

# Mulberry: A Versatile Plant, its Potential Applications in different Industries

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**Abstract**— Mulberry is a deciduous, perennial plant that grows quickly in a variety of climatic, topographical, and soil conditions. The mulberry plant's rich constituents have led to its extensive application in a range of businesses. Mulberry has long been used as a functional food due to its high concentration of phytochemical components. Mulberry fruits are difficult to preserve due to their high water content; as a result, many value-added goods such as syrups, wines, teas, squashes, jams, breads, jellies and köme, pekmez (turkish by-products), yogurts, vinegar, parathas, biscuits, and many more are produced for optimal usage. Mulberries and their extracts contain antimicrobial, anti-hyperglycemic, anti-inflammatory, anti-hyperlipidemic, and anti-cancer activities and are used to treat a variety of acute and chronic conditions. *Morus* species' fruits, twigs, leaves, and bark exhibit significant anti-tyrosinase inhibitory activity, making it a viable cosmetic whitening agent. The current review focuses on the phytochemical composition, functioning, nutritional and nutraceutical potential of Mulberry, as well as its use as a common ingredient in many cosmetic products.

**Keywords**— Antimicrobial, Anti-Hyperglycemic, Anti-Inflammatory, Mulberry.

## I. INTRODUCTION

Mulberry is a perennial plant that grows quickly and belongs to the genus *Morus* of the family *Moraceae*. It is an economically important plant and is extensively grown in the Asian countries to provide feed to the monophagous silkworm *Bombyx mori* L (Bhat *et al.*, 2024) which only feeds on the mulberry leaves, thus making mulberry an essential and crucial component of Sericulture Industry (Acharya *et al.*, 2022). Besides its importance in sericulture, the treasured constituents present in the mulberry plant has made an important application of this plant in various other industries (Jan *et al.*, 2021). According to the Chinese Ministry of Health in 1985, *M. alba* was recognized as the first fruit that was both therapeutic and edible (Yuan and Zhao, 2017), and its leaves and fruits were regarded as both pharmaceuticals and food (Wang *et al.*, 2014). The quantity and quality of protein, carbohydrates, dietary fiber, and the types of vitamins present inside any edible plant product are the primary factors that determine its nutritional content; in this regard, the Mulberry plants are highly valued. (Jan B *et al.*, 2021). Mulberry is well off with carbohydrates (Tantray *al* 2021), which can be found as simple sugars, starch, soluble and insoluble fibers, or both. They contain a lot of water and few calories. Fruits are mostly discovered to include iron, a good amount of potassium, vitamin C, vitamin E, and vitamin K. Additionally, they contain a lot of plant substances like anthocyanins, which give them the color and have beneficial health effects (Yu *et al.*, 2018). Mulberry fruits and leaves include significant components that make the plant eligible to be classified as a functional food that serves a purpose for health besides to its primary nutritional role. (Kadam *et al.*, 2019). Among the various species *Morus alba* (white mulberry), *Morus nigra* (black mulberry), and *Morus rubra* (red mulberry) are all well-known species in the genus *Morus* for their excellent medicinal capabilities. *M. alba* is one of the prominent species among all the others (Ercisli *et al.*, 2007). The food, pharmaceutical, and cosmetic industries may all gain from the valuable bioactive elements found in mulberry roots, bark, leaves, fruits stem and twigs (Ercisly *et al.*, 2007). In India this mulberry plant is called as “Kalpa Vruksha” for its flexible productiveness (Jan B *et al.*, 2021). The fruit is also known by the names toot and shahtoot (King's or "superior" mulberry). With numerous pharmacological qualities, almost all mulberry plant variants are traditionally acknowledged in Ayurveda, Unani, and Chinese systems of medicine. The *M. nigra*

fruits are one of the key ingredients of Tutiaswad, a Unani remedy thought to have anti-cancerous properties (Nursalam *et al.*, 2016). Anthocyanins belongs to the class of naturally occurring phenolic compounds that give fruits, flowers, and leaves their color. They are the best source of anti-inflammatory and antioxidant chemicals for health benefits. Chinese use mulberry fruit as a natural treatment. To help with urination, treat fever, strengthen the joints, control blood pressure, and protect against liver damage. Its fruits, leaves, and barks have been used in traditional Turkish Folk medicine as an antihelminthic agent, expectorant, urinary aid, blood pressure reducer, folk cure to treat dental disorders, diarrhea, and as a laxative, as well as diabetes, hypertension, arthritis, and anemia (Ozgen *et al.*, 2009). (Altaf *et al.*, 2024).

## II. MULBERRY A MULTIFACETED PLANT:

The woody perennial plant known as the mulberry is included in both the genus *Morus*, which encompasses more than 15 species of deciduous plants, and the family Moraceae (Pihlanto *et al.*, 2008). Mulberry grows in a broad range of climatic, topographical, and soil conditions, from temperate to subtropical locations in the Northern Hemisphere to the tropics in the Southern Hemisphere. (Wen Peng *et al.*, 2019). Mulberry foliage has long supported the silk industry by serving as the main source of nourishment for silkworms (Hoy u *et al.*, 2002). The sole food the silkworm consumes is mulberry leaves, which it uses to create the cocoon that produces silk. Due to its numerous distinctive and peculiar traits, it has a significant commercial worth outside from sericulture (Jan B *et al.*, 2021). Mulberry being a source of of high concentration of phytochemical components, has long been used as a functional food. It is valued for both direct consumption and the manufacturing of high-value commodities. Mulberry fruits are regarded for their nutritional benefits in human health. (Sengül *et al.*, 2005). Mulberry fruits also include a variety of nutrients that are essential to human metabolism (Akbulut and Zcan, 2009). *M. alba* fruit is a great source of fiber, vitamins, minerals, lipids, protein, and carbohydrates. Fresh *M. alba* fruit has more protein than both strawberries (Rao *et al.*, 2010) and raspberries (Giampieri *et al.*, 2012) and is equivalent to blackberries in terms of protein content (Kaume *et al.*, 2012). Different types of mulberries species have bioactive substances that can lengthen life (vinkatesh *et al.*, 2008) Many scientists have studied the medicinal characteristics of mulberry plants, and they have discovered that a variety of biochemical substances, including hydroxymorcin, albafulan, albanol, Morusin, and kuwanol, which are generated from mulberry trees, are crucial in the pharmaceutical business. Discrete segments of the mulberry plant are utilized to guard the body and control oxidative stress, intestinal worms, sinusitis, throat soreness, hyperglycemia, inflammation, kidney disorders, cancer, cataracts and hepatoprotectivity, menstrual problems, depression, and migraines (Naowaboot *et al.*, 2009)

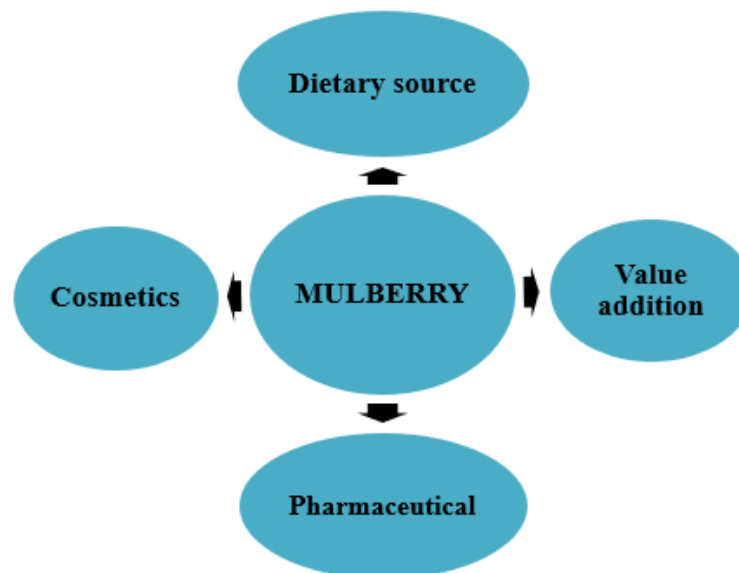


FIGURE 1: Potential utility of different parts of Mulberry

## III. MULBERRY A BUDDING DIETARY SOURCE:

The flavor of fully matured mulberry fruit is incredibly tasty, enticing, and aromatic. It is prized for both direct use and the manufacture of high-value goods. Mulberry fruits are regarded for human health due to their high nutritional value (Sengül *et al.*, 2005). Mulberry fruits include a number of elements that are both beneficial and necessary for human metabolism (Akbulut *et al.*, 2009). The essential amino acid to total amino acid ratio is 42 percent, which is nearly as high as other high-protein foods

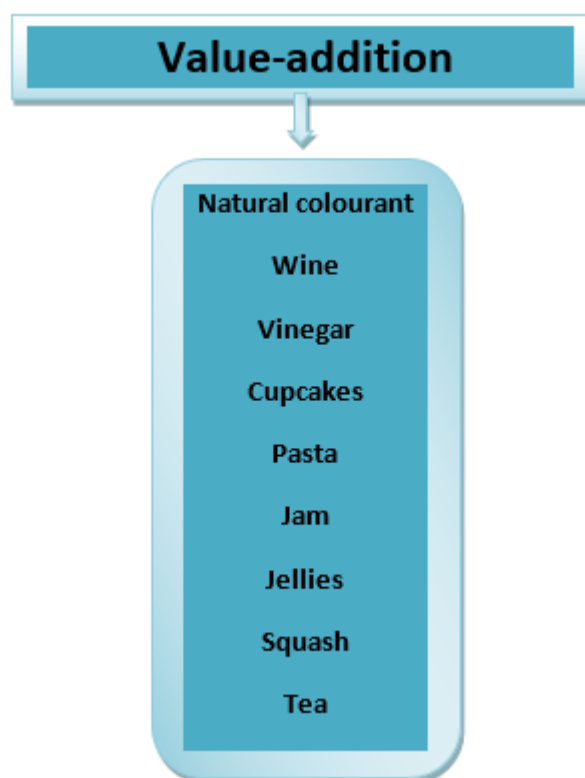
such as milk and seafood (Jiang et al., 2015). Consequently, it may be regarded as a great source of protein. Each variation of the *Morus* species includes a sizable amount of vitamin C, however *M. nigra* has the highest concentration of all the variants. The ascorbic acid concentration of *Morus alba* and *M. nigra* fresh fruit is 15.81 mg/100g and 12.81 mg/100g, respectively (Eyduan et al. (2015). Mulberries also include certain significant alkaloids that boost the immune system and activate macrophages, protecting the body from potential health risks (Kim et al., 2013). One-deoxynojirimycin (DNJ), 1, 4-dideoxy-1, 4-imino-D-ribitol, and 1, 4-dideoxy-1, 4-imino-D-arabinitol are the three most significant alkaloids discovered in mulberry leaves (Li et al., 2013, Sharma et al., 2010, Li et al.

**TABLE 1**  
**PHYSIOLOGICAL PARAMETERS OF MULBERRY**

Physiochemical Properties	<i>Morus alba</i>
Protein (g <sup>-1</sup> 100 g DW)	1.55
Fat (%)	1.1
Fiber g <sup>-1</sup> 100 g	1.47
Ascorbic acid mg <sup>-1</sup> 100 g	22.4
Malic acid (g 100 g <sup>-1</sup> fw)	3.095
Citric acid (g 100 g <sup>-1</sup> fw)	0.393
Calcium (mg <sup>-1</sup> 100 g)	152
Mg (mg <sup>-1</sup> 100 g)	106
K (mg <sup>-1</sup> 100 g)	1668
Fe (mg <sup>-1</sup> 100 g)	4.2
Nitrogen (%)	0.75
Fructose (g 100 g <sup>-1</sup> fw)	6.269
Glucose (g 100 g <sup>-1</sup> fw)	6.864

#### IV. VALUE-ADDITION

It is progressively gaining popularity with customers not only because of how good it tastes but also because of how highly nutritious and low in calories it is. The potential for using additional mulberry components as a source for processed foods is likewise quite strong. Due to this, mulberry has seen a rise in demand from the food processing sectors as well. *M.alba* squash fruits are used to make spiced squash and appetizers (Hamid et al., 2017). Pastry A pastry that has high fiber quantity and low calories is made using buckwheat flour, inulin, hulls chokeberry and *M. alba* extraction (Komolka et al., 2016). The concentrated *M. alba* paste used to create cupcakes (Jan et al., 2021), Syrup of the *M. alba* fruit is utilized directly and It can also be kept in the refrigerator for up to 6 months. (Thakur et al., 2017). Mulberry fruits can also be used to manufacture syrup since they contain high concentration of sugar. Mulberry syrup is a popular processed product in Vietnam. In the process of making syrup, the fresh fruit of mulberry and cane sugar are frequently mixed with a blender in a ceramic or a glass bottle, which can be stored indefinitely (Quang Trung et al., 2018). Anthocyanins obtained from dried fruits of *M. nigra* can be used to make chocolate (Gultekin-Ozguven et al., 2016). Producing pasta using *M. nigra* extraction, which has a hypoglycemic effect and lowers the glycemic index (Yazdankhah et al., 2019). Mulberry leaf methanolic extract increases the shelf life of minced beef (Yazdankhah et al., 2019). Anthocyanins from *M. rubra's* yogurt serve as a strawberry coloring ingredient. (Byamukama et al., 2014). Jam created with fruit jam made with a 70:30 ratio of rosella and mulberry fruit essence (Wongchalat et al., 2016). *M. alba* is used to manufacture vinegar (Karaagac et al., 2016). Alcoholic drink of *M. alba* fruit is used to make alcoholic beverages and make fruit wine. (Daris et al., 2003).



**FIGURE 2: Value Addition**

## **V. PHARMACEUTICAL USES OF MULBERRY:**

Mulberry fruits, as previously indicated, are abundant in anthocyanins (Jiang *et al.*, 2013), which both academics and consumers due to their possible pharmacological effects on health (Carvalho *et al.*, 2013). Sugars, rutin, quercetin, have piqued the curiosity of volatile oil, amino acids, vitamins, and microelements. Mulberry leaves contain a variety of therapeutic compounds including lowering blood sugar, preventing hyperlipidemia, treating hypertension, and acting as an antibacterial and antiviral (Zou *et al.*, 2003). Low-density lipoprotein (LDL) oxidation can be prevented by anthocyanins found in mulberry fruits, and they can also remove free radicals (Du Q *et al.*, 2008).

### **5.1 Anticancer activity:**

Cancer, in all of its manifestations, is the most fatal disease on the planet. There are several types of cancer therapies available on the market, but only a handful is successful and safe. Since the beginning of time, humans have utilized the mulberry plant as medicine. Mulberry has been shown in clinical studies that plants may impede cell development, most likely because to the presence of flavonoids, which are strong anticancer agents. Mulberries have been shown in animal studies to help prevent cancer. Purified anti-proliferative lectin from *M. alba* leaves caused apoptosis in human breast cancer (MCF-7) and colon cancer (HCT-15) cells by generating crucial morphological changes and DNA fragmentation associated with apoptosis. (Deepa *et al.*, 2012). Human lung metastasis when anthocyanins from the fruit of *M. alba* are isolated, A549 cancer cells invade. The leaves of this plant contain flavonoids, which have been isolated and found to have anticancer effects. (Khalid *et al.*, 2011). Albanol A (Mulberrofuran G) may be extracted from the root bark of mulberries; this chemical induces high cytotoxicity in HL60 (Human Leucemia Cell line) by inhibiting topoisomerase II activity (Kadam *et al.*, 2013)

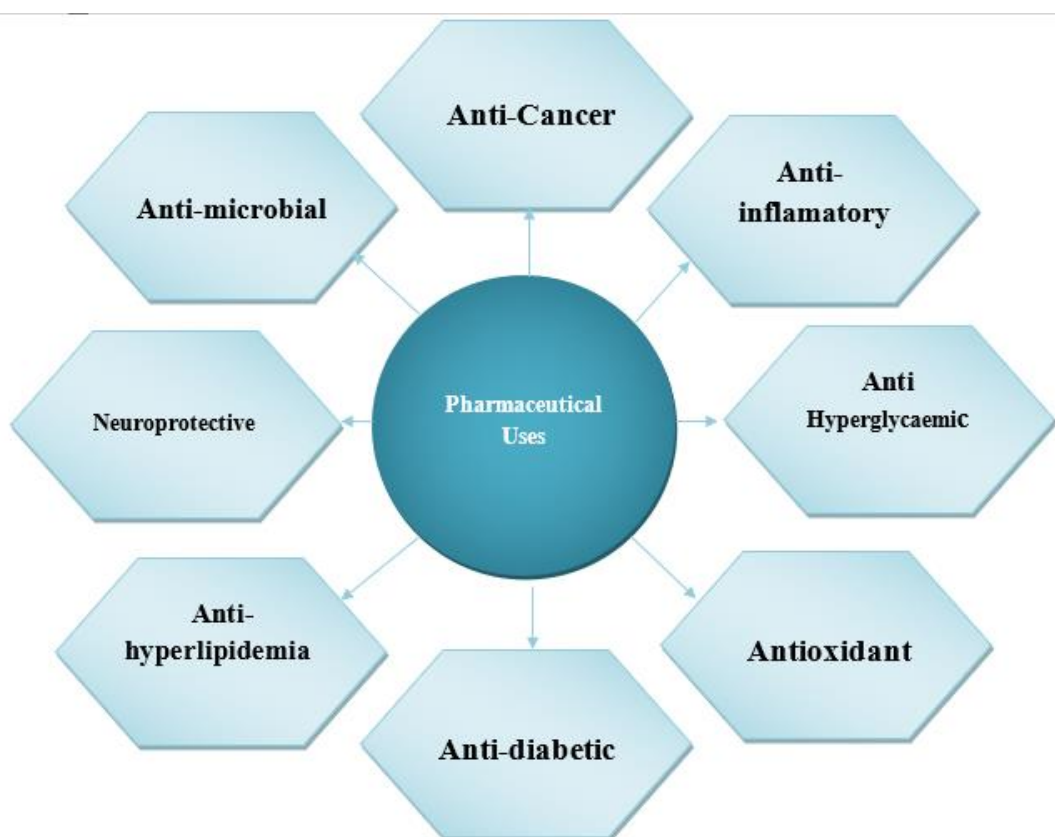
### **5.2 Anti-inflammatory activity:**

Multiple immune cells, including macrophages, use inflammation as an inherent immunological defense against potentially hazardous stimuli including bacteria and viruses (Nagarta *et al.*, 2005). Large levels of inflammatory mediators, such as nitric oxide (NO) and prostaglandin E2 (PGE2), are created as a result of an excessive inflammatory response (LeeYG *et al.*, 2008). If left unchecked for a while, it has the potential to harm the body and lead to the development of chronic diseases such as cancer, cardiovascular disease, and rheumatoid arthritis. Mulberry twigs and root bark include maclurin, morin, resveratrol, and isoquercitrin, while the fruits contain other vital fatty acids such as palmitic, linoleic, and oleic acids, which are also crucial for inflammatory responses (Kadam *et al.*, 2019). Methanolic extracts of *M. alba* root bark suppressed no future generations

by lowering iNOs over-expression in LPS- stimulated RAW264.7 9 (Eo *et al.*, 2014). *M.nigra* fruit contains anthocyanins, which have been shown to have anti-inflammatory effects. C3G and C3R have an anti-inflammatory impact in mice with carrageenan and xylene-induced paw edema via suppressing pro-inflammatory cytokines (chen *et al.*, 2014). *M. alba* root aqueous extract has strong anti-histamine and anti-allergic activity by reducing histamine release and systemic allergic responses produced by compound 48/80 in vitro and in vivo. *M. alba* root extract also suppresses mast cell-mediated allergy reactions. (Chai *et al.*, 2005).

### 5.3 Anti-hyperglycemic activity:

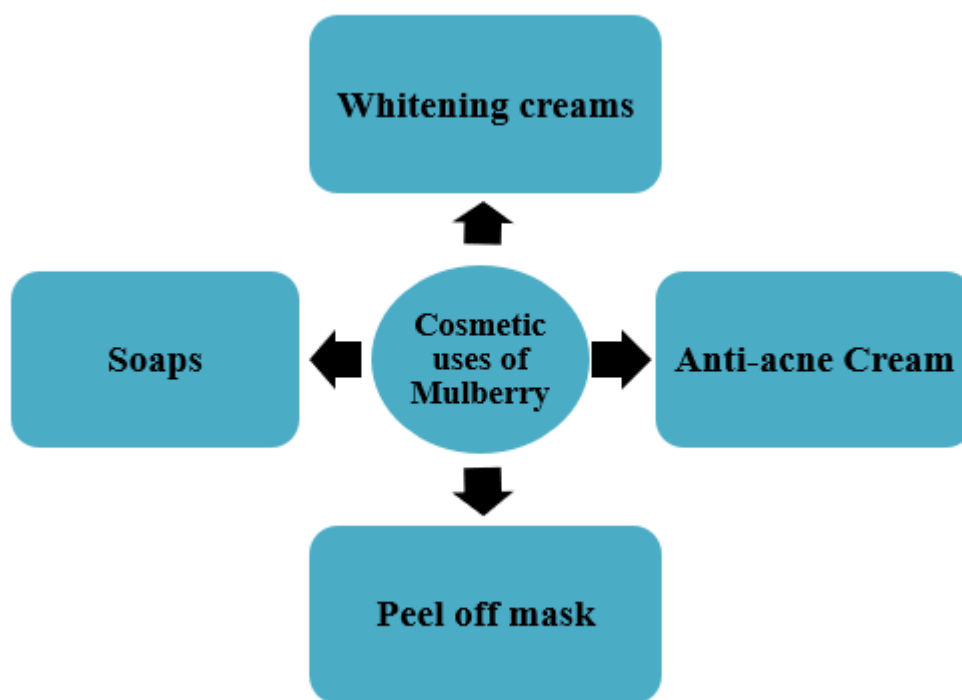
Diabetes mellitus (DM), the world's third most deadly metabolic illness, is characterized by hyperglycemia (high blood glucose levels). This chronic condition now affects more than 170 million people globally, and by 2030, the number is expected to double it is predicted to climb by 50%, with the greatest growth occurring in emerging nations including those in Asia, Africa, and South America (Wang *et al.*, 2013). In recent study *M. alba* leaves were found to help decrease blood sugar levels and minimize possible histo-pathological abnormalities in the pancreas and kidneys in brown rats (Kadam *et al.*, 2019). *M. alba* leaves help to reduce blood glucose levels and avoid any histo-pathological changes in the pancreas and kidneys that were discovered in brown rats in a recent study. (Kadam *et al.*, 2019).



**FIGURE 3: Anti-hyperglycemic activity**

## VI. COSMETIC INDUSTRY:

Skin lightening, sometimes referred to as skin whitening or depigmentation, is an aesthetic procedure that uses laser therapy or skin-lightening materials to reduce the appearance of dark skin spots and lighten the skin's overall tone (Rendon *et al.*, 2005). Exposure to UV rays or chemical irritants can result the darkening of skin or skin hyperpigmentation, which can also be a symptom of other skin conditions such melasma, solar lentigines, or post-inflammatory hyperpigmentation (Draelos *et al.*, 2013). In order to achieve a lighter skin tone, skin-lightening chemicals are used to decrease the release of the melanin production, the primary pigment in the skin (Kamakshi *et al.*, 2013). Paper mulberry extracts and its components shown potent tyrosinase activity inhibitory effects and have been used as skin-whitening agents in cosmetic products (Shivhare *et al.*, 2013). A face mask sheet made of paper mulberry and *Styela clava* extract is mixed for whitening purposes (Yun *et al.*, 2013). The skin responded favorably to a mask kit including paper mulberry (Go Un *et al.*, 2009). A cosmetic formulation for hydrating and smoothing the skin included paper mulberry and white ginseng (Slominski *et al.*, 2018).



**FIGURE 4: Cosmetic Industry**

## VII. CONCLUSION

The purpose of this mini review is to highlight the usefulness and applicability of *Morus* species in a variety of industries, and the debate demonstrated that Mulberry is a diversified and intriguing plant. The findings indicated that the *Morus* species might be suitable for a range of culinary products. This plant can be utilized in the creation of hypocaloric diets and as a new component to improve the functional properties of present meals because it has less calories. *Morus* is used to create value-added products such as jam, syrup wine, vinegar, jelly, tea, squash, and many others, allowing businesses to make better use of its fruits and leaves. The bioactive phytochemicals have been shown to have a wide range of biological activities including antioxidants, anti-inflammatory, anti-cancerous, anti-obesity, antihypertensive and hyperlipidemia effects. Varying species of mulberry plants have significantly varying nutritional contents, active component content and antioxidant activity. Cosmetics are widely used to cure hyperpigmentation. Because these conditions are frequently difficult to treat, cosmeceuticals and other skin-lightening solutions are required. As a result of current safety concerns, there is a growing need for alternative natural, safe and effective skin-lightening therapies. Similarly, academics and manufacturers should place greater attention on large-scale mulberry production for further betterment. By taking into account all of the facts about mulberry such as its potential for sericulture industry, human health and lifestyle improvement as supplementary diet, value addition in confectionary products, Cosmetic products. Thus, it can be considered a most ideal and beneficial plant for a sustainable development.

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