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Research Article

Formulation and Evaluation of an Herbal Powder Hand Wash Containing Arjuna (*Terminalia arjuna*) Bark

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ABSTRACT

The primary goal of the current study was to create and assess a herbal powder hand wash with Arjuna bark as the main active component. The formulation was created to retain skin hydration while offering efficient washing with few adverse effects. Additional herbal ingredients like Ashoka bark, Reetha, Aloe vera, and lemon were added along with appropriate excipients to improve the overall cleansing and skin-conditioning qualities. Based on initial testing, three formulations (F1, F2, and F3) were created and refined. Key characteristics such as color, odor, pH, viscosity, particle size, soap index, antibacterial activity, and potential for skin irritation were assessed for each formulation and finally F3 batch was selected. The outcomes demonstrated the created herbal powder hand wash's acceptability as a natural and skin-friendly washing solution by confirming that it satisfied the required physicochemical and functional qualities.

INTRODUCTION

Everyone agrees that one of the best and most affordable ways to stop the spread of infectious diseases brought on by bacteria, viruses, and fungi is to practice good hand hygiene. Frequent and appropriate hand washing considerably lowers microbial contamination, which in turn lowers the risk of communicable illnesses in both community and medical settings.¹ Despite their widespread usage, synthetic soaps and detergents can cause skin dryness, irritation, lipid barrier disruption,

and allergic reactions because they contain harsh surfactants, preservatives, and artificial smells.² This has stimulated a growing shift toward natural, plant-based hand hygiene products that are perceived as safer, more biocompatible, and environmentally sustainable.³

The rich phytochemical profiles, natural antibacterial activity, and skin-protective qualities of herbal preparations have drawn a lot of attention in recent years.⁴ Herbal ingredients include natural surfactants, antioxidants, tannins, flavonoids, and

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emollients that can simultaneously wash, protect, and nourish the skin, in contrast to synthetic cleansing agents.⁵ Consequently, herbal hand wash products have become attractive substitutes that minimize adverse effects while preserving good cleanliness.

Ayurveda has long regarded *Terminalia arjuna* (Arjuna bark), a member of the Combretaceae family, among other medicinal plants, especially for its wound-healing and cardioprotective qualities.⁶ Many of the polyphenols, tannins, flavonoids, triterpenoids, and glycosides found in the bark have strong antibacterial, antifungal, antioxidant, and anti-inflammatory properties.⁷ Arjuna bark is a desirable option for inclusion in herbal cleansing preparations due to these pharmacological characteristics. Its antibacterial properties assist lower the microbial load in a hand wash system, while its anti-inflammatory and antioxidant properties help preserve the integrity of the skin and reduce discomfort.

Herbal medicines frequently contain *Sapindus mukorossi* (Reetha) to improve cleaning effectiveness and give natural surfactancy. Saponins, which are naturally occurring triterpenoid glycosides that can efficiently produce foam and remove oils and grime without harming the skin's barrier, are abundant in reetha fruits.⁸ Reetha-based surfactants have been extensively investigated as substitutes for traditional synthetic detergents in cosmetic and hygiene formulations due to their mildness and biodegradability.

Complementary advantages are provided by additional botanical compounds added to the formulation, such as *Citrus limon* (lemon), Aloe vera, and *Terminalia arjuna* (Arjuna bark). Aloe vera is a well-known hydrating, calming, and healing agent; ashoka bark is well-known for its astringent and antibacterial qualities; and lemon provides natural scent, mild acidity, and

antimicrobial potential.⁹ The final hand wash formulation's cleaning action, sensory appeal, and skin-conditioning properties are all improved by the combined use of these herbs.

This study focuses on creating a novel herbal powder hand wash with Arjuna bark as the main active ingredient in response to the growing global need for safe, effective, and natural hygiene products. Three herbal formulations (F1, F2, and F3) were prepared and optimized after the necessary plant materials were chosen, verified, and processed into fine powder extracts. In addition to evaluations of antimicrobial activity and skin-irritation potential, these formulations were next assessed for important physicochemical properties as color, odor, pH, particle size, viscosity, and soap index. The study sought to determine the best formulation that could offer safe, efficient, and skin-friendly hand hygiene based on these criteria.

PLANT PROFILE

1. Arjuna Bark

The bark of *Terminalia arjuna* (Roxb.) Wight & Arn., belonging to the family Combretaceae, is a well-known medicinal plant widely distributed in India and Bangladesh. It is a large deciduous tree attaining a height of 20–30 m and has been used in Ayurvedic medicine for more than 2,500 years, primarily as a cardi tonic (Dwivedi, 2007). Phytochemical studies have demonstrated that Arjuna bark is rich in triterpenoid saponins such as arjunic acid and arjunolic acid, along with glycosides including arjunosides and arjunetin, flavonoids like arjunolone and arjunone, and phenolic compounds such as gallic acid and ellagic acid (Maulik & Katiyar, 2010; Kumar & Prabhakar, 1987). These bioactive constituents are responsible for the wide range of pharmacological activities exhibited by the bark, including



antimicrobial, antibacterial, antifungal, healing properties (Sabu & Kuttan, 2002; antioxidant, anti-inflammatory, and wound- Dwivedi, 2007).

Table 1: Chemical Constituents of *Terminalia arjuna* Bark

Class of Compound	Major Constituents	Reported Biological Activity	Reference
Triterpenoid saponins	Arjunic acid, Arjunolic acid, Arjunetin	Cardioprotective, anti-inflammatory, antimicrobial	Dwivedi, 2007
Glycosides	Arjunosides I–IV, Arjungenin	Antioxidant, cardiotonic	Maulik & Katiyar, 2010
Flavonoids	Arjunolone, Arjunone	Antioxidant, anti-inflammatory	Sabu & Kuttan, 2002
Phenolic compounds	Gallic acid, Ellagic acid	Antibacterial, antifungal, antioxidant	Kumar & Prabhakar, 1987
Minerals	Calcium, Magnesium, Zinc	Cardiovascular support	Dwivedi, 2007

2. *Sapindus mukorossi* (Reetha)

Sapindus mukorossi Gaertn., commonly known as Reetha or soapnut, is a deciduous tree of the family Sapindaceae, distributed in the Indo-Gangetic plains, Shivalik ranges, and sub-Himalayan regions at elevations ranging from 200 to 1500 m. It is regarded as one of the most valuable tropical and subtropical trees of Asia due to its high saponin content and diverse applications (Sharma & Kaur, 2011). Phytochemical investigations of

Reetha fruit have revealed the presence of triterpenoid saponins as major constituents, along with flavonoids, phenolic compounds, carbohydrates, sugars, fatty acids, and terpenoids (Kumar & Singh, 2012). The saponins present in the fruit are mainly responsible for its surfactant, antimicrobial, antifungal, and insecticidal properties, which justify its extensive use in herbal shampoos, natural cleansers, and traditional medicinal preparations (Sengupta & Malhotra, 2017; Pandey & Tripathi, 2014).

Table 2: Chemical Constituents of *Sapindus mukorossi* (Reetha) Fruit

Class of Compound	Major Constituents	Reported Biological Activity	Reference
Triterpenoid saponins	Sapindoside A, B, C, D	Antimicrobial, antifungal, surfactant	Sengupta & Malhotra, 2017
Flavonoids	Quercetin, Kaempferol derivatives	Antioxidant, anti-inflammatory	Sharma & Kaur, 2011
Phenolic compounds	Phenolic acids	Antimicrobial, antioxidant	Kumar & Singh, 2012
Carbohydrates & sugars	Glucose, Sucrose	Energy source, formulation support	Pandey & Tripathi, 2014
Fatty acids & terpenoids	Oleic acid, Terpenoid compounds	Insecticidal, antimicrobial	Sengupta & Malhotra, 2017

3. *Aloe vera* (Aloe)

Aloe vera (L.) Burm.f., commonly known as aloe or burn plant, is a perennial succulent belonging to the family Asphodelaceae (formerly placed under Liliaceae). The plant has been widely used in traditional medicine systems across the world for

centuries due to its therapeutic and cosmetic applications. *Aloe vera* is characterized by thick, fleshy leaves containing a clear mucilaginous gel rich in bioactive compounds. The plant is well known for its wound-healing, anti-inflammatory, antimicrobial, and antioxidant properties, which have been scientifically validated through



numerous pharmacological studies (Surjushe, Vasani, & Saple, 2008; Hamman, 2008).

Table 3: Chemical Constituents of *Aloe vera* Leaf

Class of Compound	Major Constituents	Reported Biological Activity	Reference
Anthraquinones	Aloe-emodin, Aloin	Antimicrobial, laxative, anti-inflammatory	Hamman, 2008
Chromones	Aloesin	Antioxidant, anti-inflammatory, skin protective	Eshun & He, 2004
Phenolic acids	Cinnamic acid	Antimicrobial, antioxidant	Surjushe et al., 2008
Vitamins	Vitamins A, C, E, B12	Antioxidant, wound healing, skin protection	Hamman, 2008
Polysaccharides	Acemannan, glucomannan	Immunomodulatory, wound healing	Eshun & He, 2004

MATERIALS & METHOD

The study was conducted between January 2025 and April 2025. The study was carried out in the Department of Pharmaceutics and Microbiology, Kamla Nehru College of Pharmacy, Nagpur, India.

Chemicals and reagents

All the chemicals and reagents used in the present study, including ethanol, concentrated sulfuric acid, and chloroform, were of analytical reagent (AR) grade and were procured from Loba Chem Pvt. Ltd. Agar media used for antimicrobial studies was obtained from HiMedia Laboratories. Distilled water was procured from Samar Chemicals. The herbal raw materials, namely *Terminalia arjuna* bark, *Aloe vera* powder, and *Sapindus mukorossi* (Reetha) fruit powder, were procured from a local Ayurvedic shop.

Method of preparation

The herbal hand wash powder was prepared by extracting the bark of *Terminalia arjuna* and the fruit of *Sapindus mukorossi* (Reetha) using a maceration method of extraction with ethanol as the solvent. The extracts were filtered, concentrated, dried, and incorporated into the formulation. These herbal extracts were then

blended with other selected herbal ingredients along with suitable excipients to formulate a powder-based hand wash. Several formulations were prepared, and phytochemical screening and evaluation of physicochemical properties, antimicrobial activity, soap index, and skin irritation were carried out to test their efficacy and acceptability as a natural hand hygiene product.

1. Extraction of Arjuna Bark by maceration method:

The powdered bark of *Terminalia arjuna* (100 g) was subjected to extraction by maceration using ethanol as the solvent. The accurately weighed plant powder was placed in a clean conical flask, and 350 mL of ethanol was added to it. The mixture was allowed to stand for a period of 20 days at room temperature with occasional shaking and stirring to facilitate efficient extraction of phytoconstituents.

After completion of the extraction period, the mixture was filtered using filter paper to separate the liquid extract from the plant residue. The obtained filtrate was then concentrated by evaporation at 50 °C until a reddish semi-solid mass of the extract was obtained. The concentrated



extract was stored in a suitable container for further analysis and formulation studies.

2. Extraction of Reetha fruit by the maceration method:

The finely powdered fruits of *Sapindus mukorossi* were accurately weighed (8.6 g) and transferred into a clean beaker. To this, 100 mL of ethanol was added, and the mixture was stirred thoroughly. The beaker was covered with aluminium foil to prevent solvent evaporation and contamination and was allowed to macerate for a period of 3 days at room temperature with occasional stirring.

After the maceration period, the mixture was filtered using filter paper to separate the extract from the marc. The obtained filtrate was then evaporated to dryness in a water bath. The completely dried extract was transferred to a desiccator and allowed to cool before further use.



Figure 1: Extraction of Arjuna Bark and Reetha fruit by maceration method

3. Preparation of handwash powder:

The initial step involved drying all the ingredients needed for the formulation of the herbal hand wash powder. The drying process was aimed at eliminating any traces of moisture. The dried substances were then pulverized separately to form coarse powders. The substances included *Terminalia arjuna* bark extract (10 g), Aloe vera powder (5 g), *Sapindus mukorossi* extract powder (7 g), rose petal powder (4 g), and lemon essential

oil (4 g). The substances were measured accurately.

The weighted crude materials were size-reduced to smaller pieces using a hand-driven mixer individually to produce fine powders. The fine powdered materials were then well mixed using a mixer to produce a uniform powdered mixture. Lemon essential oil was incrementally incorporated into the mixture to distribute evenly in the preparation.

The obtained homogeneous mixture was sifted using sieve No. 120 to get a finer size of the handwash powder. The homemade herbal handwash powder preparation work was complete. The mixture of the herbal handwash powder was collected in the airtight container.

Formulation of Herbal Hand Wash Powder

Table 4: Formulation of Herbal Handwash Powder (Batch F3)

Sr. No.	Ingredients (powder)	Quantity (per 30 g)	Category
1.	Arjuna bark extract	10 g	Antibacterial agent
2.	Reetha fruit extract	7 g	Foaming agent
3.	<i>Aleo vera</i>	5 g	Emollient
4.	Lemon	4 g	Antiseptic agent
5.	Rose petal	4 g	Fragrance



Figure 2: Formulation of Herbal Handwash Powder

Characterization of herbal hand wash

1. Phytochemical screening

Preliminary phytochemical screening of the herbal extract was carried out using standard qualitative chemical tests to identify the presence of various phytoconstituents.

a. Salkowski Reaction Test for Phytosterols:

To 0.5 mL of the chloroform extract taken in a test tube, 1 mL of concentrated sulfuric acid (H₂SO₄) was carefully added along the sides of the test tube. The appearance of a reddish-brown colour in the chloroform layer indicated the presence of phytosterols.

b. Foam Test for Saponins: A small quantity of the extract was taken in a test tube and mixed with a little amount of water. The mixture was shaken vigorously and allowed to stand. The formation of stable foam persisting for about 10 minutes indicated the presence of saponins.

c. Dragendorff's Test for Alkaloids: The extract of the herbal drug was dissolved in chloroform. The chloroform was evaporated to dryness, and the residue was acidified by adding a few drops of Dragendorff's reagent. The appearance of an orange-red precipitate confirmed the presence of alkaloids.

d. Molisch's Test for Carbohydrates: The extract was treated with Molisch's reagent, followed by the careful addition of concentrated sulfuric acid along the sides of the test tube to form distinct layers. The formation of a reddish-violet ring at the interface indicated the presence of carbohydrates.

2. Evaluation of herbal hand wash powder

A. Physical Parameters

a) Colour: The colour of the formulation was inspected visually.

b) Odour: The odour of the formulation was evaluated by sensory perception.

c) pH: The pH of the formulation was measured using a calibrated digital pH meter. Before each measurement, the pH meter was calibrated using standard buffer solutions. The electrode was rinsed with distilled water, immersed in the sample, and the pH value was recorded.

d) Stability Studies: Stability studies were conducted by storing the formulation at different temperature conditions (25 °C and 40 °C) for a period of one week. The formulation was observed for any changes in physical appearance, colour, or phase separation.

e) Angle of Repose: The angle of repose is defined as the maximum angle formed between the surface of a pile of powder and the horizontal plane. The flow properties of the powder used in the formulation were assessed.

f) Particle Size: Particle size is an important parameter affecting properties such as spreadability and grittiness. Particle size was determined by the sieving method using I.P. standard sieves. The sample was subjected to mechanical shaking for 10 minutes, and the particle size distribution was recorded.

g) Bulk Density: Bulk density is defined as the ratio of the mass of powder to its bulk volume. A known quantity of dried powder was filled into a 50 mL measuring cylinder up to the 50 mL mark. The cylinder was then dropped onto a hard surface from a height of 1 inch at 2-second intervals. The final volume was noted, and the powder was weighed. Bulk density was calculated using the formula:

$$\text{Bulk Density} = \frac{\text{Mass of powder}}{\text{Bulk volume}}$$



h) Tapped Density: Tapped density is the increased bulk density obtained after mechanically tapping the container containing the powder sample. After recording the initial volume, the measuring cylinder was mechanically tapped for 1 minute until no further significant change in volume was observed. Tapped density was expressed in g/cm^3 .

B. Chemical Parameters

a) Foam Height: One gram of the herbal handwash sample was dispersed in 50 mL of distilled water and transferred into a 500 mL stoppered measuring cylinder. The volume was adjusted to 100 mL with distilled water. The cylinder was shaken with 25 strokes and allowed to stand. The aqueous volume was noted, and the height of the foam formed above the aqueous layer was measured.



Figure 3: Foam Height of Herbal Handwash Powder

b) Skin Irritation Test: A small quantity of the formulation was applied to the skin and left

undisturbed for 30 minutes. The area was observed for any signs of redness, itching, or irritation.

c) Antimicrobial Activity: The antimicrobial activity of the herbal handwash was evaluated using the cup plate method (agar well diffusion method). In this method, the antimicrobial agent diffuses into the agar medium inoculated with the test microorganisms (*E. coli* and *S. aureus*). The plates were incubated, and the zone of inhibition around the wells was measured to assess antimicrobial activity.

RESULT & DISCUSSION

1. Phytochemical Screening:

Preliminary phytochemical screening of the herbal handwash powder revealed key bioactive constituents, confirming its medicinal potential. The Salkowski reaction indicated phytosterols, known for their anti-inflammatory and skin-protective properties. The foam test showed stable foam, verifying the presence of saponins, which enhance foaming and cleansing action while supporting antimicrobial activity. Alkaloids were identified via Dragendorff's test, contributing to antimicrobial and antifungal efficacy. Molisch's test confirmed carbohydrates, which improve formulation texture and skin hydration. Collectively, these components substantiate the traditional use of the herbal ingredients in the handwash formulation, highlighting their cleansing, antimicrobial, and skin-friendly benefits.

Table 5: (Batch F3)

Sr. No.	Phytoconstituents	Chemical test	Observation	Interference
1.	Phytosterol	Salkowski reaction test	Reddish brown colour was observed	Presence of phytosterol
2.	Saponins	Foam test	Foam was observed for 10 min	Presence of saponin
3.	Alkaloids	Dragendorff's test	Orange red precipitate was observed	Presence of alkaloids
4.	Carbohydrates	Molisch's test	Reddish violet ring was observed	Presence of carbohydrates

2. Evaluation of herbal hand wash powder:

A. Physical Parameters

The physical evaluation of the herbal handwash powder showed satisfactory organoleptic, physicochemical, and flow properties. The brown colour resulted from herbal extracts such as *Terminalia arjuna* and *Sapindus mukorossi*, while the lemon fragrance indicates the inclusion of lemon essential oil. With a pH of 5.68, the formulation is slightly acidic, closely matching human skin's natural pH, thus supporting skin health and reducing irritation risks. The powder demonstrated stability with no visible changes, and its bulk and tapped densities (0.4 g/mL and 0.32 g/mL) suggest good packing and flow characteristics. An angle of repose value of 0.857 indicates acceptable flow properties, ensuring easy processing and packing. Additionally, a particle size of 47 μm indicates a fine, uniform powder, enhancing spreadability and dispersion. Overall, the formulation exhibits favourable physical properties for hand cleansing and consumer appeal.

Table 5: (Batch F3)

Sr.no	Evaluation parameter	Result
1	Colour	Brown
2	Odour	Lemon like
3	pH	5.68
4	Stable	Stable
5	Bulk density	0.4gm/ml
6	Tapped density	0.32gm/ml
7	Angle of repose	0.857
8	Particle size	47 μm
9	Skin irritation	Non irritant

B. Antimicrobial activity

The antimicrobial activity of *Terminalia arjuna* bark extract was evaluated using the agar well diffusion (cup plate) method. One gram of Arjuna bark extract powder was dispersed in 2 mL of distilled water and tested against selected bacterial

strains. The extract showed measurable zones of inhibition against both test organisms. A control plate without any antibacterial agent was also maintained for comparison.

Table 6: Antimicrobial activity of Herbal Handwash Powder

Sr.no	Test microorganisms	Zone of inhibition
1	<i>E.coli</i>	5mm
2	<i>Streptococcus aureus</i>	9mm

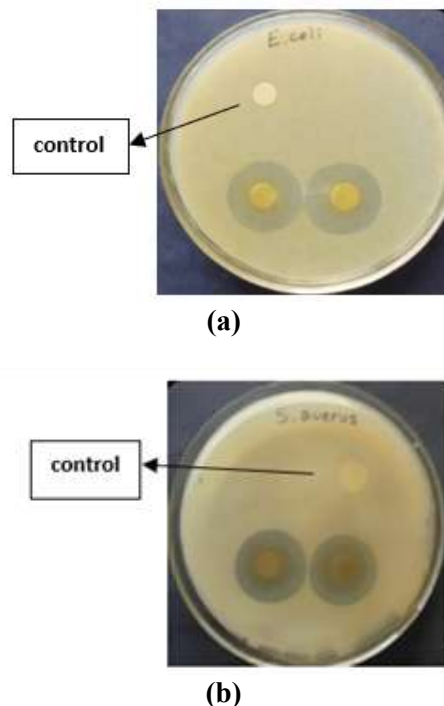


Figure 2: (a) Plate showing zones of inhibition for *E.coli* and (b) Plate showing zones of inhibition for *S.aureus*

CONCLUSION

From the present study, it can be concluded that a herbal powder handwash was successfully formulated using *Terminalia arjuna* bark extract. The developed formulation exhibited sufficient antimicrobial activity, confirming the effectiveness of Arjuna bark as a natural antimicrobial agent. The herbal handwash was found to be safe and free from synthetic sulphates, making it a suitable alternative to conventional chemical-based handwash formulations. The study also demonstrated that the formulated herbal

handwash effectively serves the purpose of hand cleansing while incorporating plant-based ingredients with added therapeutic benefits. Furthermore, future research should focus on long-term stability studies and extended antimicrobial evaluation to assess its potential for wider and prolonged use.

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