

A Fruit Review on Marvelous Milberry With Its Nutrition, Pharmacological Activity and Formulation

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ABSTRACT

The mulberry (*Morus alba*), which is a member of the Moraceae family, is a symbol of fruit coldness. It comes in three different colours: white, red, and black. Its fruits have a variety of therapeutic benefits, including antioxidant, anticancer, antidiabetic, hepatoprotective, neuroprotective, anti-inflammatory, anti-obesity, hypolipidemic, and antibacterial qualities. Their nutritional makeup and phytochemical-mediated biological pathways further bolster their significance. Although there are many different species of mulberries, the review focusses on *Morus alba*, *Morus nigra*, and *Morus rubra*, whose precise roles in biological systems are still not well understood. It also highlights recent developments in our understanding of their pharmacological properties, emphasising their relevance in therapeutic applications.

Keywords: Mulberry, Therapeutic Benefits, Nutritional Composition, Phytochemical-Mediated

INTRODUCTION

The therapeutic properties of *Morus alba* L. leaves, whose Latin name is derived from *Folium Mori*, are found in the Han dynasty more than 2,000 years ago, and are recorded in the *Shennong Materia Medica*. The dried Chinese name for these leaves is Sangye. Subsequently, Li Shizhen in the Ming Dynasty supplied mulberry leaves in the book of *Compendium of Materia Medica*, which listed the benefits of detoxifying, dispelling harmful winds, promoting blood circulation, and easing stasis. [1,2,3] A woody perennial plant, mulberries are native to China. It belongs to the Moraceae family and grows in a variety of climates, including tropical and subtropical ones. It is used in Chinese and Indian medicine for the most part, and in Japan, mulberry leaves are used to make tea and juice powder. It will be shown that it contains steroids, flavonoids, amino acids, vitamins, triterpenes, and other trace elements. It has many species, including *Morus laevigata*, *Morus rubra*, *Morus nigra*, and *Morus alba*. Its roots, leaves, bark, stem twigs, and fruits contain valuable bioactive

constituents, and its black and red varieties are known for their beneficial effects on the human body. Mulberry varieties are Unani and acknowledged in Ayurveda and Chinese medicine [4,5]. In Unani medicine is known as Tutiaswad & Indian mulberry is known as it grow in Kalpa Vruksha 24 40 28°C May through June is India's ideal growth season in terms of temperature. The physiological and biochemical roles of various molecular weight peptides generated from various plants have been extensively studied, but little is known about the oligopeptides' potential as antidiabetic and antioxidant medicines. High-performance liquid chromatography (HPLC) and protein sequencers will be used in this work to separate and characterise oligopeptides from different mulberry cultivars. Additionally, the target peptides' in vitro antioxidant and antidiabetic activities will be assessed. Substrates or byproducts of the breakdown of primary metabolites are the source of secondary metabolites. Substances known as secondary metabolites are found in minimal amounts yet are just as crucial to the basic physiological processes of plants. [6,7]. Fig.No.01 & 02

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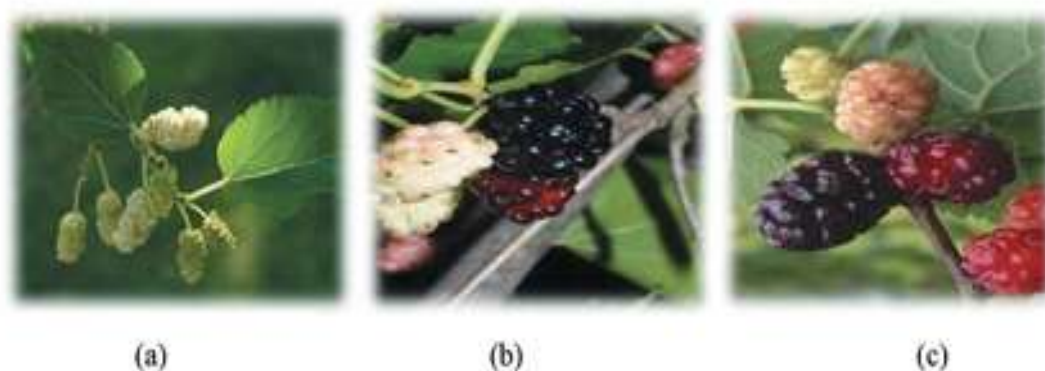


Fig.1. (a) *Morus alba*, (b) *Morus nigra*, (c) *Morus* (Source: Indian Silk, CSB, Bangalore).



Fig.02

The Geographical and Biological Origins of Mulberry

Biological Origin: Botanical Name:

The main source of mulberry leaves is the genus *Morus*, which is a member of the Moraceae family.

Principal Species: The following plants are most frequently used for their leaves: The most often grown species is *Morus alba*, or white mulberry, which is particularly used to feed silkworms. The black mulberry, or *Morus nigra*, is grown for its fruit but also for its leaves. Native to North America, *Morus rubra* (Red Mulberry) has certain applications for its leaves. India and Southeast Asia are home to the Indian Mulberry, or *Morus indica*. The genus *Morus* contains about 68 species that are known to exist.

Geographical Source:

Native Areas: The Northern Hemisphere's temperate and subtropical zones are home to the genus *Morus*.

Most of the species can be found in: **Asia:** In particular, Japan (about 19 species) and China (about 24 species) have the highest variety. There are also a lot of native species in Korea and India. Many cultivated cultivars are said to have originated in the foothills of the Himalayas. Numerous native *Morus* species can be found throughout North America.

CLASSIFICATION:

Morus Species

Kingdom: Plantae

Subkingdom: Tracheobionta

Superdivision: Spermatophyta

Division: Magnoliophyta

Class: Magnoliopsida

Subclass: Hamamelididae

Order: Urticales

Family: Moraceae

Genus: *Morus* L.

HEALTH BENEFITS:

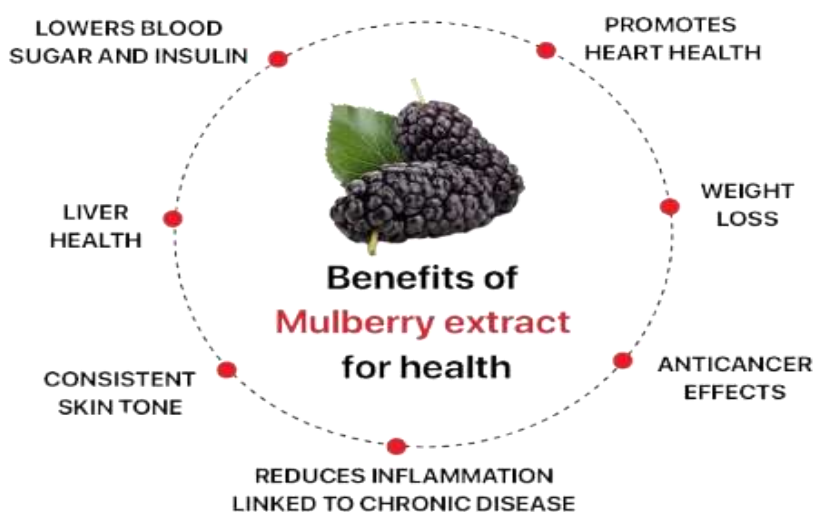


Fig.no.03

PHARMACOLOGICAL ACTIVITY:

1. Antidiabetic

The leaves of the mulberry exhibit this behaviour. There is one decynojinmyon in mulberries. It will block the alpha-amylase and alpha-galactosidases as well as flavonoids and associated components found in mulberries. A supplement called morus alba has hypoglycemic properties. Blood glucose levels dropped by 22% after consuming 1g/kg of fruit for six weeks, which also had a compounding effect on 4g/kg of insulin. The mulberry fruit extract inhibited alpha-glucosidase activity, increased glucose fasting, and caused streptozotocin-induced glycosylated blood protein in diabetic mice. In diabetic mice, glycemia-induced fasting reduction was seen in glycated serum protein, triglycerides, total cholesterol, and insulin Ampk & GLUT-4 expression levels. Sensitivity will be detected.

2. Antioxidant

Some of the withstanding compounds, such as fats, oils, meals, etc., help to prevent deterioration by oxidation, while other substances, like vitamin C and vitamin E, work together to counteract the negative effects of oxidation. Impacts of oxidation on the existence of living organisms. Free radicals include unpaired electrons, which are thought of as fragments of molecules that are usually particularly reactive. They

are continuously produced in the cells as metabolic byproducts [22]. Then, it is important to keep in mind that plants have the natural ability to produce certain protective anti-oxidative defence enzymes, such as glutathione reductases, catalases, peroxidases, polyphenol oxidases, and ascorbate peroxidases, under any given environmental stress. Mulberry leaves are rich in flavonoids, which make them a great antioxidant. Mulberry leaves' increased antioxidative ability is linked to higher concentrations of flavonoids and phenols [20, 21]. High flavonoids of antioxidants. Activity has a variety of uses, including (i) preventing reactive oxygen species suppression, (ii) immobilising leukocytes, (iii) preventing nitric oxide, and (iv) preventing xanthine oxidase [24]. Due to their physiological functions in plants, these flavonoids are essential for human consumption [25]. The reason for this could be that mulberry leaves contain more quercetin, which slows down the rate of oxidation [19].

3. Neurological Dysfunctions

One of the most well-known medicinal plants for treating various neurological dysfunctions, including cognitive issues, is mulberry. As previously stated, it has been demonstrated that phenolic chemicals, flavonoids, and anthocyanins have neuroprotective properties [26]. Mulberry leaves include alkaloids and polyphenols that both enhance the brain and slow the process of neurodegeneration [27]. It has been

demonstrated that the chemicals extracted from mulberry leaves may be useful in neurogenesis for neurodegenerative diseases like Alzheimer's. They prevent amyloid β -peptide from accumulating (91-42) and reduce its neurotoxic effects (1-42) [28].

4. Antimicrobials

Thus far, several articles have clarified the antibacterial characteristics of mulberry extracts. Antimicrobials help protect against bacteria, fungus, viruses, and other dangerous microorganisms. Mulberries suppress germs and increase the production of antibiotics, among other antibacterial qualities. Although mulberry extracts are harmless for autochthonous gut flora, they do have germicidal effects. Mulberry has the potential to be a fruit with promise and a medicinal material, as evidenced by its antiviral characteristics [31]. Mulberry leaf extracts provide a variety of beneficial phytoconstituents that effectively combat harmful diseases. Mulberry leaves include kuwanon C, mulberrofuran G, and albanol B, which have high antibacterial activity and minimum inhibitory concentrations (MICs) ranging from 5 to 30 mg/mL [32]. Zafar et al. (2013) reported that the methanolic extract of *M. alba* containing Kuwanon G substantially suppressed the tooth decay-causing bacteria *Streptococcus mutans* [33]. 8.0 mg/mL was determined to be the MIC. Because of its flavonoid and phenolic contents, the mulberry leaf extract in ethanol has a moderate antibacterial effect, according to structure–activity relationship studies. Numerous pathogens, such as *Salmonella typhimurium*, *E. Coli*, *Staphylococcus epidermis*, *S. aureus*, *Candida albicans*, and *Saccharomyces cerevisiae*, can be inhibited by the flavonoids included in mulberry leaves [34]. Because of their many defensive mechanisms, polyphenols have lately been suggested as potential agents in the battle against SARS-coronavirus-2. According to a 2020 study by Utomo et al., polyphenols found in citrus fruits, berries, grapes, green tea, and curcumin may help prevent coronavirus infections [35]. In light of this, recent research has found that polyphenols effectively block the entry of viruses, such as SARS-coronavirus-2, into human cells by binding firmly to their S protein (Chojnacka et al., 2021). Additionally, certain compounds found in *M. alba* have anti-inflammatory effects on the respiratory system. However, LPS is the main cause of inflammation, and mice are used to

evaluate these factors mostly in vivo [37]. But the effectiveness of polyphenol.

5. Anticancer

Flavonoids have been proven to be helpful in avoiding cancer, and some isoflaones have been shown to reduce cancer in a variety of animal models. Numerous studies have demonstrated that flavonoids prevent cancer in vitro, and some significant data also imply that they do so in vivo. The most common phenolic component in mulberry leaves is flavonoids [38]. The results of this study also demonstrate that mulberry leaf extracts have advantageous cytotoxic effects on cancerous cells. The galactose-bonded lectin isolated from mulberry leaves shows cytotoxic effect, with an IC₅₀ of 8.5 μ g/mL for human breast cancer and an IC₅₀ of 16 μ g/mL for colon cancer cells [40]. Mulberry leaves contain a range of phenolic compounds that block topo-isomerase II activity and capture the cell cycle at the G2-M phase, thereby causing anticancer action in hepatoma cells. Mulberry leaves also contain phenolic chemicals called anthocyanins, which have therapeutic advantages by lowering the risk of cancer due to their high chemopreventive characteristics [41]. Human beta leukaemia can be slowed down by quercetin, another flavonoid present in mulberry leaves [42]. Numerous other clinical trials have demonstrated the therapeutic potential of mulberry leaves against cytotoxicity as a readily available, affordable form of cancer treatment that reduces the invasiveness of cancer cells. Furthermore, quercetins and flavonoids found in mulberry leaves showed particular cytotoxicity against human ovarian cancer [43].

6. Antiinflammatory

Cyanidin-3-glucoside (C3 G), a known anthocyanin found in mulberry fruits, has an impact on a number of haematological parameters in animal systems, such as reducing blood triglycerides associated with inflammation and high-density lipoprotein cholesterol (Kim and Park, 2006). It has Reports state that C3 G can prevent endothelial differentiation due to its anti-inflammatory and free radical scavenging qualities (Kang et al., 2006). Additionally, the researchers observed that pro-inflammatory cytokines in the mice's serum were reduced by the flavonoids of black mulberries (Chen et al., 2016). [44]

7. Hepatoprotective

Deniz et al. (2018) investigated the hepatoprotective impact of extracts from black mulberries (*Morus nigra*) on hepatic damage caused by carbon tetrachloride (CCL₄). Rats were given injections of carbon tetrachloride diluted in soybean oil (1 ml/kg/twice a week). Serum levels of the liver enzymes aspartate aminotransferase (AST), alanine aminotransferase (ALT), and gamma-glutamyltransferase (GGT) were measured in rats given black mulberry extracts after hepatic damage. Their research showed that black mulberry extract increased the activity of the antioxidant enzymes glutathione peroxidase (GPX) and superoxide dismutase (SOD), including an increase in the production of AST and GGT, and reduced the oxidation caused by carbon tetrachloride. MFE may limit fatty acid synthesis and enhance oxidation, according to a study that confirmed its hepatoprotective qualities (Chang et al., 2013). Additionally, mulberry fruit anthocyanins were used to evaluate the hepatoprotective effects of rats with carbon tetrachloride-induced hepatic fibrosis. Rats administered mulberry fruit orally show reduced levels of liver enzymes, hydroxyproline, hyaluronidase, ALT (alanine aminotransferase), AST (aspartate aminotransferase), and collagen type 3 (Li et al., 2016). Furthermore, Hu et al. (2019) isolated the three different mulberry fruit polysaccharide fractions (MFP-I, MFP-II, and MFP-III) by stepwise precipitation with 30%, 60%, and 90% ethanol, respectively, and evaluated their capacity to stop palmitic acid (PA)-induced hepatocyte lipotoxicity. MFP-I and MFP-III demonstrated minimal protection, while MFP-II significantly reduced PA-induced hepatic lipotoxicity at 0.1 and 0.2 mg/mL. The study found that nuclear factor erythroid-2-related factor 2 was elevated by MFP-II. (Nrf2) phosphorylation and its nuclear translocation, which subsequently triggered the Nrf2/ARE signalling pathway, shielded hepatocytes against PA. Additionally, it boosted the expression of the genes for glutathione peroxidase, catalase, γ -glutamate-cysteine ligase, NAD(P)H: quinone oxidoreductase 1, and heme oxygenase 1. -caused oxidative damage and lipotoxicity. [45,46,47]

8. Obesity Hypolipidemic

Obesity is becoming a big concern in today's culture because it increases the risk of diabetes, cancer, and cardiovascular disease. In several cutting-edge studies, mulberry fruits have shown the strongest anti-obesity effects. Yang et al. (2010) discovered that when rats were given mulberry fruit powder, their blood levels of liver triglycerides, total cholesterol, low-density lipoprotein cholesterol, and atherogenic index increased. Furthermore, there was a notable rise in blood high density lipoprotein in cholesterol. Similarly, Sirikanchanarod et al. (2016) discovered that over a six-week period in which hypercholesterolemic individuals consumed 45 g of freeze-dried mulberry fruits, there was a significant. According to Lim et al. (2013), mulberry fruit and leaf extracts reduced hepatic lipids and plasma triglycerides. They also noted the extracts' blending effect on mice that were made obese by excessive fat. enhancement in adipocyte size, peroxidation level, and hepatic steatosis. Peng et al. (2011) investigated the antilipidemic properties of mulberry fruit water extract in a male hamster rat model. They discovered that the extract reduced blood triglycerides, free fatty proteins, and body weight. When mulberry fruit extract (MFE) was used to stop atherosclerosis from developing in rabbits fed a high-cholesterol diet, it was found to have anti-hyperlipidemic effect and reduce the risk of atherosclerosis (Chen et al., 2005). Mulberry fruit and leaf extracts decreased plasma triglycerides and liver lipids (Lim et al., 2013). They also observed how the extracts blended with mice that had been rendered obese by too much fat. increase in hepatic steatosis, peroxidation level, and adipocyte size. Using a male hamster rat model, Peng et al. (2011) examined the antilipidemic effects of mulberry fruit water extract. They found that the extract decreased body weight, free fatty proteins, and blood triglycerides. [48,49,50]

9. Atherosclerosis

Mulberry leaf extracts and polyphenolic extracts including polyphenols such as quercetin (11.70%), naringenin (9.012%), and gallic acid (11.02%) were found to have an anti-atherogenic effect. LDL oxidation and lipid peroxidation were decreased by both extracts, although the polyphenolic extract was more effective. The polyphenolic extract from mulberry leaves may be used to make an anti-atherogenic agent. Atherosclerosis is influenced by

the migration and proliferation of vascular smooth muscle cells (VSMC). [95] Taken from the leaves has 44.82 percent polyphenols, including rutin, quercetin, gallic acid, protocatechonic acid, catechin, gallicocatechin gallate, caffeic acid, and others, which inhibit small GTPase and the Akt/NF-KappaB signal to stop VSMC migration. [9] In vitro, it was discovered that MAC (mulberry anthocyanin extract) and MWE (mulberry water extract) possessed antioxidative and anti-atherosclerogenesis qualities. Additionally, they demonstrated that MWE and MAC may lessen macrophage death caused by oxidised LDL and that the anthocyanin components in mulberry extracts could protect atherosclerosis. [96] Apolipoprotein-deficient mice were killed at 12 weeks of age after being fed a meal containing 12 ML of powder beginning at 6 weeks. The sensitivity of the plasma lipoprotein to oxidation was assessed by diene formation. The lag time of lipoprotein oxidation was found to be significantly longer in the mulberry leaf group than in the control group. The size of the aorta atherosclerotic lesion was 40% less in the mulberry leaf group than in the control. [97] Male mice aged eight weeks were randomly assigned to four groups: control, quercetin 3-(6-malonylglucoside) (Q3MG), mulberry, and quercetin. An atherogenic diet containing 3g of cholesterol and 15g of cocoa butter per 100g was administered to the control group. The other experimental groups were fed the same atherogenic diet, but the quercetin group received 0.05g of quercetin per 100g, the Q3MG group received 0.05g of Q3MG per 100g, and the mulberry group received 3g of dried mulberry leaf powder per 100g. The mice were given different diets for eight weeks. [51, 52, 53]

10. Anti Melanogenic

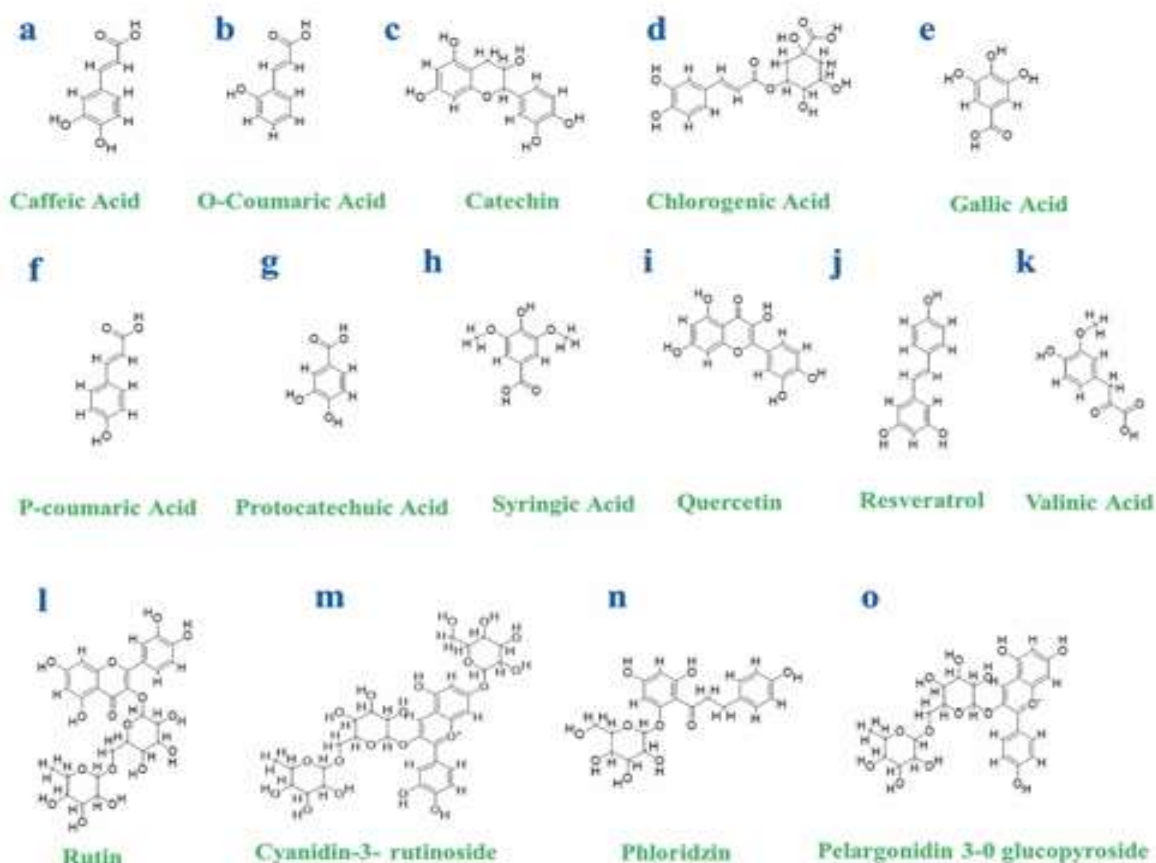
Although melanin pigmentation in the skin is an important defence mechanism against UV exposure, tyrosinase-catalyzed aberrant melanin hyperpigmentation can lead to several serious cosmetic problems [56,57]. Tyrosinase inhibitors are an anti-melanogenic strategy that has gained prominence as being essential for treating

pigmentation-related skin disorders and enhancing skin whitening. Zhang et al. [59] investigated the inhibitory effect of 2,4,2',4'-tetrahydroxy-3-(3-methyl-2-butenyl)-chalcone (TMBC), which was isolated from the stem of *M. nigra*, on tyrosinase activity and melanin synthesis. TMBC inhibited mushroom tyrosinase-mediated L-dopa oxidation in a dose-dependent and competitive manner, outperforming the well-known skin-depigmenting agent kojic acid (IC₅₀ value $24.88 \pm 1.13 \mu\text{M}$) (IC₅₀ value $0.95 \pm 0.04 \mu\text{M}$). Furthermore, TMBC significantly reduced the melanin content and cellular tyrosinase activity in B16 melanoma cells while increasing cellular tyrosinase mRNA levels. The tyrosinase-inhibitory properties of 29 distinct components isolated from *M. nigra* roots were investigated by Zheng et al. [60]. The following nine compounds were found: 5'-geranyl-5,7,2',4'-tetrahydroxyflavone, moracin N, kuwanon H, mulberrofuran G, steppogenin-7-O-β-D-glucoside, 2,4,2',4'-tetrahydroxychalcone, Morachalcone, oxyresveratrol-2-O-β-D-glucopyranoside, and oxyresveratrol-3'-O-β-D-glucopyranoside shown better tyrosinase inhibitory qualities than kojic acid (IC₅₀ value $46.95 \pm 1.72 \mu\text{M}$), with 2,4,2',4'-tetrahydroxychalcone having the highest activity (IC₅₀ value $0.062 \pm 0.002 \mu\text{M}$, 757-fold lower IC₅₀ than kojic acid). Five different batches of standardised were recently demonstrated by De Freitas et al. [61]. All ethanolic extracts of *M. nigra* leaves exhibited tyrosinase inhibitory effects, with IC₅₀ values ranging from 5.00 to 8.49 μg/mL. To maximise and optimise tyrosinase inhibitory activity, Koyu et al. [62] investigated the microwave-assisted extraction of fresh *M. nigra* fruits under different conditions. The highest tyrosinase inhibitory activity (IC₅₀ value 1.44 mg/mL) and anthocyanin content (13.28 mg/g cyanidin-3-glucoside equivalent) were thus produced by the ideal microwave extraction technology, suggesting the substantial potential of anthocyanins on tyrosinase inhibition.

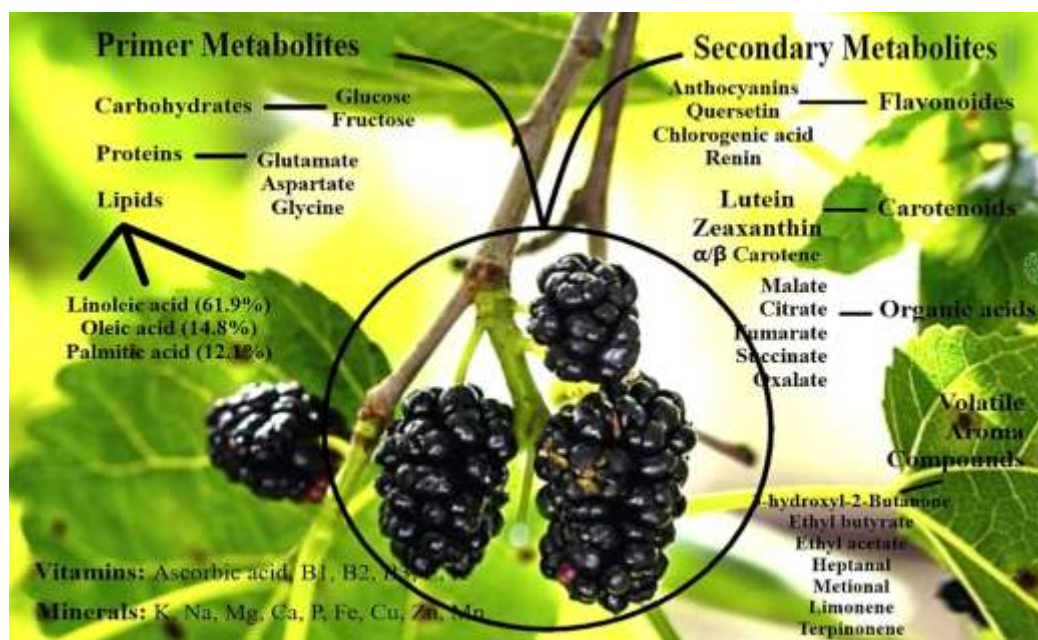
Phytochemical & Chemical Constituents of Mulberry.

Chemical Constituents Table. 01

Sr. No	Part Used	Chemical Constituents	Medicinal Activity	Marketed Formulations	Plant Images
1.	Fruits	Anthocyanins , Flavonoids, Polyphenols, Vitamins (C And E), And Minerals (Iron, Calcium, And Zinc).	Cells are shielded from oxidative damage by antioxidants. Anticancer: Prevents the growth of tumours. Neuroprotective: Prevents neurodegenerative disorders and promotes brain health. An antidiabetic aids in controlling blood sugar levels. Fig.no.04	Mulberry fruit extracts in capsules or tablets. Mulberry juice and syrups. Mulberry jams, jellies, and wines.	 Fig.no.04
2.	Leaves	Flavonoids, Alkaloids, Polyphenols, And Moranolin	Hypoglycemic: Helps control diabetes by lowering blood sugar levels. Anti-Inflammatory: Lowers the body's level of inflammation. Free radicals are neutralised by antioxidants. Fig.no.05	Mulberry leaf tea. Mulberry leaf powder in sachets or capsules. Mulberry leaf-based skincare products	 Fig.no.05
3.	Bark	Tannins, Flavonoids, And Alkaloids.	Antibacterial: Prevents infections caused by bacteria. Reduces inflammation by acting as an anti-inflammatory. Skin Health: Applied in Conventional Skin Care Treatments. Fig.no.06	Bark extracts in ointments or creams. Herbal tinctures.	 Fig.no.06
4.	Roots	Stilbenoids, Flavonoids, And Alkaloids.	Hepatoprotective: Prevents harm to the liver. Diuretics: Encourage the body to produce more urine in order to detoxify. An antipyretic lowers fever. Fig.no.07	Root extracts in capsules or liquid form. Herbal decoctions	 Fig.no.07
5.	Twigs	Flavonoids and Stilbenoids.	Traditional medicine uses: pain relief to lessen discomfort. Improved circulation and decreased blood stasis are two benefits of blood circulation. Fig.no.08		 Fig.no.08
6.	Seeds	Fatty Acids and Proteins	Skin Health: Used for its anti-aging and moisturising qualities in cosmetics. Cardiovascular Health: Regulates Lipids to Promote Heart Health. Fig.no.09	Mulberry Seed Oil. Seed-Based Cosmetic Products.	 Fig.no.09



Chemical Structure- of Mulberry –Fig.no.10



Primary & Secondary Metabolites

Chemical Constituents Table 01.

Antioxidant Gel from Black Mulberry Fruit Extract

Pharmacological Activity: Antioxidant And Potential Photoprotective Effects Against Ultraviolet (UV) Radiation.

1.Formulation Procedure:

Extraction of Mulberry Fruit:

- Dry Black Mulberry Fruits At 50°C For 72 Hours.
- Powder the Dried Fruits and Macerate Using 96% Ethanol at Room Temperature.
- Evaporate the Solvent to Obtain the Crude Extract.

Gel Formulation:

- Dissolve Carbopol 934 (1.5%) in distilled water to form the gel base.
- Add glycerin (10%) as a humectant.
- Dissolve the mulberry extract, methyl paraben (0.18%), and propyl paraben (0.02%) in water, then incorporate into the gel base.
- Adjust the pH to 4.5-6 using triethanolamine (TEA).
- Ensure homogeneity and store appropriately.



2. Liposomal Formulation of Black Mulberry Extract

Pharmacological Activity: Enhanced wound healing properties.

Formulation Procedure:

Preparation of Liposomes:

- Dissolve phosphatidylcholine and cholesterol in an organic solvent to form a lipid film.

- Hydrate the lipid film with a phosphate buffer solution containing black mulberry extract (25 µg/mL).
- Sonicate the dispersion to obtain liposomes encapsulating the extract.



FUTURE ASPECT

1. Environmental and agricultural objectives

Agricultural and Environmental Goals Creation of high-yield and disease-resistant cultivars: By using genetic engineering or selective breeding, future goals will be to create mulberry strains that are more productive, resistant to pests and diseases, and climate change tolerant. Promoting ecologically friendly farming methods to preserve soil health and reduce chemical inputs is known as "organic mulberry cultivation." Support for sustainable sericulture: Since mulberry is the primary food source for silkworms, it is crucial for the production of sustainable silk. One of the goals for the future is to optimise mulberry farming practices to support eco-sericulture. [8,9,10]

2. Medicinal and nutraceutical uses

Uses in Medicine and Nutraceuticals Examining bioactive compounds: Mulberries are rich in anthocyanins, resveratrol, flavonoids, and vitamins. One of the future goals is to do in-depth study on these substances for use in functional foods and supplements. Clinical validation of medicinal uses: examining and verifying mulberry's effectiveness in treating liver disease, diabetes, cancer, inflammation, and neurodegeneration. Formulations for standardised extracts: Using standardized mulberry extracts to create reliable and potent herbal medicines for use in medicine. [11,12,13]

3. Industrial applications

Applications in Nutraceuticals and Medicine Analysing bioactive substances: Mulberries are abundant in vitamins, flavonoids, resveratrol, and anthocyanins. Investigating these compounds in-depth for usage in functional foods and supplements is one of the long-term objectives. Examining and confirming mulberry's efficacy in treating liver disease, diabetes, cancer, inflammation, and neurodegeneration is known as clinical validation of medicinal uses. Standardised extract formulations: producing strong and dependable herbal medications for medical usage by using standardised mulberry extracts. [11,12,13]

4. Genetic and biotechnology research

Genetics and Biotechnology Research Genome editing: Enhancing traits including fruit quality, leaf yield, and stress tolerance with the use of CRISPR and

other cutting-edge technologies. The study of metabolomics and proteomics allows us to comprehend the full spectrum of beneficial chemicals and how they change under different conditions. Propagation and tissue culture: developing efficient in vitro techniques to produce superior mulberry cultivars on a large scale. [16].

5. Economic and rural development

Economic and Rural Development Promoting mulberries as a commercial crop: Encouraging farmers to use mulberries to produce fruit, leaves, or silk, especially in rural and tribal areas. Job creation: Increasing job opportunities in the industries of food processing, dyeing, herbal products, and sericulture. Export potential: Making mulberry-based products more visible on international marketplaces. [16,17].

6. Conservation and biodiversity

Conservation and Biodiversity The process of documenting and conserving wild mulberry species with unique traits for use in future breeding projects is known as wild species preservation. Agroforestry integration is the process of promoting mulberries as a component of sustainable agroforestry systems. [17].

CONCLUSION:

Mulberries are a nutritious and versatile fruit with many health benefits due to their high antioxidant, vitamin, and fibre content. Whether eaten fresh, dried, or in food, they provide a delicious way to support overall health. However, with any fruit, moderation is key, especially for those who are sensitive to natural sugars. All things considered, mulberries are a tasty and beneficial addition to a balanced diet.

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