



Morphology, chemical composition and medicinal properties of *Morus nigra* L. A review

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Abstract

Black Mulberry (*Morus nigra* L.) is a perennial shrub belonging to the Moraceae family. It has been cultivated throughout the world and used for thousands of years for food coloring, flavoring and traditional medicinal purposes. Mostly *Morus nigra* L. contains fatty acids, vitamins, proteins, carbohydrates, and phenolic compounds. The extent of each of these chemical constituents varies depending on the type of species as well as cultivation conditions such as soil type, weather, irrigation, pruning and other horticulture practices. Black Mulberry is an essential component of several applications that range from food, cosmetics to pharmaceutical products. More use and applications of black Mulberry by-products are continuously added. Further research is needed to maximize its yield, preservation and oil extraction methods, particularly in the developing world where black Mulberry leaf and flower harvesting and post-harvest processing methods are much traditional.

Key words: *Morus nigra*, linoleic acid, α -tocopherol, fatty acids

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1. Botany

1.1. Introduction

Black Mulberry (*Morus nigra* L.) is a perennial shrub belonging to the family *Moraceae* [1]. It has been used for several diseases by local people as medicine. The genus *Morus* contains 68 species and 100 known varieties [2]. Its species are native to Southern Europe and in Southwest Asia (Aydin, Yilmaz et al. 2011). Some monoecious black Mulberry bushes are pollinated by wind. Other varieties of black Mulberry set fruit without pollination [3]. *Morus nigra* is known by different names depending where you are in the world. It is known as Kala Toot (Urdu), Murier noir, mûre (French), Schwarzer (German), tut-shah-tut (Hindi), Murbei (Indonesian), Gelsonero (Italian), and Mora negra, Morero, Morera negra (Spanish) [4]. Plants may be monoecious or dioecious which can grow up to 9 m in height [5]. Black Mulberry is an ornamental plant due to its short trunk [6]. Black Mulberry is morphologically and chemically highly variable. These variations appear to be strongly influenced by environment. The origin, source and growing conditions of *Morus nigra* have an impact on the plants uses, flavors and medicinal uses. The variability of black Mulberry is reflected in wide range of its uses, which will be later explored in this article.

1.2. History

Morus nigra is native to Iran. For more than 5000 years ago, black Mulberry has been planted for its edible fruit [7]. It was brought to Europe before Roman Empire [8]. The generic name *Morus nigra* comes from the Latin word, “mora” meaning “delay” and “nigra” meaning “black”. The particular name of the plant black Mulberry is especially due to the dark color of the fruit. A number of origins are suggested for black mulberry [9]. Some people think black Mulberry came from Asia and then cultivated in different regions of Europe, America (North and South), and Africa. Today it has been cultivated in Southern Europe and Southwest Asia and is renowned as one of most vital fruits of Mediterranean regions [2].

1.3. Demography/Location

Although black mulberry is grown in a variety of climatic conditions but the optimum conditions are found in countries with temperate climate. Geographically the black mulberry is found from temperate to subtropical regions of the Northern hemisphere [2]. Black Mulberries thrive in temperate climates, open plains, and maritime habitats, as well as on the slopes of hillocks. They prefer loose, light, muddy, sandy soils which are neither too dry nor too damp. Black Mulberry is sensitive to frost and wet summers [5]. It has deep root system. Black Mulberry is grown widely in the following countries: Iran, Canada, China, Cuba, Haiti, India, Italy, Japan Dominican Republic, Germany, Sweden,

Tanzania, United Kingdom, Greece, Puerto Rico, Spain, United States of America, and Pakistan [10]. Black Mulberry has delicate fruit that's why it lacks commercial commodity.

1.4. Botany, Morphology, Ecology

Morus nigra is a deciduous tree, which grows up to 10m height. Its stem is much branched. Stem color ranges from dull orange tinged to dark grey. Its appearance is attractive. Leaves are simple, alternate, thick, rough, dark green, broadly ovate, petiolate, and sometimes irregularly lobed. Flowers are unisexual spikes. They may be dioeciously either on the same tree or different trees. The female flowers are borne in erect, cylindrical short capitate spikes. Male flowers are in catkin like spikes. Fruits are fleshy deep red drupes, 2-8.5 cm long, cylindrical or ovoid, sweet and edible [11]. Black Mulberry can grow in kitchen gardens and farmyards. Trees grow very rapidly. They need full sun and adequate space (at least 4.5 m between each tree). They generally thrive with minimal fertilization. Although black Mulberry is resistant to drought but it has to be watered during the dry season. If the roots become too dry, the fruit is likely to drop before being fully ripened. Pot trees need repotting each year before the commencement of new growth (Weiguo, Zhihua et al. 2007). Black mulberry can grow in slightly acidic to alkaline soils having pH range (5.6-6.5) [12]. Optimum temperature for germination and growth is 24°C to 34°C.

2. Chemistry

The major nutritional components found in *Morus nigra* are moisture, ash, lipids, proteins, fibers, carbohydrates, and total sugars. Its ripe fruits contain moisture 85.5%, protein 0.7%, fat 0.4%, carbohydrates 12.2%, fiber 0.8%, mineral matter 0.4%, calcium 60 mg, phosphorus 20 mg, iron 2.6 mg/100g, thiamine 58 mg, nicotinic acid 0.2 mg, riboflavin 92 mg, and ascorbic acid 10 mg /100g [13]. Glucose and fructose are the main sugars having six carbons in them. Sucrose is the most common disaccharides in fruits [14]. Seeds contain crude oil (27.5 to 33%), crude protein (20.2 to 22.5%), ash (3.5 to 6%), carbohydrates (42.4 to 46.6%), and total phenolics (112.2 to 152.0 mg/100g). Approximately, twenty fatty acids are present in seeds, of which linoleic acid, oleic acid, palmitic acid, and stearic acid are more prominent. The α -tocopherol content of seed ranges from (0.17 to 0.20 mg/100g). Major sterols of mulberry seed oil include beta-sitosterol, clerosterol, 24-stigmastadienol, D5-avenasterol, and 23-stigmastadienol [15]. Figure 1 shows structures of important phytochemicals of *Morus nigra* L. Cyanin is a red pigment, responsible for purplish red color of fruit. Chemical composition of *Morus nigra* varies due to geographic influences. The nutritional and physicochemical properties of seeds oil are affected by fatty acid composition. Climatic variations influence the fatty acid profile much more than the genotypic variations. Similarly, temperature is also the

most important factor which influences nutritional composition of the plant [16].

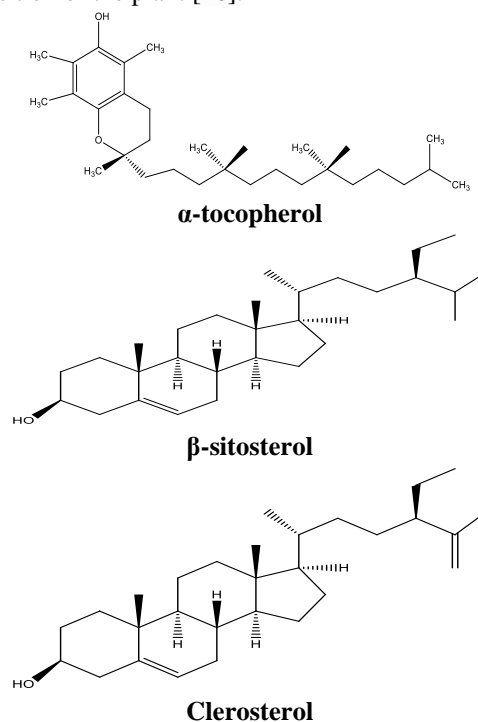


Fig.1. Structures of some important phytochemicals found in *Morus nigra* L.

3. Post-harvest technology

The fruit of black mulberry ripens in late summer. The fruits can be harvested at any time of the day. After maturation, fruit itself falls from the tree. But harvesting should not be done until they are fully ripe. After maturation, harvesting is easily done by tree shaking and hand sorting. Black Mulberry fruit is more difficult to pick, as the berries are squeezed, they tend to collapse, staining the hands and clothes with black red juice. Black Mulberry fruit has extremely short shelf life. If fruit is allowed to store for longer period of time its properties may change [17]. The black Mulberry fruits are highly perishable. So these cannot be transported to distant markets. The fruits therefore have to be sold locally. This is the biggest factor which prevents large scale commercial cultivation of this fruit. Most of the black Mulberry plantations have been raised for sericulture only.

4. Value addition

Black mulberry is used for value addition in jams, jellies, marmalade, juices, ice-creams, fruit sauces, cakes, cookies, and pasteurized milk (as coloring agent).

5. General uses

Black Mulberry has many uses ranging from medicine to cosmetics. The root, barks, twigs and fruit of *Morus nigra* are traditionally prescribed to treat cough, asthma, chest complaints and rheumatism. The fruit is especially useful in the treatment of mouth lesions, sore throat, fever, dyspepsia and melancholia. The bark is used for toothache. Leaves are used as antidote for snakebites. *Morus nigra* bark has been reputed anthelmintic, and is used

to expel tape worm [18]. The decoction of the leaves has blood-purifying properties. Black Mulberry improves blood circulation. *Morus nigra* helps to prevent heart diseases. In Chinese medicine, black Mulberry was used as a blood tonic. Black Mulberry strengthens the Kidneys and cleanses the liver. Black Mulberry is rich in ascorbic acid and flavonoids which make it a natural immune stimulator to prevent microbial infections such as flu, cough and cold. Black Mulberry also cures gastritis conditions and chronic hepatitis. Dried leaf are used in herbal tea and food supplements [19]. Black Mulberry juice stimulates healing and accelerates blood circulation to avoid the inception of infection. It boosts the nervous system and lowers cholesterol level to prevent the blockage of blood arteries and veins. Black Mulberry juice is best for those spending hours on computers because it is rich in vitamin A and stimulates vision. Leaves play a vital role in rearing silkworm, *Bombyx mori* [20]. The root extracts contains deoxyjirimycin, an alkaloid, which is considered to be effective against HIV [20]. Melanin production in hair is enhanced by black Mulberry which retains natural hair color. Black mulberry is renowned as effective anti-aging agent. It helps in removing dark blemishes from face. Experts recommend black mulberry fruit, tea, and juice to rejuvenate the skin. Leaves can be used to cure dry skin by steeping them in olive or coconut oil for some days and applying the oil onto skin. Black mulberry bath salts and soaps having skin softening properties are available in the market. Black Mulberry wood can be used as fuel [21].

6. Pharmacological uses

6.1. Anti-diabetic activity

Numerous drugs are used to control diabetes, but, perfect glycemic control is rarely achieved. Medicinal plants are being used for the treatment of diabetes, from millennia, by underprivileged people who have limited access to synthetic drugs. *Diabetes mellitus* is a group of the metabolic disorders. It is characterized by hyperglycemia resulting from defects in secretion of insulin. Pathogens also cause diabetes. Leaves of this plant contain deoxyjirimycin (a potent α -glycosidase inhibitor) and are being used by the diabetic patients in many regions of the world. Antidiabetic effects of black Mulberry leaf are comparable to standard drug Glibenclamide [22].

6.2. Anti-oxidant activity

Due to oxidative reactions in human body free radical may form which are dangerous for humans. Hydrogen peroxide intoxicated erythrocytes haemolysis is repressed by black Mulberry fruit juice. Tert-butyl hydro peroxide (tBH) induced malondialdehyde (MDA) formation, which damages cellular membranes of isolated hepatic cells, is also prevented by black mulberry. Inhibition of oxidation of low density lipids induced by copper (II) ions was also achieved. It was suggested that black mulberry fruit has a protective effect against peroxidative damage of cellular membranes and bio-molecules [23].

6.3. Anti-cancer activity

Cancer is a death causing disease which is characterized by uncontrolled cell growth [24]. The cytotoxicity of *Morus nigra* leaves extract (methanolic) against human cervical cancer cell line (HeLa) was investigated using MTT (methyl-thiazolyl-tetrazolium) model. Results revealed that extract at dose of 100 $\mu\text{g/ml}$ inhibited 89.5 to 99% of HeLa cell line, which proved its anticancer potential [24]. Prostate cancer is the 2nd greatest cause of cancer related deaths after lung cancer among man. Various treatments such as radiation therapy, chemotherapy, brachytherapy, and hormonal therapy are recommended for controlling prostate cancer. Of the conventional modalities for prostate cancer treatment, chemotherapeutic drugs lead to various side effects. Natural chemotherapeutic drugs isolated from medicinal plants induce selective apoptosis and/or growth arrest in cancer cells without causing injurious effect in healthy cells. A study was designed to investigate the cytotoxic effect of dimethyl sulfoxide extract of *Morus nigra* in human prostate adenocarcinoma cells (PC-3), using methyl-thiazolyl-tetrazolium assay. Results revealed that *Morus nigra* is a potential candidate for the development of new natural product based therapeutic drugs against prostate cancer [25].

6.4. Anti-bacterial activity

Antibacterial activity of black mulberry fruit extract (ethanolic) was assessed using microdilution and disc diffusion methods, against *Staphylococcus epidermidis* and *Propionibacterium acnes*. MIC (minimum inhibitory concentration) value was 2.5 % against both bacterial isolates. While, MBC (minimum bactericidal concentration) values for *Staphylococcus epidermidis* and *Propionibacterium acnes* were 2.5% and 5%, respectively. Results suggested potential antibacterial activity of black mulberry fruit [26].

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