



Role of Mulberry Leaves in Human Nutrition: A Review

Fareed Afzal¹, Waseem Khalid^{1*}, Muhammad Naveed Asif¹, Ayesha Jabeen¹, Ravi Prakash Jha², Muhammad Zubair Khalid¹, Chasheen Fizza¹, Afifa Aziz¹, Ramish Akram³, Aqsa Bashir⁴, Sahar Younas⁴, Farwa Nayyer¹, Rehan Yasin¹ and Muhammad Zeeshan Ahmad¹

¹Department of Food Science, Government College University, Faisalabad, Pakistan

²Department of Community Medicine, Institute of Medical Sciences, Banaras Hindu University, Varanasi, India

³Department of Rehabilitation Sciences, The University of Faisalabad, Pakistan

⁴National Institute of Food Science and Technology, University of Agriculture, Faisalabad, Pakistan

***Corresponding Author:** Waseem Khalid, Department of Food Science, Government College University Faisalabad, Pakistan.

E-mail: waseemkhalid@gcuf.edu.pk

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Abstract

Diabetes and different cardiovascular diseases are major problems across the globe for the human. Different traditional and modern medicinal techniques are being in use to cure these problems. Use of herbal medicines is one of them. Present review was conducted to determine the effects of mulberry plant powder for the treatment of these diseases. Mulberry (*Morus alba L.*) is important medicinal plant that contains numerous bioactive compounds including antioxidants i.e. flavonoids, phenolics as well as dietary fiber. Owing to presence of bioactive components, it shows strong effect against maladies like diabetes, cardiovascular disease and viral activities. Mulberry leaf powder is characterized for physicochemical characteristics (moisture content, pH, acidity, TSS, TPC). Moreover, due to high nutrients concentration, mulberry leaves are considered as vital for health.

Keywords: Mulberry Leaves; Phenolic Compounds; Bioactive Compounds; Diabetes; Cancer

Introduction

Herbs have quite a crucial part to play in the rehabilitation of various diseases worldwide. A structured action plan for improving food as a medicine [1], including identification of conventional medicine and presentation of a proper strategy and plan has recently been published by the WHO. In order to improve appropriate understanding of herbal medicines and the development of awareness particularly at university level is important. Development of herbal medicine cultivation is required and the establish-

ment of a connection between traditional and modern treatment techniques. In that comprehensive action plan released by the World Health Organization, proper nutrition is strictly defined with respect to its medicinal sources [2].

Public interest in the functional food and nutraceuticals has been increased in the form of extracts particularly in herbal medicines. About 70% of germ doctors recommended herbal medicines for the treatment of various diseases that are widely used to treat mild to moderate depression than any chemical medication. Pho-

to therapy is recommended reasonably safe because it includes many chemicals of a particular structure that act as an agent that improves effects or neutralize side effects. Scientific data for this presumption is restricted [3].

The mulberry plants with a crown stature of 5–6 feet from ground level and a stem bigness of 4–5 inches or more are called mulberry tree. They are incredibly developed by any of the combinations endorsed for rain-supported regions such as S-13 (for red loamy soil) or S-34 (dim cotton soil) that are resistant to drought or soil-moisture push conditions with the aid of all around produced saplings 8-10 months old. Every year in the middle of the rainstorm season (July-August) to a height of 5-6 feet and permitted to produce at the crown with the largest of 8-10 shoots. The leaves are collected three to four times a year, depending on the thunderstorm, by a leaf-picking process under rain-supported or semi-arid conditions. Mulberry has been made for quite some time in different nations with the sole purpose behind promoting the monophagous silkworm *Bombyx mori* L. It is used for many incredible purposes, for which it is called Kalpavriksha, regardless of the honest use of Mulberry Leaves as a silkworm engagement to goodness. The cutting-edge productivity on the way forward and the use of mulberry for the maintenance and medicinal use of creatures has been started by virtue of the yield for elective occupations of mulberry once the sericulture has rotted in the face of rivalries from outside nations when Japan and Italy should have an opportunity [4].

Mulberry (*Morus alba*) is a crucial helpful plant containing a number of bioactive compounds comprising cancer prevention agents included flavonoids, phenolics and dietary filaments in comparison. Attributable to the presence of bioactive components, it demonstrates a solid effect on disease such as diabetes, cardiovascular infection as well as viral exercises. Mulberry (*Morus alba*) is a profoundly useful plant that produces a range of bioactive compounds namely flavonoid, phenolic and dietary fibres specialists. It is inferable from the proximity of bioactive portions and has a powerful impact on ailments such as diabetes, cardiovascular infirmity and viral activity. Mulberry (*Morus alba*) explores the comprehensive grouping of critical pharmacological activities included antidiuretic, antimicrobial, antimutagenic, developmental neutralizing activity pro, anticancer, anxiolytic, anthelmintic, antistress, immunomodulatory, hypocholesterolemic, anticholeestrolmic and

particular effects such as adaptions, hyperlipidemia, melanin biosynthesis containment. This plant also displayed antiatherogenic growth and the HIV activity was unfriendly [5].

According to the survey conducted by World Health organization, there are almost 80% developing countries whose population believed on the natural medicines which assure the safety of patients and improve the knowledge and skills of medicine provider for health safety. About 25% medicines are related to plants directly and indirectly [6]. Owing to their incapability to foundation side effects and combat antibiotic resistant microorganism plants are used as medicines [7]. About 80% of the population in rural areas rest on wild plants to meet the World Health Organization needs for the primary health worldwide [8]. Contrary to this, there are many types of plants which are the main pillar in traditional health care system and are used as medicine [9]. According to the pharmacological reviews the medicinal plants are potential source for the major antioxidants and bioactive compounds. Phytochemicals extracted from medicinal plants are elements for neutraceuticals [10]. There are about 6000 species of plants which represent 22 families and 150 genera in Pakistan. About 80% populations of rural areas of Pakistan depend on the herbal medicines [11].

In Pakistan about 400 species are widespread from 6000 which are 7.8%. Due to availability and functionality of medicinal plants these are used in different areas of the world especially for respiratory disorder (10 species), diarrhea (12 species), urinary tract infection (UTI) Asthma (9 species), kidney stone (13 species) and rheumatism (6 species) [12]. There are 3000 species of plants which are reported from Gilgit Pakistan and from which almost 124 have medicinal values. Many studies have been conducted on the uses of Mulberry leaves to control the symptoms of medical condition. Some of the results of studies showed that Mulberry leaves can be used as protein source for ruminants. In sericulture industry Mulberry plant is used for determining the profitability and productivity. In sericulture industry the leaves of Mulberry are major component because quality of leaf produced per unit area has a direct bearing cocoon harvest. The maximization of mulberry leaf yield per unit area will lead to the realization of two most important objectives namely increased cocoon production per hectare and reduced cost of production [13]. The cultivation of Mulberry is an applied science involving detailed study of ecological, morphological and physiological features. The study comprises

of cultivation techniques for the best Mulberry leaves production suited for rearing of silkworms and to obtain such leaves from a constant cultivation area in a reasonably inexpensive manner [14].

Composition of mulberry

Vitamins

Mulberry, which is rich in vitamins B and C, can be used by systems for healthy, oxidizing and metabolic turnover of fats and starches for normal or accelerated activities. Similarly, the mulberry leaf contains rutin for dynamic hair-like structure, GABA for heartbeat reduction and DNJ for glucose reduction. In addition, sitosterol is used in mulberry leaves to reduce blood cholesterol levels. In later age, they found successful in relation to last experimental results with mice mulberry leaves. Mulberry leaf powder is now available as tablets or holders in the Korean market. Next emphasis in the Korean market are different techniques for the use of mulberry in humans [15].

Mulberry leaves are viable in directing fat while boosting digestion and are brimming with Vitamin C, A and B group of vitamins. It is highly safe to drink and immaculate non-lethal herb. It is useful for elderly to drink daily and can fight infection. Youthful kids, pregnant ladies and bosom bolstering moms should not drink substantial sums unless it is not recommended by qualified proficient [16].

Bioactive components

Many bioactive components are present in Mulberry leaves and fruits like anthocyanins, alkaloids and flavonoids [17]. Alkaloids are present in large concentration in Mulberry leaves included 1-deoxyojirimycin (DNJ) which is the most potent glycosidase inhibitor that decreases the level of blood-sugar [18,19]. Mulberry have Resveratrol (trans-3,4 1,5-trihydroxystilbene) and Oxyresveratrol (trans-2,31,4,51tetrahydroxystilbene) which are hydroxystilbenes [20]. This bioactive substance has cardio protective and neuroprotection effect [21]. Oxyresveratrol has an inhibitory effect on tyrosinase to lessen the biosynthesis of melanin, used as cosmetic material and medical agent for disorders included hyper pigmentation [22]. Anthocyanins are a group of phenolic compounds naturally responsible for coloring of flowers, fruits and leaves. They are the best source of health benefits as anti-inflammatory and antioxidant compounds [23].

The extract of Mulberry anthocyanin has antimetastatic activity to inhibit migration of B16-F1 cells and anthocyanin has high inhibitory ability on lipid oxidation [24]. Flavonoids are commonly occurred in plant kingdom and mulberry found to contain at least four flavonoids including rutin. Flavonoids have been recognized to possess antioxidant, anti-inflammatory, antithrombotic, antiallergic, antiviral, hepatoprotective, and carcinogenic activities in human beings [25]. Plants are also rich in nutritive compounds like crude fat, crude protein, total sugars and mineral elements and are evaluated to get the correlation between the active components and their antioxidant activities.

Alkaloids

Aegelin, fragrine (C₁₃H₁₁O₃N), agelenine, marmeline, dic-tamine, N-2-hydrooxy-2-(4-hydroxyphenyle) ethyle cinnamide, N-2-[4-(3,3-dimethyleollyoxy) phenyl] ethyle cinnamide, N-2 ethoxy-(2-methoxyphenyle) ethyle cinnamide, O-methylehalfordinine, N-4-methyleoxystyrl cinnamide, O-isopentenylehalfordinol, N-2-methoxy-2-[4-(3,3 dimethylallyloxy) phenyl] ethyle cinnamide, N-2-methoxy-(4-methoxyphenyle) ethylecinnamide and O-(3,3 dimethyleallyle) halofordinol (25). Marmesin, Marmelosin, marm-in, alloimperatorin, imperatorin, xanthotoxol, scoparone, methyl ether, scopletin, umbelliferone, psoralen and marmelide, a-7 geranyleoxycoumarin and marmenole [26].

Phenolic compounds

Epidemiological examinations have confirmed that cancer prevention agent and contamination protective part and movement of the phenolics and high point many report varieties in phenolic compound as a component of plant species. Remarkable dissimilarities were to be observed the leaves of three mulberry collections for add up to phenolic content. These results noticeably advanced than publicized oil palm leaves [27], and Iranian restorative plant [28].

Anthocyanin is rich in mulberry extract and it is a colorant constituent naturally present in plant [29]. Anthocyanins indicated the antioxidant activity by scavenging the peroxy radicals in trapping reaction. Anthocyanin glycosides after 8 hours of administration were no detected in GI tract. Sodium-dependent glucose transporter was used to transport anthocyanins across the erythrocyte. The bioactive constituents which are isolated from *Morus alba* like Kuwanon-G and leachianone showed antibacterial activities and

1-deoxynojirimycin (DNJ) showed α glycosidase inhibitors activity. Similarly extract of *Morus alba* and its other compounds like flavonoids have antioxidant properties by protecting many organs from oxidative stress and scavenging free radicals [30].

Medicinal properties of mulberry

Mulberry leaves contain many pharmacological activities like reduction of hypertension, blood glucose, bacteriostatic, antiviral and antihyperlipidemic because they have amino acids, vitamins, quercetin, sugars, microelements and volatile oils. Lifespan can be intensified due to the presence of bioactive compounds in some species of mulberry [31]. Many other biochemical compounds can be isolated from mulberry plant like Kuwanol, Albufuran, Hydroxymoricin, Albanol, Morusin, Moranoline and Calystegine as they play an imperative role in the pharmaceutical industry, viewed by many scientists [32,33]. Profitable medicinal value can be obtained by medicinal properties of mulberry plant so pharmaceutical industry and research are attracted towards them. In herbal medicine, many conditions are treated using roots, stems, leaves, flowers, bark and fruits. There are many different names of mulberry herbal supplement and each of them invoke to products obtained from mulberry leaves having similar benefits and risks. Some names are noni, wild pine, noni, mengkudu and caribe [34].

Oxidative stress

The imbalance between antioxidants and pro-oxidants mechanisms which results redundant oxidative metabolism. Several environmental factors such as medication, infection, radiations, exposure to pollutants, toxins, alcohol and poor diet etc. can contribute to this stress. It may lead to immense range of human diseases as it damages DNA, protein and other macromolecules which can cause cancer or heart diseases. *Morus alba* leaves has been used as food supplement in patients with certain diseases in that, the oxidative stress induced cellular injury in pathologically involved rats [35].

Hypolipidemic activities

Due to familiarity of its curative functions, *Morus alba* customarily utilized as hypolipidemic agent. *Ficus mysorensis* extracts Ethanol and hexane were examined and evaluated in rats suffering from hypercholesterolemia. Six fractions as well as Hexane were isolated and showed hypolipidemic activities [36]. The root bark of *Morus alba* L. (70% alcohol extract) may behave as powerful hypocholesterolemic element plus inhibit the LDL antherogenic alteration and limit lipidperoxidase synthesis in hypocholesterolemic

mouse [37].

Anti-inflammatory properties of mulberry

With significant anti-inflammatory action a flavonoid, morin is found in mulberry. It was scrutinized that the accumulation of CSA in tissues of lymph and non-lymphoid tissues plus the in the immune cells of rats, is greatly influenced by morin. The more is morin intake the lesser is CSA level in tissues [38]. Flavonoid isolates of *Morus nigra* plus *Morus alba* bark are powerful anti-inflammatory agents [39].

Atherosclerosis effects of mulberry

In a study polyphenols viz quercetin (11.70%), galocatectin gallate (11.02%) plus naringenin (9.012) are found to be present in leaf extracts of mulberry and polyphenols with their strong anti-atherogenic activities. Both of the extracts restricted the peroxidation of lipids and oxidation of low density lipids where extracts of polyphenols tend to be more strong. Polyphenolic leaves extracts of Mulberry can be enhanced as anti-antherogenic elements. Growth and migration of cells of vascular smooth muscles is known as Atherosclerosis. Mulberry leaf group displayed 40% lessening in atherosclerotic size of lesion with comparison to that of control [40].

Effect of mulberry in neurological disorders

The shielding function of mulberry fruit extracts ethanol up to 70% in opposite to neurotoxicity inside and outside of the body of Parkinson's disease models were investigated. Ultimately, mulberry considerably shielded the cells from neurotoxicity in a manner dependent upon doses [41].

Effect of mulberry in neurological disorders

The healthy influence of mulberry extract (ME) good in amounts of phenolics plus anthocyanins were studied. For 12 weeks senescent-accelerated mice [SAMP 8] and [SAMR1] of six months were fed with the diet supplement of 0.18% and 0.9% mulberry extracts. Those supplemented fed rats showed considerable reduction in amyloid beta protein plus improvement in memory to those mice which were treated with ME (Mulberry Extract), exhibited higher activity of antioxidant enzyme whereas less oxidation of lipid liver and brain in contrast to control rat [42].

Role of mulberry in cancer

Isolates of the extracts of ethyl acetate from roots of *Morus alba*, Prenylated flavanone, 7, 2', 4', 6'-tetrahydroxy-6-geranylflavanone

came to function as cytotoxic activists against cells of hepatoma in mice by the dose of an IC₅₀ of 52.8 mg/mL [43]. Likewise, anthocyanins isolate of the fruit of *Morus alba* represented restricted effect on migration as well as invasion of highly metastatic A549 carcinoma cells of human lung [44]. The production of NO was inhibited and the tumor necrosis factor- α LPS activated RAW2647 was noticeably reduced by the methanolic extract plus its sub fractions obtained from aqueous butanol and chloroform fractions.

Mulberry leaves used in Japan and Korea for different kind disease and mostly used in diabetes mellitus and mostly used as nutraceutical and likewise utilized as a tea cake and noodle [45]. In this leaves flavonoids have been detected which is used as cancer inhibition profile agent and additional various parts of species observed [46]. Many cancer inhibition agent inspections have verified which neuroprotective, hypolipidemic, aggressive to hyperglycemic, antiviral, soothing, cytotoxic exercise of various type of Mulberry and against hypotensive and HIV [47]. Soil cell support properties of Mulberry leaves, have specified interruption of oxidative peeling of oil and rice grain oil was seen to be distinct better than the synthetic cancer prevention mediator. A famous element the numerous phytochemical ingredient in Mulberry leaves have practiced in few reports [48].

Importance of mulberry in diabetics

Chinese medicine used leaves of mulberry for cure of diabetes since a long ago due to presence of chemical compounds that reduce high blood sugar levels (hyperglycemia) [49]. After the intake of high sugar foods such as potatoes or sweets the blood sugar level rises sharply that stimulates the secretion of insulin to overcome the problem. But if requirement for more and more insulin happens much strongly with frequent times, the pancreatic ability of producing enough insulin diminish plus body cells become resistant to insulin because of its duty of facilitating transport of glucose across the cell walls. Thus this resistance to insulin being dangerous is the cause of type 2 diabetes. Primarily caused by obesity. Generally, if a man is obese, the risk of diabetes is greater. It was found by a Japanese research group, that the leaves of white Mulberry exhibit compounds that inhibit these intestinal enzymes. Mulberry have 1-deoxynojirimycin (DNJ) plus its derivatives such as alpha-glucosidase inhibitors that are utilized as curatives for diabetes mellitus [50].

Phytochemical-rich plants play a crucial role in consuming less calorie-based diabetes mellitus medicines. Mulberry contains 1-deoxynojirimycin (DNJ) and some of its dependents, which are alpha-glycosidase inhibitors [51,52] used as drugs for the treatment of mellitus diabetes. Mixtures of alpha-glycosidase in the intestinal lumen and in the brush edge film have a fundamental role in the digestion of starch and oligosaccharides into monosaccharides until they are kept [5]. Covering the progress of such stomach-related forces would put off the deterioration of starch including oligosaccharides, thereby reducing glucose consumption and thus covering the stature of postprandial blood glucose levels [53]. Starting late, two or three trials in creatures and people have reported that DNJ-containing mulberry or sericulture stuff cover post-prandial glucose development [18,51,52].

Mulberry leaves are a known usual solution in Asian countries, for prevention diabetes, previous report for example indicated. A strong GI stroke have Mulberry leaves on version of 1-deoxynojirimycin (DNJ) a glucose modest. Moreover, Mulberry leaves nutrition to anticipate diabetes we check the possibility of this concentrate for postprandial glycemic control through human trails went for moving utilization [54].

In this study microarray inspection was used DNA to discover expression quality in the liver of hypercholesterolemia mice preserved with rich polyphenol mulberry leaf explain the instrument concentrate to associated with hypercholesterolemia effect of the distillate. This search is to describe the principle goal of the mulberry leaves, physico-synthetic inspection of mulberry tea and the hyperglycaemic breakdown and mulberry takes off ability of hyperlipidaemia. Importance point of restorative Mulberry tea is the tea which is removed from mulberry tree takes off. Asian yet now it is distinctive to produce world over. White Mulberry and faint mulberry are the most known generous among the 10 generous. In pre-winter the leaves are collected and dehydrated for making tea [55].

Conclusion

The current review conclude that Mulberry leaves are played vital role in human health against several diseases. Mulberry leaves are composed of antioxidants, flavonoid, phenolic compounds and dietary fiber that are used as herbal medicines against cancer, diabetes and neurological disorders.

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