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Phytochemical Evaluation and Comparative Analysis of *Moringa oleifera* Leaf and *Hibiscus rosa-sinensis* Flower Extract

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ABSTRACT: The present study focuses on the phytochemical evaluation and comparative analysis of leaf extract of *Moringa oleifera* and flower extract of *Hibiscus rosa-sinensis*, two medicinally important plant species widely used in traditional healthcare systems. Plant materials were collected, shade-dried, and subjected to extraction using suitable solvents. The obtained extracts were analysed to identify the presence of major phytochemical constituents using standard phytochemical screening methods. The results revealed the presence of several bioactive compounds. The findings highlight the phytochemical richness of both plant species and support their traditional medicinal applications.

KEYWORDS: Plants; phytochemical; analysis; compounds.

I. INTRODUCTION

The significance of plants in human life is well recognized, particularly for their role in maintaining health and treating diseases. The plant kingdom serves as a vast repository of potential pharmaceutical compounds, and in recent years there has been growing recognition of the importance of medicinal plants as sources of bioactive substances for traditional and modern healthcare systems. Phyto-therapeutic agents are readily accessible, cost-effective, safe, efficient, and infrequently associated with adverse effects. The plants selected for medicinal purposes over millennia represent the most evident candidates for investigating the contemporary quest for therapeutically effective novel drugs. Nonetheless, these plants require examination to enhance comprehension of their characteristics, safety, and efficacy (Arunkumar and Muthuselvam, 2009). Medicinal plants encompass many chemical compounds that have specific physiological effects on the human body, including bioactive substances (Edoga et al., 2005; Mann, 1978; Vasu, 2009). A substantial array of phytochemicals from various chemical families has demonstrated inhibitory effects on all types of bacteria in vitro (Cowan, 1999). Approximately 150 phytochemicals have been extensively examined (Meagher and Thomson, 1999; Moorachian, 2000; Costa et al., 1999). Levels differ across plants according on type, processing, cooking, and cultivation circumstances (King and Young, 1999). There are over a thousand identified phytochemicals, along with numerous unidentified ones. It is widely recognized that plants synthesize these substances for self-protection; nevertheless, current studies indicate that numerous phytochemicals can also safeguard humans against diseases (Rao, 2003). Phytochemicals are not essential nutrients and are not necessary for human survival; yet, they possess significant qualities that can prevent or combat some prevalent diseases. Numerous benefits indicate a potential role for phytochemicals in illness prevention and therapy. Phytochemicals are broadly classified into primary and secondary constituents. Primary constituents include chlorophyll, proteins, and simple sugars, while secondary metabolites mainly comprise terpenoids, alkaloids, and phenolic compounds. Alkaloids, another important group of secondary metabolites, possess anesthetic properties and are commonly found in medicinal plants (Hérouart et al., 1988). Therefore, in view of this, the present study focuses on phytochemical analyses of select medicinal plants.

II. MATERIAL AND METHODS

Preparation of Plant Extract for Phytochemical Analysis:

***Moringa oleifera* (Leaf):** The following methods were used for sample collection and preparation of extract:

- **Sample Collection and Preparation:** Fresh leaves of *Moringa oleifera* were collected from the selected sites within the study area and transported to the Departmental laboratory for further processing. The collected leaves were thoroughly washed with clean water to remove adhering dust and impurities, followed by slicing into small pieces. The leaf samples were then sun-dried for a period of seven days to remove moisture. After complete drying, the samples were pulverized into a fine powder using an electric grinder and stored in airtight containers until extraction.

- **Preparation of Ethanolic Extract:** For ethanolic extraction, 400 g of the dried leaf powder was soaked in 1000 ml of ethanol and kept at room temperature for 48 hours with intermittent shaking. The mixture was then filtered first through cotton wool and subsequently through Whatman filter paper No. 42 (125 mm) to obtain a clear filtrate. The filtrate was concentrated using a rotary evaporator with the water bath maintained at 40 °C until the volume was reduced to approximately one-tenth of the original. Final drying of the extract was carried out using a freeze dryer. The dried crude extract was weighed and stored at 4 °C. Prior to phytochemical analysis, the extract was reconstituted in distilled water at the required concentration.

***Hibiscus rosa-sinensis* (Flower):** The following methods were used for sample collection and preparation of extract:

- **Collection and Sterilization of Plant Material:** Fresh flowers of *Hibiscus rosa-sinensis* Linn. (approximately 0.5 kg) were collected during the flowering season (March–April) from mature plants growing in the study area. The flowers were washed thoroughly under running tap water to remove surface contaminants and then surface-sterilized using 15% sodium hypochlorite (NaOCl) solution for 15 minutes with gentle agitation. After sterilization, the samples were rinsed several times with distilled water to eliminate any residual sterilizing agent. The flowers were dried using blotting paper and then ground into a fine powder for further analysis.
- **Extraction of Phytochemicals:** The powdered flower material was soaked in methanol and kept in two separate containers for five days with continuous shaking to ensure maximum extraction of bioactive compounds. The methanolic extract was then filtered, and the filtrate was acidified to a pH range of 3–4 using 0.1 M sulfuric acid (H_2SO_4). Subsequently, solvent extraction was carried out using a mixture of ethanol and chloroform in a 1:1 ratio. The obtained extracts were concentrated and preserved for qualitative phytochemical screening.

Phytochemical Analysis:

Qualitative phytochemical screening of the plant extracts was carried out using standard chemical tests to detect the presence of major bioactive constituents.

- **Tannins and Glycosides:** The presence of tannins and glycosides was tested using freshly prepared 10% potassium hydroxide (KOH) solution. A few drops of the reagent were added to the plant extract. The formation of white precipitates indicated the presence of tannins, whereas the appearance of red precipitates confirmed the presence of glycosides.
- **Flavonoids and Quinones:** To confirm the presence of flavonoids and quinones, concentrated hydrochloric acid (HCl) was added to the plant extract. A visible change in color indicated the presence of flavonoids, while the formation of yellow precipitates confirmed the presence of quinones.
- **Steroids:** Qualitative analysis for steroids was performed by adding concentrated sulfuric acid (H_2SO_4) to the plant extract. The formation of green-colored precipitates confirmed the presence of steroids in the sample.
- **Alkaloids:** Alkaloids were detected using Dragendorff's reagent. One to two drops of the reagent were added to the plant extract, and the formation of brick-red precipitates indicated the presence of alkaloids.

Table 1: Qualitative phytochemical tests and their observed reactions

Phytochemical Constituents	Reagent Used	Observation
Alkaloids	Dragendorff's reagent	Formation of brick-red precipitates
Tannins	10% potassium hydroxide (KOH)	Appearance of white precipitates
Glycosides	10% potassium hydroxide (KOH)	Development of red precipitates
Steroids	Concentrated sulfuric acid (H_2SO_4)	Formation of green-colored precipitates
Flavonoids	Concentrated hydrochloric acid (HCl)	Noticeable color change
Quinones	Concentrated hydrochloric acid (HCl)	Formation of yellow precipitates

III. RESULT AND DISCUSSION

Traditional medicinal plants have long been used in indigenous healthcare systems, and scientific evaluation of their phytochemical constituents helps to validate these traditional claims and provides a basis for further pharmacological and clinical studies. In the present study, *Moringa oleifera* and *Hibiscus rosa-sinensis* were selected for phytochemical investigation due to their widespread use in traditional medicine and their recognized medicinal importance. *Moringa oleifera* is well known for its nutritional and medicinal value and is extensively used for treating inflammation, digestive disorders, diabetes, and skin ailments. Similarly, *Hibiscus rosa-sinensis* is traditionally employed for managing hair disorders, menstrual irregularities, wound healing, and cardiovascular health. The selection of these plants was based on their availability in the study area and their frequent use by local communities. The present phytochemical analysis focused on the qualitative detection of major secondary metabolites, including tannins, flavonoids, steroids, glycosides, alkaloids, and quinones. These phytochemicals are known to exhibit a wide range of biological activities such as antioxidant, anti-inflammatory, antimicrobial, antidiabetic, and anticancer effects. Identifying the presence of these compounds in the selected plant extracts provides scientific support for their traditional medicinal uses and contributes to the understanding of their therapeutic potential.

The qualitative phytochemical screening of *Moringa oleifera* and *Hibiscus rosa-sinensis* reveals notable variation in the presence and abundance of bioactive constituents between the two plant species. In *Moringa oleifera* leaf extract, alkaloids, flavonoids, and steroids were found to be strongly present (+++), indicating a rich phytochemical composition. The high occurrence of these compounds supports the plant's well-known medicinal properties, including its antioxidant, anti-inflammatory, antimicrobial, and antidiabetic activities. Tannins were moderately present (++), while glycosides and quinones were detected in low concentrations (+), further contributing to its therapeutic potential.

In contrast, the flower extract of *Hibiscus rosa-sinensis* showed a comparatively limited phytochemical profile. Alkaloids and tannins were moderately present (++), suggesting their role in the plant's traditional use for antimicrobial, astringent, and wound-healing purposes. Quinones were detected in low amounts (+), whereas flavonoids, steroids, and glycosides were absent. This comparatively simpler phytochemical composition indicates that the medicinal value of *Hibiscus rosa-sinensis* flowers may be primarily attributed to specific classes of compounds rather than a broad spectrum of secondary metabolites. Overall, the observations demonstrate that *Moringa oleifera* possesses a richer and more diverse phytochemical profile than *Hibiscus rosa-sinensis*, which supports its wider range of ethnomedicinal applications. The presence and variation of these phytochemicals provide scientific validation for the traditional uses of both plants and highlight their potential for further pharmacological and therapeutic investigations.

Table 2: Qualitative phytochemical profile of *Moringa oleifera* and *Hibiscus rosa-sinensis*

Phytochemical Constituents	***Moringa oleifera* (Leaf Extract)**	***Hibiscus rosa-sinensis* (Flower Extract)**
Alkaloids	+++	++
Tannins	++	++
Flavonoids	+++	–
Steroids	+++	–
Glycosides	+	–
Quinones	+	+
'–' means Absent; '+' means Present (low); '++' means Moderately present; '+++' means Strongly present.		

Qualitative screening of *Moringa oleifera* and *Hibiscus rosa-sinensis* revealed the presence of several biologically active secondary metabolites that are known to play a key role in plant-based medicine. The detection of these phytochemicals supports the long-standing reliance of local communities on these species for treating a wide range of ailments.

The phytochemical profile of *Moringa oleifera* leaf extract was found to be particularly rich and diverse. The strong presence (+++) of alkaloids, flavonoids, and steroids indicates a high therapeutic potential of the plant. Alkaloids are widely known for their antimicrobial, analgesic, and antidiabetic properties, while flavonoids are recognized for their strong antioxidant and anti-inflammatory activities. Steroids contribute to anti-inflammatory and immune-modulating effects, which further explains the extensive use of *Moringa oleifera* in managing inflammatory conditions, metabolic disorders, and skin-related problems. The moderate presence of tannins (++) suggests astringent and antimicrobial

properties, whereas the low presence of glycosides and quinones (+) may contribute additional antioxidant and protective effects. Overall, the phytochemical richness of *Moringa oleifera* substantiates its broad spectrum of ethnomedicinal applications and nutritional significance.

The phytochemical profile of *Moringa oleifera* leaf extract observed in the present study shows strong consistency with a wide range of earlier investigations. The strong presence (+++) of **alkaloids, flavonoids, and steroids** recorded in our study clearly aligns with previous qualitative and quantitative phytochemical analyses reported by several researchers. The findings are in close agreement with **Okah and Cornelius (2019)**, who reported substantial amounts of alkaloids, flavonoids, saponins, and glycosides in *Moringa oleifera* leaves, with higher concentrations in leaves compared to flowers. While their study employed IR spectral analysis and percentage quantification, the strong qualitative presence of alkaloids and flavonoids in our study corroborates their conclusion that leaves are the richest phytochemical reservoir of the plant. The moderate presence of tannins and low presence of glycosides observed in the present work also support their reported cyanogenic glycoside content in leaf tissue.

Similarly, the results of **Bagheri et al. (2019)** strongly support our observations. They reported the presence of alkaloids, tannins, phenolic compounds, terpenoids, and glycosides in leaf extracts obtained using multiple solvents. The antimicrobial activity demonstrated in their work complements the strong presence of alkaloids and flavonoids observed in our study, which are widely recognized for antimicrobial and antioxidant functions. The phytochemical richness observed in the present study is further supported by **Bhalla et al. (2021)**, who identified a wide spectrum of bioactive compounds in extracts of *M. oleifera* leaves using GC–MS. Their findings of high antioxidant activity, particularly in methanolic extracts, are in strong agreement with our observation of abundant flavonoids and steroids.

Advanced analytical evidence provided by **Rahayu and Timotius (2022)** using LC–MS further validates our results. Their identification of flavonoid glucosides and alkaloid compounds in *Moringa oleifera* leaf infusion strongly supports the qualitative detection of flavonoids and alkaloids in the present study. Although our work was qualitative in nature, the consistency in compound classes confirms the reliability of traditional extraction and screening methods. The biological relevance of the phytochemicals detected in our study is also supported by **Gupta et al. (2023)**, who demonstrated significant antibacterial and antioxidant activities of ethanolic *Moringa oleifera* leaf extracts. The strong antibacterial and antioxidant performance reported in their study directly corresponds with the high levels of alkaloids and flavonoids identified in our analysis.

Likewise, **Khalid et al. (2023)** reported rich contents of phenols, flavonoids, saponins, and tannins in *Moringa oleifera* leaf powder, along with high antioxidant capacity. Their quantitative assays support our qualitative findings of moderate tannins and strong flavonoid presence, reinforcing the nutritional and therapeutic significance of the plant. The observations of **Sivapragasam et al. (2024)** further strengthen our findings by demonstrating that leaf extracts consistently contain higher concentrations of phytochemicals compared to other plant parts, regardless of solvent polarity. Their conclusion that alkaloids, flavonoids, phenolics, and tannins are dominant in leaf extracts closely matches the phytochemical pattern observed in the present study.

Comparative pharmacognostic studies by **Metri et al. (2024)** also reported the presence of alkaloids, flavonoids, steroids, tannins, and glycosides in *Moringa oleifera*, with higher extractive values than related species. The strong presence of steroids observed in our study is particularly supported by their TLC and quantitative phenolic and flavonoid analyses. Finally, **El-Sherbiny et al. (2024)** identified flavonoids and phenolic acids such as quercetin, gallic acid, and chlorogenic acid using HPLC and linked them to antioxidant and antibacterial activities. These findings provide molecular-level validation for the strong flavonoid presence recorded in the present study.

In contrast, the phytochemical composition of *Hibiscus rosa-sinensis* flower extract was comparatively limited. The moderate presence of alkaloids and tannins (++) indicates that these compounds are primarily responsible for the plant's medicinal properties. Tannins are known for their wound-healing, antimicrobial, and astringent effects, which align well with the traditional use of *Hibiscus rosa-sinensis* in treating skin disorders, hair problems, and minor injuries. The detection of quinones in low concentration (+) further supports its antimicrobial and antioxidant potential. However, the absence of flavonoids, steroids, and glycosides suggests that the medicinal efficacy of *Hibiscus rosa-sinensis* flowers may be linked to a narrower range of bioactive compounds compared to *Moringa oleifera*.

The phytochemical profile of *Hibiscus rosa-sinensis* flower extract observed in the present study shows both agreement and variation when compared with earlier investigations, largely due to differences in plant part used, solvent system, and analytical techniques. In the current study, the flower extract exhibited a moderate presence of alkaloids and tannins, a low presence of quinones, and the absence of flavonoids, steroids, and glycosides, indicating a comparatively

narrower phytochemical spectrum than that observed in *Moringa oleifera*. The results partially contrast with **Garg et al. (2012)**, who reported high levels of phenolic compounds and flavonoids in aqueous and methanolic extracts of *Hibiscus rosa-sinensis*, along with strong antioxidant activity. This difference may be attributed to the use of polar solvents (methanol and water) and antioxidant-specific assays, which are more sensitive to phenolic and flavonoid detection. In contrast, the absence of flavonoids in the present qualitative screening suggests that either the concentration of flavonoids in the studied flower samples was low or that solvent polarity and extraction conditions influenced detectability.

Similarly, **Sugumaran et al. (2012)** described the presence of phenols, tannins, and flavonoids in *Hibiscus rosa-sinensis* flowers, along with vitamins and minerals. Their quantitative approach highlights nutritional and biochemical richness, whereas the present study, being qualitative, emphasizes dominant phytochemical groups rather than trace-level constituents. The moderate tannin content observed in both studies supports the traditional use of the plant in wound healing and astringent applications. The findings of the present study differ notably from **Udo et al. (2016)** and **Vastrad and Byadgi (2018)**, who documented strong phytochemical diversity in leaf extracts, including flavonoids, tannins, glycosides, and anthraquinones. These discrepancies can be explained by the difference in plant parts, as leaves are metabolically more active and generally richer in secondary metabolites than flowers. Our results reinforce this distinction by showing a simpler phytochemical profile in flowers compared to leaves.

Advanced pharmacognostic and phytochemical inquiries by **Rehman et al. (2024)** and **Loganathan et al. (2024)** further demonstrated the presence of flavonoids, anthocyanins, and phenolic acids in flowers using LC-MS-based techniques. While these studies confirm the biochemical potential of flowers, the present study's limited detection of such compounds suggests that instrument-based techniques are more sensitive than classical qualitative tests, which may not detect compounds present in lower concentrations. A close agreement is observed with **Munir et al. (2025)**, who reported that chloroform flower extracts of *Hibiscus rosa-sinensis* predominantly contained alkaloids, tannins, and quinones, while flavonoids were not consistently detected. This directly supports the present findings and indicates that flower extracts—particularly under certain solvent systems—may primarily express these phytochemical groups. Their reported antibacterial and antitumor activities further validate the medicinal relevance of alkaloids, tannins, and quinones detected in the current study.

Studies by **Joshi et al. (2025)** emphasize the rich phytochemical composition of *Hibiscus rosa-sinensis* leaves, including flavonoids, phenols, and saponins, reinforcing the conclusion that phytochemical diversity varies significantly between plant organs. The present findings thus support earlier research suggesting that flowers may contribute selectively to therapeutic effects, while leaves possess broader pharmacological potential.

Comparative analysis of the two species clearly indicates that *Moringa oleifera* possesses a more complex and diverse phytochemical profile than *Hibiscus rosa-sinensis*. This difference in phytochemical composition explains the wider range of therapeutic applications associated with *Moringa oleifera* in traditional medicine. Nevertheless, the presence of key bioactive compounds in *Hibiscus rosa-sinensis* confirms its medicinal relevance and supports its continued use in indigenous healthcare practices. Overall, the phytochemical findings provide evidence in support of medicinal claims associated with both plant species. These results also highlight the need for further quantitative analysis, bioactivity-guided fractionation, and pharmacological studies to explore the full therapeutic potential of these plants and to facilitate their possible application in modern medicine.

IV. CONCLUSION

The present study demonstrates that *Moringa oleifera* leaf extract possesses a rich and diverse phytochemical profile, characterized by a strong presence of alkaloids, flavonoids, and steroids, along with moderate levels of tannins and glycosides. The dominance of bioactive compounds in the leaves highlights their significance as the most valuable medicinal part of the plant and confirms the reliability of traditional extraction and qualitative screening approaches in identifying major phytochemical groups. In contrast, the phytochemical composition of *Hibiscus rosa-sinensis* flower extract was comparatively limited, with moderate levels of alkaloids and tannins and low levels of quinones, while flavonoids, steroids, and glycosides were not detected. The presence of tannins and alkaloids supports the traditional use of *Hibiscus rosa-sinensis* flowers in wound healing, skin care, and antimicrobial applications. Overall, the comparative analysis clearly indicates that *Moringa oleifera* leaves exhibit greater phytochemical complexity and broader medicinal potential than *Hibiscus rosa-sinensis* flowers. The findings provide scientific support for traditional uses of these plants and highlight the importance of plant part selection in phytochemical and pharmacological studies.

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