Formulation and evaluation of *Neem-Reetha* herbal shampoo containing glycerol and xanthan gum: A comparative study with a commercial shampoo

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ABSTRACT

Background: Shampoos are detergent solutions for the cleansing of hair and scalp. Herbal shampoos are considered as better alternatives to synthetic ones because they are kinder and they provide vital nutrients for the hair and scalp. However, there is a need for their standardization.

Objectives: This study focused on the formulation and evaluation of Neem-Reetha-based herbal shampoo as a natural, eco-friendly alternative to synthetic commercial shampoos.

Methods: Aqueous leaf extract of Neem (*Azadirachta indica*) and ethanol pericarp extract of Reetha (*Sapindus mukorossi*) were blended with glycerol, xanthan gum, sodium benzoate, citric acid, and rosemary essential oil to produce a 100 mL herbal shampoo. The formulation was assessed for organoleptic, physicochemical, and functional properties and compared with a commercial (Elan®) shampoo.

Results: The formulated shampoo appeared greenish-brown with a pleasant herbal fragrance while Elan® is a light brown perfumed product. It exhibited a slightly alkaline pH of 7.56 compared to Elan's 6.81 which is closer to the scalp-friendly mild acidity. Both products had acceptable solid content (25% versus 30%), but the herbal shampoo demonstrated better foaming ability (110.00 mL versus 93.00 mL), higher viscosity (44.79 mPa.s versus 32.08 mPa.s) and longer wetting time (188 s versus 158 s). The cleaning efficiency was comparable as dirts dispersed effectively in water in both cases.

Conclusion: This study shows that Neem-Reetha shampoo is an effective, mild and aesthetically appealing formulation with strong cleansing and foaming performance. The formulation demonstrates high potential as a sustainable, plant-based alternative to synthetic shampoos.

Keywords: Neem, Reetha, Herbal, Shampoo, Glycerol, Xanthan gum

Formulation et évaluation d'un shampooing à base de plantes Neem-Reetha contenant du glycérol et de la gomme xanthane : étude comparative avec un shampooing commercial

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RÉSUMÉ

Contexte: Les shampoings sont des solutions détergentes destinées au nettoyage des cheveux et du cuir chevelu. Les shampoings à base de plantes sont considérés comme de meilleures alternatives aux shampoings synthétiques car ils sont plus doux et apportent des nutriments essentiels aux cheveux et au cuir chevelu. Toutefois, leur standardisation est nécessaire.

Objectifs: Cette étude s'est concentrée sur la formulation et l'évaluation d'un shampooing à base de plantes de neem et de reetha en tant qu'alternative naturelle et écologique aux shampoings commerciaux synthétiques.

Méthodes: Un extrait aqueux de neem (Azadirachta indica) et un extrait éthanolique de Reetha (Sapindus mukorossi) ont été mélangés avec du glycérol, de la gomme xanthane, du benzoate de sodium, de l'acide citrique et de l'huile essentielle de romarin pour produire 100 mL de shampooing herbal. La formulation a été évaluée quant à ses propriétés organoleptiques, physicochimiques et fonctionnelles et comparée à un shampooing commercial (Elan®).

Résultats: Le shampooing formulé présentait une couleur brun verdâtre avec un agréable parfum d'herbes, tandis qu'Elan® était un produit parfumé brun clair. Son pH était légèrement alcalin (7.56) comparé à celui d'Elan® (6.81), valeur plus proche de la légère acidité favorable au cuir chevelu. Les deux produits présentaient une teneur en solides acceptable (25 % contre 30 %), mais le shampooing herbal a démontré une meilleure capacité moussante (110.00 mL contre 93.00 mL), une viscosité plus élevée (44.79 mPa·s contre 32.08 mPa·s) et un temps de mouillage plus long (188 s contre 158 s). L'efficacité nettoyante était comparable, les impuretés étant efficacement dispersées dans l'eau dans les deux cas.

Conclusion: Cette étude montre que le shampooing Neem-Reetha est une formulation efficace, douce et esthétiquement attrayante, avec de bonnes performances de nettoyage et de formation de mousse. Cette formulation présente un fort potentiel en tant qu'alternative durable et végétale aux shampoings synthétiques.

Mots-clés: Neem, Reetha, shampoing, à base de plantes, glycérol, gomme xanthane

INTRODUCTION

A shampoo is a detergent solution that contains the appropriate ingredients for use as cleansing agent for the scalp and hair.[1] Today, there are many types of shampoos available, including synthetic, herbal, medicated, and non-medicated varieties.[2] Synthetic shampoos contain synthetic surfactants primarily for their washing and foaming properties. However, long-term use of such surfactants can cause dry hair, eye and scalp irritation, and hair loss.[3]

Herbal shampoos are considered as better alternatives to synthetic shampoos. They contain natural substances that are kinder to the hair and scalp.[4] Some of the ingredients commonly used (such as Neem and tea tree oil) have antimicrobial qualities that can help prevent dandruff and scalp infections.[5] Aloe vera and chamomile are two examples of herbs with anti-inflammatory qualities that can help calm and lessen inflammations on the scalp.[6] Herbal shampoos can give the hair and scalp vital nutrients, encouraging healthy hair development and maintenance.[7] They are characterized by fewer negative effects than shampoos with chemical bases.[4] Since they contain natural ingredients, they produce fewer chemical wastes and are more environmentally friendly.[5] By choosing particular herbs for formulation, herbal shampoos can be tailored to each person's unique hair and scalp needs.[6]

Azadirachta indica (Mahogany tree) sometimes called neem, Margosa, nimtree or Indian lilac belongs to the Meliaceae family. It belongs to the genus Azadirachta and is one of the two species originally from the Indian subcontinent and some part of the Southeast Asia. It has spread throughout the world and is now grown in tropical and subtropical regions. Neem is a multipurpose plant.[8] In Ayurvedic medicine, it is a highly prized herb with a well-established use in hair care. The leaf is the commonly used part for this purpose (Figure 1). According to Kumar *et al.*,[4] neem oil is used to cure lice and dandruff on the scalp and it encourages healthy hair development. Neem shampoo is used to promote healthy hair development by cleansing the hair and scalp of debris, oil, and other pollutants.[5]

Reetha (*Sapindus mukorossi*) belongs to the Family: Sapindaceae. The commonly used part is the fruit (Figure 2). Reetha which is commonly known as Soapnut or washnut is used as a natural surfactant.[9] It stops hair loss, prevents dandruff and battles scalp infections.

Figure 1: Leaves of Neem *(Azadirachta indica)*[8]

Figure 2: Fruits of Reetha (*Sapindus mukorossi)*[9]

To improve the effectiveness of neem shampoo, Reetha, which is another Ayurvedic herb can be included as a surfactant.[9] Some limitations have been identified with herbal shampoos of neem. These include: potential for over-drying hair, inconsistent formulation and efficacy,[4] and limited scientific evaluation.[5] The aim of the present study is to formulate and evaluate Neem-Reetha herbal shampoo containing glycerol and xanthan gum. Glycerol is a humectant while xanthan gum is a viscosity modifier. These two adjuvants are capable of improving the properties of a shampoo especially the humidity and consistency.

MATERIALS AND METHODS

Materials

Neem leaf powder was derived by milling of dry leaves of *Azadirachta indica* obtained from Orlu, Imo State, Nigeria. The plant was identified and authenticated by Dr Imoh Johnny in the Herbarium of the Department of Pharmacognosy and Natural Medicine, University of Uyo, Nigeria (Voucher number UUPH49a). The other botanical, Reetha fruit shell powder, is a product of Indo Art International, India.

The chemical used include: Glycerol (TOO BEST, Nigeria), Xanthan gum (Thosco Thode and Scobel, Hamburg, Germany), Citric acid (BDH Chemical limited, England), Sodium benzoate (Thosco Thode and Scobel, Hamburg, Germany) and 99 % Ethyl alcohol (Fisher's Scientific International Company, USA).

Preparation of Neem leaf extract

A 100 g quantity of the leaf powder was weighed and transferred into a clean and well-calibrated beaker containing 200 mL distilled water. The mixture was stirred using a glass rod to ensure even dispersion of the powder in the liquid. The beaker was placed on a hot plate and the mixture was allowed to boil for 30 minutes with intermittent stirring to facilitate the release of the active phytochemicals like tannins, ascorbic acids et cetera. After boiling, the beaker was removed from the hot plate and the mixture allowed to cool at room temperature. The solution was filtered using muslin cloth to remove coarse particles. The filtrate was heated gently in the water bath to evaporate excess water, and the final volume of the extract was taken. The extract was stored in a clean, airtight amber container and placed in a cool place until it was required for use.

Preparation of Reetha pericarp extract

A 100 g quantity of Reetha pericarp powder was weighed using an analytical weighing balance and transferred into a clean container. Ethanol (70 %) was prepared by diluting 70 mL of absolute ethanol in 30 mL of distilled water and poured into the container containing the plant material. The container was sealed properly to prevent the ethanol from evaporating and to allow the submerged Reetha to macerate for 24 hours. The mixture was stirred occasionally using a glass rod to aid extraction. After maceration, the mixture was filtered using a muslin cloth to remove coarse residue. The filtrate was then evaporated and the final volume of the extract was taken. The extract was stored in a clean, airtight amber container and placed in a cool place until it was required for shampoo formulation.

Formulation of herbal shampoo

The shampoo formulation was prepared based on the formula shown in Table 1. A 2 g quantity of xanthan gum was weighed and transferred into a beaker containing 10 mL glycerol. The mixture was thoroughly stirred with a glass rod until it was lump-free. A homogenizer (High speed homogenizer FSH-2) was used to blend 25 mL of Neem extract with 30 mL of Reetha extract and the mixture was gradually transferred into the beaker containing the xanthan gum and glycerol combination until a homogeneous mixture was obtained. An analytical balance was used to precisely weigh 0.1 g of sodium benzoate which was added to the mixture and well agitated with a glass rod. To adjust the pH, 1 % citric acid was added. Essential rosemary oil (0.25 mL) was also added to the mixture for fragrance. The mixture was thoroughly mixed, the volume made to 100 mL with water, and the preparation was continuously stirred for 5 minutes to avoid lump formation.

Table 1: Shampoo formula

Ingredients	Quantity
Neem extract	25 mL
Reetha extract	30 mL
Glycerol	10 mL
xanthan gum	2 g
Citric acid (1% solution)	2 mL
Sodium benzoate	0.1 g
Essential rosemary oil	0.25 mL
Water to	100 mL

Evaluation of shampoo

Organoleptic evaluation

The resulting formulation's colour, odour and transparency were assessed using the appropriate sense organs.[10]

Determination of pH

Using a pH meter at room temperature, the pH of a 10%v/v shampoo solution in distilled water was determined.[11]

Determination of percentage solid content

A 4 g quantity of shampoo was transferred to an evaporating dish that had previously been cleaned, dried, and weighed. To verify the shampoo's exact weight, the dish and shampoo were weighed once more. The evaporating dish was set on the hot plate to evaporate the shampoo's liquid component. After the shampoo had completely dried, the weight of the dish with the remaining solid content was determined. Thereafter, the weight of the solid content was determined and the percentage solid content was calculated using the formula: -

$$\% \text{ solid content} = \frac{C-A}{B-A} \times 100 \quad \text{..... (i)}$$

Where

A= weight of empty evaporating dish
B= weight of evaporating dish with the shampoo solution
C= weight of evaporating dish with the solid content left after evaporation of shampoo solution.

Determination of viscosity

Viscosity of shampoos was determined by using Brookfield viscometer with spindle No. 2 (NDJ-5S Brookfield viscometer) operated at 10 rpm and 27 ^{o}C.[12] A 10 ml sample of the shampoo was taken in a beaker and the spindle of the viscometer was dipped in it for about 5 mins after which the reading was taken.

Assessment of foaming ability and foam stability

The ability to foam was assessed utilising the quick cylinder shake method as described by Klein.[13] A 250 mL graduated cylinder was filled with 50 mL of the 1 % commercial or formulated herbal shampoo solution. The cylinder was covered with one hand and then shaken ten times. The volume of the foam content was recorded. By measuring the foam volume following a one- and four-minute shake test, the foam stability determined.

Wetting time test

A disc with a diameter of 1 inch and an average weight of 0.44 g was carved out of canvas paper. The smooth surface of the disc was positioned on top of a 1 % v/v shampoo solution and simultaneously a stopwatch was started. The wetting time was defined as the amount of time needed for the disc to start sinking.[14]

Dirt dispersion test

Two drops of shampoo were added to 10 mL distilled water that was placed in a test tube. This was followed by the addition of one drop of India ink to the solution. The test tube was sealed and given 10 shakes.[15]

Statistical analyses

Every test was run three times, and the data were analyzed using SPSS v.[19] The results were presented as mean + standard deviation.

RESULTS

Quantity of the intermediate products

The volume of the neem leaf extract after drying was 34.01 mL equivalent to 17.00 % yield while that of Reetha was 71.10 mL equivalent to 71.10 % yield.

Organoleptic properties

Organoleptic properties of the formulated shampoo and those of the commercial shampoo are shown in Table 2. Assessment of the formulated herbal shampoo in comparison with the commercial shampoo shows that both products share some similarities while also differing in certain features.

Table 2: Organoleptic properties

Parameter	Herbal shampoo	Elan® shampoo
Colour	Greenish-brown	Light brown
Odour	Herbal, pleasant	Perfumed, pleasant
Transparency	Not clear	Not clear

The herbal shampoo was observed to be greenish-brown while the commercial Elan® shampoo appeared light brown. The herbal shampoo possessed a mild pleasant smell while the commercial shampoo had a strong perfumed fragrance. However, both shampoos were non-transparent.

Physicochemical properties

Physicochemical properties of the formulated shampoo and those of the commercial shampoo are shown in Table 3.

Table 3: Physicochemical Properties

Parameter	Herbal shampoo	Elan® shampoo
pH (27 °C)	7.56 ± 0.09	6.81 ± 0.27
% Solid Content (%)	25.00	30.00
Viscosity (mPa.s)	44.79 ± 0.02	32.08 ± 0.03

The formulated shampoo had a mean pH value of 7.56 ± 0.09 while the commercial had a value of 6.81 ± 0.27. The solid content was found to be 25 % for the herbal shampoo and 30 % for the commercial shampoo. The herbal shampoo had a higher viscosity compared to the commercial.

Functional properties

The functional properties of the formulated shampoo and those of the commercial shampoo are shown in Table 4.

Table 4: Functional properties

Parameter	Herbal shampoo	Elan® shampoo
Foam Volume (mL)	110.00 ± 3.01	93.00 ± 1.73
Foam Character	Small, dense, stable bubbles	Small, dense, stable bubbles
Wetting Time (s)	188.00 ± 4.22	158.00 ± 2.18
Dirt Dispersion	Dirt remained in water, not in the foam	Dirt remained in water, not in the foam

The herbal shampoo gave a mean foam volume of 110.00 ± 3.01 mL which is higher than the commercial shampoo. However, both shampoos formed small dense stable bubbles. For wetting time, the commercial shampoo recorded a lower value of 158.00 ± 2.18 s while dirts remained in water and not in the foam for both shampoos.

DISCUSSION

The herbal shampoo appeared greenish-brown due to the natural extracts of neem and reetha, which impart their intrinsic phytochemical pigments to the formulation. In contrast, the commercial Elan® shampoo appeared light-brown, which is likely due to the presence of synthetic surfactants, emulsifiers, and colorants used during its formulation. This difference in colour highlights the natural origin of the herbal formulation.

The herbal shampoo was characterized by a mild herbal and pleasant smell, which originated from the natural extracts and essential oil incorporated during the formulation. This contrasts with the commercial shampoo, which had a strong perfumed fragrance. While perfumed shampoos may enhance consumer appeal, the herbal fragrance provides a more natural alternative, particularly for users who are sensitive to artificial fragrances.

Both shampoos were observed to be unclear. The lack of clarity in the herbal shampoo may be attributed to the suspended plant particles and thickening agents such as xanthan gum, while in the commercial shampoo, opacity is likely due to the stabilizers and conditioning agents. Although transparency is often perceived as an indicator of refinement in cosmetic products, the opacity of the herbal shampoo does not compromise its functional quality because of its origin and the components.

The pH values of both the formulated shampoo and the commercial are within the acceptable limit of 5 to 8 based on the report of Adejumo *et al.*[16] The formulated shampoo had a slightly alkaline pH in contrast to the commercial which is slightly acidic. While the herbal shampoo is unlikely to cause excessive scalp irritation, a slight reduction could make it more aligned with the natural scalp pH (which is slightly acidic), thereby reducing the risk of dryness with prolonged use. A pH above the natural scalp range may negatively affect scalp barrier function or hair cuticle condition with prolonged use. The major advantage of the formulation is that the tendency of causing irritation to the eye is low because of the near-neutral pH. A good shampoo should enhance the qualities of hair, maintain the ecological balance of the scalp and should not cause a significant irritation to the eyes.[17]

The solid contents of the two shampoos are within the acceptable range of 20 to 30 %.[18] Solid content indicates the concentration of dissolved and suspended materials in the formulation, directly affecting the viscosity and overall performance. The lower solid content in the herbal shampoo suggests a slightly lighter formulation, which can be advantageous for ease of rinsing, though it may reduce storage stability compared to the commercial product.

The herbal shampoo exhibited higher viscosity (thicker consistency) which can be attributed to the incorporated natural gum. Such natural polymers are known to be characterized by high viscosity.[19] Higher viscosity in shampoos is often preferred by consumers because it improves product handling, lather retention, and application. However, excessively high viscosity may affect pouring ease and wetting time, which aligns with the results observed.

The higher foam volume of the herbal shampoo can be attributed to the presence of saponins in Reetha.[20,21] This demonstrates the efficiency of saponins from reetha extract in generating stable foam without the need for synthetic surfactants. Since foaming is closely associated with consumer acceptance, this property provides the herbal shampoo with a competitive edge and perceived cleansing ability.

The herbal shampoo exhibited a longer wetting time which is less desirable. A shorter wetting time generally indicates better spreading ability and quicker penetration into hair strands. The slightly longer wetting time for the herbal shampoo may be due to the presence of natural gums, which increases thickness and slows down wetting efficiency.

Both shampoos demonstrated effective cleansing ability as dirts were dispersed in water rather than accumulating in the foam. This indicates that both the herbal and commercial formulations provide efficient cleansing action, with the herbal product performing equally well in this aspect despite being free of synthetic surfactants. Surfactant property is not limited to synthetic materials as some natural polymers have demonstrated some levels of surface activity.[22]

A limitation of this study is the unavailability of evidences of stability and safety which would have enabled practical applicability and product quality. These could be provided in subsequent work by assessment of stability under different storage conditions, viscosity changes over time and microbial preservation effectiveness. An optimization study can also be conducted with varying concentrations of neem extract, reetha extract, glycerol and xanthan gum.

CONCLUSION

The herbal shampoo has an appealing appearance and smell. The viscosity is relatively high and the product is of moderate consistency suitable for cosmetic application. The high foaming property of the formulation is consistent with the natural saponins present in Reetha, which act as an efficient foaming and cleansing agent. There is a slight limitation in spreading efficiency also manifesting as longer wetting time but the dirt dispersion is comparable to that of the commercial product. The combination of neem extract, reetha extract, and the other ingredients in shampoo formulation is promising; and it reinforces the viability of herbal formulations as substitutes for conventional hair care products.

REFERENCES

1. Pal SK, Tiwari S, Mishra S, Suran S (2024). Formulation and evaluation of herbal shampoo. *International Journal of Life Science Research Archive* 7(2): 43-57.
2. Dubey R (2021). Development and evaluation of herbal shampoo using neem (*Azadirachta indica*) and other Ayurvedic ingredients. *International Journal of Ayurvedic Medicine* 12(3): 142-149.
3. Lee J, Khalil NB, Durve A, Redwine LS, Tosti A (2025). Ayurvedic treatments for hair disorders: A narrative review. *Skin Appendage Disorders.* DOI: 10.1159/000549251.
4. Kumar S, Saini R, Prasad R (2013). Neem oil poisoning: Case report and review of literature. *Indian Journal of Pediatrics* 80(9): 745-747.
5. Garum A, Patel H (2023). Phytochemical and antimicrobial assessment of neem leaf extracts for cosmetic formulations. *Journal of Natural Products Research* 12(3): 101-108.
6. Singh G, Gupta A (2020). Formulation, evaluation, and comparison of herbal and marketed shampoos. *Journal of Drug Delivery and Therapeutics,* 10(3-s): 167-171.
7. Gupta SC, Prasad S, Tyagi AK, Kunnumakkara AB, Aggarwal BB (2017). Neem (*Azadirachta indica*): An Indian traditional panacea with modern molecular basis. *Phytomedicine* 34: 14-20.
8. Tufail T, Ain HRU, Ijaz A, Nasir MA, Ikram A, Noreen S, Arshad MT, Abdulahi MA (2025). Neem (*Azadirachta indica*): A miracle herb: Panacea for all ailments. *Food Science and Nutrition* 13: e70820.
9. Singh S, Ali M (2019). *Sapindus mukorossi*: A review article. *The Pharma Innovation Journal* 8(12): 88-96.
10. Aghel N, Moghimipour E, Raies Dana S (2010). Formulation and evaluation of herbal shampoo containing *Ziziphus spina-christi* extract. *Iranian Journal of Pharmaceutical Research* 9(4): 301-308.
11. Thakur DTD, Divyanshusachar D, Dheeraj D, Sharma PSP (2025). Soapnut shampoo: A natural and sustainable hair care shampoo. *International Journal of Pharmaceutical Research and Application* 10(2): 1991-1402.
12. Olorunsola EO, Majekodunmi EO (2016). Emulsifying properties of afzelia gum in liquid paraffin emulsion. *International Journal of Pharmacy and Pharmaceutical Sciences* 8(11): 195-198.
13. Klein AM, Lewis JD (2022). The cosmetic potential of *Azadirachta indica*: A review of its bioactive compounds. *Frontiers in Pharmacology* 13: 887654.

14. Manika R, Joly PD (2024). Evaluation of herbal surfactants in polyherbal shampoo formulations. *International Journal of Herbal Science and Technology* 6(1): 44-52.
15. Ali HA, Kadhim KA (2021). Antimicrobial and antioxidant effects of neem (*Azadirachta indica*) extract in topical formulations. *Journal of Cosmetic Dermatological Science* 7(2): 59-65.
16. Adejumo IO, Oyeniyi YJ, Oladipo OO (2018). Formulation and evaluation of herbal shampoos using extracts of medicinal plants. *Journal of Applied Pharmaceutical Science* 8(3): 45-51.
17. Deeksha MR, Sharma PK (2014). Evaluation of marketed shampoo (synthetic and natural) for their hair cleansing, dirt dispersion, wetting time, solid content and foaming capacity properties. *Global Journal of Pharmacolology* 8(4): 490-493.
18. Ihoeghian NA, Akwara E (2021). Formulation, evaluation and comparison of herbal shampoo with marketed synthetic shampoos. *Journal of Science and Technology Research* 3(4): 342-348.
19. Olorunsola EO, Bhatia PG, Tytler BA, Adikwu MU (2015). Physicosurface properties of afzelia and prosopis hemicellulosic gums: potential surface active agents. *IOSR Journal of Pharmacy and Biological Sciences* 10 (4 version 3): 1 - 7.
20. Adejumo IO, Bello KA, Lawal AF (2018). Evaluation of foaming and cleansing properties of natural saponin-based shampoo formulations. *Journal of Applied Sciences and Environmental Management* 22(6): 889-894.
21. Sochacki M, Vogt O (2022). Triterpenoid saponins from Washnut (*Sapindus mukorossi Gaertn*.) - A source of natural surfactants and other active components. *Plants (Basel)* 11(18): 2355. doi: 10.3390/plants11182355.
22. Olorunsola EO, Bhatia PG, Tytler BA, Adikwu MU (2014). Surface activity and hydrophile-lipophile balance of hydrophilic polymers from exudates of cashew and khaya plants. *International Journal of Biological and Pharmaceutical Research* 5(5): 443-448.