

Design and Characterisation of Herbal Soap for the Treatment of Acne and Dry Skin: Factorial Design Approach

Aswathy Das D¹, Fathima Sherin¹, Sana Mathew¹, Sivakumar R^{1*}

¹Department of Pharmaceutics, Grace College of Pharmacy, Palakkad – 678 004

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*Corresponding author: Sivakumar R

Department of Pharmaceutics, Grace College of Pharmacy, Palakkad – 678 004

Abstract

The aim of the study was to formulate herbal soap for the treatment of acne and dry skin and statistical optimization of herbal ingredients by 2² factorial design approach. Totally six soaps were developed with varying concentration of herbals for preliminary trial. The prepared products are evaluated for pH, foam stability, antimicrobial activities, foam height, moisture content, foam retention time, percentage free alkali, alcohol insoluble content, washing capability etc were also measured. The best preliminary trial soap formulation (F 6) was subjected for optimization by 2² factorial design approach. The study result suggests increasing the concentration of neem extract exhibit improved antibacterial activity. When the concentration of SLS increased, it increases foam retention time. In conclusion, the optimized formulation (R4) is suitable for effective treatment of acne and dry skin.

Keywords: Herbal soap, Acne, Dry Skin, factorial design.

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INTRODUCTION

The maintenance of beautiful skin and hair is the desire of many people all over the world, thus, the application of safe cosmetic products is inevitable [1]. Soaps are surface-active agents that have both hydrophobic and hydrophilic groups embedded in their structure. Soaps made of natural products and represent a part of the requisite cleansing products used for domestic processes. They are required in the removal of germs, contaminants and dirt. The principle of green chemistry was adopted for the preparation of herbal antiseptic soaps which were plant-based, biodegradable and free of artificial colorants and preservatives [2].

Aloe vera is one of the most widely used botanicals. *Aloe vera* reduces inflammation, enhances wound healing, increases collagen synthesis and moisturizes the skin [3]. Neem (*Azadirachta indica*) derived extracts have been shown to work from anywhere from antimicrobial agent, lower inflammation, diabetic control, and even to combat cancer [3]. Topical application of turmeric (*Curcuma longa*) is recommended against sprains, cuts, injuries, swellings, skin infections and pimples [4]. *Centella asiatica* In the traditional system of medicine, this plant extract has been used as an antioxidant, wound healing [5].

Acne caused by *Acne vulgaris*, is a disease of the pilosebaceous unit—hair follicles in the skin that are associated with an oil gland. The clinical features of acne include excess grease, papules and pustules and scarring. There is no good evidence that acne is caused or cured by washing [3]. Dry skin is roughened, scaling skin with possibly some cracking. The patient may also experience pruritis and reddening associated with the dry skin [4]. Considering all the factors, the study aimed to formulate an anti-microbial soap and to statistically optimize the quality of the soap for the management of acne and wrinkles.

MATERIALS AND METHODS

Glycerin Soap Base (Vedini ayurveda, Haryana), Sodium lauryl sulphate (Spectrum laboratories, Cochin), Cocoa butter, Almond oil, Lemon grass oil (Yarrow Chem, Mumbai), *Aloe vera* gel (Himalaya, Bangalore). All other chemicals were of reagent grade [5].

Preparation of Herbal Extract

All the herbal extracts were prepared by decoction method. The herbal (Neem leaf, vallarai leaf, Betel leaves, tripala, turmeric and reetha nut) extracts were separately prepared by decoction method. In this, the herbals were collected, dried and powdered and it

was boiled at 100° C for 15 min. The resultant extract was filtered and the filtrate was collected and stored in a refrigerator [6].

Preparation of herbal soap

Melt and pour method was employed for the preparation of soap. About 55 g of glycerin of soap base was placed into the 250 ml beaker and melted and mixed with herbal extract (Table 1). Along with these extracts honey, cocoa butter, *Aloe vera*, SLS were also added into the beaker. The prepared mixture was heated for 10 minutes with frequent stirring. Perfumes were added in sufficient quantity and transferred into mould for solidification [7].

Evaluation of the Herbal Soap

The prepared preliminary trial batch soaps were characterized for various parameters [8, 9].

Determination of pH

For each soap sample, 1 g was dissolved in 100 mL of distilled water and filtered. The filtrate was taken immediately for determination on a pH meter [8].

Moisture Content

Ten gram of the soap taken in a petriplate and kept in a hot air oven at 115°C for 30 minutes. Samples are periodically withdrawn and weighed until the soap was dried [8].

$$\text{Moisture content (\%)} = \frac{W_2 - W_1}{W_1} \times 100$$

Where W_2 is the weight of dried paper and soap, W_1 is the weight of dried paper and dried soap sample [9].

Alcohol insoluble content

Five (5g) of soap was dissolved in 50ml warm ethanol and quantitatively transferred to already weighed filter paper; the residue was dried in an oven at 105°C for 30 minutes, cooled in a desiccators and weighed again [9].

Percentage free alkali

About 5g of sample was taken in a conical flask and added to it into 50 ml of neutralized alcohol. It was boiled under reflux on a water bath for 30 minutes, cooled and 1ml of phenolphthalein solution was added. It was then titrated immediately with 0.1 N HCL [9].

Foam height

About 1g of the soap was dissolved in distilled water in about 50ml taken in a measuring cylinder of 100ml. It was shaken for about 2 min and then allowed to stand still for 10 min. After 10 min measure the foam height. Repeat the same for 3 times for mean readings [10].

Foam retention time

Foam retention time refers to the amount of time the soaps foam remains intact. 25ml of 1% soap solution was taken into measuring cylinder. It was then shaken 10 times. Then record the foam at interval for 5 minutes [10].

Viscosity

The viscosity of 1% soap solution was assessed by Brook field viscometer (Spindle 63) at various rpm at the room temperature [10].

Skin irritation

It is carried out by applying the soap on the skin for 10 minutes. If no irritation, the product is considered as non-irritant product [11].

Antimicrobial study

The given sample of the soap was tested for its antimicrobial properties by well diffusion method. The microorganisms used were *E.coli*. In this method soap solution was prepared by dissolving 1g of soap in distilled water. The plates were then kept for incubation for about 24 hrs at a temperature of 37°C. Calculated the zone of inhibition [11].

Washing capability

Washing capability of the was assessed by washing the soap with water.

Clinical assessment of herbal soap

We investigated the hypothesis that application of herbal soap and plain soap impacts on dry skin of teen age people. After obtaining a second informed written consent six female individuals were assigned to the experimental group to use herbal soap for one week and the effect of soap on the skin was recorded [12].

Statistical optimization

Factorial design is one of the methods commonly used in optimization study using the design of the experimental (DoE) approach. The layout and results of the optimization study that was conducted using factorial were presented in table 3-4 and Fig 1-2.

RESULTS AND DISCUSSION

The herbal soap was successfully developed and optimized. The composition of soap and the results of the all evaluation are presented in the table 1 & 2. Despite the relatively low quality of evidence, the herbal soap holds promise in helping patients with acne to achieve remission status. It is concluded that herbal drugs can be utilized in better way by modifying into a convenient dosage form. The soap was formulated by adding minimal additives to achieve effectiveness, with cost effective benefits and less or no side effects.

Table 1: Composition of Herbal Soap for Preliminary Trial Batch

S. No	Ingredients	F1	F2	F3	F4	F5	F6
1	Neem extract (ml)	1.5	1.75	2.0	2.2	2.3	2.5
2	Vallarai extract (ml)	1.3	1.5	1.8	1.3	1.5	1.75
3	Triphala extract(ml)	2.5	2.25	2.3	2.0	2.2	2.3
4	Turmeric extract(ml)	0.5	0.5	0.5	0.5	0.5	0.5
5	Reetha extract (ml)	1.3	1.5	1.8	2.0	2.5	2.75
6	Honey extract(ml)	1.0	1.3	1.5	1.8	1.3	1.5
7	Aloe vera (g)	1.1	1.3	1.5	1.1	1.3	1.5
8	Cocoa butter (g)	0.5	0.5	0.5	0.5	0.5	0.5
9	Betel extract(ml)	2	1.5	1	0.75	0.5	0.25
10	SLS (g)	4.5	5.0	5.5	6.0	6.5	7
11	Glycerine base	55	55	55	55	55	55
12	Almond oil	1.0	1.0	1.0	1.0	1.0	1.0
13	Lemon Grass Oil	<i>q.s</i>	<i>q.s</i>	<i>q.s</i>	<i>q.s</i>	<i>q.s</i>	<i>q.s</i>

Table 2: Results of Evaluation of Soap – Preliminary trial batch

Evaluation parameter	F1	F2	F3	F4	F5	F6
Color	Brown	Brown	Brown	Brown	Brown	Brown
Odor	Fragrant	Fragrant	Fragrant	Fragrant	Fragrant	Fragrant
Shape	Heart	Round	Square	Oval	Heart	Oval
Texture	Smooth	Smooth	Smooth	Smooth	Smooth	Smooth
pH	7.1	7.4	7.2	7	7.3	7.5
Moisture content	3.3	1.9	2.6	2.5	3.0	1.5
Foam height(cm)	2.0	2.2	2.5	2.7	2.9	3.0
Foam retention time(minute)	3.1	3.7	3.2	3.3	3.4	3.5
Free alkali (%)	0.27	0.28	0.26	0.28	0.27	0.25
Alcohol insoluble matter	21	17	15	19	18	16
Viscosity (cp)	48	48	60	72	84	144
Skin irritation	Non Irritant	Non Irritant	Non Irritant	Non Irritant	Non Irritant	Non Irritant
Antimicrobial study (mm)	5.0	6.1	6.5	7.2	7.6	8.1

Table 3: Optimization Using 2² Factorial Design Approach

Factors(independent)	Independent variables		Dependent variables	
	-1	+1	Y ₁	Y ₂
Conc. of Neem extract	2.0 ml	3.0 ml	Anti-microbial test	Foam retention time
Conc. of SLS	6.5 g	7.5 g		

Table 4: Results of effect of herbal soap using 2² full factorial design

Run	X ₁ (Neem extract)	X ₂ (SLS)	Y ₁ (Antimicrobial Test)	Y ₂ (Foam Retention Time)
R1	-1 (2ml)	-1 (6.5g)	7.1 mm	2min31s
R2	-1 (2ml)	+1 (7.5g)	7.8 mm	3min10s
R3	+1 (3ml)	-1 (6.5g)	8.2 mm	2min51s
R4	+1 (3ml)	+1 (7.5g)	8.6 mm	3min47s

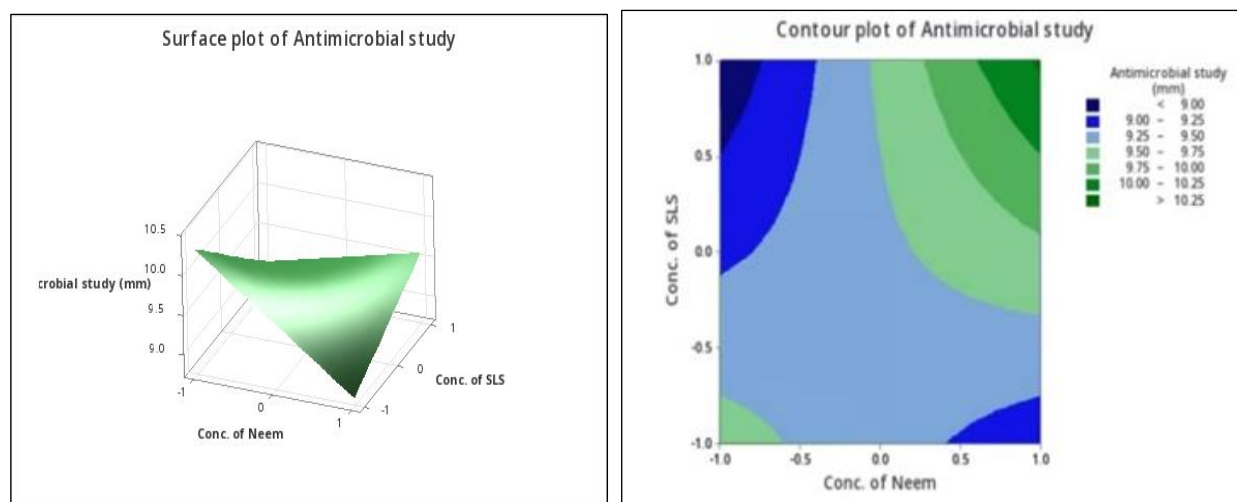


Figure 1: Respose and conter plot of antimicrobial activity of the soap

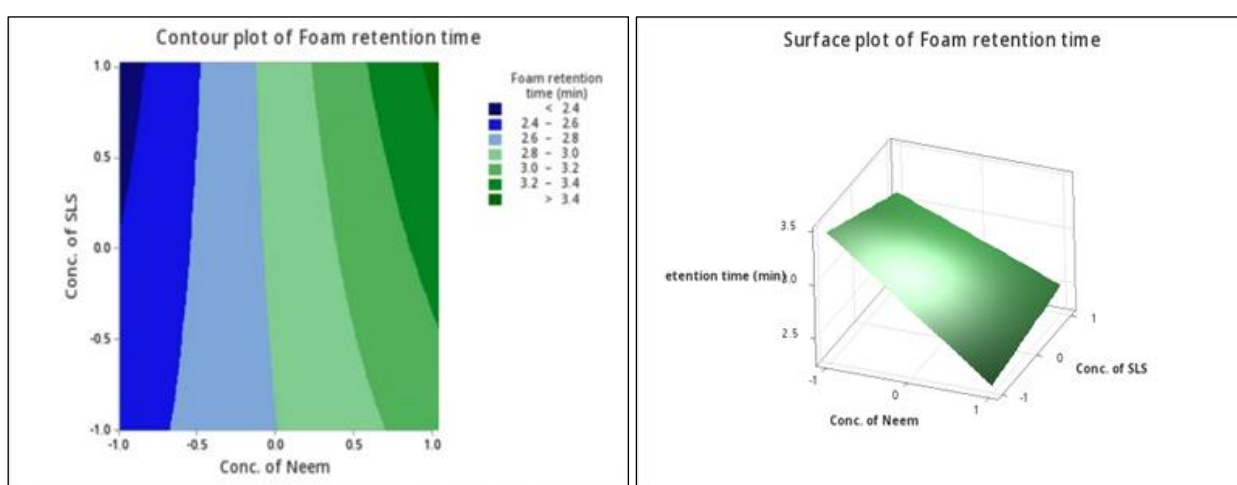


Figure 2: Surface and conter plot of foam retention time of the soap

Characterization of preliminary trial

Totally six formulation was developed with varying concentration of herbal extracts. The concentration of herbal extracts were partial arbitrarily and partial scientifically selected which is based on the previous study. All the prepared soaps were brown in colour, rose fragrant with smooth texture. The pH of all the soap was around 7, indicate that the sop was compatible with the pH of the skin. The moisture content of all the prepared soap was ranged from 1 – 3 % The moisture content in the code F - 1 soap were higher than that of F- 6. Indicate that the soap has lower moisture content than the reference value (10 %.) It may be due to lower concentration of herbals and higher concentration of glycerin incorporated in the soaps. This indicated that the soap needs to enhance the concentration of glycerin to retain the moisture content. from SLS had significantly higher water. The percentage of free alkali for all prepared soap was ranged from 0.25 to 0.28. The alcohol insoluble matter was ranged from 15 to 19.

The alcohol insoluble matter was determined and the insoluble residue was ranged from 15 to 21 %.

The alcohol insoluble matter may be organic or inorganic. The viscosity of the all the soap products were ranged from 430 to 1140 cp, which indicated increase the concentration of the herbals lead to increased the viscosity of the soap. All the soaps were tested for the skin irritation study. The results of the study showed that all the soap do not produce any irritation. Antimicrobial study was perfo5rmed with agar well plate method. The highest zone of inhibition found in code F 6. soap. Foam height was measure for all the soap which is ranged from 20 to 30 ml8. The product has short lather height due to the low concentration of sodium laurel sulphate. The foam retention time was between 3.11 minutes to 3. 25 minutes. The free alkali was around 0.25 % (Ref value 0.05) indicate that the product has slightly higher concentration of free alkali

Statistical optimization

A 2² factorial design was selected for the optimization of best preliminary trial formulation.. Based on the evaluation study The formulation code F 6 was found to best soap formulation.

$$Y = b_0 + b_1 X_1 + b_2 X_2 + b_{12} X_1 X_2$$

Where Y is the Dependent variables is the Arithmetic mean response of 4 runs, bi is the (b1, b2, b3) estimated coefficient factor.

Influence of antimicrobial study

The influence of dependent variables on antimicrobial study was analysed. The results of the study suggest that enhancement of neem extract concentration significantly improve the antimicrobial activity. Also sodium lauryl sulphate alone enhance the antimicrobial activity. But combined effect reduces the antimicrobial activity. It may be due to the cleavage of antimicrobial molecules of the neem.

$$Y_1 = 0.034 + 0.047 + 0.038 + 0.025$$

Influence of foam retention time

The influence of dependent variables on foam retention time was analysed. The results of the study suggest that enhancement of neem extract on foam retention not significantly improve the foam retention time. Also sodium lauryl sulphate alone significantly enhance the foam retention time. But the combined result showed insignificance effect on foam retention time

$$Y_1 = 0.032 + 0.023 + 0.076 + 0.021$$

CONCLUSION

It is concluded that herbal drugs can be utilized in better way by modifying into a convenient dosage form. The soap was formulated by adding minimal additives to achieve effectiveness, with cost effective benefits and less or no side effects. The results revealed that an antibacterial soap code R 4 was effective than a plain soap for control of acne and dry skin.

Conflict of Interest

The authors declare no conflict of interest.

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