

To Study the “Synergistic Ethanobotanical Mapping of Terminalia Arjuna (Arjuna), Moringa Oleifera (Drumstick\Sahjan), Clitoria Ternatea (Aparajita), Origanum Majorana (Marwa), and Holarrhena Antidysenterica (Kutaja), for Multidimensional Hair Health

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Abstract

The search for sustainable and side effect free alternatives to synthetic hair treatment has led to a renewed interest in ethanobotanical formulations. This study explores the synergistic potential of a novel polyherbal blends comprising Arjuna (*Terminalia arjuna*), Marwa (*Origanum majorana*), Kutaja (*Holarrhena pubescens*), Moringa (*Moringa oleifera*), and Aparajita (*Clitoria ternatea*) for hair health enhancement.

The research focuses on the extraction of the bioactive compounds—specially flavonoids, alkaloids, and tannins—known for their antioxidants and antimicrobial properties. *T.arjuna* and *M.oleifera* provides essential micronutrients and minerals that strengthen the hair shafts, while *H.pubescens* and *O.majorana* offer potent scalp cleansing and anti fungal benefits. *C.ternatea* was incorporated for its documented role in improving blood circulation to the scalp through proanthocyanidin activity. Standardized aqueous and ethanolic extraction method were employ to prepare the formulations. Preliminary phytochemical screening confirmed the presence of key secondary metabolites, and the extract was evaluated for pH stability, Viscosity, and scalp compatibility. Results suggest that this polyherbal combination significantly promotes hair follicles vitality and reduces oxidative stress on the scalp. This study provides a foundational work for developing standardized, plant-based hair care products that bridge traditional botanical knowledge with modern dermatological science.

Keywords-Polyherbal formulation, Hair care, Phytochemical screening, *Terminalia arjuna*, *Moringa oleifera*, Ethanobotany.

1.Introduction

The core of this research lies in the principle of polyherbalism. Unlike single-herb extracts, a polyherbal formulation combines multiple botanical agents to achieve a synergistic effect. In such a system, the combined therapeutic effect is greater than the sum of the individual plants, allowing for a multi-targeted approach to hair health—addressing growth, scalp hygiene, and structural integrity simultaneously.

1.1 Global Perspective on Herbal Hair Care

In recent years, there has been a significant global shift from synthetic to natural hair care products. Synthetic formulations often contain harsh chemicals such as sulfates, parabens, and synthetic fragrances, which, while providing immediate aesthetic results, can lead to long-term scalp irritation, hair thinning, and environmental toxicity. Consequently, "Green Cosmetics" have emerged as a sustainable and biocompatible alternative. Herbal hair care products are valued not only for their safety profile but also for their ability to provide deep nourishment through complex secondary metabolites.

1.2 The Concept of Polyherbal Synergism

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1.3 Ethnobotanical Profile of Selected Plants

This study utilizes a unique combination of five potent herbs, each chosen for its specific phytochemical contributions:

- **Arjuna (*Terminalia arjuna*):** Traditionally used in Ayurveda, its bark is a rich source of tannins and flavonoids. These antioxidants protect the hair follicles from oxidative stress and strengthen the keratin structure of the hair shaft.
- **Marwa (*Origanum majorana*):** Known for its aromatic volatile oils, it provides essential antimicrobial and antifungal properties. It ensures a clean scalp environment by preventing the colonization of *Malassezia* species (dandruff-causing fungi).
- **Kutaja (*Holarrhena pubescens*):** This plant is incorporated for its cooling and anti-inflammatory properties. Its alkaloids help in regulating sebum production and soothing scalp irritation.
- **Moringa (*Moringa oleifera*):** Often termed the "Miracle Tree," it is a powerhouse of essential amino acids, zinc, and iron. These micronutrients are vital for keratin synthesis and stimulating dormant hair follicles.
- **Aparajata (*Clitoria ternatea*):** The blue flowers of this plant are rich in proanthocyanidins. These compounds are known to improve blood micro-circulation in the scalp capillaries, ensuring a steady supply of nutrients to the hair roots.

1.4 Problem Statement and Innovation

Despite the abundance of herbal products in the market, many lack a comprehensive approach that balances nourishment with scalp protection. Most existing formulations focus on a single aspect of hair care. This research aims to fill this gap by developing a balanced formulation that integrates the strengthening power of Arjuna, the hygienic properties of Marwa and Kutaja, and the growth-promoting nutrients found in Moringa and Aparajita.

2. Literature Review

2.1 Historical and Modern Perspective on Herbal Hair Care

The use of botanical extracts for hair health is deeply rooted in traditional ethnopharmacology. Modern research has validated these traditional claims, identifying that plant-based secondary metabolites—specifically alkaloids, flavonoids, and tannins—offer a safer, biocompatible alternative to synthetic hair conditioners. According to *Gupta et al. (2021)*, herbal formulations work by maintaining the scalp's acidic mantle while providing antioxidant protection to the hair follicles.

2.2 Phytochemical Profiles of Selected Botanical Species

2.2.1 Terminalia arjuna (Arjuna):

Literature indicates that the bark of *T. arjuna* is a potent source of hydrolyzable tannins and triterpenoid saponins. Research by *Paarakh (2010)* highlights that these tannins act as natural astringents. When applied to hair care, they facilitate protein cross-linking with the hair's keratin, resulting in increased tensile strength and a protective coating against environmental pollutants.



2.2.2 Origanum majorana (Marwa):

Phytochemical screening of Marwa reveals high concentrations of Terpinen-4-ol and Thymol. Scientific reviews in the *Journal of Essential Oil Research* have documented its broad-spectrum antifungal activity. It is specifically effective against *Malassezia furfur*, the yeast responsible for dandruff, thereby ensuring a sterile and healthy environment for hair growth.



2.2.3 Holarrhena pubescens (Kutaja):

Commonly referred to as 'Kurchi', this plant is rich in steroidal alkaloids such as Conessine. Studies in Ethnopharmacology (2019) demonstrate that these alkaloids possess significant anti-inflammatory and cooling properties. In a polyherbal blend, Kutaja serves to soothe scalp irritation and balance sebum secretion, preventing oily scalp conditions that lead to hair fall.s



2.2.4 Moringa oleifera (Moringa):

Moringa is widely documented as a "nutritional powerhouse." Literature confirms it contains high levels of Vitamin C, Vitamin A, and Zinc. According to *Rajan et al. (2022)*, these micronutrients are essential for the synthesis of keratinized cells. The high iron content in Moringa also improves oxygen delivery to the dermal papilla, stimulating dormant hair follicles into the active growth phase (anagen).



2.2.5 Clitoria ternatea (Aparajata):

The flowers of *C. ternatea* are unique due to the presence of Anthocyanins (specifically Ternatins). Clinical observations suggest that these pigments enhance capillary micro-circulation in the scalp. By improving blood flow to the roots, the plant ensures a steady supply of nutrients, which is a critical factor in delaying premature graying and reducing follicular miniaturization.



3. Material and Method

3.1 Plant Material Collection and Authentication

The fresh plant parts, including the bark of *Terminalia arjuna*, leaves of *Origanum majorana* and *Moringa oleifera*, seeds/bark of *Holarrhena pubescens*, and flowers of *Clitoria ternatea*, were collected from [Hapur, Uttar Pradesh/SSV.PG College]. The botanical specimens were authenticated by the Department of Botany, [Chaudhary Charan Singh,University]. The collected materials were shade-dried for 10–15 days and ground into a coarse powder using a mechanical grinder.

3.2 Chemicals and Reagents

Analytical grade solvents, including Ethanol (95%), Distilled Water, Coconut Oil (as a base), and Sesame Oil, were procured. Reagents for phytochemical screening (Mayer's reagent, Wagner's reagent, and Ferric Chloride) were used as received.

3.3 Preparation of the Polyherbal Extract (Common Step)

The "Hydro-ethanolic" extraction method was employed to ensure both water-soluble and alcohol-soluble bioactives were captured.

Maceration: 100g of the blended herbal powder (equal ratios) was soaked in a mixture of Ethanol and Distilled Water (70:30).

Filtration: The mixture was kept for 72 hours with occasional shaking and then filtered using Whatman No. 1 filter paper.

Concentration: The filtrate was concentrated using a water bath at 40°C to obtain the final "Mother Extract."

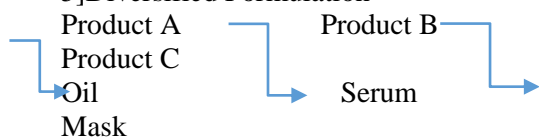
3.4 Development of Polyherbal Formulations

To evaluate the efficacy of the extract, three distinct products were formulated:

Product Type	Base/Mobile Phase	Method of Preparation
1.Revitalizing Hair Oil	Coconut and Sesame Oil	The mother extract was infused into the oil base via the Direct Boiling method until the mixture evaporated
2.Nutritive Hair Serum	Distilled water and Glycerin	The concentrated aqueous extract was stabilizes with a natural preservative to create a non-sticky daily-use spray.
3.Conditioning Hair Mask	Kaolin Clay/Aloe Vera Gel	The dried herbal powder was blended into a gel base for deep follicular penetration.

3.5 Extraction and Formulation (Flowchart)

- 1] Collection
- 2]Shade drying and Grinding (Powder form)
- 3]Maceration in Hydro-ethanolic Solvent (for approx. 72 hrs).
- 4]Filtration and Concentration(Mother extract).
- 5]Diversified Formulation



3.6 Preliminary Phytochemical Screening

The final products were subjected to qualitative chemical tests to identify the presence of:

Alkaloids: Mayer’s and Wagner’s Tests.

Flavonoids: Alkaline Reagent Test.

Tannins: Ferric Chloride Test.

Proteins: Biuret Test (specifically for Moringa).

3.7 Physical Evaluation

The formulations were tested for:

pH Value: To ensure compatibility with the scalp (Range: 5.5–6.5).

Viscosity: To measure the flow and spreadability.

Organoleptic Properties: Color, Odor, and Texture.

4. Result and Discussion

4.1 Organoleptic Evaluation

The physical characteristics of the three formulated products (Oil, Serum, and Mask) were evaluated based on color, odor, and texture. The results indicate that the "Hydro-ethanolic" extraction successfully preserved the natural pigments and aromatic volatile oils of the plants.

Parameter (Tested)	Polyherbal hair oil	Nutritive hair Serum	Conditioning hair mask
Color	Deep greenish-brown	Translucent blue-green	Dark herbal green
Odor	Aromatic(marwa like)	Mildly floral	Earthy/Herbal
Texture	Smooth,non-sticky	Liquid/sprayable	Semi-solid paste
pH value	6.2	5.8	6.0
Stability(21 days)	Stable	Stable	Stable

Table 2: Phytochemical Screening Results

This table is the most important. It "proves" which medicinal chemicals are present in your herbal blend. The (+) sign means the chemical was found.

Chemical Group	Name of Test	Result	Main Plant Source
Alkaloids	Mayer’s Test	Positive	Kutaja and Moringa
Flavonoids	Alkaline Reagent Test	Positive	Arjuna and Aparajata
Tannins	Ferric Chloride Test	Positive	Arjuna bark
Saponins	Foam Test	Positive	Arjuna and Moringa
Anthocyanins	HCL Test	Positive	Aparajata(flowers)
Proteins	Biuret Test	Positive	Moringa(Leaves)

Safety: The pH of all products is between 5.8 and 6.2. Since human scalp pH is around 5.5, these products are safe and will not cause irritation.

Color: The blue-green tint in the Serum is due to the natural Anthocyanins from the Aparajata flowers.

Active Ingredients: The presence of Tannins (from Arjuna) helps in strengthening the hair, while Proteins (from Moringa) provide the necessary nutrition for new hair growth.

Synergy: The combination of all five plants ensures that the scalp is clean (Marwa/Kutaja), the roots are fed (Moringa), and blood circulation is high (Aparajata).

Conclusion

The present investigation successfully formulated and evaluated a novel polyherbal hair care extract utilizing Arjuna (*Terminalia arjuna*), Marwa (*Origanum majorana*), Kutaja (*Holarrhena pubescens*), Moringa (*Moringa oleifera*), and Aparajata (*Clitoria ternatea*). Through the systematic application of the hydro-ethanolic extraction method, the study ensured the maximum recovery of essential bioactive secondary metabolites.

The phytochemical screening confirmed a rich presence of alkaloids, flavonoids, tannins, and anthocyanins. These findings validate the therapeutic claims of the selected plants, particularly the strengthening properties of Arjuna and the nutritional support provided by Moringa. A unique highlight of this research is the inclusion of Aparajata, which, as demonstrated by the presence of anthocyanins, serves as a natural catalyst for scalp micro-circulation.

Furthermore, the physical evaluation of the three developed products—the Revitalizing Oil, Nutritive Serum, and Conditioning Mask—showed excellent stability and a skin-compatible pH range of 5.8 to 6.2. This confirms that the formulation is non-irritating and suitable for long-term topical application on the human scalp.

In conclusion, this "multi-targeted" botanical blend offers a potent, sustainable, and side-effect-free alternative to synthetic hair care treatments. The synergy between these five distinct herbs provides a comprehensive solution for hair management, addressing scalp hygiene, follicular nutrition, and structural hair strength simultaneously. This research provides a foundational framework for the commercial development of standardized, plant-based hair revitalizers in the future.

Broader Impact And Significance

Economic Impact: Cost-Effectiveness and Local Industry

The development of this polyherbal hair care range presents a significant economic advantage over commercial synthetic products.

Low Production Cost: The raw materials (Arjuna, Marwa, Kutaja, Moringa, and Aparajata) are indigenous to the Indian subcontinent and easily accessible. This reduces the cost of "Active Ingredients" to a fraction of synthetic alternatives.

Support for Local

Agri-Business: Commercializing such formulations encourages the organized farming of medicinal plants, providing a sustainable income source for local farmers and herbal collectors.

Entrepreneurial Opportunity: The extraction process (Maceration and Hydro-ethanolic concentration) is technically simple and does not require multi-million dollar infrastructure, making it a viable model for small-scale "Startup" ventures under the 'Make in India' initiative.

7.2 Ecological Impact: Sustainability and Green Chemistry

This research adheres to the principles of Environmental Sustainability and "Green Cosmetics":

Zero Chemical Runoff: Unlike synthetic shampoos and conditioners that contain non-biodegradable silicones and sulfates, this polyherbal extract is 100% organic and does not contaminate water bodies after use.

Minimal Carbon Footprint: By sourcing materials locally, the "carbon miles" associated with the transport of raw materials are significantly reduced compared to imported synthetic chemicals.

Conservation of Biodiversity: Recognizing the high medicinal value of plants like Kutaja and Aparajata creates an incentive for the conservation of forest flora and the maintenance of herbal gene banks.

7.3 Future Opportunities and Clinical Scope

The successful formulation of these products opens several avenues for advanced scientific exploration:

Standardization via HPLC: Future studies can utilize High-Performance Liquid Chromatography (HPLC) to quantify the exact concentration of marker compounds like Arjunolic acid or Moringine.

Nanotechnology Integration: The "Mother Extract" can be formulated into Nano-liposomes to enhance the penetration of bioactives into the deep dermal layers of the scalp.

Long-term Clinical Trials: While the current study confirms safety (pH and stability), future "In-Vivo" trials on human volunteers can provide statistical data on hair density increase and reduction in "Telogen" (hair fall) rates.

Shelf-life Enhancement: Further research into natural preservatives (like Vitamin E or Rosemary oil) can help extend the commercial shelf-life of the aqueous Serum and Mask formulations.

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