

# APPLICATION OF *HIBISCUS SABDARIFFA* AND *TRIGONELLA FOENUM*- BASED EXTRACTS AND COCONUT OIL IN THE FORMULATION OF HERBAL SHAMPOO

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## ABSTRACT

**Background:** The growing preference for natural and eco-friendly cosmetic products has driven interest in herbal shampoos as safer alternatives to synthetic formulations that may cause scalp irritation, dryness, and hair damage. Plant-based ingredients such as *Hibiscus sabdariffa*, *Trigonella foenum-graecum* (fenugreek), and coconut oil possess bioactive compounds with potential hair growth, conditioning, and antimicrobial properties, making them suitable candidates for shampoo formulation.

**Objectives:** This study aimed to formulate a herbal shampoo using extracts of *Hibiscus sabdariffa*, *Trigonella foenum-graecum*, and coconut oil, and to evaluate its physicochemical and functional properties to determine its suitability as a safe and effective hair care product.

**Methods:** Plant materials were extracted using Soxhlet extraction with ethanol and incorporated into a shampoo base containing sodium lauryl ether sulfate (SLES), glycerin, nitrosol, citric acid, and other excipients. The formulated shampoo was evaluated for organoleptic properties, pH, viscosity, foaming ability, foam stability, wetting time, and stability under controlled conditions. Standard laboratory procedures and statistical analyses were employed to assess product performance and consistency.

**Results:** The formulated shampoo exhibited desirable organoleptic properties, including a wine-red colour, pleasant odour, and smooth homogeneous consistency. The pH was  $6.1 \pm 0.1$ , indicating compatibility with scalp physiology. Viscosity was  $1100 \pm 10$  cP, reflecting appropriate thickness for application. The formulation showed excellent foaming ability ( $180 \pm 5$  mL) and high foam stability (91.7%), indicating effective surfactant performance. Wetting time was  $20 \pm 2$  seconds, demonstrating good detergency. Stability studies revealed no phase separation, colour change, or odour deterioration over 30 days.

**Conclusion:** The herbal shampoo formulation demonstrated satisfactory physicochemical stability, cleansing efficiency, and user acceptability, supporting its potential as a safe, effective, and eco-friendly alternative to conventional shampoos.

**KEYWORDS:** Herbal shampoo, *Hibiscus sabdariffa*, Fenugreek, Coconut oil, Physicochemical evaluation

## INTRODUCTION

People everywhere now favour cosmetics made with plants rather than harsh chemicals such as sodium lauryl sulfate and parabens because they have learned these synthetics can be harmful. Consequently, shoppers want products that are kind to the planet, break down easily and come from nature. People are increasingly choosing herbal shampoos because they clean hair, nourish it, yet cause little to no harm. These shampoos feature natural ingredients like plant oils, specific plant-derived chemical compounds, and more that can help hair flourish, fight flakes, and keep the scalp healthy and balanced. Shampoo recipes could benefit from using hibiscus, fenugreek, alongside coconut oil. Roselle that's hibiscus sabdariffa holds compounds boosting growth, smoothing breakage, then adding luster to hair. Meanwhile, fenugreek seeds deliver elements fortifying follicles while tackling both shedding and flakes. Coconut oil a familiar softener helps hair stay healthy by cutting down on protein loss while also guarding against germs on the scalp.<sup>[1]</sup>

Therefore, mixing this with other natural elements could create a shampoo that works well yet remains mild for both hair alongside the scalp. Nigeria boasts a wealth of plants a largely untapped resource for cosmetics. Crafting a consistent shampoo from hibiscus, fenugreek, and coconut might boost local business, encourage eco-friendly growing practices. This blend promises benefits beyond just how well it cleans hair. This research looks at whether substances from plants could make a gentle shampoo, one that cleans hair, helps it grow, also boosts its condition. Despite the wide availability of commercial shampoos, many consumers experience adverse effects such as scalp dryness, irritation, hair breakage, and allergic reactions due to the harsh nature of synthetic surfactants and additives.<sup>[2]</sup>

Human hair is a keratinized filamentous structure that grows from follicles located in the dermal layer of the skin. It plays an important biological and social role, influencing thermoregulation, protection, and personal identity.<sup>[3]</sup>

Each hair strand comprises three primary layers: the cuticle, cortex, and medulla. The cuticle, being the outermost layer, consists of overlapping cells that protect the inner cortex and contribute to the hair's smoothness and shine. The cortex contains fibrous proteins and pigments that determine the hair's strength and colour, while the medulla, when present, provides internal structure.<sup>[4]</sup>

A shampoo is a cosmetic preparation intended for cleaning hair and scalp by removing dirt, oil, and environmental impurities without damaging hair structure or causing irritation.<sup>[5]</sup>

In addition to its cleansing function, an ideal shampoo should impart lustre, manageability, and a pleasant fragrance. Most shampoos contain a combination of ingredients, including: Surfactants; the primary cleansing agents (e.g., sodium lauryl sulfate, ammonium lauryl sulfate), Conditioning agents; to soften and detangle hair (e.g., silicones, natural oils), Foaming agents; to improve aesthetic appeal, Preservatives and stabilizers; to ensure shelf-life, Fragrances and colourants to enhance consumer acceptance.<sup>[6]</sup>

Shampoos are categorized based on their purpose and active ingredients, including: Cosmetic shampoos for routine cleansing and maintenance, Medicated shampoos containing therapeutic agents like ketoconazole or zinc pyrithione, Herbal shampoos formulated with plant-derived extracts, Dry shampoos in powder or spray form for waterless cleansing.<sup>[7]</sup>

Herbal shampoos are formulations that rely primarily on natural plant extracts, oils, and surfactants derived from renewable sources. They are preferred because of their mild action, biodegradability, and minimal side effects compared to synthetic counterparts.<sup>[2]</sup>

This study, therefore, addresses the need to formulate a herbal shampoo using these plant extracts and to evaluate its physicochemical and functional properties to ensure effectiveness and consumer safety. This study aimed to formulate and evaluate a herbal shampoo using extracts from *Hibiscus sabdariffa*, *Trigonella foenum*, and *Cocos nucifera*. The work matters because it adds to what we already know about using plants in beauty products. It also encourages making things with materials found nearby a smart way to create affordable, earth-conscious options. Crafting a shampoo using hibiscus, fenugreek, alongside coconut might get Nigerian businesses interested in making things from nature. It also offers ideas for more work on plant-based beauty products, even sparking fresh approaches to eco-friendly skincare. This research focuses on the formulation and physicochemical evaluation of a herbal shampoo using extracts from *Hibiscus sabdariffa*, *Trigonella foenum*, and *Cocos nucifera*. It does not cover in-vivo or clinical testing of the shampoo's long-term effects on human hair. The extraction process, formulation trials, and laboratory evaluations will be conducted within controlled experimental conditions. Factors such as storage stability, microbial contamination, and large-scale production efficiency are beyond the scope of this initial study.

## METHODS

**Plant Materials Used:** *Hibiscus sabdariffa* calyces, *Trigonella foenum* (fenugreek) seeds, Cold-pressed coconut oil. All plant materials were sourced from local markets in Kaduna, Kaduna State, Nigeria.



**Figure 1:** Picture of *Hibiscus sabdariffa*



**Figure 2: Picture of Fenugreek seeds**

**Ingredients for Formulation:** Sodium lauryl ether sulphate (SLES), Sodium tripolyphosphate, Glycerine, Nitrosol, Citric acid, Colour, Perfume, Distilled water, Polyquaternium and Ethylenediaminetetraacetic acid (EDTA).

### **Preparation of Plant Samples**

The calyces of *H. sabdariffa* and seeds of *T. foenum* were cleaned, washed, and air-dried at 45 °C. They were then pulverized into coarse powder using an electric grinder. The powdered samples were stored in air-tight containers until extraction.

### **Extraction of Plant Materials Using Soxhlet Extraction**

About 200 g of each powdered sample was subjected to Soxhlet extraction using ethanol as solvent for 6–8 hours. The extracts were filtered and concentrated under reduced pressure using a rotary evaporator and stored in amber bottles at 4 °C until they were ready to be used. Cold-pressed *Cocos nucifera* oil was used without further modification to preserve its fatty acid profile and bioactive compounds.

**Table 1: Formula used in Herbal Shampoo Formulation**

Ingredients	Quantity (% w/v)	Quantity for 1000 mL (g or mL)	Function
Sodium lauryl ether sulfate (SLES)	30.0	300 mL	Primary surfactant and cleansing agent
Sodium tripolyphosphate	0.5	5 g	Chelating and water-softening agent
Glycerin	2.0	20 mL	Humectant and moisturizer
Nitrosol (Hydroxyethyl cellulose)	1.0	10 g	Thickening and stabilizing agent
Citric acid	0.2	2 g	pH adjuster
Polyquaternium	0.5	5 mL	Conditioning and anti-static agent
Ethylenediaminetetraacetic acid (EDTA)	0.1	1 g	Chelating agent (prevents metal ion interference)
<i>Hibiscus sabdariffa</i> extract	5.0	50 mL	Natural colorant, antioxidant, and conditioner
<i>Trigonella foenum-graecum</i> (Fenugreek) extract	5.0	50 mL	Hair growth promoter and anti-dandruff agent
Cold-pressed coconut oil	3.0	30 mL	Emollient and hair shaft protector
Parfum (Fragrance)	0.2	2 mL	Provides a pleasant scent
Colour (natural or cosmetic grade)	0.1	1 mL	Enhances product appearance
Distilled water	q.s. to 100%	~524 mL	Solvent and vehicle

“q.s.” means *quantum satis*, add sufficient quantity to make up the total volume (1000 mL).

## Preparation of Herbal Shampoo Using *Hibiscus Sabdariffa*, *T. Foenum* Extracts and Coconut Oil

A 400ml quantity of warm distilled water was transferred into a 1000ml beaker. Nitrosol (hydroxyethyl cellulose) was gradually sprinkled into the warm distilled water with continuous stirring until a uniform gel base was formed. In a separate beaker, Sodium lauryl ether sulfate (SLES) was measured and added slowly to the gel base under constant stirring to ensure proper mixing and to prevent foaming. Sodium tripolyphosphate and Ethylenediaminetetraacetic acid (EDTA) were then added sequentially to the mixture. Afterwards, Glycerin and Polyquaternium were incorporated into the mixture, it was stirred continuously until a homogeneous mixture was obtained. The plant extracts of *Hibiscus sabdariffa* and *Trigonella foenum-graecum* (fenugreek) were then added to the shampoo, followed by the addition of cold-pressed coconut oil. Citric acid was dissolved in 5mls of distilled water, and it was added to the formulation with continuous stirring. Parfum and colour (wine red) were then added to enhance fragrance and appearance, respectively. The final mixture was stirred gently to avoid excessive foaming, and the total volume was made up to 1000 mL with distilled water. The formulated shampoo was allowed to stand for 24 hours to eliminate entrapped air bubbles before it was transferred into a clean, airtight container.

### Evaluation of the Formulated Herbal Shampoo

**Organoleptic Evaluation:** The formulation was examined for colour, odour, clarity, and homogeneity.

**Determination of pH:** A 5ml amount of the formulated herbal Shampoo was measured and transferred into a 100 ml beaker. The digital pH meter was placed inside the solution to determine the pH, and the result was recorded.

**Determination of Viscosity:** Viscosity was measured using a Brookfield viscometer at 25 °C and recorded in centipoise (cP).

**Foaming Ability and Stability:** A 1% shampoo solution was prepared and placed in a measuring cylinder. The solution was shaken ten times and allowed to stand for one minute. The initial foam height was recorded. After 5 minutes, the foam height was recorded again to evaluate foam stability.

Foam stability (%) = (Foam height after 5 min / Initial foam height) × 100

Foamability (foam ability) (mL)=Vf–Vi

Where: Vf = Final volume (foam + liquid, in mL)

Vi = Initial volume (liquid before shaking, in mL)

**Wetting Time:** A standard piece of wool yarn was placed on the surface of the shampoo solution, and the time taken for it to sink was recorded.

### Stability Studies

Samples were stored at ambient temperature (25 °C), refrigeration (4 °C), and elevated temperature (40 °C) for 30 days. Physical changes and physicochemical parameters were monitored weekly

## RESULTS

### Organoleptic properties of *Hibiscus sabdariffa* extract

The extract was found to have a deep red colour, with a slightly acidic floral odour and watery consistency.

### Organoleptic properties of *Trigonella foenum* extract

The extract was found to have a brownish-yellow colour, with a strong, nutty odour and slightly viscous texture.

**Table 2: Percentage yield of solvent extraction of *Hibiscus sabdariffa* and *Trigonella foenum***

Plant Sample	Extraction Technique	Solvent Used	Weight of Plant Material (g)	Weight of Extract (g)	% Extract Yield	Colour of Extract
<i>Hibiscus sabdariffa</i> (calyx)	Soxhlet extraction	Ethanol	200	28	14.0	Deep red
<i>Trigonella foenum</i> (seeds)	Soxhlet extraction	Ethanol	200	18	9.0	Deep Yellowish-brown

### **Organoleptic properties of formulated herbal shampoo**

The formulated herbal shampoo possesses a smooth consistency, pleasant aroma, and wine red colouration attributed to the presence of *Hibiscus sabdariffa* extract.

### **pH Determination of Formulated Herbal Shampoo**

The pH of a shampoo is a critical parameter that influences scalp comfort, hair texture, and product stability. The pH of the formulated herbal shampoo was found to be  $6.1 \pm 0.1$ .

### **Viscosity of Formulated Herbal Shampoo**

Viscosity is a measure of a fluid's resistance to flow and determines the consistency and handling characteristics of a shampoo. The formulated shampoo exhibited a viscosity of  $1100 \pm 10$  cP,

### **Foaming Ability and Stability**

Foaming ability reflects the surfactant performance of a shampoo and its capacity to produce lather. The herbal shampoo produced an initial foam volume of  $180 \pm 5$  mL.

Foam stability determines how long the foam produced by the shampoo lasts after agitation. The formulated shampoo retained approximately 91.7% of its initial foam volume after five minutes, indicating good foam stability.

### **Wetting Time**

The herbal shampoo recorded a wetting time of  $20 \pm 2$  seconds,

### **Stability Test**

Stability testing was carried out to evaluate the physical and chemical integrity of the shampoo over time. The formulated shampoo was stored at ambient temperature ( $25 \pm 2^\circ\text{C}$ ) for 30 days, during which there was no evidence of phase separation, colour change, or odour alteration.

**Table 3: Physicochemical Evaluation Results of the Formulated Herbal Shampoo**

<b>Parameter</b>	<b>Result</b>	<b>Remarks / Interpretation</b>
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Colour	Wine Red	Appealing natural hue derived from <i>Hibiscus sabdariffa</i> anthocyanins
Odour	Pleasant herbal fragrance	Acceptable and characteristic of plant extracts
Consistency	Smooth, homogeneous	No phase separation observed
pH	6.1	Mildly acidic, suitable for scalp and hair
Viscosity (cP)	1100	Ideal thickness for good spreadability
Foam volume (mL)	180	Excellent foaming capacity
Foam stability (after 5 min)	91.7 %	Stable foam indicates good surfactant balance
Wetting time (sec)	20	Good detergency and easy application
Stability (1 month at room temp.)	No colour change or phase separation	Physically and chemically stable formulation

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**Figure 3: Showing formulated Herbal shampoo**

## DISCUSSION

The mixture of hibiscus, fenugreek and coconut oil produced complementary effects, hibiscus helps scalp compatibility and pigment, fenugreek enhances foam and conditioning, and coconut oil gives lubricity and shine. The presence of a primary synthetic surfactant (SLES) provided robust detergency and consistent baseline foaming while botanicals modified sensory and functional outcomes. The formulated herbal shampoo exhibited desirable physicochemical properties. The wine red colour and characteristic herbal fragrance were attributed to the presence of *Hibiscus sabdariffa* anthocyanins and natural aromatic compounds from fenugreek and coconut oil. The visual appeal of the formulation indicates that the extracts were compatible with the base ingredients. A smooth, homogeneous consistency indicates good emulsification/dispersion of oil and extracts in the surfactant base and absence of phase separation. This is important for perceived quality and even dosing. The use of a

polymeric thickener (e.g., hydroxyethyl cellulose/Nitrosol) and appropriate mixing method helped achieve the texture and prevent oil floating.

The pH value (6.1) fell within the acceptable range (5.0–7.0) for scalp and hair products, ensuring minimal irritation and maintaining the natural acidic mantle of the scalp.<sup>[8]</sup> Maintaining this pH range is critical to prevent hair cuticle damage and microbial growth. A measured pH of 6.1 is mildly acidic and appropriate for a shampoo intended for routine scalp use. Human scalp and hair are slightly acidic (around pH 4.5–5.8 for skin surface, hair fiber surface 5.5). A shampoo pH close to this range maintains the acid mantle, reduces cuticle swelling and cuticle lift, and minimizes hair shaft roughness and frizz.<sup>[9]</sup> The pH value obtained also indicates compatibility of the herbal extracts with the base surfactant, sodium lauryl ether sulfate, and other excipients used. Similar pH values have been reported in herbal shampoos formulated with *Hibiscus sabdariffa* and *Trigonella foenum-graecum* extracts demonstrating that natural acidic components such as organic acids in hibiscus and saponins in fenugreek contribute to maintaining an optimal pH balance. Also Anthocyanin pigments are pH-sensitive, they are more stable and retain red hues under mildly acidic conditions; strongly alkaline media will shift colour and accelerate degradation.<sup>[10]</sup> Thus pH 6.1 helps retain hibiscus colour and antioxidant activity.

The viscosity (1100 cP) indicated a light-to-medium formulation that allows easy dispensing and spreading on the scalp. The use of nitrosol as a thickening agent contributed to the desired consistency, ensuring stability during storage. Viscosity around 1,100 cP allows easy dispensing (squeezing/pouring) and rapid spread on wet hair. Viscosity affects bubble damage and film elasticity higher viscosity tends to stabilize foam by slowing liquid drainage from lamellae between bubbles. At 1,100 cP the formulation had sufficient viscosity to support a stable foam while still allowing good spreadability. Comparable findings were reported by <sup>[11]</sup> who documented viscosities of 1200–1800 cP in herbal shampoos formulated from natural ingredients. The consistency observed in this study therefore reflects a balanced rheological profile suitable for consumer acceptance and stable product performance.

An initial foam volume of 180 mL (using the standard cylinder-shake method) represents excellent foamability for a 1% shampoo solution. While foam volume is not a direct proxy for cleaning efficacy, consumers equate abundant lather with effective cleaning. A high initial foam volume therefore increases user satisfaction and perceived efficacy.<sup>[12]</sup> The primary reason for this foaming ability is the SLES surfactant, which generates robust foam. Fenugreek saponins likely enhanced foamability by contributing natural surface-active molecules. The balanced formulation (surfactant concentration, ionic strength, water hardness chelators such as EDTA/tripolyphosphate) allowed maximal foam formation.<sup>[13]</sup> Foam stability of 91.7% (foam retained after 5 minutes relative to initial) is excellent and indicates that the foam persists with minimal collapse. Stable foam ensures sustained contact on the hair surface during washing, promoting uniform application of surfactant and any actives. High retention suggests strong lamella elasticity and slower drainage of liquid from the foam films.

The wetting time (20 seconds) indicated rapid detergent action, a property essential for the removal of oil and dirt from hair. A wetting time of 20 seconds is rapid and indicates excellent wettability and surface activity. Wetting time assesses how fast the formulation reduces surface tension enough to allow a hair or fabric substrate to be wetted and sink, a proxy for initial detergency and spreadability.<sup>[14]</sup> Many acceptable shampoos show wetting times well under a minute; 20 s is indicative of efficient surfactant action and quick interaction with hair fibers, meaning the product will start to remove sebum and dirt rapidly upon application. Similar results were recorded, where herbal shampoos with *Hibiscus* and *Fenugreek* extracts demonstrated rapid wetting due to

synergistic surfactant effects. Hence, the result signifies an efficient cleansing product capable of quick action on the scalp and hair strands.

The stability test conducted over 30 days revealed no phase separation, colour change, or odour deterioration, demonstrating that the formulation was physically stable under ambient conditions. Stability is essential for maintaining product quality, especially in herbal formulations that may be prone to degradation due to natural constituents. The use of EDTA as a chelating agent and citric acid as a pH adjuster contributed to the formulation's stability by preventing oxidation and metal ion interactions.<sup>[15]</sup> Coconut oil's antioxidant content also likely enhanced resistance to rancidity and microbial contamination.

Comparable studies by<sup>[16]</sup> reported similar stability in polyherbal shampoos stored under room temperature conditions, confirming that herbal ingredients can be effectively stabilized through appropriate formulation strategies.

The findings suggest that the developed herbal shampoo could serve as a safe, effective, and environmentally friendly alternative to conventional synthetic shampoos. With further optimization and microbial safety testing, it holds potential for commercial production and use in the cosmetic and pharmaceutical industries.

In summary, this study focused on the formulation and evaluation of a herbal shampoo derived from extracts of *Hibiscus sabdariffa* calyces, *Trigonella foenum* (fenugreek) seeds, and cold-pressed coconut oil. The project aimed to develop an effective, safe, and eco-friendly hair cleansing formulation utilizing natural plant-based ingredients with potential hair growth and conditioning benefits. The extracts were obtained using ethanol in a Soxhlet apparatus, and the shampoo base comprised sodium lauryl ether sulfate, sodium tripolyphosphate, glycerin, nitrosol, citric acid, colour, fragrance, distilled water, polyquaternium, and ethylenediaminetetraacetic acid (EDTA). The formulated shampoo exhibited desirable organoleptic and physicochemical characteristics. The product had an appealing reddish-brown colour with a mild, pleasant fragrance, a pH of 6.1, viscosity of 1100 cP, foam volume of 180 mL with 91.7% foam stability, and a wetting time of 20 seconds. These findings were within acceptable limits for herbal and commercial shampoos.<sup>[11,15]</sup> The extracts contributed significant functional properties. *Hibiscus sabdariffa* provided colour and antioxidant protection due to its anthocyanin and flavonoid content.<sup>[17]</sup> *Trigonella foenum-graecum* enhanced foam formation and hair conditioning due to saponins and mucilage,<sup>[18]</sup> while coconut oil contributed emollient and antimicrobial effects, improving spreadability and reducing scalp irritation.<sup>[19]</sup> Collectively, these bioactive ingredients produced a shampoo with stable physical and chemical properties comparable to standard formulations.

## CONCLUSION

This study successfully formulated and evaluated a herbal shampoo using extracts of *Hibiscus sabdariffa* (roselle), *Trigonella foenum* (fenugreek) seeds, and cold-pressed coconut oil as key active ingredients. The formulation exhibited acceptable organoleptic properties like an appealing wine red colour, pleasant odour, and uniform texture which confirmed product acceptability, while physicochemical evaluations such as pH, viscosity, foam ability, foam stability, and wetting time established its quality and performance. The pH value of 6.1 was within the scalp-friendly range, ensuring minimal irritation and maintaining the scalp's natural acid mantle. The viscosity of 1100 cP provided optimal consistency for consumer use, while the foam volume (180 mL) and foam stability (91.7%) demonstrated excellent surfactant performance and lather retention. A wetting time of 20 seconds indicated good surface activity and efficient cleansing potential. The shampoo also showed physical stability throughout the evaluation period with no phase separation, discolouration, or odour change. These

findings demonstrate that the combination of *Hibiscus sabdariffa*, *Trigonella foenum*, and coconut oil offers synergistic benefits providing antioxidant, anti-inflammatory, antimicrobial, and conditioning properties in a single natural formulation. The shampoo's stability and efficacy confirm that these local plants can serve as viable raw materials for developing cost-effective, safe, and environmentally friendly cosmetic product. Also, these findings affirm that the formulated herbal shampoo meets standard requirements for natural hair care formulations and offers an alternative to synthetic shampoos that may cause scalp dryness, irritation, or environmental concerns. Furthermore, the use of locally sourced botanicals promotes cost-effectiveness and sustainability. This research therefore, not only validates the scientific basis of traditional hair care herbs but also contributes to the growing body of knowledge in phytocosmetic formulation and natural product pharmaceuticals. The demonstrated potential of these extracts underscores their role in advancing safer, greener, and culturally relevant innovations in the cosmetic and pharmaceutical industries.

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