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Biochemical Evaluation of Different Mulberry Varieties-A Review

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ABSTRACT: Mulberry plant is the sole food of silkworm, *Bombyx mori* as it is a monophagous insect which falls under order Lepidoptera. The quality mulberry leaves should be the main focus of silkworm rearers, because after feeding quality mulberry leaves, the healthy growth of larva occurs and finally leads to the formation of quality cocoon crop. The mulberry varieties vary in the biochemical constitution of leaves *viz.*, proteins, carbohydrates, amino acids, ascorbic acid etc which are needed for the proper growth and development of silkworms, hence the selection of quality mulberry plants is of prime importance to yield maximum benefits.

Keywords: Biochemical, Evaluation, Different, Quality, Mulberry varieties.

INTRODUCTION

There are about 68 species in the genus *Morus* and most of them are situated in Asia (Datta, 2000). In China there are over thousand varieties under cultivation which originated from four main species *viz., Morus alba, Morus multicaulis, Morus bombycis* and *Morus atropurpurea* (Yongkang, 2000). In India, *Morus* is divided into four species *viz., Morus alba* L., *Morus indica* L., *Morus laevigata* Wall. and *Morus serrata* Roxb. (Tikader and Dandin, 2005). Japan has exploited *M. laevigata* genetic resources for the production of new improved mulberry genotypes (Naik *et al*., 2015). The mulberry tree is an invaluable tree of immense economic importance in the silk industry for its leaves, which constitutes the chief food for the silkworm, *B. mori*. The role of nutrition (Islam *et al.*, 2020a, 2020b) and quality mulberry leaf (Majid and Islam 2022) for the success of sericulture has been reported by many researchers. The silkworm like other insects *viz.*, insect pollinators (Dar *et al.*, 2020a, 2020b), lac insect is of commercial importance and selection of host plant is vital for attaining good results. The mulberry varieties vary in the biochemical constituents and influences the development of silk gland and growth and development of silkworms (Islam *et al.*, 2023). The silkworms varied with regard to nutritional consumption parameters and post cocoon parameters after fed on different mulberry varieties (Islam *et al.*, 2022a, 2022b). Further, the improvement in the mulberry varieties plays an important role in the progress of sericulture (Dandin *et al.*, 2003; Biasiolo *et al.*, 2004). Mulberry being considered as commercial crop because its leaves stem, roots are used in agricultural, industrial and pharmaceutical fields for different purposes.

MATERIAL AND METHODS

Mulberry is a perennial plant and provides leaves for the proper growth and development of silkworm. The biochemical constitution of different mulberry varieties is found to vary and even within the same mulberry variety it varies with respect to the maturity of leaves on the branch. The mulberry leaves *viz.*, tender, medium and coarse leaves on the branch are collected and estimation of biochemical constituents is carried out by following the standard methods.

RESULTS AND DISCUSSION

Ahalya *et al.* (2020) analyzed fifteen mulberry genotypes *viz.*, ME-03, ME-06, ME-27, ME-18, ME-67, ME-95, MI-79, ME-052, MI-66, MI-143, ME-224, MI-012, MI-517, M5 and S13 with regard to moisture content and moisture retention capacity with regard to seasons and found significant variations among mulberry varieties. ME-052 recorded highest moisture content (83.03 %) and M5 recorded highest moisture retention capacity at 6 and 9 hr (74.15 % and 68.70 %) in rainy season. Shah *et al*. (2019) observed the moisture content and moisture retention capacity of five mulberry varieties namely S146, S1635, G4, Vishala and C2038 and found that among these mulberry varieties highest evaluation index for moisture content (64.61 %) and moisture retention capacity (61.79 %) was recorded in C2038 followed by Vishala mulberry variety (53.61 %, 46.94 %). The different mulberry genotypes *viz.*, V1, MR2, G4, S36 were studied and highest moisture (78.5 ± 2.50 %) and protein content (24.8 ± 0.22 %) was recorded in the leaves of V1 variety (Ramamoorthy *et al.*, 2018). Kumar *et al*. (2018) conducted biochemical analysis of ten mulberry varieties *viz*., BC-259, K-2, RFS-175, S-1, S-146, S-776, S-1635, S-1531, TR-8 and UP-1 and

observed highest moisture content (80.6 %), moisture retention capacity (81.6 %) and total protein (27.31 %) in case of S1635 variety. Suman *et al*. (2018) studied the nutrient variation in biochemical constituents of different clones of *M. alba viz.*, TR10, Mandaley, S36, S799, S30, Kanva 2, China white, Philipino, S146, K2MS, S1531, Berhampore, S1307, ME-65 and Nauni in different seasons and found highest crude protein content (17.82 %) in rainy season and lowest in autumn season (14.34 %). The effect of fertilizers on the biochemical constituents of mulberry leaf (Ahmed *et al*., 2017) was studied and highest moisture, moisture retention capacity, total sugar, crude protein and soluble carbohydrate content of 74.38 %, 33.31 %, 3.99 %, 21.01 % and 11.41 % respectively was recorded in BUM (basal+urea+magic growth) treated mulberry leaves as compared to control and moisture retention capacity showed no significant difference among these mulberry varieties. Abdelmegeed (2016) carried out biochemical estimation in leaves of *M. nigra* and *M. alba* and recorded highest total carbohydrate (3.19%), protein (21.00 %), phenol (1.16 %) and crude fiber (13.74 %) in leaves of *M. nigra* than *M. alba*. The total carbohydrate estimation in leaves and fruits of three mulberry varieties namely *M. alba*, *M. rubra* and *M. nigra* was carried out and highest total carbohydrate content in leaves (4.1 ± 1.0 g/100 g) and fruits (9.8 ± 0.9 g/100 g) was recorded in *M. rubra* mulberry variety (Dimitrova *et al*., 2015). Murthy *et al*. (2013) investigated ten mulberry varieties *viz.,* TR-8, TR-12, TR-20, S1708, MS5, C6, C10, *Matigara black*, *M. nigra* and M5 and found that S1708 contained highest total proteins (27.31 %) and amino acids (68.3 µmole/g) (Table 1 and 2). The chemo assay of some mulberry cultivars *viz.,* Mysore local, V1 and S1635 (Khan and Naik 2012) was conducted and highest protein (238.84 mg/g), carbohydrate (40.71 mg/g) and moisture content (78.32 %) was reported in case of S1635. Srivastava and Elangovan (2011) analyzed some mulberry varieties namely S-1, S-13, S-1635, S-146, TR-10, K-2 and Mysore local and found highest protein content in the tender leaves of K-2 variety (0.196 mg/gm) followed by S-1635 (0.168 mg/gm) and Mysore local (0.165 mg/gm) (Table 3 and 4). The biochemical constituents of some mulberry variety leaves *viz.,* S-13, S-146, S-1, S-54, BR-2, AR-12 and S-36 was carried out (Kumar and Chauhan., 2011) and highest protein (0.317 mg/gm), carbohydrate (0.624 mg/gm) and total lipid (0.923 mg/gm) content was recorded in case of S-36, AR-12 and S-13 respectively. Imran *et al*. (2010) carried out biochemical estimation of four mulberry species *viz.*, *M. alba* (white mulberry), *M. laevigata* (large black fruit), *M. laevigata* (large white fruit) and *M. nigra* (black mulberry) with regard to fruit and recorded highest protein (1.73 ± 0.10 g/100g) and total carbohydrate (17.96 ± 1.54 g/100g) content in *M. laevigata* (large black fruit) as compared to other species. Adeduntan and Oyerinde (2009) studied mulberry varieties *viz.,* Obeche, S36, S54 and K2 with regard to biochemical constitution of leaves and reported highest protein content of 34.31 ± 0.0 % in Obeche followed by S36 mulberry variety. Shah *et al.* (2007) while evaluating different mulberry varieties namely Husang China, Japan Early and Chinese Evergreen reported highest protein content (36 %) in Husang China as compared to the other varieties. Khan *et al.* (2007) studied seven mulberry varieties *viz.,* SKM-20, SKM-27, SKM-33, SKM-36, SKM-48, Goshoerami and Ichinose through chemo and bioassay and found that mulberry varieties differ significantly in their chemical constituents that influence the economic parameters of the silkworm. They further reported that maximum moisture content was found in Ichinose (74.46 %) which was at par with Goshoerami (73.82 %) and SKM-27 (73.80 %) and moisture retention capacity was maximum in case of Goshoerami (67.94 %) followed by SKM-27. Ghosh *et al*. (2006) studied some mulberry genotypes namely V1, C2016, C2017, Anantha, RFS-175, C1730, Thallaghatapura, Vishala, S1 and S1635 and found that among these varieties S1635 recorded highest total soluble protein (39.63 mg/g) as compared to these varieties. The seven mulberry varieties *viz.,* V1, S1635, RFS175, MR2, SV1, Jatuni and JRH (Sinha *et al*., 2003) was studied for the estimation of moisture, total carbohydrate and crude protein content and significant variations was reported among these genotypes. Highest moisture and total carbohydrate content of 73.04 % and 22.83 % respectively was recorded in S1635 genotype whereas, highest crude protein content (26.40 %) was recorded in JRH genotype. Venkataramana *et al.* (2002) carried out study on moisture and moisture retention capacity in leaves of mulberry varieties, namely V1, Kanva-2 and S-36 and recorded highest moisture (71.84 %) and moisture retention capacity (70.17 %) in V1 followed by S-36 variety. The biochemical estimation in leaves of different mulberry varieties (Bose and Bindroo., 2001) was carried out and among these mulberry varieties highest moisture (80.45 %), crude protein (23.00 %) and water soluble protein (7.95 %) content was recorded in leaves of Chakmajra variety. Sujathamma and Dandin (2000) evaluated 25 mulberry varieties and found that TR-10 variety recorded maximum moisture content (76.94 %) and moisture retention capacity (71.41 %) whereas Sujanpur variety recorded lowest level of moisture content (64.04 %) and moisture retention capacity (57.39 %). Similar studies were carried out by Fotedar and Dandin (1997) after studying ten mulberry varieties and reported maximum soluble proteins in Ichinose, C4, China white and Kairyoroso while mineral component was maximum in Goshoerami. Moisture content and moisture retention capacity varied among the genotypes.

Table 1: Biochemical composition in leaves of different mulberry varieties (Murthy *et al*., 2013).

Mulberry varieties	Leaf maturity	Total Proteins (%)	Total Sugars (%)	Amino acids (µ mole/g)	Phenols (mg/g)	Prolines (µg/g)
Tr_8	T	25.81	13.81	64.90	7.02	2.33
	M	20.10	13.36	59.83	8.42	3.39
	C	13.50	10.73	27.80	7.37	2.84
Tr_{12}	T	23.98	15.05	60.99	7.26	2.06
	M	17.95	13.52	53.44	8.82	3.27
	C	11.67	11.11	25.60	7.80	2.77
Tr_{20}	T	23.77	13.67	53.65	6.32	2.02
	M	17.63	13.02	46.08	7.32	3.20
	C	11.43	09.61	23.87	6.87	2.68
S_{1708}	T	27.31	16.02	68.43	7.16	1.61
	M	20.92	14.10	62.97	8.59	3.20
	C	15.58	11.74	33.01	7.82	2.44
MS_5	T	22.12	12.08	49.03	6.75	1.88
	M	15.63	10.58	44.96	7.71	3.17
	C	11.04	08.76	27.71	7.21	2.38
C_6	T	19.18	10.85	45.94	6.89	1.96
	M	14.80	09.73	42.02	8.24	3.28
	C	10.14	08.02	21.88	7.29	2.54
C_{10}	T	22.00	12.00	48.00	6.58	1.28
	M	15.32	10.33	44.18	7.94	3.10
	C	10.84	08.55	26.17	6.94	2.48
Matigara black	T	20.82	11.10	47.93	6.10	2.36
	M	15.15	10.10	43.08	7.61	3.53
	C	10.41	08.11	22.52	6.79	2.95
Morus nigra	T	21.03	11.14	46.33	7.40	2.08
	M	15.19	10.77	43.76	8.54	3.48
	C	10.59	08.36	23.04	7.84	2.91
M_5	T	15.91	13.09	55.44	7.51	1.23
	M	12.94	11.90	52.58	8.98	3.01
	C	09.84	09.73	33.11	8.00	2.28
CD @ 5%		3.31	1.70	9.54	1.01	0.83

Table 2: Biochemical composition in leaves of different mulberry varieties (Murthy *et al*., 2013).

Mulberry varieties	Leaf maturity	Total Chlorophyll (mg/g)	Chl – a(mg/g)	Chl – b(mg/g)	Moisture Content (%)	Moisture retention After 6 hours (%)
Tr_8	T	3.42	2.16	1.28	78.10	80.16
	M	5.52	3.60	1.92	76.41	78.15
	C	4.56	2.95	1.62	74.03	75.61
Tr_{12}	T	3.74	2.41	1.32	76.80	78.55
	M	6.04	3.95	2.09	75.73	76.13
	C	4.88	3.22	1.68	73.68	75.29
Tr_{20}	T	2.72	1.86	0.84	72.89	74.60
	M	4.21	3.02	1.18	71.14	72.32
	C	3.49	2.47	1.03	68.78	70.78
S_{1708}	T	4.49	2.89	1.60	80.64	81.56
	M	6.38	4.16	2.22	78.19	79.54
	C	5.53	3.68	1.84	75.74	77.19
MS_5	T	2.44	1.53	0.94	70.77	72.04
	M	3.51	2.29	1.23	69.36	68.14
	C	3.07	2.01	1.08	66.84	67.26
C_6	T	2.18	1.24	0.76	66.72	68.26
	M	3.27	2.03	1.02	64.77	66.84
	C	2.79	1.62	0.98	63.16	64.78
C_{10}	T	2.34	1.43	0.81	68.70	70.14
	M	3.41	2.10	1.16	66.71	68.37
	C	2.91	1.82	1.00	64.93	66.90
Matigara black	T	2.70	1.74	1.08	69.05	71.08
	M	4.28	2.93	1.29	67.24	69.12
	C	3.44	2.30	1.14	65.16	67.00
Morus nigra	T	2.64	1.60	1.05	67.19	69.14
	M	4.15	2.83	1.23	65.04	67.32
	C	3.32	2.20	1.10	63.17	66.08
M_5	T	2.86	1.82	1.08	70.59	72.57
	M	4.36	2.98	1.38	69.32	70.93
	C	3.58	2.42	1.19	67.57	69.11
CD @ 5%		0.73	0.60	0.85	5.07	5.14

T: Tender, **M:** Medium, **C:** Coarse

Table 3: Protein content in leaves of different mulberry varieties (Srivastava and Elangovan 2011).

Mulberry varieties	Apical leaf			Middle leaf			Bottom leaf		
	Mean	SD	CV%	Mean	SD	CV%	Mean	SD	CV%
K-2	0.196	0.0543	20.26	0.284	0.103	26.38	0.146	0.05	23.40
S-1	0.160	0.0441	23.65	0.184	0.194	76.66	0.167	0.04	71.70
S-146	0.122	0.0164	9.74	0.14	0.227	11.78	0.208	0.16	21.00
S-13	0.129	0.021	11.87	0.141	0.152	7.82	0.142	0.01	17.90
S-1635	0.168	0.0449	22.87	0.128	0.018	7.50	0.138	0.02	3.24
TR-10	0.147	0.0226	11.17	0.109	0.119	79.66	0.128	0.01	8.21
Mysore local	0.165	0.0123	5.44	0.163	0.163	114.9	0.169	0.06	6.65
Value of' F'	0.002			3.45			1.99		
Test of significance	L.S			H.S			L.S		

Table 4: Carbohydrate content in leaves of different mulberry varieties (Srivastava and Elangovan., 2011).

		Apical leaf		Middle leaf			Bottom leaf		
Mulberry varieties									
	Mean	SD	CV%	Mean	SD	CV%	Mean	SD	CV%
K-2	0.363	0.0753	20.76	0.459	0.0874	19.04	0.374	0.1585	42.39
S-1	0.292	0.125	42.81	0.464	0.0667	14.37	0.519	0.0839	16.16
S-146	0.374	0.0446	11.92	0.474	0.0579	12.23	0.246	0.0163	6.62
S-13	0.326	0.0077	2.36	0.421	0.0131	3.12	0.391	0.0106	27.18
S-1635	0.313	0.1404	44.87	0.257	0.0136	5.30	0.546	0.0101	1.86
TR-10	0.476	0.0466	9.81	0.547	0.0108	1.98	0.342	0.0228	6.68
Mysore local	0.331	0.0179	5.42	0.581	0.0544	3.16	0.562	0.0094	1.68
Value of „F‟	3.47			1.67			-0.19		
Test of significant	H.S			L.S			L.S		

Ali *et al.* (1994) analyzed leaves of various mulberry varieties with regard to biochemical composition and reported highest crude protein content (21.62 %) in leaves of Jatuni followed by M5 variety, similarly Bose *et al.* (1991) studied biochemical composition of mulberry varieties namely S-54, K2, S-36, S-41 and Local and recorded highest moisture content (73.71 %) in leaves of S-54 variety. Furthermore, highest crude protein content (9.88 %) was recorded in leaves of S-36 and S-41 mulberry varieties. Das and Prasad (1974) studied few triploid (TR-8 and TR-10) and tetraploid (T-1 and T-20) mulberry varieties and found triploid mulberry varieties superior in terms of total protein, total sugar and moisture content. The similar research study was conducted by Das and Sikdar (1970) with regard to biochemical constituents of diploid mulberry strains and found no significant differences in protein and carbohydrate contents of these mulberry varieties in comparison to control.

CONCLUSION

Mulberry varieties differ in the biochemical constitution of leaves and also differ with regard to the position of the leaves on the branches. Comparatively the tender mulberry leaves are found to contain most of the biochemical constituents in higher concentration followed by medium and coarse leaves. The mulberry leaves which are rich in optimum level of nutrients are found to accelerate the healthy growth of worms which reflects in the better silk gland development and increased cocoon crop production. Therefore, the careful selection and development of new mulberry varieties with respect to the regions acquires importance for the overall development of the sericulture industry.

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