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SYNTHESIS OF SOAP FROM NON-EDIBLE OILS AND A COMPARATIVE STUDY OF QUALITY PARAMETERS

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ABSTRACT

Samples of soap were prepared by mixing various non-edible oils such as Jatropha oil, Castor oil and Mahua oil by mixing with warm lye. In order to improve quality and market value, controlled quantity of fillers, permissible colors and fragrances were added in these samples. Soaps prepared from non-edible oils were compared with popular soaps in terms of several parameters such as % yield, TFM value, total alkali content, free caustic alkali content, pH and antimicrobial activity. It was found that TFM value of non-edible oil soap is more than 65%. According to BIS norms, such soap can be categorized as Grade II soap and it can be used for general bathing purpose. Also, total alkali content, free caustic alkali content, pH value etc. were found within prescribed value of BIS. *S. aureus* was chosen for study of antimicrobial activity. It was observed that soap from non-edible oil has more potential of inhibiting bacterial growth as compared to commercial antiseptic soap, which shows that production of soap from non-edible oil could be of great importance in agriculture as well as pharmaceutical sector.

Key words: Non-edible oil, Saponification, TFM value, Fillers, Antibacterial action, Medicinal soap.

INTRODUCTION

Soap is sodium or potassium salt of a fatty acid. Oil contains saturated fatty acid such as stearic, palmitic, myristic and some unsaturated fatty acids such as linoleic acid, and oleic acid which attributes to cleansing properties of the soaps. Market value, grading and cleansing action of soap depend on several chemical and physical parameters such as total fatty matter (TFM), total alkali content, free caustic alkalinity, pH etc. Several non-edible oils, such as Jatropha, Castor, Mahua etc. could be utilized for soap manufacturing, which will reduce the dependence on edible oils for making soaps. *Jatropha* oil is not edible due to a toxic ingredient known as phorbol ester present in the seeds[1]. *Jatropha* oil contains natural ingredients, which kills bacteria and fungus[2-4]. Chemical composition of *Jatropha* seed oil is

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Oleic acid (44%), Linoleic acid (34%), Palmitic acid (14%) and Stearic acid (6%)[5,6]. Due to the greater amount of Ricin oleic acid (90%) in castor oil, a soap made by this oil will be a great conditioner having stable lather[7]. Mahua oil is rich in saponins; thus, inclusion of Mahua oil in soap making will pace up the process of saponification. Also, Mahua oil is reported to have antimicrobial activity, which will enhance the medicinal importance of these soaps[8]. Production of soap at commercial level requires addition of certain fillers such as sodium silicate, which not only improves texture of soap but also provide it firmness so that soap can be mould into desired shapes.

EXPERIMENTAL

Materials and methods

Preparation of soap

Lye solution was prepared by adding caustic soda in water. This lye was warmed up to temperature 40^{o}C. In this solution of lye, sodium silicate (10% w/v) was added as filler. Jatropha oil, Castor oil and Mahua oils were mixed in the ratio of 8:1:1. Experiment performed on pure Castor oil revealed that soap made from Castor oil is comparatively soft and lacks proper firmness. Likewise soap prepared from pure Mahua oil turns rancid. So in order to achieve a good combination, several trials were performed by using these three oils. Mixture of oil was heated on heating mantle up to temperature 75^{o}C. When temperature of oil decrease up to 55^{o}C, warm oil was added to lye with continuous stirring in one direction. When reaction mass turned viscous like honey, it was poured in moulds for solidification[9]. After complete drying, crude soap was unloaded from mould and spray washed with water on Buchner funnel so as to remove unreacted caustic soda. Now soap was placed in hot air oven at temperature of 40-45^{o}C for drying (Fig. 1).

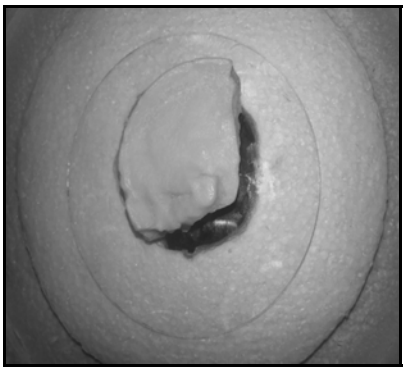

Fig. 1: Picture of soap prepared by mixing Jatropha, Castor, Mahua oil and sodium silicate

Few more samples of soap were prepared by following the same procedure along with addition of color (permitted by BIS) and fragrance (Fig. 2).

Fig. 2: Picture of soap prepared by mixing Jatropha, Castor, Mahua oil and filler (Sodium silicate) with red color and fragrance

Calculation of % yield of soap was done by the formulae –

$$\% \text{ Yield} = \text{Output/Input} \times 100 \quad \ldots(1)$$

Determination of total fatty matter

First of all, weight of a clean, dry and empty beaker was noted. In this beaker, about 5 g of the soap sample was dissolved in water and hydrolysed by adding dilute sulphuric acid. The soap decomposed liberating fatty acids. The fatty acids so formed were separated by addition of known quantity of bee wax in hot solution. Fatty acid residue in water was extracted by using chloroform. Organic layer was combined with layer of wax and reheated so that total fatty acid content was impregnated in wax. After cooling, increase in weight of bee wax was noted. From this, TFM value was calculated[10,11]. Same procedure was repeated for estimation of fatty acids in branded soaps.

Weight of wax layer (having fatty matter) = Weight of wax containing beaker – Weight of empty beaker = X (say)

Quantity of bee wax added = Y (say), Weight of fatty matter = X – Y

$$\text{Total \% of fatty matter} = X - Y/Z \times 100 \quad \ldots(2)$$

Where, Z = Quantity of soap utilized in experiment.

Determination of total alkali content

10 g of soap was added to sufficient quantity of neutralised Ethanol in a RBF and 1 N H_2SO_4 was added. This mixture was refluxed at heating mantle till entire soap sample was dissolved in ethanol, followed by hydrolysis in acidic medium. Flask was gradually cooled up to room temperature and remaining amount of sulphuric acid (after hydrolysis and neutralisation of all alkaline components in soap) was estimated by back titrating test mixture with standard 1 N NaOH. Same procedure was repeated for estimation of total alkali content in branded soaps. The total alkali content expressed as a percentage (m/m) is given by the formula[10,11].

$$4.0 \times [V_a - V_b]/m \text{ (for sodium soap)}$$

Where, V_a = Volume of acid added in experiment,

V_b = Volume of base at end point, and

m = Mass of soap used in experiment.

Determination of free caustic alkali content

10 g of soap was added to sufficient quantity of neutralised ethanol in a RBF and refluxed at heating mantle till entire soap sample was dissolved in ethanol. Dilute $BaCl_2$ was added to precipitate the possible impurities of carbonate and silicate. Free caustic alkali was calculated by titrating reaction mass with 0.05 M H_2SO_4 (0.1N H_2SO_4). The free caustic alkali content expressed as a percentage (m/m) is given by the formula[10,11].

$$0.4 \times V_a/m \qquad \ldots(4)$$

Where, V_a = Volume of acid added in experiment, and

m = Mass of soap used in experiment

Determination of antimicrobial activity of synthesised soap

Preparation of nutrient agar plate: 28.00 g of nutrient agar was dissolved by boiling in 1000 mL distilled water. Resulting solution was sterilized and cooled first at room temperature and then at low temperature so that media sets into gel like mass. This agar plate was divided into three sectors and small hole was punched in each sector known as “well”. *Staphylococcus aureus* was selected as test organism. With the help of sterile Platinum loop colony of *S. aureus* was spread on agar medium. In first well, few micro-litre of sample

(5% Non-edible oil soap solution) was injected with the help of syringe; in second well, 5% commercial antiseptic soap solution was used and third well was left as such as "control". Plates were left for incubation at 37°C. After 24 hrs of incubation, zone of inhibition of sample was observed. Antimicrobial activity can be calculated by following formula[12]:

$$\% \text{ Inhibition} = (A - B)/A \times 100 \quad \ldots(5)$$

Where, A = Average diameter of growth of organisms in the control,

B = Average diameter of growth of organisms in the sample region, and

A – B = Zone of Inhibition.

Determination of pH

pH of aqueous non-edible oil soap solution (5%) was recorded by using pH paper as well as pH meter . In the similar manner, pH of various branded soaps were recorded.

RESULTS AND DISCUSSION

It was observed that % yield of non-edible soap was found to be almost 119% (59.60 g of soap from 50 g oil). TFM value of soap was 65.60%. According to BIS norms, such soap can be categorized as Grade II soap and it can be used for general bathing purpose[13]. Total alkali content was 0.96% (BIS Limit: 1%), Free caustic alkalinity content 0.040% (BIS Limit: 0.05%), pH 9.1%, zone of inhibition (Antimicrobial activity) 48.19%, Comparison of soap from non-edible oil with various other branded soaps has been displayed in Tables 1-5.

Table 1: TFM Value

S. No.	Name of soap	Wt. of wax layer with fatty acid (X) (g)	Wt. of pure wax (Y) (g)	Wt. of fatty acids (X - Y) (g)	Wt. of soap (Z) (g)	TFM (%) (X - Y)/Z x 100
1	Non-edible oil soap	6.81	3.53	3.28	5	65.60
2	Lifebuoy	6.70	3.53	3.17	5	63.40
3	Lux	7.10	3.50	3.60	5	72.00
4	Cinthol	7.41	3.52	3.89	5	77.80
5	Dettol	7.15	3.54	3.61	5	72.20

Table 2: Total alkali content

S. No.	Name of soap	Vol. of acid (V_a) (mL)	Vol. of base (V_b) (mL)	Mass of soap (m)	Total Alkali % 4.0 x [V_a-V_b] / m
1	Non-edible oil soap	5	2.6	10	0.96%
2	Lifebuoy	5	3.5	10	0.60%
3	Lux	5	3.7	10	0.52%
4	Cinthol	5	4.7	10	0.12%
5	Dettol	5	4.2	10	0.32%

Table 3: Free caustic alkali content

S. No.	Name of Soap	Vol. of acid (V_a) (mL)	Mass of soap (m) (g)	Free caustic alkali % = 0.4 x V_a/m
1	Non-edible oil soap	0.5	5	0.040%
2	Lifebuoy	0.3	5	0.024%
3	Lux	0.2	5	0.018%
4	Cinthol	0.1	5	0.008%
5	Dettol	0.2	5	0.018%

Table 4: pH Value

S. No.	Name of soap	pH Range as (indicated by pH paper)	pH (from pH Meter)
1	Non-edible oil soap	8-9	9.1
2	Lifebuoy	7-8	8.0
3	Lux	7-8	7.8
4	Dettol	7-8	7.5
5	Cinthol	7-8	7.4

Table 5: Antimicrobial activity

S. No.	Name of Soap	A (mm)	B (mm)	A - B (mm)	% Inhibition (A - B)/A x 100
3	Non-edible oil soap	8.30	4.30	4.00	48.19
4	Commercial antiseptic soap	8.30	6.80	1.50	18.07

Soaps produced from non-edible oils such as Jatropha, Castor and Mahua oil has several quality parameters such as TFM, total alkali content, free caustic alkali content, pH etc., which are comparable with various branded soaps present in market. By adopting proper techniques of saponification, these oils could be utilized production of high quality soaps. Antimicrobial activity of soap prepared from non-edible oil (48.19%) (Fig. 3a) is much greater as compared to commercial antiseptic soap (18.07%) (Fig. 3b).

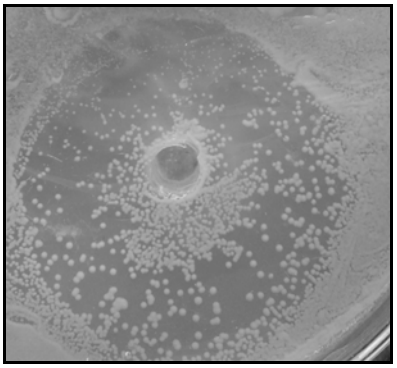

Fig. 3 (a): Antimicrobial activity of non edible oil soap

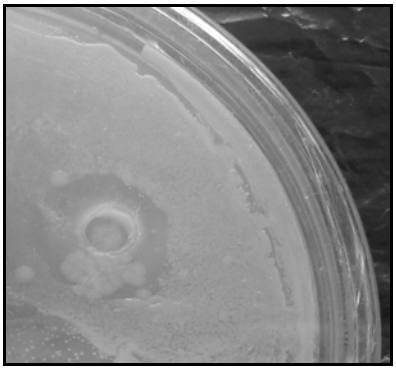

Fig. 3 (b): Antimicrobial activity of commercial antiseptic soap

By applying antimicrobial test on different kind of microbes, more information can be collected about antimicrobial activity of these soaps from non-edible oil, which may prove to be beneficial in treatment of dermatological problems.

CONCLUSION

The overall conclusion of this study is that soap produced from non-edible oils such as Jatropha, Castor and Mahua oil are comparatively cheap, having higher medicinal value and may develop a great importance in cosmetic as well as pharmaceutical sector.

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