RESEARCH NOTE

SMALL SCALE INDUSTRIAL APPLICATION OF RUBBER SEED OIL IN SOAP MANUFACTURE

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Abstract

The oil, which was extracted from the rubber seed using the mechanical pressing method, was of high acid value, that is, the free fatty acid content is high and the oil is not edible, with an average saponification value. Its pH was slightly basic which makes it suitable for use in soap manufacture. It was, therefore, used as a substitute for palm kernel oil in the production of soaps (bar soap and detergent soap). Tests for the foam capacity and stability of the soaps exhibited good visual foam stabilities and capacities. These make it suitable for washing and cleaning.

1. Introduction

Rubber tree, botanically known as Hevea Brasiliensis, is indigenous to Brazil and is cultivated in India, Sri Lanka, Bangladesh, Malaysia and Nigeria. The production in Nigeria began in the 1890s and was subsequently being tapped for latex of high yield and quality. Research (Alem *et al.*, 1982) indicates that the oil extract of rubber is suitable for various industrial uses, for example in the paints, soaps, cosmetics and leather industries. The derived cake from rubber seed after oil extraction is potentially useable for livestock feeds and diet, because it contains no saponin alkaloid. It can also be used as nitrogenous fertilizers. It is estimated that Nigeria currently has a gross total yield of 42,980,000 kg of natural rubber seeds annually containing 13,929,818 kg of seed oil and 13,388,270 kg of seed cake. The kernels were found to comprise 50% of whole seeds and 42.3% oil yield. The residual cake contains 18% proteins and 30% carbohydrate. Rubber seed oil is used as semi-drying oil in the paint industry, for the production of linoleum, rocket fuel, vanishes and in engineering as core binder (Alem *et al.*, 1982).

2. Types of Oils

2.1 Mineral Oil

Mineral oil consists mainly of mixtures of hydrocarbons or compounds composed mostly of carbon and hydrogen. Most of these oils are obtained from coal and petroleum. They contain no glyceride and so cannot be saponified. Examples are fuel and lubricating oil (Enabor, 1983).

2.2 Fatty Oil

Fatty oils are of animal or vegetable origin. They consist almost entirely of glycerides which are chemical acids occurring in oils as palmitic acid, oleic acid and stearic acid. The glycerides formed by these acids are called tripalmitins.

Fatty oil may be drying, semi drying or non-drying. Drying oils dry completely and form tough films when exposed to air. They do not dry by process of evaporation like water but as a result of a series of complex chemical reactions in which the oils combine with oxygen from the air. Semi drying oils do not dry at all. They remain liquid and may eventually turn rancid. Fatty oils do not evaporate when exposed to air and they are often called fixed oils; when dropped on paper, they leave a permanent greasy mark. Fatty oils can be saponified which involves their acids being converted into sodium and potassium salts soaps.

2.3 Vegetable Oils and Fats

Vegetable oils may be drying, semi drying or non-drying. The most important drying vegetable oil is linseed oil, which is widely used in the manufacture of paints. Semi drying vegetable oils include corn and Soya bean oils, cottonseed, and rubber seed oils. Examples of non-drying vegetable oils are peanut and olive oils. They are used for cooking. Castor oil is used in medicine. Vegetable fats are called oils because in the tropics where they are produced, they are liquids (Enabor, 1983).

2.4 Animal Oils and Fats

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Animal oils are non-drying oils. Most animal oils are derived from fresh water and other marine animals while most animal fats are obtained from land animals. Cod liver oil and whale oil are examples of animal oils. Bee fallow and butterfats are examples of animal fats.

2.5 Essential Oils

Essential oils are of vegetable origin. They are often called volatile oils because they evaporate readily. When dropped on paper, they leave spots but these disappear as the oils evaporate. Almost all essential oils have distinctive tastes and aromas. They may be used as flavoring oil for peppermint. Cassia oil, verbena oil, and rose oil (or altar of rose oil) àre used for perfume. For paints and vanishes, oils of turpentine that are distilled from wood of certain species of pine tree are widely used(Enabor, 1983).

2.6 Rubber Seed Oil

Rubber seed has fat splitting enzymes, which rapidly make the oil rancid. Rubber seed oil requires further refinement to allow for long storage of the oil. Acid or alkali treatment can be used to refine the rubber seed oil. Alkali treatment involves mixing 1-5 mL of concentrated sulphuric acid (H_2SO_4) into the raw oil that has the effect of charring and flocculating mucilaginous matter. Alkali refining is the most widely used and it causes the mucilaginous matter to separate, coagulate and react with free fatty acids to form soaps.

The factors affecting oil spoilage include air, degree of unsaturation of the oil, heavy metals, light, natural oxidative enzymes, ratio of pro-oxidants to anti-oxidants present in the oil and temperature. Therefore it is recommended that the storage containers for the rubber seed oil should admit little or no light at all(Nadarajah, 1973). Composition of rubber seed oil is shown in Table 1.

Table 1: Composition of Rubber Seed Oil

Composition/properties	Rating %
Saturated Acids	16
Oleic Acid	27.3
Linoleic Acid	31.5
Unsaponifiable matter	1.14
Oil content	23
Specific Gravity	0.9185
Iodine Value	145.80
Refractive index	1.47
Moisture and volatile matter	4.30
Dirt content	0.30

3. Materials and Methods

3.1 Extraction of Rubber Seed Oil

Before the extraction of the rubber seed oil, the seeds were washed with clean water, dried for four days, decorticated and ground into very fine powder to enhance purity of the oil, low moisture content, increased surface area, and maximum yield of oil. The powdery kernel was weighed and poured into a mesh bag and put inside a perforated plate, which was placed inside a collector pan. These were placed between the platens of a preheated bench press that was hydraulically raised to touch the upper platen till there was enough pressure to force oil out of the crushed rubber seeds. The collector pan on the other hand consists of a side outlet through which the oil will flow out into a clean plastic container. The extracted oil was allowed to cool, weighed, and then stored for further analysis. This was repeated using varying weights of crushed seeds, temperature and pressure respectively. (See table 2)

Cold pressing was not adopted as a means of extraction because previous work showed that this method has a much lower percentage of oil yield compared to hot extraction using same mechanical press. Although oils obtained through cold pressing has lighter colour, they contain no solvent and have higher purity.

Table 2: Oil Yield from Rubber Seeds

	Sample A	Sample B	Sample C
Weight of rubber seed	800	700	680
Temperature (°C)	100	90	90
Pressure (psi)	3	3	3
Oil yield (g)	260.0	225.0	196.8
% Oil yield	32.50	32.14	28.94

3.2 Clarification of Oil

The desired quantity of the extracted oil was measured and poured into a beaker and boiled with a quarter of its volume of water. After separation, another quarter of its volume of water was added to the clarified oil and separated. This process removes water-soluble stains from the oil.

3.3 Preparation of Sodium Hydroxide (NaOH)

To prepare a 6 molar solution of NaOH, 240 g of NaOH was weighed and added to 1000 dm^3 of H_2O in a bowl and stirred for proper mixing. The solution was allowed to cool for between 24 and 48 hours before use.

3.4 Characterization of Rubber Seed Oil

Natural rubber seed oil, which was freshly extracted, is characterized by determining:

Acid value and free fatty acid content - These were necessary to give an indication of the free fatty acid content of the oil, it helps to determine whether the oil will be suitable for the production of soap and to know the level of saturation or unsaturation of oil. A high acid value portends the possible decomposition of the oil. Acid value and free fatty acid content results for the oil sample are presented in the Table 3.

Saponification value - is defined as the number of milligrams of potassium hydroxide required to saponify one gram of oil. It is the amount of hydroxide required

Table 3: Acid Value and Free Fatty Acid of Oil

Test	Wt of oil (g)	Normality	Vol. NaoH (cm^3)	Acid Value	% FFA
1	10.00	0.1	82.50	46.28	23.27
2	9.50	0.1	80.15	47.33	23.80
3	9.00	0.1	74.60	46.50	23.38
Average				**46.70**	**23.48**

Table 4: Saponification Values of Oil Samples

Sample	Wt. of Oil sample	Vol. of HCl in sample	Vol. Of HCl in Blank	Saponification value
1	1.96g	11.94cm^3	25.25cm^3	190.45
2	1.98g	11.35cm^3	25.00cm^3	190.54
3	2.00g	11.00cm^3	24.80cm^3	193.55
			Average	**191.52**

Table 5: Formulation for Soap

Ingredients	Quantity (g)
Rubber Seed Oil	500
Sodium Hydroxide	250
Potash	20
Colour	0.05
Perfume	2

Table 6: Formulation for Detergent

Ingredients	Quantity (g)
Rubber Seed Oil	500
Sodium Hydroxide	250
Hydrogen Peroxide	100
Potash	30
Colour	0.05
Perfume	2

Table 7: Foam Stability

Time (min)	Bar soap (mL)	Detergent (mL)
0	900	900
5	850	720
10	790	570
15	610	490
20	520	380
25	480	350

to neutralize the fatty acid and fatty acids combined as glyceride in the oil sample. Saponification value is the neutralization point of potassium hydroxide with the oil and thus gives an indication of when soap is formed. The saponification values of the oils samples are shown in Table 4.

Moisture Content - This is the determination of the amount of water in the oil. The essence is to ascertain the level of oil saturation. The moisture content of the oil was 1.703 %

Specific Gravity - The test is related to the density of the oil and gives an idea of its viscosity, which is used to determine the actual weight of the oil. The specific gravity of the oil was found to be 0.9292.

3.5 Production of Soap

The formulation for the production of the soap is shown in Table 5.

500g of the clarified oil are poured into a bowl and the colour is added with a quarter of its volume of water. 250 g of sodium hydroxide was added and stirred gently in one direction. The potash (builder) and finally, perfume are added; the mixture is stirred continuously until the soap sets. The mixture is then poured into moulds. The saponification process is completed in the mould and the bar of soap is allowed to stand for 48 hours in the mould. The soap is removed from the mould and then placed in an open air to complete solidification.

3.6 Production of Detergent

The formulation used for the production of the detergent is shown in Table 6.

Pour 500 g of clarified oil into a bowl and add colour, a quarter of its volume of water, and 250 g of the prepared sodium hydroxide in that order and stir gently in one direction, then add 30 g of potash (builder) and stir until the soap sets. Hydrogen peroxide is then added to blow the soap up. After the forming reaction of hydrogen peroxide, it is allowed to properly dry into flakes. The flakes are grounded into powder and sieved to fine particle sizes.

3.7 Determination of pH of Soaps

The pH is defined as the negative logarithm, to base 10, of the aqueous hydrogen ion concentration $[H_3O^+]$ measured in mol/dm^3. It is an indication of the acidity or alkalinity of a substance.

Samples of each of the soaps were put in a boiler. The source of heat was switched on until the soaps melted to liquid. A piece of universal indicator was dipped into the liquid for 3 seconds, the indicator was removed and the colour compared with the colour card on the dispenser by holding the test strip adjacent to the dispenser on which the pH scale is drawn to match the colour. The pH of the soap and detergent were 8.0 and 8.5 respectively.

3.8 Determination of Foam Capacity

5g each of the soaps were dissolved in 300 mL of water. The mixture was agitated until foam was formed. The foam capacities for soap and detergent were found to be satisfactory by visual inspection.

3.9 Determination of Foam Stability

5 g each of the soaps were dissolved in 300 mL of water. The mixture was agitated until they foam. The mixtures were then poured into measuring cylinders and the reductions of foam were recorded at different time intervals. See Table 7.

4. Discussion of Results

The results obtained from the mechanical extraction of oil from rubber seeds as shown in table 2 indicate that rubber seeds have oil and an average recovery of 31.2% was obtained as against the expected recovery of 35%. Initially, one was of the opinion that at constant temperature and pressure, oil yield would be proportional to the weight of the seeds but this was not so. This is due to the strength of the mesh bag used and the presence of dried milled seeds in the batch, which would rather absorb oil than give out.

From the acid value and free fatty acid results showed in table 3, the mean percentage of acid value and free fatty acid content of rubber seed oil are 46.50 and 23.46% respectively. These indicate a high degree of acidity, an indication that the oil is suitable for soap manufacture; thus the oil will require an alkaline media to increase its pH before it can be used for the production of soap. An average saponification value of 191.52 for the rubber seed oil also indicates a high chance of it being used in soap manufacture.

That the pH of the soap and detergent are 8.0 and 8.5 respectively, which is an indication of slight alkalinity, which is permissible for domestic soaps (Enabor, 1983), while the soap capacity and stability results further confirm the lathering ability of the produced soaps.

5. Conclusion

The extraction of oil from rubber seeds, using mechanical pressing method, yielded a considerable percentage of oil by weight. From the observed results of tests carried out, rubber seed oil in soap production is suitable and can be used as a close substitute for palm kernel oil. The pH values of the soaps are alkaline which further strengthens the view that the soaps are suitable for use.

Above all, rubber seed oil can be used as a close substitute for paraffin oil in the manufacture of cosmetics (Ohikhena, 2005), palm kernel oil used in soap production, and process oil used for rubber compounding respectively (Enabor, 1983).

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