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EVALUATION OF MULBERRY GENOTYPES FOR REARING PERFORMANCE OF MULBERRY SILKWORM *BOMBYX MORI* L.

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ABSTRACT

The growth and development of mulberry silk worm *Bombyx mori* L. are based on the quality and quantity of mulberry leaves used as food, which, in turn, affects the quality and yield of the cocoons. This study was carried out to evaluate the mulberry genotype, *Morus* spp., and its feeding value in relation to the rearing performance in southwest Ethiopia. Seven genotypes of mulberry were evaluated in a randomized complete block design, and the suitability as feed also evaluated in a completely randomized design under laboratory conditions. Three replications were used in both field and laboratory conditions. Among the genotypes tested, the M-4 genotype demonstrated relatively better agronomic performance and mulberry silkworm rearing performance.

Key words: Mulberry silkworm, *Bombyx mori*, mulberry genotype, rearing performance, leaf quality, cocoon yield

Bombyx mori L. has long been recognized as one of the most important silk producing insects (Habeanu et al., 2023), with mulberry leaves being its primary nutritional source from *Morus* spp. (Chundang et al., 2020). The mulberry plant has diverse genotypes that impact silkworm performance and sericulture practices in Ethiopia. Evaluating these genotypes for their feeding values and effects on cocoon production is crucial (Ruth et al., 2019; Alipanah et al., 2020; Kedir et al., 2020; Tulu et al., 2022). Ongoing evaluations seek to develop new *Morus* spp. varieties suited to the region's conditions and sericulture needs (Terefe et al., 2018). Identifying suitable parent materials and understanding genetic diversity within genotypes are key to efficient germplasm management (Rahman and Islam, 2019). Studies highlight the variability in mulberry germplasm and its impact on silkworm performance and silk production (Lalfelpuii et al., 2014). Seasonal variations and agronomic factors influence the nutritional value of mulberry leaves, affecting cocoon production and silk quality (Rohela et al., 2020). The choice of mulberry variety affects the development of silkworms and cocoon production (Sori and Gebreselassie, 2016; Alipanah et al., 2020). Despite its importance, there is limited information on evaluation of mulberry genotypes and their impact on silkworm rearing in Ethiopia. This study aims to evaluate the genotypes of mulberry and their feeding values for the rearing of mulberry silkworms, helping to optimize the sericulture industry and improve competitiveness. By assessing growth, cocoon quality and silk yield in different mulberry genotypes, this research aims to guide optimal genotype selection, promote sustainable silk production, and improve the livelihoods of farmers in southwest Ethiopia.

MATERIALS AND METHODS

The experiment was carried out in Tepi, southwest Ethiopia, with rainfall ranging from 600 to 1500 mm annually and an altitude of 1200 m.a.s.l. It spanned three years from June 2020 to June 2022 at the Tepi Agricultural Research Center. Seven mulberry genotypes (S-13, M-4, Nekemte, Keftegna, Local, K-2 and Tepi), obtained from the Melkassa Agricultural Research Center and local areas, were studied. Land preparation such as plowing, digging, and leveling was done before planting. 25-30 cm mulberry cuttings with 5-6 buds were planted at 60 x 60 cm spacing, under rainfed conditions with supplemental irrigation during dry periods. Management practices followed recommendations, which included pruning and weeding. The experiment used a randomized complete block design (RCBD) with three replications. In the laboratory, the strain of white mulberry silkworms was reared under controlled conditions. The equipment and rearing rooms were sanitized with 2% formalin. Silkworms were reared in a completely randomized design (CRD) with three replications, fed appropriate diets based on larval age, and kept at recommended temperature and humidity levels. Field evaluations began from planting and included data collection on plant height, emergence rate, stand count, leaf yield, internode length, leaf weight, leaf area and pest incidence. The collected data related to silkworms included observations of larval stage, mature larval weight, developmental periods, cocoon characteristics and reproductive parameters. Data were tested for variance homogeneity and normality before analysis of variance (ANOVA) using SAS 9.0 software. Treatment means were compared using the least significant difference (LSD, p=0.05).

RESULTS AND DISCUSSION

Evaluation of various mulberry genotypes revealed significant differences in leaf characteristics, fresh leaf yield, and mulberry silkworm rearing performance. Genotype S-13 exhibited the highest mean number of leaves per plant (19.00), followed by M-4 (15.67) and Nekemt (15.00), indicating their potential for higher leaf production. On the contrary, the local genotype had the lowest number of leaves per plant (6.67) (Table 1). This variability in leaf number is attributed to genetic differences among genotypes, which affect their branching and leaf formation (Rukmangada et al., 2020). Sori and Gebreselassie (2016) and Santoshkumar et al. (2020) observed that genotype selection is crucial for leaf production, which aligns with this study on the impact of genotypes on mulberry plant height. Similar findings have also been reported in previous studies, emphasizing the role of genotype selection in leaf production and overall plant growth (Kedir et al., 2020; Sun et al., 2023). The number of non-palatable leaves per plant varied significantly between genotypes, with S-13 having the most (17.67) and the local genotype having the least (10.00). This variation influences the quality and desirability of mulberry leaves for consumption or silkworm feed. This finding suggests that genotypes differ in their leaf characteristics, making some more suitable for consumption than others (Krishna et al., 2020; Toolir and Mirjalili, 2023). The number of leaves is directly related to the potential for silkworm rearing, as more leaves can sustain a larger silkworm population (Urbanek Krajnc et al., 2022). Different genotypes are known to produce varying numbers of leaves due to genetic diversity. Furthermore, the number of leaves is influenced by factors such as pruning practices and pest damage (Wang et al., 2017). The genotypes also showed variability in leaf area, fresh leaf weight, plant height, dry leaf weight, emergence date, and fresh leaf weight/ ha (Table 1). These variations highlight the genetic diversity among mulberry genotypes, affecting their productivity and suitability for various purposes, such as livestock feed and silk production (Rohela et

Table 1. Mulberry plant height, leaf area, internode length, stand count, emergence date, leaves/ plant, and dry and fresh leaf weight of mulberry (Tepi conditions)

Genotypes	Plant height (cm)	Leaves/ plant	Non-palatable leaves/ plant	Leaf area (cm^2)	Ten fresh leaves weight (g)	Ten leaves dry weight (g)	Internode length (cm)	Stand count	50% emergency date	Fresh leaf weight kg/ha
S-13	101.67	19.00^{a}	17.67^{a}	195.67^{c}	88.67	27.00^{ab}	4.00	21.33	14.00^{b}	9490^{ab}
M-4	103.67	15.67^{ab}	13.00^{ab}	360.00^{a}	120.00	31.33^{a}	6.20	18.67	14.00^{b}	9603^{a}
Nekemt	100.00	15.00^{ab}	13.67^{ab}	322.00^{ab}	113.00	26.67^{ab}	4.67	18.00	13.67^{b}	8651^{ab}
Keftegna	96.00	13.67^{ab}	14.00^{ab}	296.33^{ab}	111.67	28.33^{ab}	4.67	16.33	17.00^{ab}	9205^{ab}
Local	65.00	6.67^{c}	10.00^{b}	216.00^{c}	84.00	22.33^{ab}	4.67	16.00	18.00^{ab}	3667^{b}
K-2	78.33	14.67^{ab}	14.00^{ab}	245.00^{bc}	94.67	26.00^{ab}	6.00	15.33	14.00^{b}	8393^{ab}
Tepi	75.00	12.33^{bc}	14.33^{ab}	199.67^{c}	80.00	17.67^{b}	4.33	10.33	22.33^{a}	6239^{ab}
LSD (5%)	57.64	5.78	6.80	104.86	54.97	12.13	2.90	11.05	7.57	5934.80
CV (%)	6.25	2.75	8.11	2.48	3.26	6.61	2.80	7.32	6.36	4.27
P-value	0.505	0.012	0.039	0.040	0.564	0.020	0.24	0.26	0.026	0.023

Means with the same letter in a column not significantly different (Tukey test, $p > 0.05$); different letters indicate significant differences (Tukey test, $p < 0.05$).

al., 2020; Jan et al., 2021). These results are consistent with a study by Krishna et al. (2020) that highlights the positive correlation between leaf area and mulberry leaf yield. Previous studies have demonstrated the importance of leaf area in maximizing photosynthesis and consequently plant growth (Hou et al., 2021). Sori and Gebreselassie (2016) reported a similar leaf weight of M-4 genotypes (25.00 g/ five leaves). Similar studies have also highlighted the importance of fresh leaf weight in assessing mulberry plant productivity (Wang et al., 2017; Yu et al., 2018).

Regarding the rearing performance of mulberry silkworms, genotype M-4 demonstrated the highest hatchability (98.63%), the shortest larval duration (31.40 days) and the highest larval weight (2.36 g), leading to a shorter total life cycle (47.82 days) and the highest effective rate of rearing (96.98%) (Table 2). These results underscore the importance of selecting appropriate genotypes of mulberries for sericulture, as they significantly influence hatchability, larval development, and overall silk production efficiency (Terefe et al., 2018; Kedir et al., 2020). Several studies have consistently emphasized the crucial role of the mulberry genotype in various aspects of silkworm rearing. For example, Kedir et al. (2020) and Ljubojević et al. (2023) highlighted its influence on hatchability. Urbanek Krajnc et al. (2022) found specific genotypes that impact the larval period, while Alipanah et al. (2020) noted variations in larval duration. In addition, Khamenei-Tabrizi (2020) and Zhang et al. (2022) reported genotype effects throughout the life cycle and economic efficiency, respectively. Bu et al. (2022) further support these findings, stressing the need to choose suitable genotypes for optimal silk production. These collective insights underscore the critical role of mulberry genotype selection in improving sericulture efficiency and productivity (Urbanek Krajnc et al., 2022).

The present study showed that genotype M-4 also exhibited a better cocoon weight, pupal weight, shell weight, and silk ratio compared to other genotypes (Table 2), indicating its potential for high-quality silk production. Different genotypes of mulberry plants can have varying nutrient compositions, including protein and carbohydrate levels. These differences can influence the growth and development of silkworm larvae, which could lead to higher silk ratios when fed to silkworms. This, in turn, is likely to support silkworms in producing more silk and less sericin, resulting in a higher quality silk product (Bu et al., 2022; Ruth et al., 2019; Alipanah et al., 2020). The results are consistent with various studies that highlight the significant influence of mulberry genotypes on silkworm characteristics. Thangapandiyan and Dharanipriya (2019), and Kedir et al. (2020) observed the impact on cocoon weight, which is consistent with the findings of our study. Terefe et al. (2018) and Urbanek Krajnc et al. (2022) noted the effect of the mulberry genotype on the weight of the pupae. Similarly, Ruth et al. (2019) and Andadari et al. (2022) reported shell weight variations that were also observed in our study. Consistent with these findings, Terefe et al. (2018), Lalfelpuii et al. (2014) found that the nutritional quality of mulberry leaves affects the silk ratio in silkworm cocoons. Mulberry plant genotypes also play a role in the silk ratio (Giora et al., 2022; Alipanah et al., 2020) and cocoon production (Kadri et

Table 2. Effect of mulberry genotypes on hatchability, larval period, weight, lifecycle, effective rate of rearing (ERR), cocoon, pupae, shell, and silk ratio of *B. mori*

Genotypes	Hatchability (%)	Larval period (days)	Weight of larvae (g)	Total life cycle (days)	ERR (%)	Cocoon weight (g)	Pupal weight (g)	Shell weight (g)	Silk ratio (%)	Number of cocoons
S-13	98.00^{a}	36.20^{a}	2.25^{a}	52.20^{a}	90.50^{d}	1.058^{a}	0.724^{b}	0.136^{b}	16.35^{a}	88.60^{a}
M-4	98.63^{d}	31.40^{e}	2.36^{a}	47.82^{d}	96.98^{a}	1.092^{b}	0.940^{a}	0.106^{c}	16.58^{b}	96.98^{b}
Nekemt	97.32^{abc}	34.00^{c}	2.17^{ab}	50.10^{abc}	95.45^{ab}	1.076^{c}	0.792^{ab}	0.152^{ab}	15.06^{ab}	89.52^{ab}
Keftegna	98.20^{cd}	32.30^{d}	2.12^{ac}	48.91^{cd}	93.60^{bc}	1. 042^{a}	0.821^{ab}	0.172^{a}	16.03^{c}	94.65^{ab}
Local	96.45^{ab}	34.42^{b}	2.19^{ad}	51.32^{ab}	89.80^{d}	1.054^{a}	0.822^{ab}	0.153^{ab}	15.65^{b}	90.89^{bc}
K-2	98.17^{bcd}	34.00^{c}	2.17^{ab}	49.17^{bcd}	94.94^{ab}	1.045^{a}	0.792^{ab}	0.163^{ab}	15.89^{b}	88.90^{a}
Tepi	97.63^{a}	32.34^{d}	2.01^{c}	52.22^{a}	91.80^{cd}	1.006^{a}	0.835^{ab}	0.174^{a}	15.71^{b}	93.54^{d}
P-value	0.036	0.029	0. 02	0.003	0.018	0.021	0.027	0.031	0.02	0.018
LSD	2.14	0.28	0.17	2.24	2.19	0.02	0.16	0.027	0.14	10.19
CV	2.29	2.31	2.19	2.24	2.31	2. 12	2.31	2.21	2.31	2.29

Means with same letter in a column not significantly different (Tukey test, $p > 0.05$); different letters indicate significant differences (Tukey test, $p < 0.05$).

al., 2021; Bu et al., 2022; Zambrano-Gonzalez et al., 2022), as supported by previous research. However, it is essential to acknowledge the limitations of this study, such as the lack of investigation into genetic factors that contribute to genotype variations and the influence of environmental conditions on genotype adaptability.

In conclusion, the study highlights the significant impact of mulberry genotypes on leaf characteristics, fresh leaf yield, and rearing performance of mulberry silkworms. Genotype M-4 emerged as a top performer in terms of productivity and silk quality, suggesting its potential to improve sericulture practices and contribute to the success of the sericulture industry. More research is recommended to explore the responses of these genotypes to various environmental conditions and address genetic factors for future breeding efforts in mulberry cultivation and silk production.

AUTHOR CONTRIBUTION STATEMENT

Conceptualization: ST, DT, MA, AB, KS, MT; methodology: ST, DT, MA, AB, KS, MT; formal analysis: DT, ST; investigation: ST, DT, MA, AB; resources: MT and KS; data curation: ST and DT; writing—original draft preparation: ST and DR.; writing—review and editing: EM and DT; project administration: DT; funding acquisition, DT, KS and MT.

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CONFLICT OF INTEREST

No conflict of interest.

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