Research Article

# Phytochemistry and Pharmacology of Mulberry fruit

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**Abstract**

Mulberry, an edible fruit is commonly utilized in Asia as natural and functional food, and traditional Chinese drug. Mulberry is an economical and widespread woody plant used in pharmaceuticals and the leaves of mulberry are primarily used as food of silkworms in most Asian countries. It has several potent bioactive substances, including polyphenols and anthocyanins. Novel pharmacological properties of *M. alba* contain anti-asthmatic, antiplatelet, cardioprotective, antidepressant and immunomodulatory behavior. On the other hand, additional experimental studies are required to assess the function of mulberries polyphenols to sustain individual wellbeing. Moreover, the methods by which they present the wellbeing advantage, the mulberry's polyphenols bioavailability studies are likewise rare. In this review, the detailed composition of mulberry's bioactive compounds is presented.

**Keywords:** Anthocyanins, antioxidants, bioactive compounds, flavonoids.

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## Introduction

Mulberry (Morus spp.; Family- Moraceae) is globally distributed in the tropical, subtropical, or temperate zones of the world and can grow in a wide range of climatic, topographical, and soil conditions [1] There are approximately 24 species of mulberry and more than 1000 cultivars predominately originated in south-east Asian countries. The three foremost mulberry species are white mulberry (*Morus alba L.*), red mulberry (*Morus rubra L.*), and black mulberry (*Morusnigra L.*) which are grown all over the world [2]. *M. alba* has white and purple fruits with low acidity and sweet in taste which are mostly used for fresh consumption and are perishable. *M. rubra*, known as "red mulberry", has a sweet taste and low acidity and high in dry matter. *M. nigra*, known as "black mulberry", has slightly acidic flavouring and has juicy fruits with extraordinary color [3]. Due to its high nutrient content mulberry fruit is a popular fruit and has a delicious savour. In most European countries, mulberries are grown for fruit production rather than foliage, due to its nutritive value it is consumed both fresh and processed forms and mulberry can also be utilized for catering diversified needs such as food, fuel, fibre and fodder [4]. More recently, red and black mulberry fruits due to the presence of anthocyanins have gained an important place in the food industry and other bioactive compounds. Thus, the mulberry-based products, syrup, jam, pulp, ice-cream, marmalade, vinegar, concentrate, alcohol, juice, pekmez, muffin and cosmetic products are manufactured.

## Nutritional value

The moisture content of the mulberry fruit varied widely between 78.03–82.4 g/100 g fresh weight (FW). The ash contents were in the range of 0.46 and 0.87 g/100 g dry weight (DW). The total protein content is small, varying between 0.96 and 1.73 g/100 g DW. The total lipid content varies between of 0.48–0.71 g/100 g DW. The crude fibre content of the fruit varies widely between 0.57 and 11.75 g/100 g DW. Among carbohydrates, the main sugars in the mulberry were glucose and fructose, with sucrose not being detected. The concentration of carbohydrates was found to be in the range of 13.83–17.96 g/100g DW. The calorific value, calculated on a dry weight basis, ranged between 64.11 and 84.22 kcal/100 g. The other nutritional components were in the range of titratable acidity (0.84-2.00 %), total sugar (6.64-10.89 g/100 g FW)), reducing sugar (4.94-8.11 g/100 g FW)), non-reducing sugar (1.65-1.78 g/100 g FW)), ascorbic acid (15.20- 17.03 mg/100 g FW)), niacin (0.40-3.10 mg/100 g FW)), riboflavin (0.040-0.088 mg/100 g FW)), alkaloid (390-660 mg/100 g FW) [5].

Phenols increase during the last ripening stage in re colored fruits, due to the maximal accumulation of anthocyanins and flavonols. Phenols have a wide spectrum of biological activitiesthat shows mulberry fruits could be good source ofthese natural constituents. The concentration of phenols was in the range of 880-1650 mg/100 g FW) [6].

The concentration of mineral composition in mulberry fruits is found to be varied among the species and even between the same species. Among the macro minerals (K, Ca, Na, and Mg), the concentration of K, Ca, Na, and Mg Were in the range of 1270-1731 mg/100 g, 440-576 mg/100 g, 260-280 mg/100 g, 240-360 mg/100 g, respectively. Among the essential micro-minerals, Fe, Zn and Ni were present in the concentration of 48-77 mg/100 g, 50-59 mg/100 g, 1.20-2.20 mg/100 g respectively.

## Pharmacology

Pharmacological results have revealed that crude extracts of M. alba polysaccharides and other purified fractions possess various promising bioactivities, including antidiabetic activity, immunomodulatory activity, anti-inflammatory activity, antioxidant activity, hepatoprotective and renoprotective activities and anti-obesity.

### *Antidiabetic Activity*

Diabetes mellitus is a constant endocrine issue portrayed by hyperglycemia identified with metabolic weakness of insulin creation, emission, as well as usage. M. nigra has likewise exhibited great anti-diabetic effects on concentrates and dynamic constituents from specific species of this plant. A few phenolic compounds and isoprenylated flavonoids disengaged from concentrates of M. nigra twigs indicated great antidiabetic activity, including mechanism of peroxisome proliferators-initiated receptor gamma (PPAR) actuation and glucosidase restraint [7].

Research on the constraints of mulberry for improving diabetes focus around the leaves and less on the fruits. Mulberry anthocyanin (125–250 mg kg−1) not only prevented the progressive declining of insulin secretion through protecting β-cell, yet in addition improved hepatic/peripheral tissue glucose uptake. Mulberry's C3G and C3R expanded the degree level of phosphorylated AMPK, AS160, and GLUT4 levels in the plasma membrane, thus reducing diabetes symptoms, especially polydipsia.

### *Antiobesity activity*

Obesity or overweight is a rising issue in the world, which is characterized as a bunching of hazard factors including central obesity, type 2 diabetes insulin opposition, dyslipidemia, osteoarthritis, coronary diseases, certain cancers, and hypertension [8]. A perfect anti-obesity drug should demonstrate positive effects on weight reduction with any adverse effects. Morus alba or “white mulberry” is one of these valuable plant with great potency as antiobesity impacts particularly its leaves and fruits. There are numerouspre-clinical examinations, which confirmed the viabilityof mulberry in decrease of tri-glycerides, total cholesterol, low-density lipoprotein cholesterol (LDL-C) or elevating of high-density lipoprotein cholestrol (HDL-C). Plasma LDL-C has vital job in development and progression of atherosclerosis. Endothelial and vascular smooth muscles produce the free radicals, which are associated with procedure of atherogenesis by activation of NADP, oxidases and NO synthase and produce the lipid peroxides. Antioxidant action of mulberry extract has main role in management of obesity. This system alongside different mechanisms including lipase and adipocyte differentiation inhibitory impacts, stimulatory consequences on energy expenditures, suppressive impacts on absorption and food intake and regulatory effects on lipid metabolism help mulberry to deal with the obesity in obese patients. In spite of the fact that, there are numerous preclinical examinations which clarify the mechanism of action for anti-obesity effects of mulberry, but there is no clinical experiment on anti-obesity effects of mulberry in obese patients [9].

### *Anti-inflammatory activity*

Inflammation is characterized as a set of physiological guard mechanismsoccurring in the body. Notwithstanding, inflammation is likewise viewed as an underlying occasion of major constant ailments, for example, cardiovascular, immune system, eye, age-related, neurodegenerative illnesses, and tumors [10]. Restraining and controlling inflammatory reactions in the human body can be one of basic methodologies for treating chronic ailments.

As we know, mulberry is a good source of C3G, customarily utilized for treating inflammatory conditions, for instance, rheumatoid joint pain.There is developing proof to suggest that MP (a detached M. alba fruit glycoprotein) has anti-inflammation potential by means of modulating pro-/anti-inflammatory cytokine secretion profiles. Mulberry fruit polysaccharides diminished proinflammatory cytokines including interleukin (IL)- 1b and IL-6,particularly

expanding the antiinflammatory cytokine IL-10 and ensuring lipopolysaccharide (LPS)- stimulated macrophages from apoptotic cell termination through the rule of anti and pro- apoptotic protein levels (Liu & Lin, 2012). Morus alba fruit polysaccharide moreover can go about as an immunomodulator by stimulating murine RAW264.7 macrophage cells to release chemokines (RANTES and macrophage incendiary protein-1α) and proinflammatory cytokines (TNF-α and IL-6), and to incite the expression of inducible nitric oxide synthase (iNOS) and cyclooxygenase (COX)- 2, which are responsible for the creationof nitric oxide (NO) and prostaglandin E2, separately [11].

***Anticancer activity***

Malignant growth is a threatening ailment described by unregulated and perpetual cell growth and expansion. On account of its capacity to avoid programmed cell death (apoptosis) as one of the principle forces for keeping up cancer cell multiplication, acceptance of apoptosis in malignant growth has been viewed as a sensible technique to treat malignant growth [12]. The impacts of mulberry polyphenols on cell separation, expansion, and apoptosis are studied in a few malignant growth cell lines or animal tumor models. The conceivable anti-carcinogenesis mechanisms incorporate antioxidant action, initiation of apoptosis, antiproliferation, detoxification action and antiangiogenic movement. For example, the antiproliferation activities of crude and aged Korean mulberries on human gastric carcinoma cell lines [13]. Hydroxycinnamic acid derivatives of mulberry fruit increases ROS creation by acting as pro-oxidants and thus killing the malignant growth cells. Anthocyanins, cyanidin 3-rutinoside, and cyanidin 3-glucoside, from fruits of mulberry exhibited an inhibitory effect on the migration and invasion of a human lung cancer cell line.

## Conclusion and Future Prospects

We know that mulberryis the primary food for silkworms, which supported the silk trade overhundreds of years, besides that*M. alba* has a extensive way to be a versatile plant with uses as animal feed, food, cosmetics, and medicine. Majority of the features of the mulberry were attributable to its antioxidant capacity owing to plentiful phytochemical constituents for instance polyphenols, flavonoids and anthocyanins. Mulberry juice and its other products also provide shield for various diseases such as diabetes mellitus, neurodegenrative diseases, atherosclerosis and depression. The potential mechanisms of the wellbeing-promising effects of mulberry's polyphenols are yet uncertain. Last but not least, there is, however, a need of further studies that ought to focus on the interactions between mulberry's polyphenols and responsible genes to increase a better sympathetic at the molecular level.

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