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Green Chemistry Approach to Polyherbal Shampoo Tablets with *Cyclea peltata*

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Abstract: Herbal formulations are increasingly favored over synthetic cosmetics due to their safety, efficacy, and eco-friendly nature. In this study, a polyherbal shampoo tablet was formulated and evaluated with *Cyclea peltata* as a key ingredient, along with other herbal constituents selected for their hair-care properties. The formulation aimed to overcome the drawbacks of conventional liquid shampoos, such as instability, bulkiness, and the environmental burden of plastic packaging, by adopting a green chemistry approach in the form of solid shampoo tablets. The shampoo tablet includes the powdered form of herbal ingredients such as *Cyclea peltata* (Indian moonseed), mango leaves, guava leaves, brahmi, bhringaraj, black myrobalan, shikakai, and reetha, having antidandruff as well as other hair benefits. Two powder formulations were prepared and screened for physicochemical and cleansing characteristics, from which the optimized batch was selected for direct compression into tablets**.** The prepared tablets were evaluated for physicochemical parameters, including hardness, friability. Results indicated that the formulation met acceptable quality standards, showed good foaming and cleansing ability, and maintained a pH compatible with scalp and hair. The polyherbal shampoo tablet demonstrated stability and ease of use, suggesting it as a convenient, sustainable, and effective alternative to conventional shampoos.

***Index Terms*—Polyherbal shampoo tablet, antidandruff, Cyclea peltata, eco-friendly formulation.**

I. INTRODUCTION

Shampoo is a practical cosmetic preparation that is serves to clean the hair and scalp of unwanted pollutants, filth, debris, and leftovers from prior preparations. Herbal shampoos have become popular due to their ability to cleanse, nourish, and protect hair without harmful side effects. Solid dosage forms like shampoo tablets are emerging as a novel, convenient, and sustainable approach, aligning with the concepts of green chemistry. Polyherbal formulations combine the therapeutic benefits of multiple medicinal plants, enhancing efficacy through synergistic action. *Cyclea peltata*, a well-known medicinal plant, has traditionally been used for its antimicrobial, antioxidant, and hair-strengthening properties, making it a promising candidate for herbal hair care formulations. Incorporating *Cyclea peltata* into a polyherbal shampoo tablet may provide an effective, eco-conscious, and user-friendly solution to conventional shampoos. The current research is centered on the development and assessment of polyherbal shampoo tablets containing *Cyclea peltata*. The work emphasizes green chemistry principles by utilizing herbal ingredients, minimizing synthetic additives, and developing a stable solid dosage form that combines efficacy, convenience, and sustainability for improved hair care.

HERB PROFILE
INDIAN MOONSEED (Cyclea peltata)

Fig. 1 Indian moonseed

Indian moonseed, belonging to the family Menispermaceae, is a twining shrub, climbing upon tall trees, found across India and Sri Lanka, in tropical forests and plains, and known to own medicinal values mentioned in the primitive scriptures of Ayurveda. Leaves of paada are alternate, heart-shaped, 3-7 cm length,2.5- 4 cm broad.
Indian moonseed or paada, is used in traditional medicine systems as a wound healer for skin and inflammatory disorders [1,2].

MANGO LEAVES

Fig. 2 mango

Mango leaves are foliage of an evergreen tree native to Asia. Mango leaves are simple, alternate, 12-30 cm long and 2-7 cm broad. Mango leaves exhibit antibacterial characteristics which help heal bacterial skin infections. Mango leaves are an ancient technique to grow hair rapidly. The leaves contain nutrients that boost collagen production which is important for healthy hair and gives a shine to dull hair [3,4,5].

GUAVA LEAVES

Fig. 3 Guava

Guava, belonging to the family Myrtaceae is native to tropical America and is now grown in tropical and subtropical areas. Leaves of Guava is widely used in Thai folk medicine as a traditional herbal cure for hair loss. Guava leaves are green, oval in shape,6-14 cm long, 3-4.5 cm broad and characterised by obtuse apex. Guava leaves stimulate collagen activity, which promotes hair growth and also have anti-bacterial and anti-inflammatory properties [6].

BHRAMI LEAVES

Fig. 4 Bhrami

Bhrami, belonging to family Scrophulariaceae is found in marshy or waterlogged areas of India. Bhrami leaves are small, bright green, oval, fleshy and is completely edible. Leaves are 0.4-0.6 cm thick and arranged oppositely to the stem. Bhrami helps in boosting hair growth in areas with reduced hair growth and thus treats hair loss and baldness. It also helps reduce inflammation and dryness of scalp and imparts a cooling effect to the scalp [7].

BHRINGARAJ LEAVES

Fig. 5 Bhringaraj

Bhringaraj or false daisy, family Asteraceae, is a creeping herb native to India and southwest America. The leaves are sessile, lanceolate, 2-10 cm long, 5-3 mm wide and oppositely arranged to the stem. Bhringaraj promotes blood circulation to the scalp, activates hair follicles and thus promotes hair growth. It treats and prevents hair baldness and also restores the natural colour of hair [8,9]

BLACK MYROBALAN

Fig. 6 black myrobalan

Black myrobalan, belonging to the family Combretaceae, is a deciduous tree native to Southeast Asia. Myrobalan fruits are yellow to orange brown and ovoid in shape. Fruits of myrobalan are used as dye that darkens and softens the hair. It is useful for treating hair fall, itching, and scalp infections like dandruff [10].

REETHA

Fig. 7 Reetha

Reetha, commonly called soapnut, is a deciduous tree native to western coastal areas of India, southern china and Japan and belongs to the family Sapindaceae. Reetha fruits are solitary round nuts, yellowish brown in colour. the fleshy portion contains saponins which act as natural surfactant. Reetha act as natural shampoo due it its cleansing property. It also has antifungal properties that treat scalp disorders like dandruff [11,12,13].

SHIKAKAI

Fig. 8 shikakai

Shikakai is a shrub-like tree belonging to the family Mimosaceae and found in tropical woods and dry plains of India. Pod like fruits of shikakai contain saponins, which act as natural cleanser. Its a natural surfactant that helps clean the scalp, remove dandruff and impart shine to the hair [14,15,16].

LEMON

Fig. 9 lemon powder

Lemon is a small evergreen tree native to Southeast Asia, China and Myanmar that grows in Mediterranean climates and belongs to family Rutaceae. Lemon is round, green-to-bright-yellow-colored fruit with strong aroma. Lemon contain vitamin c abundantly, which is a powerful antioxidant and also act as a natural preservative that improve shelf life of the product [17,18,19]

II. MATERIALS AND METHODS

COLLECTION OF HERBS

The plants selected for the formulation are gathered locally, shade-dried, ground in a blender, and then sieved to produce powder.

PREPARATION OF POLYHERBAL POWDER SHAMPOO

a) Weighing of powders:

The requisite herbal powders for the formulation of powder shampoo are weighed individually in a digital balance.

b) Mixing of powders:

The accurately weighed, finely ground herbal powders are blended in ascending order of their amounts by continuous trituration until a homogenous mixture is obtained.

c) Storage:

The mixture of herbal powder obtained is collected and stored in airtight containers [20].

FORMULATIONS OF POLYHERBAL POWDER SHAMPOO

Two batches of polyherbal powder shampoo (PS1 and PS2) were prepared and used for further evaluation. The table 1 depicts the formulations prepared in different quantities.

table 01: formulations of shampoo powder

INGREDIENTS	PS1	PS2
Indian moonseed leaves	15 g	20 g
Mango leaves	10 g	10 g
Guava leaves	15 g	10 g
Bhrami	10 g	10 g
Bhringaraj	10 g	10 g
Black myrobalan	8 g	8 g
Reetha	10 g	15 g
Shikakai	20 g	15 g
Lemon powder	2 g	2 g

EVALUATION OF POLYHERBAL POWDER SHAMPOO

■ ORGANOLEPTIC EVALUATION:

The prepared compositions are evaluated based on characteristics like texture, color, and smell[21].

■ GENERAL POWDER CHARACTERISTICS

Evaluation of criteria that impact powder qualities, such as appearance and flow characteristics, constitutes assessment of general powder characteristics.

Particle size:

Particle size determination of polyherbal powder shampoo is done by using sieving method. A powder sample is placed to the top of a nest of sieves that are organized from top to bottom in decreasing size order. The particle size is calculated by weight of the sample that was retained on each sieve [22].

Angle of repose:

A funnel is placed 2 cm over a graph sheet. Particles are gently allowed to pass through the funnel until a heap forms and reaches the funnel orifice. The height and radius of the heap formed were measured using a ruler. The angle of repose was thus estimated by the formula,

$$\text{Angle of repose}, \theta = \text{Tan}^{-1}\frac{H}{R}$$

Where,

H = height of pile formed.

R = the radius of base of pile[23]

Bulk density:

The bulk density of a powder is the ratio of the mass of the powder sample to its volume. Into a 100 ml graduated cylinder, introduce approximately 10 g of the powder sample weighed accurately. Carefully level the powder devoid of compacting. Bulk density is calculated by the formula,

$$\text{Bulk density} = \frac{\text{Weight of the sample}}{\text{Bulk volume}}$$

Tapped density:

Pass a weighed quantity of sample to 100 ml measuring cylinder. Tap the cylinder 500 times and record the volume.

$$\text{Tapped density} = \frac{\text{Tapped volume}}{\text{Bulk volume}}$$

Hausner ratio:

The Hausner ratio is an indirect bulk parameter of a powder, as well as a measure of particle interaction [24].

$$\text{Hausner ratio} = \frac{\text{Bulk density}}{\text{Tapped density}}$$

Carr's compressibility index:

Carr's compressibility index predicts the aptness of a powder. Carr's index of a powder is calculated by the formula [25]

$$\text{Carr's index} = \frac{\text{Tapped density} - \text{bulk density}}{\text{Tapped density}} x\ 10$$

■ PHYSICO CHEMICAL EVALUATION:

Foamability:

A 250 ml graduated cylinder was loaded with 2 g of shampoo powder, 50 ml of water, and shaken. The total height of foam after one minute of shaking was observed at different time intervals, such as 0, 10, 20, and 30 minutes [26].

Determination of pH:

1 g of herbal powder shampoo was taken, 9ml of distilled water was added to it, and the pH of the resulting solution was measured using a pH meter [27].

Moisture content determination:

10 g of prepared herbal powder shampoo was weighed in an evaporating dish and kept in hot air oven (105℃). Drying is carried out until a uniform weight is obtained.The moisture content of each formulation of powder shampoo was calculated [28].

Loss on drying:

A quantity of 2 g of the herbal shampoo powder was placed in a pre-dried petri dish and stored in a desiccator over calcium chloride for two days. The powder was then reweighed to determine its loss on drying [29].

Washability:

The herbal shampoo powder was applied onto the skin. The sample was manually assessed to determine the ease and extent of washing with water [30,31].

Solubility:

An accurately measured 1 g portion of the powder was transferred into a beaker with 100 ml of water. The solution was shaken well, gently heated to improve dissolution, cooled, and subsequently filtered. The residue obtained was weighed and noted [32].

Dirt dispersion:

A test tube with 10 ml of distilled water was added with 2 drops of the 1% shampoo powder solution, followed by 1 drop of India ink. The degree of ink retention in the foam was assessed [33,34].

PREPARATION OF POLYHERBAL POWDER SHAMPOO TABLET

Tablet formation is carried out through direct compression of the herbal powder blend. An optimum powder formulation (PS 1) was chosen for the production of shampoo tablets based on comparative study. Neither wet nor dry granulation is necessary as a pre-processing step for the powder blend.

Direct compression:

Direct compression involves compression of powder ingredients directly, without modifying the physical nature of the powder material itself. Tablet compression is achieved by taking formulation ingredients volumetrically in a die and compressing it between a set of two punches. In the initial stage of the compression process, the lower punch descends to form a die cavity that is subsequently filled with the powder blend. Any excess material on the die surface is removed to ensure uniform dosing. The upper punch then applies the required compressive force, consolidating the powder into a coherent tablet. Following compaction, the lower punch rises to eject the finished tablet from the die. [35]

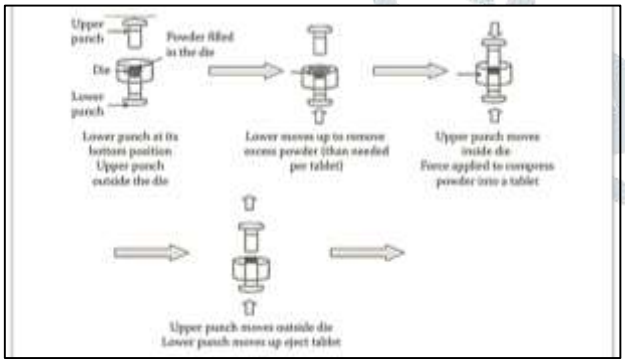

Fig. 10: tableting process

EVALUATION OF POLYHERBAL POWDER SHAMPOO TABLET:

Physical evaluation:

The assessment of organoleptic qualities is based on sensory attributes, notably colour, odour, shape, and size.

Tablet Hardness:

A Monsanto hardness tester was used to assess the hardness of the tablets. The tablet was set between the plungers, and pressure was gradually applied by turning the threaded bolt. The breaking force was noted. [36]

Weight variation:

The weights of ten individual tablets were recorded, followed by determination of their average weight and individual values were assessed relative to this mean. The weight variation test determines the drug content uniformity of tablets.

Friability:

The friability test was performed using a tablet friability apparatus. 10 tablets were individually weighed, placed in the rotating drum for 100 revolutions, and subsequently reweighed to determine weight loss. The percentage friability was calculated by the following formula [37]

Percentage friability = $\frac{W1-W2}{W1}$ x 100

Where, w_1 = initial weight

w_2 = final weight

III. RESULTS AND DISCUSSION

EVALUATION OF POLYHERBAL SHAMPOO POWDER

ORGANOLEPTIC EVALUATION:

The prepared powder formulations [PS 1 and PS2] was evaluated for physical parameters like colour, odour, texture and results are depicted in the table 2 below.

table 02: organoleptic properties of shampoo powder

Sl. No	Characteristics	PS1	PS2
1	Particle Size	220-250 μm	220-250 μm
2	Angle Of Repose	34.4°	34.3°
3	Bulk Density	0.42 g/cc	0.45 g/cc
4	Tapped Density	0.52 g/cc	0.56 g/cc
5	Hausner's Ratio	1.24	1.24
6	Compressibility	19.2 %	19.6 %

GENERAL POWDER CHARACTERISTICS:

The prepared powder shampoo formulations are evaluated for general powder prop erties and results are given in the table: 03.

Table 03: General Powder Characteristics

Sl. No.	Evaluation parameter	PS1	PS2
1	Colour	green	green
2	Odour	characteristic	characteristic
3	Texture	Slightly coarse	Slightly coarse

PHYSICO CHEMICAL EVALUATION

Both formulations were evaluated for their physicochemical properties PH, cleansing ability, foamability, irritatability, and moisture content and loss on drying and the results are depicted in table: 04. Based on comparative analysis, 1 optimized powder formulation (PS 1) was selected for the preparation of shampoo tablets.

Table 04: Physico-chemical evaluation of shampoo powder

Sl. No	**Test**	**PS1**	**PS2**
1	Foaming Index	Good foam	Small amount of foam
2	PH	Slightly Acidic	Slightly Acidic
3	Washability	Excellent	Good
4	Dirt dispersion	The estimated amount of ink in the foam is light	The estimated amount of ink in the foam is moderate
5	Loss on drying	Within limit	Within limit
6	Moisture content	1.86%	1.78%

EVALUATION OF POLYHERBAL SHAMPOO TABLET

PHYSICAL EVALUATION:

The prepared shampoo tablets are evaluated based on physical features and results are given in table 05.

Fig. 11 polyherbal shampoo tablets

Table 05. Physical evaluation of shampoo tablets

Sl. No	Evaluation parameter	Observation
1	Colour	Jungle green
2	Appearance	Round
3	Solubility	Easily soluble

HARDNESS

Hardness test was performed for 4 tablets and its average is calculated. The results are given in table 06.

Table 06: hardness test of shampoo tablets

Tablet	Force required to break (mg/cm ^{2})	Average
Tablet 1	4	4.37 mg/cm^2
Tablet 2	4.5	
Tablet 3	4	
Tablet 4	5	

WEIGHT VARIATION

The weight variation test was assessed on 10 shampoo tablets, with individual weights ranged between 410 mg and 560 mg**,** and a mean weight of 470 mg. The variation observed among the tablets was within the acceptable limits specified by pharmacopeial standards for tablets of this weight range, indicating uniformity of fill and consistency of the formulation process**.**

FRIABILITY

The physical strength of 10 tablets was determined, percentage friability is calculated and results are given in table 07.

Table 07: percentage friability of shampoo tablets

Initial weight (w_1) (g)	Final weight (w_2) (g)	Friability (%)
4.82	4.81	0.2

CONCLUSION

The present study successfully formulated and evaluated a polyherbal shampoo tablet using a green chemistry approach. Two shampoo powder formulations were initially developed, of which the optimized batch was selected for tablet compression based on superior physicochemical and cleansing characteristics. The prepared tablets exhibited acceptable colour, odour, appearance, solubility, hardness, friability, weight uniformity, and pH within the ideal range for scalp application. The formulation showed good foamability, washability, and non-irritant properties, confirming its safety and efficacy. By combining the therapeutic benefits of Cyclea peltata along with other traditionally recognized herbs such as mango leaves, guava leaves, brahmi, bhringaraj, black myrobalan, reetha, shikakai, and lemon, the shampoo tablets demonstrated synergistic hair-care potential. Moreover, the solid dosage form offers advantages of stability, portability, reduced bulk, and eco-friendly packaging**,** making it a sustainable alternative to conventional liquid shampoos.Thus, the polyherbal shampoo tablet developed in this work can be considered a promising, consumer-friendly, and environmentally sustainable formulation for effective hair and scalp care.

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