BIOCHEMICAL CONSTITUENTS OF FOUR DIFFERENT MULBERRY VARIETIES

N. Yasmin[1,*], E. Sree Vaisnava Devi[2] and M. Ramani Bai
[1]P.G and Research Department of Zoology, Muslim Arts College, Thiruvithancode, Kanyakumari District
[2]Research Scholar, Reg Number – 18213092012019, P.G and Research Department of Zoology, Muslim Arts College, Thiruvithancode.
Affiliated to Manonmaniam Sundaranar University, Tirunelveli – 627 012, Tamilnadu, India.

Abstract: The quality of mulberry leaves play an important role in the success of the sericulture industry and directs its economics and hence much effort and research have been carried out to improve the quality and quantity of mulberry leaf production for silkworm rearing and then cocoon production. The nutritional status of different mulberry varieties is ascertained by its biochemical constituents. Mulberry is rich sources of protein, carbohydrate, free aminoacids, chlorophylls, moisture etc. An attempt was made to know the changes in the biochemical components (protein, carbohydrate, free aminoacids), photosynthetic pigments (chlorophyll a, b and total chlorophyll), elements (copper and zinc) and moisture in four popular indigenous mulberry varieties (V1, S36, MR2 and K2) under the influence of minerals such as, copper and zinc by soil application method. The results revealed that the biochemical components were increased in almost all the varieties chosen. The protein (277.25 mg) content was increased in S36 mulberry leaves. The carbohydrate (48.25 mg) and free amino acids (15.70 mg) total chlorophyll (3.18 mg) also increased in MR2 varieties. The moisture content (84.31%) was increased in V1 mulberry. The alterations in biochemical components of mulberry foliage will influence the health, growth and development of silkworm. This in turn results in the production of high quality silk.

Key words **- Mulberry varieties, Nutritional value, Sericulture, Silk**.

I. INTRODUCTION

Mulberry, *Morus alba* (*Moraceae*) is a fast growing deciduous, deep rooting perennial tree that grows throughout the temperate, subtropical and tropical regions. Depending on cultivation conditions, the tree can be grown as a bush or tree [1] and there are at least 1000 known varieties of mulberry [2]. Thirumalaisamy *et al*. [3] screened biochemical content of six varieties of mulberry leaves viz S13, S30, ML, V1 and RFS135 to find out nutritively richer one. Kumar and Chauhan [4] investigated the biochemical constituents in different parts of seven mulberry genotypes. The results indicated that AR-12 mulberry variety have recorded highest biochemical constituents. Foliar application of phosphorous enhance leaf moisture percentage, total chlorophyll, crude protein, total carbohydrates and plant nutrients such as nitrogen, phosphorous, potassium, calcium, magnesium and sulphur [5]. Mulberry leaves are very rich in protein (15-35%), minerals (2.42-4.71%), calcium (0.23-0.97%), and phosphorus 1130-2240 kC /Kg [6-9]. Micro-nutrients improve the moisture and chlorophyll content in mulberry leaf producing thicker and darker leaves with high nutritive value [10]. The quality of the mulberry leaf fed to the silkworm is reflected by the quality of the silk produced. It is very important to produce quality leaves for feeding silkworms. The growth and production of leaf in mulberry depend on intensive management. The naturally occurring fertility of the soil alone cannot be entirely depended upon for good growth and farmers rely on organic and inorganic fertilizers to supplement nutrients for good health and high leaf yield. *M. alba* also contains a considerable amount of dietary supplements such as proteins, carbohydrates, fats, fibres, essential minerals [11], ascorbic acid and carotene [12]. Zinc is an essential element for living organism and an integral component of thousands of protein, although it is toxic in elevated level [13]. Zinc deficiency induces photo oxidative damage under high light intensities [14].

II. MATERIALS AND METHODS

In the present study, four popular mulberry varieties (V1, S36, MR2 and K2) were selected. The micronutrients (copper and zinc) as sulphates were AR grade chemicals. The active ingredient of 1 mg of Cu present in the 3.9 mg $CuSO_4.5H_2O$ and 1 mg of Zn present in the 3.8 mg $ZnSO_4.7H_2O$, were completely dissolved in 100 ml double distilled water to obtain the following concentrations of individual and binary mixture of the two metallic nutrients.

Cu - 0.1 and 0.5%, Zn - 0.1 and 0.5%

Cu + Zn - 0.1 + 0.1%, Cu + Zn - 0.5 + 0.5%

In soil application method, the different mulberry varieties were cultivated on separate pots and supplied with minerals of individual and binary mixtures at different concentrations. The minerals were applied in four times at 15 days interval. After the treatment, 100 g leaves were collected from each variety, dried at 60 °C, powdered, sieved and processed to analyse quantitatively the biochemical constituents such as, protein [15], carbohydrate [16] and free amino acids [17], pigments, chlorophyll a, b and total chlorophyll [18], copper and zinc [19] and moisture [20]. Biochemical analyses were carried out both in control (untreated with mineral) and experimental leaves.

III. RESULT

Maximum protein content (277.25 ± 6.18 mg) was recorded in S36 variety when treated with 0.1% zinc. Protein content reduced (133.14 ± 2.32 mg) in the K2 variety when the leaves were treated with 0.5% zinc (Table 1). Maximum carbohydrate (48.25±1.07 mg) was observed in MR2 leaves treated with 0.1% Cu and reduced (31.28 ± 1.63 mg) in K2 variety treated with 0.5% Zn (Table 2). Maximum (15.70±0.32 mg) amino acid was obtained in MR2 variety with binary mixture of copper and zinc at 0.1% and decreased in (4.00 ± 0.29 mg) V1 variety with 0.5% (Table 3). Maximum moisture content (84.31 ±2.75%) was recorded in V1 variety when treated with Zn at 0.1% and reduced (61.21 ±3.69) in K2 variety with binary mixture of 0.1% copper and zinc (Table 4). Total chlorophyll content was analysed in all the mulberry varieties. When the leaves were treated with low percentage of minerals, chlorophyll contents was increased and was decreased with high percentage of minerals. Maximum total chlorophyll (3.18 ± 0.28 mg) was recorded in MR2 variety with 0.1% Zn and minimum (1.10 ± 0.15 mg) was noticed with binary mixture of Cu + Zn (0.5%) in V1 variety (Table 5). Copper (0.48 mg) content was also increased in S36 mulberry variety. Maximum Zn (1.54± 0.11 mg) was obtained at 0.5% Zn treated group in V1 variety (Table 6 and 7).

Table 1. Effect of minerals on the protein (mg) content of mulberry varieties

Minerals	Concentration (%)	Mulberry varieties			
		V1	S36	MR2	K2
	Control	211.29±4.15	227.31±3.18	212.32±4.13	193.14±2.31
Cu	0.1	231.11±4.53 (9.38)	241.27±4.43 (6.14)	250.18±3.35 (17.83)	225.16±2.35 (16.57)
	0.5	185.12±4.03 (-12.38)	211.32±5.32 (-7.03)	233.28±5.81 (9.87)	173.42±3.43 (-10.21)
Zn	0.1	220.22±4.05 (4.22)	277.25±6.18 (21.96)	273.36±5.85 (28.74)	226.17±3.48 (17.09)
	0.5	196.36±4.09 (-8.48)	190.24±6.25 (-16.30)	175.16±5.18 (-17.50)	133.14±2.32 (-31.06)
Cu+ Zn	0.1+0.1	230.16±1.25 (8.93)	240.36±3.38 (5.74)	263.24±1.14 (23.98)	187.18±5.33 (-3.08)
	0.5+0.5	187.32±2.11 (-11.34)	191.12±4.37 (-15.92)	191.18±5.25 (-9.95)	177.34±5.49 (-8.18)

Table 2. Effect of minerals on the carbohydrate (mg) content of mulberry varieties

Minerals	Concentration (%)	Mulberry varieties			
		V1	S36	MR2	K2
	Control	38.67±2.22	35.36±1.22	40.24±1.15	35.38±2.31
Cu	0.1	43.16±1.11 (11.61)	39.99±1.25 (13.09)	48.25±1.07 (19.90)	39.85±1.43 (12.63)
	0.5	40.75±1.13 (5.37)	36.65±2.23 (13.64)	42.18±1.35 (4.82)	33.31±1.41 (-5.85)*
Zn	0.1	39.45±2.32 (7.45)	38.97±2.46 (10.20)	45.07±1.43 (12.00)	39.89±2.33 (12.74)
	0.5	37.50±1.45 (-3.02)*	32.45±1.37 (-8.22)*	43.85±1.93 (8.97)	31.28±1.63 (-11.58)
Cu+ Zn	0.1+0.1	42.02±2.92 (8.66)	40.09±1.35 (13.37)	44.05±1.05 (9.46)	41.97±2.71 (18.62)
	0.5+0.5	35.45±1.43 (-8.32)*	33.50±1.43 (-5.26)*	39.71±1.08 (-1.31)*	32.32±1.53 (-8.64)*

Table 3. Effect of minerals on the free aminoacids (mg) content of mulberry varieties

Minerals	Concentration (%)	Mulberry varieties			
		V1	S36	MR2	K2
	Control	5.31±0.53	9.32±0.41	10.30±0.38	7.00±0.73
Cu	0.1	6.98±0.39 (31.45)	10.47±0.43 (12.33)	10.35±0.38 (0.48) *	8.30±0.48 (18.57)
	0.5	6.31±0.88 (18.83)	7.53±0.38 (-19.20)	9.00±0.28 (-12.62)	7.98±0.32 (14.00)
		6.00±0.45	11.58±0.38	12.80±0.34	12.00±0.24

Zn	0.1	(12.99)	(24.24)	(24.27)	(71.43)
	0.5	4.00±0.29 (-24.67	7.00 ±0.15 (-24.89)	4.32±0.49 (-58.05)	6.80±0.19 (-2.85) *
Cu+ Zn	0.1+0.1	9.80±0.23 (84.55)	14.88±0.22 (59.65)	15.70±0.32 (52.42)	13.00±0.29 (85.71)
	0.5+0.5	7.45±0.89 (40.30)	5.00±0.28 (-46.35)	6.39±0.23 (-37.96)	4.39±0.22 (-37.28)

Table 4. Effect of minerals on the moisture (%) content of mulberry varieties

Minerals	Concentration (%)	Mulberry varieties			
		V1	S36	MR2	K2
	Control	70.22±3.13	71.25±2.73	74.33±2.22	67.81±4.53
Cu	0.1	72.23±3.14 (2.86) *	77.14±2.86 (8.26)	79.35±1.87 (6.75)	69.75±3.73 (2.86)*
	0.5	67.11±4.25 (-4.43)*	68.25±4.89 (-4.21)*	74.54±2.54 (0.28)*	71.00±2.53 (2.01)*
Zn	0.1	84.31±2.75 (20.06)	81.41±5.32 (14.25)	74.81±1.73 (0.64)*	74.71±2.75 (10.17)
	0.5	61.22±4.68 (-12.81)	64.32±3.14 (-9.73	71.21±3.83 (-4.19)*	69.31±4.73 (2.21)*
Cu+ Zn	0.1+0.1	84.12±2.63 (19.79)	79.81±2.87 (12.01)	78.25±4.89 (5.27) **	61.21±3.69 (-9.73)*
	0.5+0.5	69.08±3.18 (-1.62)*	67.08±3.89 (-5.85)*	75.20±3.53 (1.17)*	61.22±1.83 (-9.71)*

Table 5. Effect of minerals on the total chlorophyll (mg) content of mulberry varieties

Minerals	Concentration (%)	Mulberry varieties			
		V1	S36	MR2	K2
	Control	2.44±0.31	2.71±0.21	2.94±0.17	1.77±0.19
Cu	0.1	2.73±0.31 (11.88)	2.80±0.17 (3.32)*	3.17±0.19 (7.82)	1.91±0.32 (7.90)
	0.5	1.89±0.35 (-22.54)	2.34±0.19 (-13.65)	1.98±0.20 (-32.65)	1.34±0.31 (-24.29)
Zn	0.1	3.03±0.48 (24.18)	2.78±0.32 (2.58)*	3.18±0.28 (8.16)	2.19±0.38 (23.72)
	0.5	1.30±0.43 (-46.72)	1.38±0.24 (-49.07)	2.24±0.27 (-23.80)	1.19±0.41 (-32.76)
Cu+ Zn	0.1+0.1	2.03±0.41 (-16.80)	2.57±0.17 (-5.16)*	2.64±0.26 (-10.20)	2.82±0.42 (59.32)
	0.5+0.5	1.10±0.15 (-54.91)	1.28±0.28 (-52.76)	1.32±0.31 (-55.10)	1.15±0.41 (-35.02)

Table 6. Effect of minerals on the copper (mg) content of mulberry varieties

Minerals	Concentration (%)	Mulberry varieties			
		V1	S36	MR2	K2
	Control	0.15±0.02	0.17±0.04	0.16±0.05	0.17±0.02
Cu	0.1	0.16±0.05 (6.66)*	0.19±0.03 (11.76)	0.19±0.08 (18.75)	0.19±0.04 (11.76)
	0.5	0.46±0.11 (206.66)	0.42±0.12 (147.05)	0.46±0.15 (187.50)	0.38±0.14 (123.52)
Zn	0.1	0.17±0.03 (13.33)	0.18±0.06 (5.88)*	0.22±0.07 (37.50)	0.19±0.06 (11.76)
	0.5	0.27±0.11 (80.00)	0.26±0.12 (52.94)	0.24±0.15 (50.00)	0.28±0.11 (64.70)
		0.19±0.04	0.18±0.08	0.26±0.15	0.18±0.06

Cu+ Zn	0.1+0.1	(26.66)	(5.88)	(62.50)	(5.88)
	0.5+0.5	0.45±0.14 (200.00)	0.48±0.13 (182.35)	0.47±0.13 (193.75)	0.45±0.14 (164.70)

Table 7. Effect of minerals on the zinc (mg) content of mulberry varieties

Minerals	Concentration (%)	Mulberry varieties			
		V1	S36	MR2	K2
	Control	1.08±0.12	1.07±0.12	1.10±0.15	1.11±0.14
Cu	0.1	1.25±0.12 (15.74)	1.19±0.21 (11.21)	1.15±0.15 (4.54)*	1.13±0.14 (1.80)*
	0.5	1.21±0.15 (12.03)	1.24±0.10 (15.88)	1.22±0.15 (10.90)	1.24±0.12 (11.71)
Zn	0.1	1.40±0.13 (29.62)	1.41±0.19 (31.77)	1.42±0.14 (29.09)	1.44±0.13 (29.72)
	0.5	1.54±0.11 (42.59)	1.46±0.15 (36.44)	1.37±0.16 (24.54)	1.38±0.14 (24.32)
Cu+ Zn	0.1+0.1	1.32±0.15 (22.22)	1.39±0.12 (29.90)	1.33±0.12 (20.90)	1.41±0.17 (27.02)
	0.5+0.5	1.43±0.20 (32.40)	1.42±0.13 (32.71)	1.38±0.13 (25.45)	1.39±0.15 (25.22)

IV. DISCUSSION

In the present study, biochemical analysis of four different varities of mulberry leaves was carried out. Among the four varieties, MR2 contains highest carbohydrate, free amino acids and total chlorophyll content. The information collected on the effect of different nutritional sources via. of soil application method on the biochemical analysis revealed that the change in the mean values was significant for the improvement of quality of mulberry leaves. The highest protein content (277.25 ± 6.18 mg) was recorded in S36 mulberry leaves administered with 0.1% Zn. The high protein values observed is in agreement with Thirumalaisamy *et al*. [3] who screened total protein content of six mulberry leaves viz, S13, S30, S36, Mysore local, V1 and RFS135, of which V1 recorded maximum total protein content (26.72%). The carbohydrate content of mulberry leaves is used for physiological combustion. In the study, maximum carbohydrate content (48.25±1.07 mg) was recorded in MR2 mulberry leaves treated with 0.1% of Cu. The free amino acid content was found maximum in MR2 (15.70 mg) with binary mixture 0.1%. The results are correlated with high leaf yield and high protein content. These amino acids provide the nutritional need of the larva. The present result was in agreement with Matei *et al*. [21] who reported that the mulberry leaves contain four main amino acids such as, glycine, alanine, serine and tyrosine. The chlorophyll is the most important component of plants. The result indicated that the total chlorophyll content of mulberry leaves was increased with minerals and also the chlorophyll -a and chlorophyll - b content were increased with individual and binary mixture except binary mixture of 0.5%, where the chlorophyll content decreased when compared to control. Thus, the content of photosynthetic pigments varied depending upon the concentration of minerals and the mulberry varieties thereby increasing photosynthetic activity. Zn concentration in mulberry leaves increased with the supplementation of zinc. The same type of result, in case of Zn accumulation by weed, *Chromolaena odorata* was reported by [22]. Cu also increased in the mulberry leaves when Cu was supplemented to the leaves through oral and soil application methods. The moisture content of the mulberry leaves is a genetic character and is related to the available soil moisture content and root proliferation.

REFFERENCES

1. Rangaswami, G., Narasimhanna, S.M.N., Kaviviswanathan, S.K., Sastry, S.C.R. and Manjeet, S.J. Mulberry Cultivation. FAO, Agri. Seri. Bull., 1976.

2. Rajan, M.V., Dandin, S.V., Magadum, S.V. and Datta, R.K. Nutritional evaluation of mulberry (Morus spp) genotypes through silkworm growth studies. Uttar Pradesh J. Zoo., 20(1): 47-53, 2000.

3. Thirumalaisamy, R., Gowrishankar, J., Suganthapriya, S., Prakash, B., Ashok Kumar, L.and Arunachalam, G. Studies on the biochemical contentsof six varieties of mulberry leaves. J. Biomed. Sci. Res., 1 (1): 11-18, 2009.

4. Kumar, R. and Chauhan,S. Biochemical constituents of different parts of mulberry genotypes. Int. J. Agric. Sci., 2: 90 -96, 2011

5. Trivedy, K., Nair, K.S., Ramesh, M., Gopal, N. and Kumar, S.N. New semi synthetic diet Nutrid - A technology for rearing young instar silkworm in India. J. Sericul., 42: 158 – 161, 2003.

6. Omar, S.S., Shayo, C.M. and Uden,P. Voluntary intake and digestibility of mulberry (Morus alba) diets by growing goats. Trop. Grassland., 33: 177- 181, 1999.

7. Sanchez, M.D. Mulberry for Animal Production FAO. Animal Production and Health Paper, 147: 331, 2002.

8. Saddul, D., Jelan, Z.A., Liang, J.P. and Halim, R.A. The Potential of mulberry (*Morus alba*) as a Fodder Crop: The Effect of Plant Maturity on Yield, Persistence and Nutrient Composition of Plant Fractions. Asian-Aust. J. Anim. Sci., 17(12): 1657- 1662, 2003.

9. Sarita, S., Rashmi, K., Anju, T. And Rajesh Prakash. Nutritional quality of leaves of some genotypes of mulberry (Morus alba). Int. J. Food Sci. Nut., 57(5/6): 305-313, 2006.

10. Mohan, R., Saratchandra, B. and Chakrabarti, S. Response of ß -nine on mulberry. Prospects and Problems of Sericulture an Economic Enterprise inNorth West, India. 126-127, 2006.

11. Srivastava, M.S., Kapoor, R., Thathola, A. and Srivastava R.P. Nutritional quality of leaves of some genotypes of mulberry (*Morus alba*). Int. J. Food Sci. Nutr., 57: 305-313, 2006.

12. Ercisli, S. and Or-han, E. Chemical composition of white (*Morus alba*), red (*Morus rubra*) and black (*Morus nigra*) mulberry fruits. Food Chem., 103: 1380-1384, 2007.

13. Broadley, M.R., White, P.J., Hammond, J.P., Zelko, I. and Lux, A. Zinc in plants. New Phytologist., 173: 677–702, 2007.

14. Cakmake, R.I., Aydln,D.F. and Sahin, A.F. Growth promotion of plants by plant growth promoting Rhizobacteria under green house and two different field soil conditions. Soil Biol. Biochem., 38: 1482- 1487, 2006.

15. Lowry, O.H., Rosenbrough, N.J., Fair, A.L. and Randall,R.J. Protein measurement with folin phenol reagent. Journal of Biological Chem., 193: 265-275, 1951. Lange medical publications, California.

16. Ranganna, S. A Hand book of Fruits and vegetable analysis and Quality control, Oxford Publishing Company, New Delhi. India, 1998.

17. Moore, S. and Stein, W.H. Photometric method for use in chromatography of amino acid. J. Biol. Chem., 176: 367-388, 1948.

18. Mahadevan, A. and Sridhar, R. In: Methods in physiological plant pathology (3rd edn) Sivakami publications, Chennai, pp. 65-66, 1986.

19. Issac, R.A. and Kerber, J.D. Atomic absorption and flame photometry:techniques and uses in soil, plant and water analysis. In: Instrumental Methods for Analysis of Soil and Plant Tissue. Soil Science Society of America–Agronomy Society of America,Inc, Madison, Wisconsin., pp. 17–37, 1971.

20. Babu, R.S., Dorcus, D. and Vivekanandan, M. Possible control of tukra disease in mulberry using aqueous plant extracts of natural pesticide origin. J. Seric. Sci.Jap., 63: 175-182 1994.

21. Matei, A., Machii, H. and Katagiri, K. Varital differences in nutritive values of mulberry leaves for rearing silkworms. J. Agric. Res. Quart., 25: 202- 208, 1997.

22. Tanhan, P., Kruatrachue, M., Pokethitiyook, P. and Chaiyarat, R. Uptake and accumulation of cadmium, lead and zinc by Siam weed [Chromolaenaodorata (L.) King & Robinson]. Chemosphere, 68: 323-329, 2007.