

**PREPARATION, EVALUATION, AND ANTIBACTERIAL ACTIVITY OF  
POLYHERBAL SOAP CONTAINING *HYLOCEREUS POLYRHIZUS***

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**ABSTRACT**

There is a growing interest in the demand for herbal and natural cosmetic products, which has encouraged the formulation of plant-based products with the advantages of higher therapeutic properties and fewer side effects. Thus, the purpose of this study was to evaluate the formulation and antibacterial activity of the polyherbal soap prepared from *Hylocereus polyrhizus* (dragon fruit), neem, aloe vera, turmeric and sandalwood. The formulation of soaps (F1, F2 and F3) was performed using a standard soap base and various concentrations of dragon fruit extract (F-1 1 gm, F-2 3gm, F-3 5 gm). The physicochemical parameters (pH, foam height, foam retention, washability and skin irritancy) of the prepared soaps were assessed. The antibacterial activity of the prepared soaps was evaluated against *Escherichia coli* and *Staphylococcus aureus* using the disc diffusion method. The results show that all of the soap formulations had acceptable physicochemical characteristics and were safe for use on the human body. F3, the soap formulation with the greatest amount of dragon fruit extract exhibited the largest zones of inhibition against *Escherichia coli* and *Staphylococcus aureus*. Polyherbal soaps containing dragon fruit extracts are safe, effective and natural alternatives to conventional soaps.

**KEYWORDS:** Polyherbal soap, Dragon fruit, Antibacterial activity, Herbal cosmetics, *Hylocereus polyrhizus*, Skin care.

**1. INTRODUCTION**

In recent decades, there has been a dramatic increase in the popularity of herbal cosmetics as more and more people become aware of the dangers of synthetic chemicals to both their health and the environment. Herbal cosmetics are made from natural (plant-based) ingredients that have been shown to have beneficial properties (e.g., they may have antioxidant, antimicrobial, or anti-inflammatory effects).<sup>[1]</sup> As such, herbal cosmetics are generally considered to be safer and more compatible with the skin compared to their synthetic counterparts. As the largest organ of the body, the skin serves an important role in providing protection from external elements, such as microorganisms, ultraviolet light, and pollutants. Therefore, it is critical to maintain the health of the skin so that the overall health of the individual is also taken care of. One type of





product that is used to cleanse the skin is soap, which is commercially produced through the saponification process, wherein an alkali (sodium hydroxide or potassium hydroxide) combines with various fats or oils.<sup>[2,3,4]</sup> Typically, herbal soaps are created by mixing herbal extracts with the soap itself to improve their medicated and beauty-enhancing properties.<sup>[5]</sup>

Tropical in origin, dragon fruit (*Hylocereus polyrhizus*) is a cactus species (Cactaceae) and has been recognized as having high nutritional values and phytochemical compositions.<sup>[7]</sup> In particular, it contains a variety of vitamins, minerals, polyphenols, flavonoids, and betalains, all of which are thought to be responsible for its antioxidant and antimicrobial properties.<sup>[8]</sup> Because of these properties, dragon fruit may serve as an excellent ingredient for use in making cosmetic products. In

addition to dragon fruit, there are a number of other herbal materials that are recommended for use in skin care products; neem (*Azadirachta indica*), aloe vera (*Aloe barbadensis*), turmeric (*Curcuma longa*) and sandalwood have all been found to be very effective.<sup>[9,10]</sup> Neem is known to have excellent antibacterial properties; aloe vera is considered to be very good at moisturizing;

turmeric is thought to offer a number of anti-inflammatory benefits; and sandalwood is often added to improve the scent of a product and its overall appearance on skin.<sup>[11,12]</sup> The current research project proposes to produce a polyherbal soap using these ingredients and measure its physico-chemical properties and antibacterial activity.<sup>[13]</sup>

**Table 1: Herbal Ingredients for soap formulation.**

SL.NO	NAME	Biological Source	PARTS	Chemical Constituents	USES
1	Dragon fruit	 <p><b>Fig. 1: Hylocereus polyrhizus.</b></p>	Pulp and peel	betacyanin, lycopene, vitamins (vitamin C mainly), dietary fiber, flavonoids, amino acids, phenolic acids, sugars and organic acids.	Rich in antioxidants, skin whitening Property. <sup>[14]</sup>
2	Neem	 <p><b>Fig. 2: Azadirachta indica (Meliaceae).</b></p>	Leaves	Azadirachtin, glycerides, poly phenols, triterpenes.	Anti-bacterial, anti-septic. <sup>[15]</sup>
3	Aloe vera	 <p><b>Fig. 3: Aloe barbadensis (Liliaceae).</b></p>	Pulp	Polymannans, anthraquinone, C Glucosides.	Moisturizer and anti- ageing. <sup>[16]</sup>
4	Turmeric	 <p><b>Fig. 4: Curcuma longa (Zingiberaceae).</b></p>	Rhizome	curcumin, zingiberene.	Anti-septic and Anti-inflammatory. <sup>[17]</sup>

## 2. MATERIALS AND METHODS

### 2.1 Materials

Materials used for experiments were coconut oil, castor oil, sodium hydroxide, glycerin, sorbitol, propylene glycol, citric acid (Anhydrous), Dragon Fruit Extract, Neem Powder, Aloe Vera Gel, Turmeric Powder, and Sandalwood Powder.<sup>[18]</sup>

### 2.2 Preparation of Dragon Fruit Extract

For the preparation of Dragon Fruit Extract, wash the outside of the dragon fruit with regular tap water before using.<sup>[19]</sup> Remove the rate pieces of flesh from inside the fruit, blend them together, then strain out the solids using a clean paper or cheesecloth to yield the liquid extract. Once complete, refrigerate for future use.<sup>[20]</sup>

**Table 2: Phyto constituents in dragon fruit.**



### 2.3 Preparation of Soap Base

Using the hot process method, a soap base was created by mixing together coconut oil, castor oil and heating them until they were fully blended.<sup>[21]</sup> The lye came from mixing sodium hydroxide with water to create a lye solution which was slowly added into the blended oils with constant stirring to create the saponification process of producing soaps.<sup>[22]</sup> To improve the clarity of the soap

and to retain moisture in the final product, glycerin, sorbitol and propylene glycol were added.<sup>[23]</sup> To ensure that the pH level was correct prior to pouring the final mixture into the soap molds, citric acid was added. Finally, the soap base was heated until it reached a uniform consistency (homogenous) and was poured into soap molds then allowed to cool and solidify.<sup>[24]</sup>

**Table 2: Formula for Soap base.**

S.No	Constituent	Procedure	Observation	Inference
1.	Polyphenols	Ferric Chloride Test: Add few drops of FeCl <sub>3</sub>	Blue-green or dark coloration	Present
2.	Flavonoids	Shinoda Test: Add Mg ribbon + conc. HCl	Pink/red coloration Present	Present
3.	Vitamins (Vit C)	DCPIP Test: Add DCPIP solution	Decolorization of blue dye	Present
4.	Alkaloids	Mayer's Test: Add Mayer's reagent	white precipitate	Present
5.	Saponins	Foam Test: Shake extract with water	Persistent foam formation	Present
6.	Tannins	Ferric Chloride Test	Blue-black or green precipitate	Present
7.	Terpenoids	Salkowski Test: Add chloroform + conc. H <sub>2</sub> SO <sub>4</sub>	Reddish-brown interface	Present
8.	Glycosides	Keller-Killiani Test	Brown ring formation	Present
9.	Betalains (Pigments)	Spectro photometric / visual observation	Deep red-violet color	Present
10.	Proteins	Biuret Test: Add NaOH + CuSO <sub>4</sub>	Violet color	Present
11.	Carbohydrates	Benedict's Test	Orange/red precipitate	Present

**Table 3: Soap base preparation formula.**

S.NO	Name of Ingredients	Quantity	Category
1.	Coconut oil	75ml	Main cleaning agent, produces rich Foam and gives hardness to soap
2.	Glycerin	15ml	Acts as a moisturizer, keeps skin soft and prevents dryness
3.	Castor oil	25ml	Enhance creamy lather and stabilizes foam
4.	Sorbitol	37.5gms	Humectants, retain moisture and improves transparency of soap
5.	Propylene glycol	60gms	Helps in retain moisture, also improves clarity and smooth texture
6.	Critic acid	2.5gms	Adjusts the PH, reduces the alkalinity and makes soap mild for skin
7.	NaOH	20g	Detergent
8.	Stearic acid	1g	Hardening agent

### 2.4 Formulation of Polyherbal Soap

Three formulations (F1, F2, F3) were prepared by incorporating different concentrations of dragon fruit extract into the soap base. Aloe vera gel, neem powder, turmeric powder, and sandalwood powder were added as supporting herbal ingredients.<sup>[25]</sup>

The molten soap base was mixed with herbal ingredients, poured into molds, and allowed to solidify for 24 hours.<sup>[26]</sup>

**Table 4: Formula for Formulation of poly herbal soap.**

SL.NO	INGRIDIRNTS	F1	F2	F3	USES
1.	Soap base (gm)	50	60	70	Remove dirt form skin
2.	Dragon fruit (gm)	20	25	30	Antioxidant, skin whitening property
3.	Aloevera gel (gm)	2	2	2	Skin conditioner, anti-bacterial
4.	Neem powder (gm)	1	1	1	Antibacterial, anti-microbial
5.	Turmeric(gm)	0.5	0.5	0.5	Anti-bacterial ,anti-septic
6.	Sandalwood powder (gm)	0.5	0.6	0.7	Fragrance, skin benefit, natural look



**Fig. 6: Poly herbal soap.**

## 3. EVALUATION OF POLYHERBAL SOAP

### 3.1 Physical Evaluation

The prepared soaps were evaluated for color, shape, and odor by visual inspection. All formulations showed a uniform reddish-brown color, oval shape, and pleasant fragrance.<sup>[27,28,29,30]</sup>

### 3.2 pH Determination

The pH of the soap was measured using a digital pH meter by dissolving 1 g of soap in 10 mL of distilled water. The pH values ranged between 9.3 and 9.4, which is within the acceptable range for skin cleansing.<sup>[31,32]</sup>

### 3.3 Foam Height

Foam height was determined by shaking a soap solution in a measuring cylinder. The foam height increased with

increasing concentration of dragon fruit extract, indicating good foaming ability.<sup>[33,34]</sup>

### 3.4 Foam Retention

Foam stability was measured over a period of 5 minutes. All formulations showed good foam retention, indicating stable lather formation.<sup>[35,36,37,38]</sup>

### 3.5 Washability

Washability was tested by applying soap on the skin and rinsing with water. The formulations were easily washable without leaving residue.<sup>[39,40,41,42,42,43]</sup>

### 3.6 Skin Irritation Test

The soap was applied to the skin and observed for any irritation. No redness or itching was observed, confirming that the formulations are safe for skin use.<sup>[44,45,46]</sup>

## 4. ANTIBACTERIAL ACTIVITY

### 4.1 Method

The antibacterial activity was evaluated using the disc diffusion method against:

- *Escherichia coli* (Gram-negative bacteria)
- *Staphylococcus aureus* (Gram-positive bacteria)

Soap samples were dissolved in solvent to prepare different concentrations (25, 50, and 100 µg/mL). Sterile discs were soaked in the solutions and placed on agar plates inoculated with bacteria. The plates were incubated at 37°C for 24 hours.<sup>[47,48,49]</sup>

## 4.2 RESULTS

**Table 5 – Evaluation tests of poly herbal soap results.**

S.No	Test	F1	F2	F3
1	Colour	Reddish brown	Reddish brown	Reddish brown
2	Odor	Sandell wood	Sandell wood	Sandell wood
3	Appearance	Good	Good	Good
4	Size	2.2cm x 3.15cm	2.2cm x 3.15cm	2.2cm x 3.15cm
5	Shape	oval shape	oval shape	oval shape
6	Foam Height(cm)	20ml	30ml	40ml
7	Foam Retention (ml)	15ml	20ml	30ml

8	PH	9.3	9.4	9.3
9	Wash ability	Clear washing	Clear washing	Clear washing
10	Irritancy test	No irritation	No irritation	No irritation
11	Antibacterial activity (Zone of inhibition) Staphylococcus Aureus	12mm	15mm	18mm
12	E. coli	11mm	14mm	17mm

### Antibacterial activity -Zone of inhibition

**Table 11: Zone of inhibition of test samples.**

Sl.no	Samples	Escherichia coli			Staphylococcus aureus		
		Conc. 25µg/ml	Conc. 50µg/ml	Conc. 100µg/ml	Conc. 25µg/ml	Conc. 50µg/ml	Conc. 100µg/ml
1	F1	7	9	11	8	10	12
2	F2	8	10	14	9	11	15
3	F3	<b>10</b>	<b>14</b>	<b>17</b>	<b>10</b>	<b>13</b>	<b>18</b>
4	Standard	12	15	18	13	17	20

The antibacterial activity of the prepared dragon fruit soap formulations was evaluated against *Escherichia coli* ( $G^{-ve}$  bacteria) *Staphylococcus aureus* ( $G^{+ve}$  bacteria) using the Disc Diffusion Method. The results showed that all formulations exhibited antibacterial activity with clear zones of inhibition around the discs.

For *Escherichia coli*, the zone of inhibition ranged from 7–17 mm for the prepared soap formulations (F1, F2, and F3). Among the formulations, F3 showed the significant antibacterial activity with a maximum Zone of inhibition 17 mm.

For *Staphylococcus aureus*, the zone of inhibition ranged from 8–18 mm, and again F3 showed the significant antibacterial activity with a maximum zone of inhibition 18 mm.

All the formulated soaps F1, F2, F3 are subjected to evaluate antibacterial activity by Zone of inhibition method in which one  $G^{+ve}$  (*Staphylococcus aureus*) and one  $G^{-ve}$  (*Escherichia coli*) bacterial organisms are selected 25µg, 50µg and 100µg/ml concentrations. The formulated soap F3 shows significant activity against  $G^{+ve}$  organism *Staphylococcus aureus* and  $G^{-ve}$  organism *Escherichia coli* strains and rest of the formulated soaps F2, F1 shows good to moderate activity.

The zone of inhibition was measured in millimeters. All formulations showed antibacterial activity.

- F1: Moderate activity
- F2: Good activity
- F3: Highest activity

F3 showed maximum inhibition

- *E. coli*: up to 17 mm
- *S. aureus*: up to 18 mm

The antibacterial activity increased with higher concentration of dragon fruit extract.

### 5. DISCUSSION

This research demonstrated that polyherbal soap can be made from all-natural materials, and the physicochemical analysis indicated that the soap was within acceptable parameters (e.g., pH, foaming ability, and stability). The phytochemicals found in Dragon Fruit, such as flavonoids and phenolic compounds, as well as antioxidant and antimicrobial properties, contributed to their possibly providing an antibacterial effect on the final product. Neem and turmeric contributed further to the antibacterial activity of the final product. Formulation F3 exhibited the greatest efficacy of the formulations tested due to the increased concentration of active ingredients. The observed bactericidal activity of the final product is likely due to the ability of the formulation to create a synergistic bactericidal effect through the use of several different herbs. The absence of any irritation to the skin resulted in evidence that the product is safe and suitable for regular use.

### 6. CONCLUSION

The goal of this study was to create and assess a polyherbal soap that contains dragon fruit (*Hylocereus polyrhizus*) extract and other natural ingredients such as neem, aloe vera, turmeric, and sandalwood. All of the herbal ingredients included in this soap have antioxidant, antimicrobial, and anti-inflammatory properties beneficial for skin health. The physical characteristics (appearance, smell, lathering ability, and washing ability) of the soaps developed were good; meanwhile, the pH levels of the developed soaps fall into an accepted level for use on the skin. The irritation tests performed on each soap show that the soaps produced are safe and do not cause any skin irritation. The F-3 formulation produced in this study had the highest antibacterial activity of the three formulations (F-2 and F-1 other two formulations showed good to moderate antibacterial activity). It therefore follows that this polyherbal soap has the potential to become an effective and safe natural product alternative for skin care. The above statement indicates that this researcher has made a commitment to continue

to conduct research to develop and evaluate “herbal” products.

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