amount of ingestion and digestibility of a silkworm because moisture act as olfactory and gustatory stimulant. Kasiviswanathan and Iyengar [14] Kasiviswanathan et al. [15,16]. have carried out studies on the leaf yield and bioassay of mulberry varieties through silkworm rearing which clearly indicated varietal difference in all parameters regulating leaf quality. Terkaraptyan et al. [17] Narayanan et al. [18] Krishnaswami et al. [19] Koul et al. [20] Sastry et al. [21] studied the effect of mulberry varieties on the growth and economic characters of silkworm. These studies showed that quality of mulberry leaf is one of the major deciding factors for healthy growth of silkworms and success of cocoon crops. The quality of leaf is influenced by many factors such as variety, cultural practices, incidence of pest and diseases, method of harvesting and preservation of leaves. Ueda and Suzuki [12] and Paul et al. [13] observed that availability of moisture content in the leaves enhances the feeding efficiency of larvae which in turn increases the growth rate. Parpiev [22] reported that the leaf moisture content may serve as one of the criteria in estimating the leaf quality. Anonymous [23] noticed wide range of variation for moisture content in tender (61.58 to 74.17 %), medium (58.48 to 70.35 %) and coarse mulberry leaves (53.36 to 69.00 %). Sengupta et al. [24] also reported that the low moisture adversely affects the growth and development of silkworm. Kasiviswanathan et al. [25] demonstrated that moisture loss can be minimized over a certain time period using wet gunny cloth or alkathene sheet. Roarke and Quisenberry [26] reported that the additive and dominant gene decide the inheritance of water retention capacity in F1 and F2 generation of cotton is under the control. The moisture retention capacity (MRC) plays an important role because the leaves with high moisture remain fresh and acceptable to worms for longer time.

Sastry et al. [21] observed the loss of moisture from 9.00 am to 4.00 pm in leaves of improved strains of mulberry like S-30, S-36, S-41, S-54, Kanva-2 and Mysore local in three traits. The loss of moisture content was found to be 17.61 % ± 0.94 in S-30 and 23.17 % ± 0.98 in S-36. There were considerable varietal differences with regard to The degree of moisture loss from the leaves is variety-dependent and varies considerably among them The moisture content of the leaf fit for young age silkworm rearing ranged from 75 (Ber S1) to 78 % (S-41) whereas S-30 and S-36 showed 74 % leaf moisture. Maximum moisture content in Chawki leaf was recorded in Kosen (77.34 %) followed by Ber C-799 (77.30 %) out of 25 varieties, except in S-1 where the moisture content was not above 70 %. Thangamani and Vivekanandan [27] observed wide range of variation in eight varieties of mulberry for moisture content (63.67 to 70.60 %) and total sugars (8.64 to 15.58 %). Higher moisture content and its retention capacity of leaves, help to keep them fresh for longer time. The leaves acceptability by silkworms is related to leaf thickness, which is due to the ratio of palisade to parenchyma cells as reported by Hesketh et al. [28] The role of the stomata size and their frequency in moisture retention, transportation and CO2 exchange rate was discussed by Susheelamma and Jolly [29]. Jolly and Dandin [30] reported that even 12 hours of excision, the moisture content and moisture retention capacity of leaves were higher in triploid genotypes likely due to lower number of stomata per $mm^2$. Similar observations were made by Geok and Dunn [31] Sikdar et al. [32] and Sharma [33]. Krishnaswami [34]; outlined the package of practices for cultivating five mulberry varieties *viz*., S30, S36, S41, S54 and K2. Studied fifteen exotic mulberry varieties for moisture content. Results revealed that Okinawa-2, *Morus lambing*, Thailand, Papuva, *Morus nigra*, *Morus multicaulis* varieties have higher moisture content compared to control K-2 variety. Govindan et al. [35] observed significant difference in moisture content at 8 and 24 h after harvest in leaves of six varieties of mulberry like Mysore local, Kanva-2, S-30, S-36, S-41 and S-54. Susheelamma et al. [36] utilized twelve drought resistant mulberry varieties along with two cultivars for evaluation under natural stress (rain-fed) conditions. Moisture percentage and moisture retention capability of leaves after 6, 12 and 24 h of excision were estimated [1] It was observed that the new mulberry varieties DTS-14, DRS-28, DRS-3, and DRS-34 retained higher moisture in the leaves after 6, 12 and 24 hours of excision. Observed that the leaves of polyploidy possess thickest cuticle, maximum thickness of upper and lower epidermis, and maximum thickness of palisade tissues which are responsible for higher moisture retention capacity of polyploidy. Since Goshoerami is also triploid mulberry genotype, this may be the reason for its higher moisture retention percentage reported by Baksh et al. [37] Mala et al. [38] studied moisture per cent and moisture retention capacity in five mulberry varieties and concluded that S-36, S-30, K-2 varieties possessed maximum moisture per cent and moisture retention capacity as compared to other varieties.

## 4. ANALYSIS OF ECONOMIC TRAITS

Agastian et al. [39] screened different mulberry varieties C1, C20, Kosen, Ichinose, BC259, Tr4, Tr8, Tr10, S30, S36, S41, S54, MR2 and M5 for their agro-botanical parameters in the costal saline area of Vedharniyam and found S36,S30 and BC259 to be superior to other varieties. Water loss was comparatively lower in MR2, S30 and BC259 whereas TR4, M5 and S36 were found to be intermediate. Bongale and Chaluvachari [40] reported that Mysore local variety possessed lower leaf moisture content and moisture retention, while English Black, KNG, Berhampore-5 variety had relatively higher moisture and moisture retention capacity out of eight mulberry varieties used for the study. Ajay koul et al. [41] screened nine promising mulberry varieties for leaf characters, dry matter and water retention during three seasons of spring, summer and autumn, and observed significant differences in these characters among the varieties and season. Vijayan et al. [42] studied 152 mulberry varieties for leaf moisture and observed wide range of variation in different seasons. The leaf moisture varied from 54.93 to 82.43 %, 61.66 to

84.39 % and 56.73 to 80.39 % during summer, rainy and winter seasons respectively. Mallikarjunappa et al. [43] evaluated four improved mulberry genotypes, namely S-30, S-36, Viswa and M-5, for moisture content and moisture retention capacity. The leaf moisture content was significantly higher in Viswa (77.74 %) and S36 (77.24 %) genotypes. Leaf moisture loss at 6 h after harvest was significant loss in S-36 and S-30 genotypes (13.46 and 13.92 % respectively). Sujathamma and Dandin [44] studied 23 elite mulberry genotypes and observed wide range of variation in moisture content of fresh leaves which ranged from 64.4 to 76.94 %. The maximum value was found in Tr-10 followed by Tr-4 (75.99 %) and minimum moisture percentage was recorded in Sujanpur-5 [1]. The moisture retention ranged from 57.39 to 71.41 % in 23 elite genotypes. Higher moisture retention was found in Tr-10 (71.41 %) followed by Tr-4 (70.14 %) and the minimum was noticed in Sujanpur-5 (57.39 %).

Basavaiah and Murthy [45] studied 16 diploid mulberry genotypes, 4 triploid genotypes and 5 induced tetraploids for leaf anatomical features. The results showed direct correlation between anatomical features, moisture content and moisture retention capacity of leaf are genotype specific. Drought tolerance adaptation, involving dehydration tolerance, would be most advantageous in mulberry plants, in which leaf production is of primary importance as dehydration tolerance adaptation would allow a range of plants to produce maximum leaf growth at given water potential Ninge Gowda & Sudhakar [46] Tikader and Roy [47] conducted the experiment on 15 accessions for moisture percentages and recorded maximum values for Senmates (81.40 %) and lower in Kajli (56.83 %), moisture retention capacity was higher in Senmates (88.07 %) and lower in *M. indica* (35.21 %). Tikader and Thangavelu [48] utilized wild species of *M. laevigata* and *M. serrata* for hybridization program. The F1 progenies showed enhancement for growth traits over that of both parents. The single leaf weight, leaf area, moisture percentage, moisture retention percentage, and leaf yield, increased from 8.44 to 45.50 % compared to female parent and from 11.84 to 102.67 % compared to male parent. Studied five mulberry varieties for moisture percentage and moisture retention capacity which ranged from 74.15 to 79.00 %, 61.60 to 66.15 % respectively. The improved cultivars like S-13, S-34 and V-1 exhibited higher moisture content and moisture retention capacity of leaf compare to commercial cultivars like Kanva-2 and S-36. Ramachandra et al. [49] evaluated the leaf quality of five selected varieties of mulberry *viz*., S-36, S-54, M-5, DD and V-1 and their study indicated that significant difference was observed for leaf moisture content, protein, sugar, total chlorophyll. Among all the varieties V-1 showed better values for all the parameters.

Jalaja Kumar and Ram Rao [50] studied leaf quality parameters in seven mulberry genotypes *viz*., V-1, V-2, V-4, K-2, S-13, S-36 and S-54 and reported higher leaf moisture content (LMC) and moisture retention capacity(MRC) in V-1 (75.93 and 82.17 %) followed by V-4 (75.67 and 81.64 %) and S-36 (75.14 and 81.27 %), while these two traits were found to be lowest in K-2 (69.50 and 76.25 %). Leaves characterized by higher LMC and MRC were identified as superior quality leaves [40] Also, the above two traits are closely associated with the feeding efficiency and growth rate of silkworm larvae [13,40] Mamrutha et al. [51,1] studied variability for moisture retention capacity (MRC, measured as leaf relative water content after one to five hours of air drying) by screening 250 diverse mulberry accessions and the relationship between MRC and leaf surface (cuticular) wax was determined [1] Leaf MRC was significantly different among accessions and was found to correlate strongly with leaf surface wax. Moisture contents were high in tender followed by medium and coarse leaves. Moisture content and moisture retention capacity were significantly high in S1708 and lowest in C6 leaves [52-64].

## 5. CONCLUSION

Acceptable cultivar preference based on plant morphological characteristics, resistance to disease, biochemical processes, and their influence on development and cocoon yield parameters of *B. mori* races/hybrids in different agro-climatic conditions is required to identify and fully utilize good potential cultivars for improved sericulture activities. The nutritional content of mulberry leaves has a significant effect on the development of silkworm cocoon crops and, ultimately, raw-silk production.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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