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REVIEW ARTICLE

Mulberry: A Most Common and Multi-therapeutic Plant

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Abstract

The leaves of *Morus alba* Linn. (Family: Moraceae) commonly known as mulberry are mainly used as food for the silkworms and they are sometimes eaten as vegetable or used as cattle fodder in different parts of the world is a mineral rich plant with many therapeutic activity such as anti-diabetic, antibacterial, antioxidant and immune-modulator etc the mineral compositions of mulberry fruit 3.10-3.36 g 100g⁻¹ N, 0.298-0.417 g 100g⁻¹ P, 1.82-2.12 g 100g⁻¹ K, 2.63-2.93 g 100g⁻¹ Ca, 0.593-0.723 g 100g⁻¹ Mg, 0.180-0.325 g 100g⁻¹ S, 63.7-71.2 mg kg⁻¹ Na, 114.3-126.3 mg kg⁻¹ Fe, 69.8-76.8 mg kg⁻¹ Mn, 29.0-36.2 mg kg⁻¹ Zn, and 11.2-17.2 mg kg⁻¹ Cu were determined. The extract of this plant may reduce blood glucose levels by regeneration of β cells and increase in enzyme activity was associated with an increased rate of 3-O-methyl-d-glucose transport in the absence of insulin and with phosphorylation of AS160, a signaling intermediary leading to glucose transporter 4-translocation. Decreased GSH concentrations and the activity of glucose-6-phosphate dehydrogenase and antioxidant enzymes viz., glutathione peroxidase (GPx), glutathione reductase (GR), glutathione-S-transferase (GST) and superoxide dismutase (SOD) observed in uncontrolled diabetes were improved (52%, 69%, 151%, 95%, 24% and 106%) by mulberry treatment very efficiently.

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Introduction

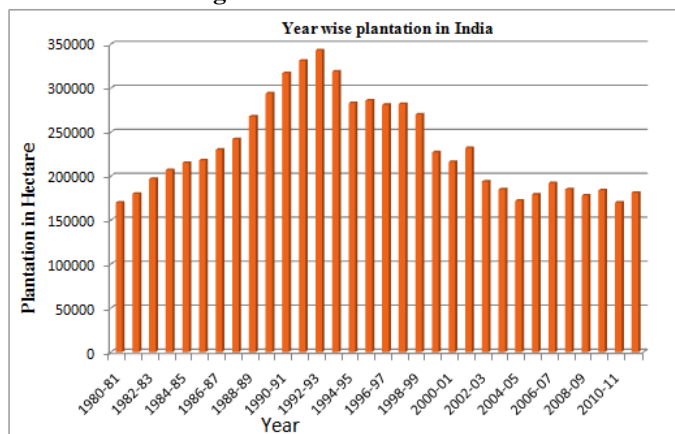
Plants and animal products have been the basis of treatment for human diseases since ancient times. Ayurveda has been one of the traditional systems of medicine practiced in India¹. Mulberry, a fast-growing deciduous plant, grows under different ecological conditions such as tropical, subtropical and temperate worldwide; Mulberry is known in India as "Kalpa Vruksha" as all the parts of the plant have many uses². Mulberry leaf is a major economic component in sericulture since the quality and quantity of leaf produced per unit area has a direct bearing on cocoon harvest³. Over 150 species names have been published, and although differing sources may cite different selections of accepted names, only 10-16 are generally cited as being accepted by the vast majority of botanical authorities⁴. There are about 68 species of the genus *Morus*. The majority of these

species occur in Asia, especially in China (24 species) and Japan (19). Continental America is also rich in its *Morus* species. The genus is poorly represented in Africa, Europe and the Near East, and it is not present in Australia. In India, most states have taken up sericulture as an important agro-industry with excellent results².

Plantation in India- The total acreage of mulberry in India is around 282,244 ha. Year wise plantations of mulberry are as follow till the year 2012⁴.

Table 1- Year wise plantation of Mulberry in India.

Year	Mulberry plantation (in Hectare)
1980-81	170
1981-82	180
1982-83	197
1983-84	207
1984-85	215
1985-86	218
1986-87	230
1987-88	242
1988-89	268
1989-90	294
1990-91	317
1991-92	331
1992-93	343
1993-94	319
1994-95	283
1995-96	286
1996-97	281
1997-98	282
1998-99	270
1999-00	227
2000-01	216
2001-02	232
2002-03	194
2003-04	185
2004-05	172
2005-06	179
2006-07	192
2007-08	185
2008-09	178
2009-10	184
2010-11	170
2011-12	181

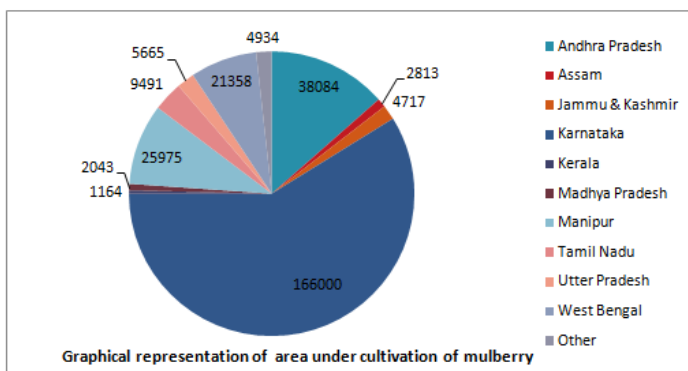
Figure- 1 Plantation Vs Year

Maximum plantations of mulberry were found in the year of 1992-93.

State wise plantations of mulberry are as follow²-

Table- B state wise plantation of mulberry

Sr. no.	State	Area (in hectare)
1	Andhra Pradesh	38084
2	Assam	2813
3	Jammu & Kashmir	4717
4	Karnataka	166000
5	Kerala	1164
6	Madhya Pradesh	2043
7	Manipur	25975
8	Tamil Nadu	9491
9	Utter Pradesh	5665
10	West Bengal	21358
11	Other	4934

Figure- 2 – Graphical representation of cultivation in India

Utilization of mulberry in India- As a most common plant the green mulberry leaves are uses as animal fodder, and the ripe fruit are edible throughout the India.

Mulberry in Industries- In India, Sericulture is mostly a village-based industry providing employment opportunities to a large section of the population. India is the second largest producer of silk in the world with an annual silk production of more than 21,000 M. Tons in 2010-11(provisional). Mulberry silk alone contributes more than 80% of the Country's silk production⁵.

Medicinal Value of mulberry- Immunomodulatory Activity-

The *Morus alba* extract affects humoral immunity as shown by its effect in the indirect haemagglutination test, serum immunoglobulin levels and mice lethality test and it also has effect on the cell mediated immunity as it showed significant increase in the neutrophil adhesion, carbon clearance and a reduction in cyclophosphamide induced neutropenia⁶.

Protective Effects

The *Morus alba* extract in experimental diseased groups was shown by attenuating retinal cell death.

This may be attributed to the observed hypoglycemic effects and reduction of LDL, total cholesterol and creatine phosphokinase activity, which have roles in retinal cell damage. Similar attenuation of atherosclerotic lesion development in mice was carried out by quercetin 3- (6-malonylglucoside), the major flavonoids glycoside in mulberry leaves. The *Morus alba* leaves are rich in flavonoids that act as free radical scavengers. Quercetin and other flavonoids were shown to bind to the surface of LDL particles, and prevented cell death enhancement⁷.

Antioxidant role of mulberry-

Mulberry-treated diabetic rats showed a significant decrease in fasting blood glucose concentrations indicating a good glycemic control. Increased lipid peroxidation and the activity of catalase (CAT) in erythrocytes observed in diabetic controls were significantly decreased by mulberry leaves (48% and 33%, respectively). Decreased GSH concentrations and the activity of glucose-6-phosphate dehydrogenase and antioxidant enzymes viz., glutathione peroxidase (GPx), glutathione reductase (GR), glutathione-S-transferase (GST) and superoxide dismutase (SOD) observed in uncontrolled diabetes were improved (52%, 69%, 151%, 95%, 24% and 106%) by mulberry treatment very efficiently^{8,9}.

Anti-diabetic effect of mulberry-

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The histopathologic effects of mulberry -

The histopathologic studies undertaken on the islets demonstrated the recovery of damaged islets and an improvement in the number of β cells after treatment with the plant extract. It can thus be assumed that *M. alba* leaf extract has a therapeutic effect that alleviates diabetes mellitus. The actual chemical compound that is responsible for this effect requires further investigation¹².

Stimulation of 5_-AMP-activated protein kinase-

Mulberry Leaves Extract increases the activity of both AMPK₁ and ₂ in skeletal muscle, and that this increase is associated with insulin-independent glucose transport without change in the energy status of the muscle. It proposes that *Morus alba* leaf fosters a metabolic milieu that reduces the risk of type 2 diabetes, at least in part, by activating skeletal muscle AMPK¹³.

Antibacterial activity of mulberry-

The antibacterial activity of control drug tetracycline (Aldrich, Germany), extracts and compounds (1 to 6) was studied using serial micro-dilution method (Danielle, 2006). The test microorganisms were supplied by the Microbiology unit of the Department of Basic Sciences, Botswana College of Agriculture. The test microorganisms were *Staphylococcus aureus* (NCTC 4163), *Bacillus subtilis* (NCTC 10073), *Micrococcus flavus* (NCTC 2665), *Streptococcus faecalis* (NCTC 775), *Salmonella abony* (NCIMB 6017), and *Pseudomonas aeruginosa* (NCIMB 10421). The antibacterial activity was expressed as minimum inhibitory concentration (MIC). The assay was also used to establish whether the crude extract or pure compounds were bacteriostatic (MBSC) or bactericidal (MBCC)¹⁴.

Mineral Composition of Mulberry Fruits-

Mulberry fruit mineral compositions of the fruits were determined between 3.10 and 3.36 g 100g⁻¹ for N, 0.298 and 0.417 g 100g⁻¹ for P, 1.82 and 2.12 g 100g⁻¹ for K, 2.63 and 2.93 g 100g⁻¹ for Ca, 0.593 and 0.723 g 100g⁻¹ for Mg, 0.180 and 0.325 g 100g⁻¹ for S, 63.7 and 71.2 mg kg⁻¹ for Na, 114.3 and 126.3 mg kg⁻¹ for Fe, 69.8 and 76.8 mg kg⁻¹ for Mn, 29.0 and 36.2 mg kg⁻¹ for Zn, 11.2 and 17.2 mg kg⁻¹ for Cu during the harvest season. There were significant differences (P<0.01) between the harvest dates in terms of P, K, Ca, Mg, S, Na, Fe, Zn and Cu content of mulberry fruits and statistical differences (P<0.05) were also found in Mn. Whereas, no significant differences were found in N, K, Ca, Mg, S and Zn minerals increased towards the end of the harvest season, but Na and Fe were their highest level even at the beginning of the harvest season¹⁵.

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