

Development of Jute-Based Herbal Soap: A Sustainable Approach to Value-Added Personal Care Products

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Abstract

The development of green solutions has exploded due to the growing need for eco-friendly and sustainable substitutes for synthetic personal care products. Using natural parts from jute leaves as a primary ingredient, this study aims to create a biodegradable, herbal soap. The cold saponification process was used to make the soap, and essential vegetable oils were added to improve its cleansing and therapeutic qualities. Assuring product quality and consumer safety was done by analyzing physicochemical parameters such as pH, moisture content, hardness, and foaming ability. The final soap met the criteria of green chemistry and the circular economy by exhibiting good washing effectiveness and skin compatibility. This jute-based herbal soap not only provides a sustainable substitute for store-bought soaps but it also significantly enhances the value of jute, supporting environmental preservation and rural livelihoods. The study lays the groundwork for future innovation in the creation of green products while highlighting the potential of agricultural waste in personal hygiene applications.

Keywords: Herbal Soaps; Jute Leaves; Water Extract; Oil Extract; Sustainable

1. Introduction

Organic products, such as herbal soap, are made from natural herbs and skin-beneficial ingredients. People have used medicinal plants as a kind of treatment since the dawn of time (1). The main barrier that protects the body from various diseases is the human skin, which is the outermost layer of the body. The skin is vulnerable to injury when it interacts with the environment because it is constantly exposed to different environmental stimuli (2). Herbal soaps work well for a variety of skin conditions. Glycerin, a substance uncommon in commercial soaps, is an ingredient in these soaps. These soaps are excellent for people with dry skin because glycerin is necessary for the skin to retain moisture (2). The human skin serves as the body's first line of protection against a variety of illnesses. The skin interacts with the environment, exposing it to a variety of stimuli all the time. Consequently, the skin is vulnerable to damage (4). Usually depigmented and discolored, scar tissue appears when severely damaged skin attempts to recover. Conversely, it is well recognized that chemical soaps exacerbate skin irritation and dryness (5).

A natural soap bar contains no artificial surfactants and is made from natural ingredients, such as plant extracts or essential oils. Because they are natural, effective, affordable, accessible, and beneficial to the human body, herbs are used to treat a wide range of skin conditions and diseases.

According to the technique of manufacture, natural soaps can be broadly classified as melt-pour, hot process, or cold process. Transparent or translucent soap is the term for the hot process soap. The soap offers long-lasting aroma, good

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moisturizing properties, minimal irritation, and good detergency or washing power. Various dried herbs, flowers, and stems are added to a soap base to create herbal soaps (3). Herbal soaps are great for the environment and the skin because they are generally made by hand and only include organic ingredients (1).

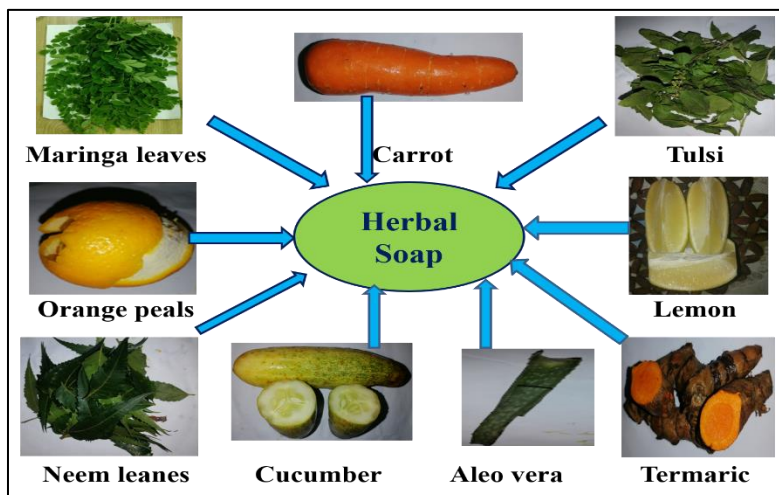


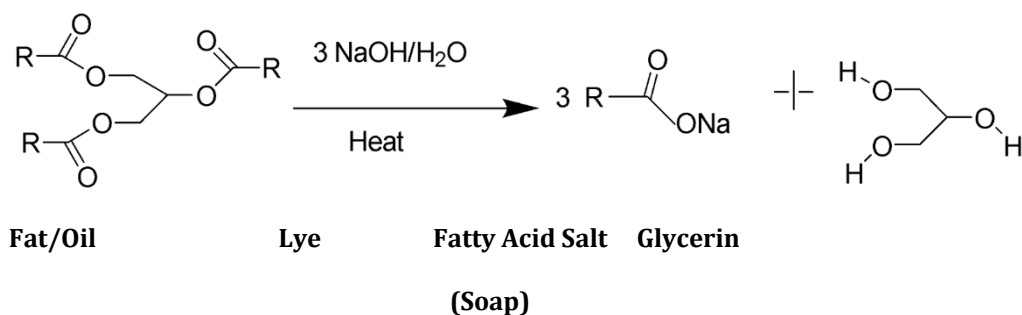
Figure 1 Some commonly used herbs in herbal soap making

Some commonly used herbs in herbal soap making, known for their skin-beneficial properties. Different herbal plants contain various beneficiary properties. Turmeric has anti inflammatory, skin brightening, acne properties(4). Neem leaves have antibacterial, antifungal, treats acne and skin infections remedies (5). Aloe Vera is useful for moisturizing, burn soothing burns, irritated skin remedies (6). Tulsi (Basil) is best for antioxidant, anti-inflammatory, and purifying skin (7). Lavender is good for calming, antiseptic and it promotes relaxation (8) . Peppermint is prominent for cooling, refreshing and relieving itching (9). Lemongrass possesses antibacterial, refreshing scent and tones skin properties (10) . Rosemary has antioxidant properties, improves blood circulation, antimicrobial properties (11). Tea has antibacterial characteristics and it helps with acne-prone skin (12).

Since ancient times, traditional medicine has employed plants with therapeutic qualities. As a natural treatment for a number of illnesses and conditions, extracts made from the leaves, stem, and roots of many medicinal plants have been used (3)

Throughout history, soaps have played a significant role in our daily life for over 6,000 years. In ancient Babylonia, animal fats, wood ash, and water were combined to make what is now called "soap." The basic method of producing soap, called saponification, is the reaction of fats or oils with lye or a base (15).

1.1. Reaction of the saponification



Herbal soap is eco-friendly and biodegradable. It has a refreshing aroma and cleanses without stripping natural oils. Also, it reduces acne and eczema conditions of the skin. Herbal soaps are produced from jute leaves (fresh and dry), using medicinal plants (jute) known for their antioxidant and antimicrobial properties, which adds even more value to the soap.

Jute leaf has long been used as a traditional cure in many cultures. Finding reveals that jute leaves also contain many phytochemicals including cardiac glycosides, triterpenoid, phenol, sterols, ionones etc. which can cures from many

critical diseases. Out of the different medicinal herbs, jute leaf is granted with vast array of healing benefits. Jute leaf contains protein, calories, fibers and as well as antitumor promoters like Phytol and Monogalactosyl-diacylglycerol. It may reduce risk of cancer. Therefore, jute leaf has a great importance in terms of human nutrition, health and beauty care. In future, controlled studies are required to prove the effectiveness of jute leaf under the various conditions. Jute leaves have a well-established nutritional value because they include up to 17 essential raw elements, including ash, crude fibers, fat, carbohydrates, crude protein, and other minerals. Vitamins A, C, and E are abundant in it, as are calcium, potassium, magnesium, copper, manganese, phosphorus, and beta-carotene. Recent research indicates that jute extract contains cardiac glycosides, triterpenoids, phenolic compounds, sterols, fatty acids, and ionone's, all of which have direct health benefits for humans, including anti-inflammatory, anti-tumor, and antiseptic qualities, as well as aiding in the treatment of numerous chronic illnesses (16).

Optimization of a stable and effective herbal soap preparation from jute leaves and mesta calyx represents a novel contribution to sustainable product innovation. This objective aligns with the growing global interest in green chemistry, the zero-waste utilization of agricultural byproducts, and natural skincare alternatives. While soap-making with other herbs is well established, incorporating of jute leaf in herbal soap has yet not been done to our best knowledge.

2. Materials and Methods

2.1. Materials

2.1.1. Herbs

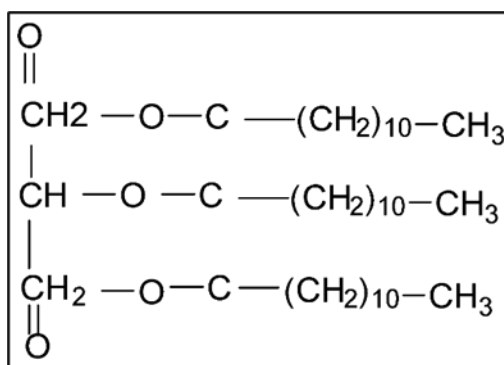
Jute leaves: Jute leaves have been used in two different ways. These are fresh jute leaves and dry jute leaves (in figure 2). Jute leaves were collected and washed well and then dried in the oven at 50-60°C. The dried jute leaves were ground in the grinding machine into a powder form. This jute leaves powder (in figure 2) was used for preparing mixed jute herbal soap.

Aloe vera: It helps to reduce inflammation and speeds up wound healing by promoting collagen production and new cell growth. Additionally, it reduces acne and dead skin cells (in figure 2)

Vegetable Oil: Different types of oils, like coconut oil, olive oil, castor oil, palm oil are utilized for herbal soap preparation. Besides this, essential oils are also used. These oils are mixtures of triglyceride esters formed from glycerol and fatty acids. In this research, coconut oil has been used for herbal jute soap preparation. Coconut oil has triglycerides of lauric acid. The chemical structure of lauric acid is given below:



Figure 2 Ingredients of the jute herbal leaves soap

**Figure 3** Glyceryl trilaurate (a primary component of coconut oil)**2.2. Chemicals**

- Sodium Hydroxide (NaOH)
- Glycerin

Table 1 Formulation for Preparation of herbal jute leaves soap

SL No.	Ingredients	Quantity	Uses
1.	Fresh jute leaf	35-40 pieces	Antioxidant, anti-inflammatory and prevent aging
2.	Dry jute leaf (powder)	10 gm	Anti-inflammatory and prevent aging
3.	Aloe vera	5ml	Anti-microbial and anti-oxidant activity
4.	Coconut Oil	30ml	Moisturizes, heals, soothes, protects
5.	Glycerine	10ml	Humectant and soothing properties.
6.	Sodium Hydroxide	10 gm	Cleansing and foaming

2.3. Methodology

- Collection of raw materials
- Collection of various oils and chemicals
- Preparation of samples for herbal jute soap in different ratios/ingredients
- Making herbal jute soap from fresh and dry jute leaves
- Analysis of pH Test (skin compatibility), moisture content.
- Comparative cost study between herbal jute soap and local soaps

Equipment's

- Hot water bath
- Balance machine
- pH meter
- Heat-safe glass or stainless-steel containers
- Silicone or wooden molds
- Thermometer
- Blender
- Soap cutter
- Safety gear: Gloves, goggles

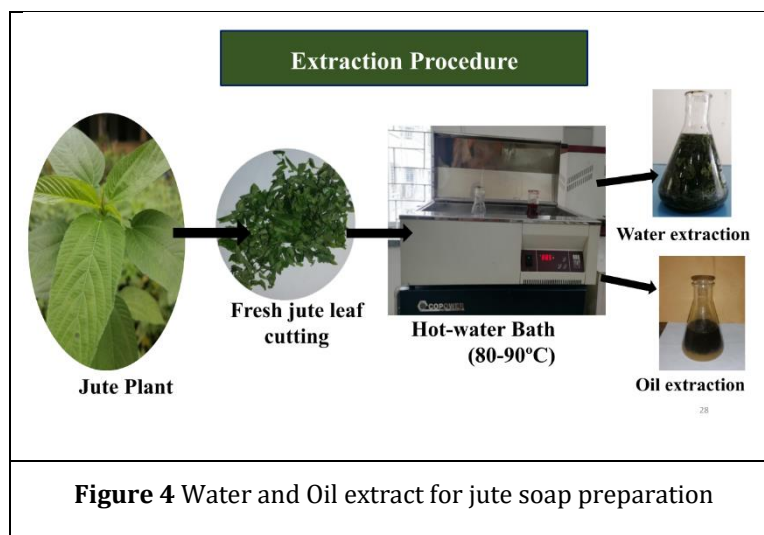
2.4. Preparation of the Jute herbal soaps (JHS)

2.4.1. Water extract of jute leaves

Jute leaves and 50 ml of distilled water have been taken into the conical flask. 35-40 pieces of jute leaves were added. This mixture was heated in the water bath at 70-80 °C. Then the solution was filtered to get the jute leaves water extract solution and it was used for preparing jute leaves soap (in figure 3).

2.4.2. Oil extract of jute leaves

50 ml of coconut oil was added with 35-40 pieces of jute leaves and the solution was heated at 70-80°C in the water bath. Then the oil-treated solution was filtered to get oil extract for making soap (in figure 3).



In this research, three different types of jute herbal soap were prepared. Such as: i) water-extracted jute herbal soap ii) coconut oil extracted jute soap and iii) mixed soap (water and oil extract added with dried powder form of jute leaves). Here, the saponification cold-process has been used for preparing jute leaves herbal soap.

2.5. Saponification Process

2.5.1. Saponification with water extracts

First, sodium hydroxide (NaOH) was dissolved in distilled water and the solution was allowed to cool at room temperature. At room temperature, the coconut oil was added with glycerin. The cooled NaOH solution was then slowly mixed with that solution. Then water extract of jute leaves was added to that solution. 5 ml of aloe vera was also added. The mixed solution was blended until the mixture reached the concentrated stage, indicating the start of saponification. Then, the mixture was poured into the silicon molds and left to set for 24 hours. The jute herbal soap has been taken out from the mold and dried in the air for 10-15 days. The ratio of NaOH, glycerin, water, and coconut oil used in the preparation was 1:1:3:3, respectively.

2.5.2. Saponification with oil extracts

Another oil extract, JHS was made by the same procedure. But the coconut oil extract solution was used in place of water extract. Here, a 1:1:3:3 ratio of glycerin, NaOH, coconut oil and jute leaves oil extract was used for oil extract JHS.

2.5.3. Saponification with oil extracts mixed water and oil extracts

Three types of raw materials, such as water extract, oil extract and NaOH was used for mixed saponification. Here, dried jute leaves powder was used as additives for preparing mixed JHS.

- **Neutralization:** In jute herbal soap production, neutralization may be used to remove excess alkali (NaOH) for JHS.
- **Additives Integration:** The basic soap was formed, and additives such as fragrances, colorants, and moisturizers (e.g., shea butter, essential oils) have been mixed in for the customer's demand.

- **Curing:** i) Cold-process soap ii) Hot-process soap. Here, the cold process was used for preparing jute herbal soap.
- **Milling:** In some cases, JHS was shredded and reprocessed (triple-milled soap) to enhance texture and durability.
- **Shaping and Cutting:** The jute herbal soap was removed from molds and cut into bars or shaped as desired.
- **Packaging:** The finished JHS is wrapped, labeled, and stored for use.

2.6. Determination of physico-chemical properties of JHS

2.6.1. Determination of pH of the JHS

50 ml of distilled water and 0.5 g of herbal jute soap were measured. Distilled water has been taken to the beaker and heated at 70°C in a water bath. After that, the herbal soap was added to the distilled water, and it was continuously stirred to dissolve the soap. Then the solution was cooled at room temperature (35°C). The pH value of the solution was determined (in figure 5) by the pH meter (table 3) [12].



Figure 5 The pH value of the jute leaves soaps were identified

2.7. Determination of moisture content and volatile matter of the JHS

5.0 g of jute herbal soap was measured and put into the electrical oven at 110±2°C for 4 to 6 hours. After that, the soap was cooled in the desiccators and then weighed [9]. The procedure was repeated until the difference in mass between two successive weightings was less than 0.01 g. The volatile matter and moisture content were determined by using this procedure.



Figure 6 Before the moisture content of the jute herbal soap

The moisture content and volatile matter (MV) in the JHS were determined using the following equation:

$$MV = \frac{m_2 - m_0}{m_1 - m_0} \times 100$$

Here,

m_0 = Weight of the watch glass (in gm)

m_1 = Before heating the sample (soap) with watch glass (in gm)

m_2 = After heating the sample (soap) with watch glass (in gm)

3. Results and discussion

3.1. Morphological characters of raw materials and produced three JHS

From Table 1, it was observed that color distinguishes fresh jute leaves from dry jute leaves. In this work, aloe vera has been incorporated into herbal soap for skincare.

Table 2 Morphological characters of raw materials

Raw materials	Source	Colour	Oduor	Taste
Fresh jute leaf	Plant	Green	Bitter	Fresh jute leaves are less bitter than dry leaves
Dry jute leaf	Plant	Pale green	Bitter	Bitter
Aloe vera	Plant	White (Transparent)	Bitter	Bitter

Visual appearance of the three types of produced soaps appeared as pale green for water extract JHS, dark green for oil extract JHS, dark green for mixed extract JHS.

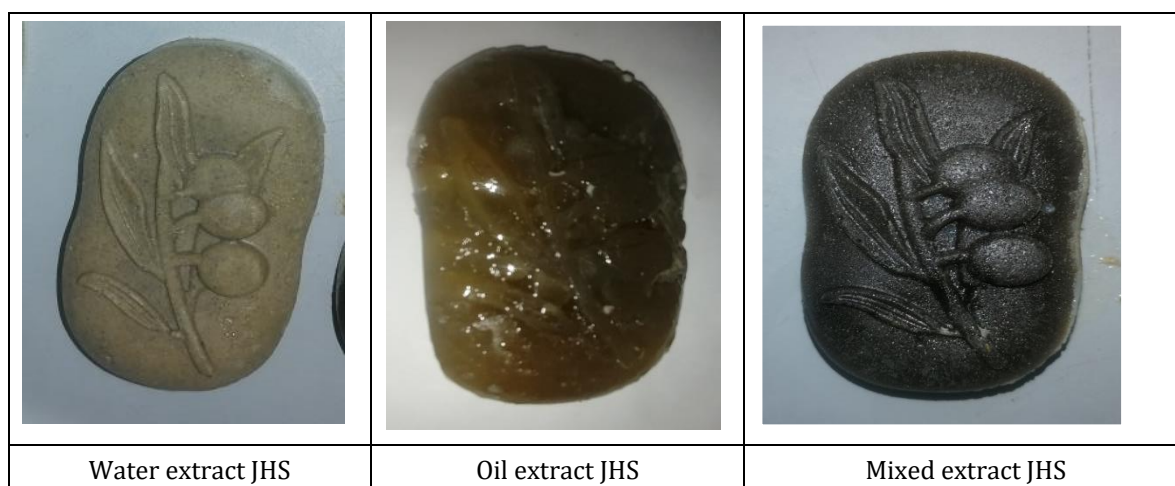


Figure 7 Three type's herbal soaps produced from jute leaves

Table 3 Evaluation of Jute leaves herbal soap

Parameters	Water-extract JHS	Coconut oil-extract JHS	Mixed JHS (oil + water extract + dry jute leaf powder)	Local soap
Colour	Pale green	Dark green	Dark green	Dark green
Odour	Strong Fragrant	Strong Fragrant	Strong Fragrant	Scented, Fragrant
Shape	Oval	Oval	Oval	Oval
Texture	Smooth	Smooth	Smooth	Smooth
pH	9.51	8.32	9.03	9.57
Skin irritation	Non-Irritant	Non-Irritant	Non-Irritant	Non-Irritant

All the three types of JHSs showed strong fragrant odour and texture is more or less same i.e. smooth except oil extract was oily hand feel. It was observed that all the three types of JHSs showed non-irritant for skin.

3.2. pH Analysis

The effect of skin cleansing ability and stability depends on the pH values of the herbal soap because in higher pH i.e. at alkaline condition more foam formation, thus more surface activity and hence more cleansing ability. Therefore, the cleaning effect of water extract JHS (pH 9.51) and local soap (pH 9.57) showed most cleaning effects.



Table 4 pH of different soaps

Parameters	Water-extract JHS	Coconut oil-extract JHS	Mixed JHS (oil + water extract + dry jute leaf powder)	Local soap
pH	9.51	8.32	9.03	9.57

The pH must be kept at the right level to obtain a creamy texture that improves the user experience. Oil extract JHS gave the lowest pH value and local soap gave the highest value 9.57. The pH value is slightly alkaline and can interfere with the skin's acid mantle, which protects against bacteria and moisture loss. To get a creamy lather that improves the user experience. The pH value of the JHS is found to be 8-9.5 and pH<8 is required for sensitive skin. If the pH value of the JHS is more than 10, that causes dryness. Jute leaf is one kind of herb that is used in this soap and it may soothe the skin and balance these effects. At the same time, jute extract enhanced the antimicrobial properties of JHS, even in alkaline pH(17).

3.3. Analysis of moisture and volatile matter content of JHSs

Table 5 In the local soap, lower values were found 6.01%, indicating better stability and maturity. To achieve optimal moisture levels, it is essential to properly dry or cure herbal soaps. Water molecules acquire significant energy as the heating temperature rises, overcoming intermolecular forces (such as hydrogen bonds) and transitioning from liquid to vapor. Among all the soap samples, oil extract JHS obtained the highest moisture content 41.49%. The local soap contained 6.01% moisture and volatile matter content.

Table 5 Moisture and volatile matter content of the herbal jute soap

Water extract soap	Oil extract soap	Mixed soap	Local soap
21.20%	41.49%	31.55%	6.01%

Due to different amount of moisture content, local soap was harder than jute herbal soap. Oil extract JHS was softer than the others. The moisture and volatile matter content significantly impact the hardness, usability, and shelf life of soap. Higher values, as seen in oil-based JHS, can result in a softer texture and quicker degradation (in figure 4).

3.4. Cost analysis

Table 6 Variable cost of JHSs

Materials	Price (Tk.)
Sodium Hydroxide	200/- (per Kg)
Coconut Oil (1L)	550/- (per liter)
Glycerin	200/- (per liter)
Jute leaves	30/- (per Kg)
Others	20/-
Total Cost	1000/-

- Weight of the produced herbal jute leaves soap ~ 50 gm
- 50 ml of Coconut oil has been used for preparing 1-piece JHS
- 1 liter/1000 ml of Coconut oil has been used for preparing = 20 pieces JHS
- Cost for 1 (one) piece of soap = Tk. 1000 /20 = Tk.50

4. Conclusion

An eco-friendly and promising substitute for conventional soaps made of chemicals is the creation of jute herbal soap. According to this study, cold-process saponification of fresh and dried jute leaves yields soap with important medicinal and skin-beneficial qualities, such as antibacterial, anti-inflammatory, and antioxidant benefits. The soap's ability to moisturize and cure was further improved by the addition of aloe vera and natural coconut oil.

The mixed jute herbal soap exhibited a balanced pH, a potent scent, a smooth texture, and notable skin compatibility among the three formulations—water extract, oil extract, and mixed extract. According to cost research, the herbal jute soap is competitively priced and reasonably priced when compared to local soaps, which makes it a feasible product for commercial scale. Additionally, making soap from jute, a plentiful and underutilized plant, helps reduce waste and promote agricultural sustainability.

Conclusively, jute herbal soap serves as a sustainable and health-conscious alternative, meeting the functional needs of a skin cleanser. Future research should investigate customer acceptability across various marketplaces, the long-term dermatological effects, and the feasibility of large-scale manufacturing.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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