Qualitative and Quantitative Phytochemicals Determination of *Morus alba L.*(White Mulberry) Leaves

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Abstract - This Study aimed to investigate the phytochemical constituents of various parts of *Morus Alba*, with a focus on leaves and fruits, using standard qualitative and quantitative analytical techniques. Aims to comprehensively evaluate the phytochemical constituents of *M. alba* leaves, focusing on their antioxidant and antimicrobial potentials. Using standard qualitative and quantitative methods, the presence of alkaloids, flavonoids, tannins, saponins, phenolic compounds, and steroids was confirmed. Quantitative analysis revealed significant concentrations of alkaloids (40%), glycosides (20.05%), flavonoids (14%), steroids (3.5%), tannins (11.9%), saponins (11.5%), and anthraquinones (0.5%). These observations call attention to the dense phytochemical content of *M. alba* leaves and their multidimensional pharmacological activities, which point towards their use as a natural lead for drugs. Additional research, including in vivo studies and clinical trials, would be necessary to establish their complete range of pharmacological uses.Quantitative assays were performed to estimate the total phenolic content(TPC),Total flavonoid content(TFC),and other major phytochemicals using spectrophotometric methods. The TPC was determined using the Folin-Ciocalteu method and expressed as quercitin equivalents (QE). High level of flavonoids and phenolics were found in the results, suggesting substantial antioxidant potential.

Keywords- *Qualitative analysis, quantitative phytochemical analysis, Morus alba, White Mulberry*

I. INTRODUCTION

Conventional medicine often incorporates phytochemical-rich plant extracts for the treatment of various ailments. Compared to synthetic drugs, natural medications tend to be less harmful and are associated with fewer adverse effects. The genus *Morus* (mulberry) comprises approximately 150 species, with *Morus alba* L. (white mulberry) being the most prominent (**Srivastava et al., 2006)**. *M. alba* is a medium-sized, monoecious, deciduous tree that can grow up to 30 meters in height and approximately 1.8 meters in diameter. It is widely distributed across Asia, Africa, Europe, as well as North and South America, thriving in a variety of environments. According to Kumar and Chauhan (2008), white mulberry has been used in traditional Chinese medicine since as early as 659 A.D. The Chinese pharmacopoeia recognizes various parts of the plant—including the root bark, stem, fruits, and leaves—as active constituents in medicinal formulations. White mulberry is also commonly known as silkworm mulberry or *shahtoot* in Urdu, Persian, and Hindi. In addition to its medicinal applications, *M. alba* is gaining attention in the agricultural sector. In many developing countries, nonconventional feeds like white mulberry are increasingly being used due to their rich amino acid profile, which can enhance milk production in dairy cows **(Mohammadabadi and Chaji, 2012)**. *Morus alba* leaves serve as a primary food source for silkworms and are also used as fodder for livestock. In Europe, the plant is cultivated mainly for its fruit, while in other parts of the world it is consumed as a vegetable. In Japan, the leaves are popularly processed into tea and powdered juice (**Gerasopoulos and Stavroulakis, 1997; Ercisli and Orhan, 2007; Katsube et al., 2009)**. Mulberry leaf infusions are widely used in several Asian countries, particularly Japan and Korea, for their health-promoting properties. According to **Deshmukh et al. (1993),** the leaves contain a rich array of bioactive compounds, including steroids, flavonoids, amino acids, vitamins, triterpenes, and other trace elements, which contribute to their therapeutic potential. Various plants have demonstrated significant biological activities, including anthelmintic, anti-parasitic, and anti-diarrheal properties (**Badar et al., 2011; Babar et al., 2012; Jung et al., 2011).** Among these, *Morus alba* has long held an important place in traditional Chinese medicine, valued for its broad therapeutic efficacy and low toxicity **(Li, 1998).** Scientific studies have confirmed that *M. alba* exhibits a wide range of pharmacological effects, including neuroprotective, skin tonic, antioxidant, antihyperglycemic, antibacterial, antihypertensive, and anti-hyperlipidemic activities (**Nomura et al., 1980; Butt et al., 2008; Sun et al., 2011).** According to Gutierrez-Uribe et al. (2011), the medicinal potential of herbal and indigenous plants is largely attributed to their chemical constituents, which exert specific physiological effects in the human body. Several investigations have identified polyphenolic compounds as the primary contributors to these pharmacological properties.

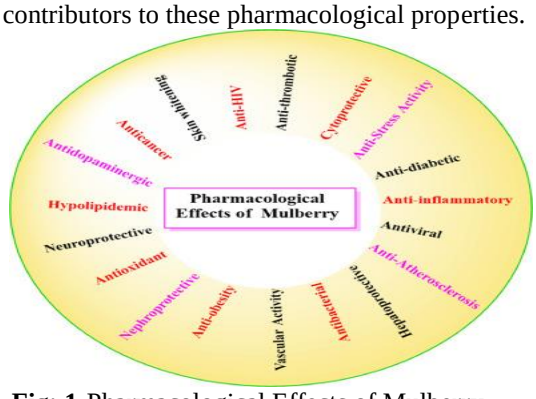


Fig: 1-Pharmacological Effects of Mulberry

II. MATERIAL AND METHOD

2.1 Material Required

Collection and Preparation of *Morus Alba* sample - Fresh leaves of *Morus alba* L. were collected from a verified Subharti botanical garden in Meerut, Uttar Pradesh. The plant was authenticated by a taxonomist, and a voucher specimen was deposited in the herbarium. Fresh samples were transported to the laboratory in sterile, insulated containers. Fruits and leaves were washed with distilled water to remove dust and contaminants, and then air-dried at room temperature. Seeds were manually separated from the fruit pulp and rinsed with distilled water. Plant materials were then freeze-dried or oven-dried at 40°C until constant weight was achieved.

2.1.1Analysis of samples

The leaves samples collected were analysis for the phytochemical parameters like water content, pH, and alkalinity and acidity as well as the biochemical parameters like flavinoids, tannin, terpenoids, and quinines.

2.2 Method

Extraction Method:

Maceration-100 g of the dried plant powder was soaked in 1000 mL of 70% methanol in an airtight amber glass bottle. The mixture was shaken periodically 3-4 times daily and allowed to macerate for 72 hours at room temperature. The extract was then filtered through Whatman No. 1 filter paper, and the residue was re-extracted twice with fresh solvent to ensure maximum extraction.

Estimation of pH for *Morus alba* Solution: A pH meter was used to measure the pH of the leaf samples. A pH meter's pH electrode was used to measure the pH of roughly 10 milliliters of the filtered sample.

Qualitative screening using a UV-VIS spectrophotometer: UV spectra based on absorption maxima at particular wavelengths of the current phytochemical were used to qualitatively analyze a number of samples using a UV-VIS Spectrophotometer 119. Pure methanol was used for calibration. A spectrophotometer was used to screen newly prepared samples that had been placed in a cuvette. Fermented samples' absorption spectra were scanned light across the visible (400–700 nm) and ultraviolet (185–400 nm) portions of the electromagnetic energy spectrum. The λ-max of phytochemicals is used to determine the absorbance of current substances.

Qualitative phytochemical examination of *Morus alba* leaves:

Alkaloids test (Chhetri-PH etal.,2008, jigna Parek et al, 2007. Evans WC,1989).

Mayer's Reagent: Dissolve 1.358g ofHgcl2 in 60 ml of water and pour into a solution of 5g of KI in 10ml of H2O, and distilled water to make the volume 100ml(white precipitate with most alkaloids in slightly acid solution.

Wagner Reagent: 1ml of the leaves sample of solution in a test tube was mixed with 1 ml of Hager's reagent/Wagner's reagent.

Observation: The appearance of colored precipitates indicated the presence of alkaloid.

2ml of extracts was treated with 1ml of 1% of Hcl and boiled for few minutes.1ml of the above mixture was treated with 6 drops of Wagner's reagent. The formation of brownish –red precipitate indicated the presence of respective alkaloid.

Phenolic test: (Mallikharjune LN et.al.,2007, Dey PM and HarbourJB,1987, Evans WC,1989) solution was mixed with 2ml solution of Fecl3 a blue green or black coloration indicated the presence of phenol.

Ellegic acid test:(MallikharjuneLN et.al,2007, Dey PM and Harbour JB,1987, Evans WC,1989) solution was mixed with a few drops of 5% mixture containing glacial acetic acid and 5% sodium nitrate solution. A muddy yellow, olive brown, Niger brown or deep chocolate color indicated the presence of phenol.

Flavonoids

Alkaline reagent Test(MallikharjuneLNet.al.,2007, DeyPM and Harbour JB ,1987, Evans WC,1989) solution was treated with 2ml of 2% of solution of NaoH. An intense yellow color formed which turned colorless and addition of few drops of diluted acid which indicated the presence of flavinoids.

Flavinoids test(MallikharjuneLNet.al.,2007, DeyPM and Harbour JB, 1987, Doff A, 2009) 5ml of dilute Ammonia solution was added to a portion of the aqueous filtrate of plant extract followed by addition of concentrated H2SO4.The appearance of yellow color indicated the presence of flavinoids. Yellow coloration disappeared on standing.

Few drop of 1%ammonia solution were added to a portion of each extract. A yellow coloration indicated the presence of flavinoids.

Tannin (MallikharjuneLN et.L., 2007, chhetri PH et.al.,2008, Jignapareket.al., 2007, Doff A,2009) solution was mixed with 2ml of 2% solution of Fecl3 A blue- green or black coloration indicated the presence of tannin.

Lignin's test (MallikharjuneLN et.al.,2007, Dey PM and Harbour JB ,1987, Evans WC,1989) when solution was treated with 2%formaldehyde. The formation of red color indicated the presence of lignin.

Steroid test Salkowski's Test (MallikharjuneLNet.al.,2007, Dey PM and Harbour JB,1987, Evans WC,1989) the solution was mixed with 2ml of chloroform.Then 2ml of concentrated H2SO4 was added carefully and shaken gently.The reddish brown color indicated the presence of steroid.

Glycosides (krishmaih D et.al.,2009, Edeoga HOet.al.,2005, Doff A 2009) solution mixed with 2ml of glacial acetic acid containing 1-2 drops of 2%solution of Fecl3.The mixture was poured into another test tube containing 2ml of concentrated H2So4.The formation of the brown ring at the interface indicated the presence of cariac glycosides.

Saponins (Dey PM and Harbour JB ,1987, Evans WC ,1989) solution was treated with 5ml of distilled water(DW) in test tube.It was shaken vigorously the formation of stable form was taken as an indication for the presence of saponins.

Terpenoid test(Rajasekariahetal.,1991) solution was mixed with 2ml of chloroform. The 2ml of concentration H2SO4 was

added carefully and shaken gently. The reddish coloration on the interface sure the presence of terpenoid.

Quantitative Phytochemical Estimations:

Phytochemicals are natural compounds found in plants that are responsible for various biological activities. Among them, alkaloids, flavonoids, tannins, and saponins are known for their antimicrobial, antioxidant, anti-inflammatory, and antidiabetic effects. This study focuses on the quantitative estimation of these compounds from dried and powdered Morus alba leaves.

Biochemical Test Methods:

Quantitative Estimation of Alkaloids (Harborne's Method): 5 g of powdered leaf sample was taken and mixed with 200 mL of 10% acetic acid in ethanol. The mixture was allowed to stand for 4 hours and then filtered. The filtrate was concentrated to one-fourth of the original volume using a water bath. Concentrated ammonium hydroxide was added dropwise until complete precipitation. The solution was allowed to stand and the precipitate was collected by filtration, washed with dilute ammonia, and dried at 60°C. Alkaloid content (%) was calculated as:

$$\% \text{ Alkaloid} = (\text{Weight of residue} / \text{Initial weight of sample}) \times 100$$

Quantitative Estimation of Flavonoids (Aluminium Chloride Method): 10 g of powdered leaves were extracted with 80% methanol at room temperature for 24 hours. The mixture was filtered and the filtrate was evaporated to dryness. A known volume of the extract was treated with 0.1 mL of 10% $AlCl_3$, 0.1 mL of 1 M potassium acetate, and 2.8 mL of distilled water. The mixture was incubated at room temperature for 30 minutes and absorbance was read at 415 nm using a UV-Vis spectrophotometer. Quercetin was used as the standard for calibration.

Quantitative Estimation of Tannins (Folin-Denis Method): 0.5 g of sample was boiled in 50 mL distilled water for 30 minutes, cooled, and filtered. 5 mL of filtrate was mixed with 2 mL of Folin-Denis reagent and 2.5 mL of 20% Na_2CO_3 solution. The mixture was diluted to 50 mL with distilled water and incubated for 30 minutes. Absorbance was measured at 760 nm. Tannic acid was used for standard calibration.

Quantitative Estimation of Saponins (Gravimetric Method): 10 g of powdered sample was extracted with 100 mL of 20% ethanol. The mixture was heated on a water bath at 55°C for 4 hours and filtered. The residue was re-extracted with 100 mL of 20% ethanol. Combined extracts were concentrated to 40 mL and transferred to a separating funnel with 20 mL diethyl ether. The aqueous layer was collected and extracted with n-butanol. The n-butanol extract was washed with 5% NaCl solution, dried in an oven, and the weight of residue was recorded.

These leaves contain bioactive phytochemicals with antioxidant, anti-inflammatory, antihyperglycemic, and antimicrobial properties. Among these, alkaloids, flavonoids, tannins, and saponins have received significant attention due to their physiological activity and traditional medicinal use.

Thin Layer Chromatography (TLC) Analysis

TLC Plate Preparation-Pre-coated silica gel 60 F254 plates were used. Sample solutions were applied with capillary tubes.

Tab. Solvent Systems for TLC analysis

Phytochemical	Solvent System
Alkaloids	Chloroform: Methanol (9:1)
Flavonoids	Ethyl acetate: Formic acid: Water (10:1.1:1.5)
Tannins	Toluene: Acetone: Formic acid (4:4:1)
Saponins	n-Butanol: Acetic acid: Water (4:1:5, upper layer)

Development and Visualization-The plates were developed in TLC chambers saturated with respective solvent systems. Plates were dried and visualized under UV light (254 and 366 nm) and iodine vapor. For alkaloids, plates were sprayed with Dragendorff's reagent. For flavonoids and tannins, ferric chloride reagent was used. Rf values were recorded.

III. RESULTS AND DISCUSSION

Table 2. Measurement of pH *Morus Alba* Solution:

S.NO.	SAMPLE	FIRST WEEK	SECOND WEEK	THIRD WEEK
1.	MORUS ALBA	6.24	4.14	3.73

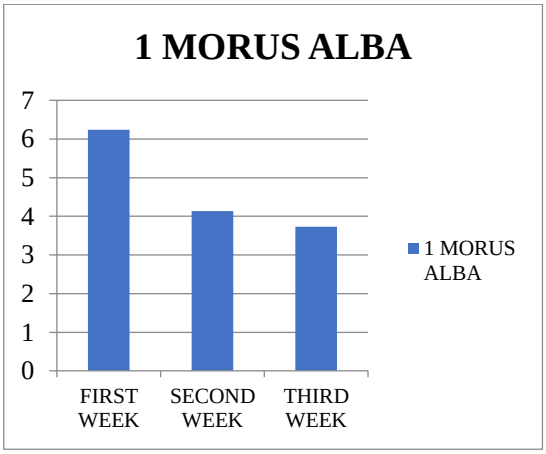


Fig:7-pH of *Morus Alba*

The pH of Morus Alba were found 6.24 in the First week,in second week pH were found 4.14 and in the the 3rd week pH of the *Morus Alba* were found 3.73.

4.1Physical Characteristics

Table 3.-Physio-chemical properties of *Morus Alba*

Solutions	TDS (ppm)	Color	Smell
Morus Alba	124	Light brown	Mildly sweet or grassy

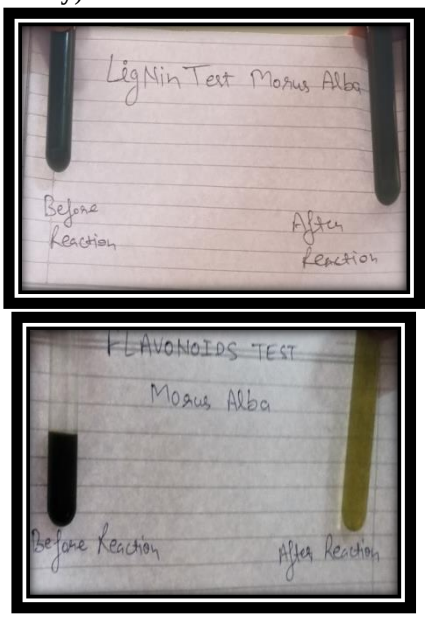
Table 4. Phytochemical Analysis of *Morus alba* samples-

S.NO	Name of phytochemicals	Quality of morus alba phytochemicals
1.	Alkaloids	-
2.	Flavonoids	++
3.	Quinone	+
4.	Saponin	+
5.	Tannins	++
6.	Carotenoids	+
7.	Keeler Test	-
8.	Terpenoid Test	-
9.	Lignin's test	-

The phytochemical examination of *Morus alba* leaf extracts revealed the presence of various bioactive components, including flavonoids, phenols, tannins, and alkaloids, which exhibit antioxidant, anti-inflammatory, and antibacterial properties. All three extracts contained flavonoids and phenols, indicating that *Morus alba* possesses high antioxidant capacity regardless of the solvent used.

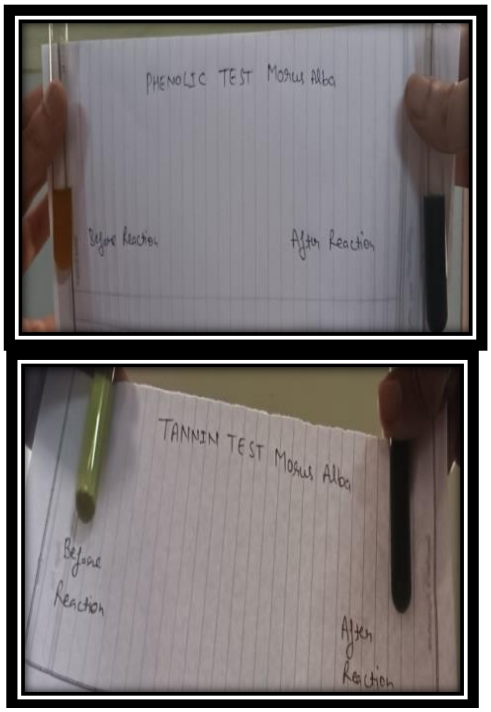
Alkaloids and terpenoids were primarily extracted using organic solvents such as ethanol and methanol, suggesting that these compounds are less soluble in water. Saponins and glycosides were detected in the ethanol extract, reflecting their mild polarity and solubility in alcohol-based solvents. Steroids were found exclusively in the methanol extract, likely due to methanol's high efficiency in penetrating plant cell walls.

4.2 Qualitative Phtochemical analysis of *Morus alba* (White Mulberry)



(A) (B)

Fig:2- Phtochemical analysis of *Morus alba* For (A) Lignin and (B) Flavonoids



(C) (D)

Fig:3- Phtochemical analysis of *Morus alba* For (C) Phenolic and (D) Tannin

Quantitative Phytochemical Estimations

Results and Observations Alkaloid Content:

- Average weight of precipitate: 0.49 g (from 5 g of sample)
- % Alkaloid content = (0.49 / 5) × 100 = 9.8%

Flavonoid Content:

- Absorbance of extract = 0.745 at 415 nm
- Based on quercetin calibration, total flavonoid content = 78.2 mg/g dry weight

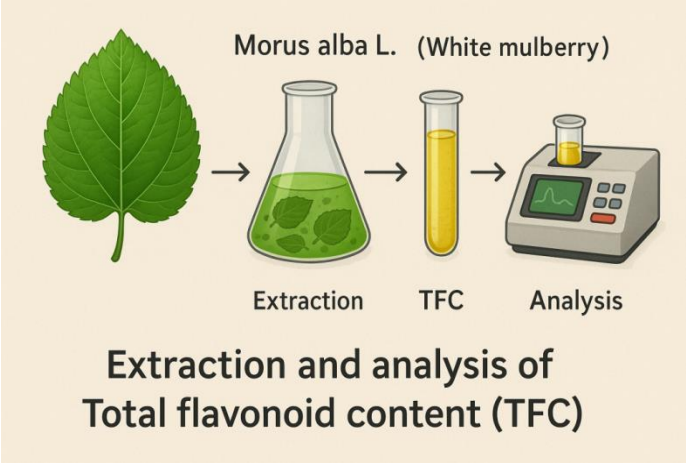


Fig:4-. Extraction and analysis of Total flavonoid content

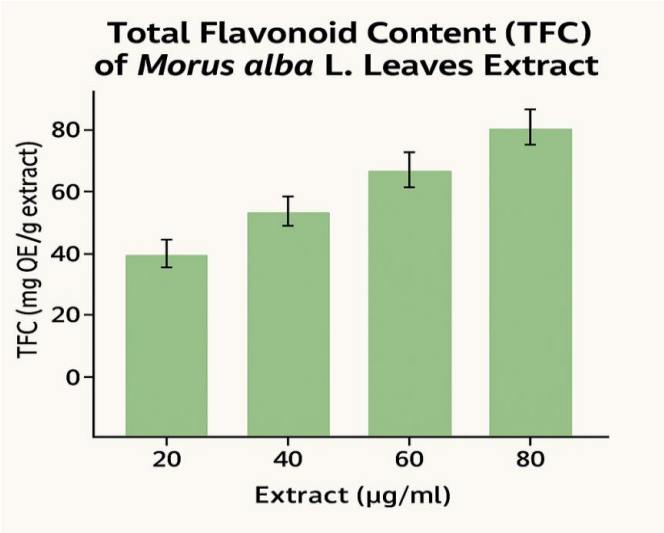


Fig 5. Analysis of Total flavonoid content

Tannin Content:

- Absorbance of extract = 0.602 at 760 nm
- Based on tannic acid calibration, total tannin content = 6.52% dry weight

Saponin Content:

- Weight of dried saponin extract = 0.31 g from 10 g sample
- % Saponin content = (0.31 / 10) × 100 = 3.1%

Table 5. Summary for quantitative phytochemical analysis:

Phytochemical	Method Used	Content in Leaf Sample
Alkaloids	Harborne's method	9.8%
Flavonoids	Aluminum chloride assay	78.2 mg/g
Tannins	Folin-Denis method	6.52%
Saponins	Gravimetric method	3.1%

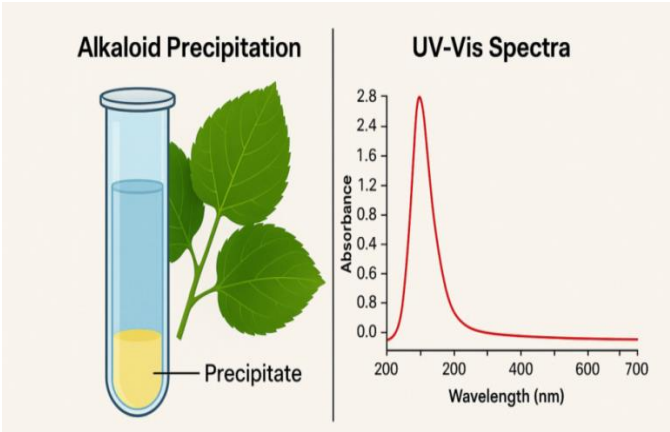


Fig 6. Extraction and Characterisation of *Morus Alba* leaves

"TLC Analysis of *Morus alba* Leaf Extracts" Separated bands of flavonoids.

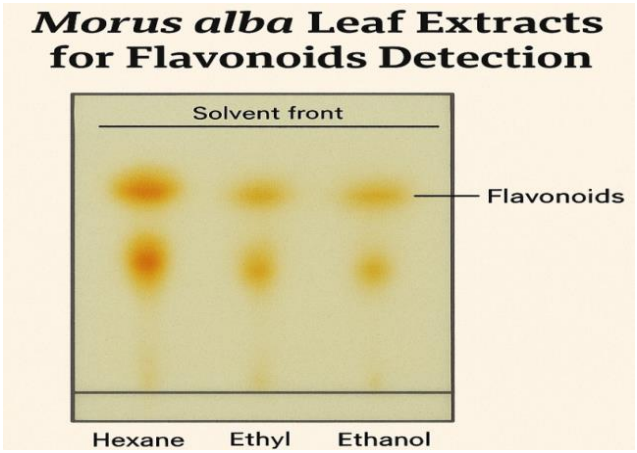


Fig 7.-TLC Analysis of Flavonoids of *Morus alba*

Discussion:

The analysis confirms a substantial presence of flavonoids (78.2 mg/g), which supports previous reports of antioxidant and anti-inflammatory potential of *Morus alba* leaves. Alkaloid content (9.8%) suggests possible analgesic and antimicrobial properties, while the tannin content (6.52%) may contribute to anti-diarrheal and astringent activity. Moderate saponin concentration (3.1%) aligns with its reported cholesterol-lowering and immune-modulating effects. Variability in phytochemical content may arise from geographical factors, leaf age, extraction solvent, or seasonal variation. Nevertheless, this study underlines the phytopharmaceutical relevance of *Morus alba* L. leaves.

IV. CONCLUSION

Traditionally, *M. alba* has been used for its diverse health-promoting effects, including its roles as a kidney and liver tonic, cardio-protective agent, skin whitener, anti-hyperglycemic remedy, neuroprotective agent, and treatment for ulcers. These traditional applications are increasingly supported by scientific evidence, underscoring the plant's potential in modern medicine and as a natural supplement for enhancing health and well-being. Continued research into *M. alba* will be essential for validating its traditional uses, identifying its active constituents, and exploring its therapeutic potential in clinical settings. *Morus alba* leaves are not only valued for their medicinal properties but also for their nutritional content, being notably high in protein and commonly incorporated into food products in various cultures. Beyond their dietary role, these leaves exhibit neuroprotective effects and hold promise in the management of neurological disorders such as Alzheimer's and Parkinson's disease. Given these multifaceted benefits, there is a strong rationale for further scientific investigation into other potential health-promoting properties of *M. alba*, such as immune modulation and chemo-protection. Future research should prioritize the isolation and characterization of the plant's active constituents to better understand their mechanisms of action and therapeutic potential, thereby providing scientific validation for its widespread use in traditional medicine.

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Conflicts of Interest: The authors declare no conflict of interest.

REFERENCES

[1]. Batiha, G. E. S., Al-Snafi, A. E., Thuwaini, M. M., Teibo, J. O., Shaheen, H. M., Al-Kuraishy, H. M., Al-Garbeeb, A. I., Alexiou, A., & Papadakis, M. (2023). *Morus alba: A comprehensive phytochemical and pharmacological review*. *Phytochemistry Reviews*. https://doi.org/10.1007/s11101-023-09712-4

[2]. Butt, M. S., Nazir, A., Sultana, M. T., & Schroen, K. (n.d.). *Morus alba L.: Nature's functional tonic*. National Institute of Food Science & Technology, University of Agriculture, Faisalabad, Pakistan; Agrotechnology and Food Sciences, Food and Bioprocess Engineering Group, Wageningen University, The Netherlands.

[3]. Chen, X.-Y., Zhang, T., Wang, X., Hamann, M. T., Kang, J., Yu, D.-Q., & Chen, R.-Y. (2018). *A chemical investigation of the leaves of Morus alba L.* Molecules, 23(5), 1022. https://doi.org/10.3390/molecules23051022

[4]. Chhetri, P. H., Yogol, N. S., Sherchan, J., Anupa, K. C., Mansoor, S., & Thapa, P. (2008). *Phytochemical and antimicrobial evaluations of some medicinal plants of Nepal*. Kathmandu University Journal of Science, Engineering and Technology, 4(1), 49–54.

[5]. Devi,B.,Sharma,N.,Kumar,D.,And Jeet,K. (2013). *Morus alba Linn*: A phytopharmacological review.International journal of Pharmacy and Pharmaceutical Sciences,5(suppl 2),14-18

[6]. Dey, P. M., & Harborne, J. B. (1987). *Methods in Plant Biochemistry: Volume 2 – Plant Phenolics*. Academic Press.

[7]. Dey, P. M., and J. B. Harborne. *Methods in Plant Biochemistry: Volume 2 – Plant Phenolics*. Academic Press, 1987.

[8]. Doff, A. (2009). *Standard Methods of Phytochemical Analysis*. Green World Publications.

[9]. Edeoga, H. O., D. E. Okwu, and B. O. Mbaebie. "Phytochemical Constituents of Some Nigerian Medicinal Plants." *African Journal of Biotechnology*, vol. 4, no. 7, 2005, pp. 685–688.

[10]. EIBaz,F.K.,Hassan,A.Z.,AbdAlla,H.I.,Aly,H.F.,andMah moud,K.(2017).Phytochemical analysis,assessment of antiproliferative and free radical scavenging activity of Morus albaMorus rubra Fruits.Asian journal of Pharmaceutical and Clinical Research,Received February20,2017,Revised and Accepted March 15,2017.

[11]. Evans, W. C. (1989). *Trease and Evans Pharmacognosy* (13th ed.). Baillière Tindall.,1989

[12]. Jeong, H. I., Jang, S., & Kim, K. H. (2022). *Morus alba L. for blood sugar management: A systematic review and meta-analysis*. Evidence-Based Complementary and Alternative Medicine, 2022, Article ID 7488791. https://doi.org/10.1155/2022/7488791

[13]. Kim, D.-S., Kang, Y. M., Jin, W. Y., Sung, Y.-Y., Choi, G., & Kim, H. K. (2014). Antioxidant activities and polyphenol content of *Morus alba* leaf extracts collected from varying regions. *Biomedical Reports*, *2*(3), 367-372. https://doi.org/10.3892/br.2014.294

[14]. Krishnamurthy, D., Ramesh, D., and M. Raghavendra. "Phytochemical Screening and Antimicrobial Activity of Some Medicinal Plants." *International Journal of Pharmacy and Pharmaceutical Sciences*, vol. 1, no. 1, 2009, pp. 33–36.

[15]. Kumar,S,andSingh,B.(2020).Medicinal and traditional uses of sahtoot.International Journal of Unani and Integrative Medicine,4(2),40-47

[16]. Lochynska,M.,and Oleszak,G.(2011).Multi- use of the white mulberry.Ecological Questions,15,91-95.

[17]. Lukša, J., & Servienė, E. (2020). *White mulberry (Morus alba L.) fruit-associated bacterial and fungal microbiota*. Department of Chemistry and Bioengineering, Vilnius Gediminas Technical University, Vilnius, Lithuania. Received April 6, 2020; accepted September 28, 2020.

[18]. Mallikharjuna, N., Rajanna, L. N., Seetharam, Y. N., & Sharanabasappa, G. K. (2007). *Phytochemical studies of Strychnos potatorum Lf – A medicinal plant*. E-Journal of Chemistry, 4(4), 510–518.

[19]. Moussa, A. M. I., & Darwish, E. A. (2024). Physical and mechanical properties of white mulberry fruits (*Morus alba*). *Al-Azhar Journal of Agricultural Engineering*, *6*, 38.

[20]. Munir,A.,Khera,R.A.,Rehman,R.,and Nisar,S.(2018).Multipurpose white mulberry:A review.International journal of Chemical and Biochemical Sciences,13,31-35.

[21]. Nacic,M.M.,Dabic,D.C.,Papetti,A.,Aksic,M.M.F.,Ognjanov,V.,Ljubojevic,M.,and Tesic,Z.L.(2015).Analysis and characterization of phytochemicals in mulberry (*Morus albaL.*)fruits grown in Vojvodina,North Serbia.Food Chemistry,171,128-136.

[22]. Omnidiran,M.O.,Baiyewu,R.A.,Ademola,I.T.,Fakorede, O.C.,Toyinbo,E.O.,Adewumi,O.J.,and Adekunle,E.A.(2012).Phytochemical analysis,nutrition composition and antimicrobial activities of white mulberry(*Morus alba*).Pakistan journal of Nutrition,11(5),456-460.

[23]. Parekh, Jigna, and Sumitra Chanda. "In Vitro Antimicrobial Activity and Phytochemical Analysis of Some Indian Medicinal Plants." *Turkish Journal of Biology*, vol. 31, no. 1, 2007, pp. 53–58.

[24]. Rajasekarian, S., M. Kalaivani, and K. E. Sabitha. "Evaluation of Phytochemicals in Medicinal Plants Using Standard Protocols." *Indian Journal of Plant Sciences*, vol. 2, no. 1, 1991, pp. 101–105.

[25]. Saensouk, S., Senavongse, R., Papayrata, C., & Chumroenphat, T. (2025). *Evaluation of color, phytochemical compounds, and antioxidant activities of mulberry fruit (Morus alba L.) during ripening*. Mahasarakham University.

[26]. Shahana, S., & Nikalje, A. P. G. (2019). *Bioactivity of Morus alba (Mulberry) plant: A comprehensive review*. Asian Journal of Pharmacy and Pharmacology, 5(2), 1–7. https://doi.org/10.31024/ajpp.2019.5.2.1

[27]. Wani, M. Y., Mir, M. R., Baqual, M. F., Ganie, N. A., Bhat, Z. A., & Ganie, Q. A. (2017). Roles of mulberrytree.*ThePharmaInnovationJournal,6*(9),143–147.https://www.thepharmajournal.com/

[28]. Zafar, R., & Muhammad, A. (2013). *Morus alba L. – A plant with diverse pharmacological potential: A review*. Asian Journal of Pharmaceutical and Clinical Research, 6(2), 10–17.

[29]. Zafar,M.S.,Muhammad,F.,Javed,I.,Akhtar,M.,Khalid,T., Aslam,B.,Waheed,A.,Yasmin,R.,and Zafar,H.(2013).White mulberry (*Morus alba*):,A brief phytochemical and pharmacological evaluations account.International Journal of Agriculture and Biology,15(3),612-620.

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