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Analysis of Locally produced Soap using Sheabutter Oil (SBO) Blended with Palm-Kernel Oil (PKO)

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Abstract

Eleven different blends of sheabutter oil (SBO) and palm kernel oil (PKO) were employed in soap production. The 150:350 blend gave best soap judging by TFM while the 350:150 blend gave a better soap than the former in terms of foam stability. The saponification values of the oils 173.30 (SBO) and 249.18 (PKO), and the iodine values 65.04 (SBO) and 18.58 (PKO) agreed with those found in literature. The unsaponified matter, free fatty acid (FFA) and acid value were found to be 1.23%, 1.713 and 3.60 for PKO and for SBO the corresponding values were 3.60%, 5.499 and 11.76 respectively. The results showed that PKO is a purer oil than SBO.

Introduction

Soap may be defined as a chemical compound or mixture of chemical compounds resulting from the interaction of fatty acids or fatty glycerides with a metal radical (or organic base). A soap may also be described as any water-soluble salt of those fatty acids which contain eight or more carbon atoms. The metals commonly used in soap making are sodium and potassium, which produce water-soluble soaps. These are characteristically different from soaps made from divalent metals such as calcium, magnesium, iron or aluminium which are not water soluble (Chalmers and Bathe, 1978).

Soaps are use for laundry and cleaning purposes, though calcium soap have been used in animal feed formulation (Kuntom *et al*, 1994). The properties of soap are determined by the amount and composition of the component fatty acids in the starting oil. In all the soap production methods, blends of oils have always been used. For example in the cold process method, blends or mixture of coconut oil, palm kernel oil and tallow fat is used. The fat charge for the semi-boiled process method uses tallow fat and coconut oil (Chalmers and Bathe, 1978). Kuntom and co-workers (1996) produced soaps of desirable quality by blending distilled fatty acids of palm oil (PO) and palm kernel oil (PKO) and the quality of the soap produced is comparable to the quality of commercially available soaps. Good quality soaps are therefore produced from blends of oils.

Sheabutter tree is known as *Butyrospermum paradoxum*. It grows well in the guinea savannah agroecological zones which fall within the middle belt of Nigeria. The leaves are highly relished by sheep and goats. The oil is obtained from the seed and this oil is used for cooking in some parts of Nigeria but it is generally used as a fuel for local lantern. The fatty acid composition of this oil is 5.1% palmitic, 43.5% stearic, 45.3% oleic, 5.8% linoleic and 0.3% linolenic acids (Talabi and Koleoso, 1984; Hilditch, 1931). There are also trace amounts of phytosterol, resin, cinnamic acid and karitene. Mange, a contagious, chronic debilitating skin disease of domestic animals characterized by severe itching, irritation and inflammation of the skin is effectively cured by application of sheabutter and salt in the ratio 100:1 (Oguntola, 2002). It is also used as topical balm for ailments like boil and rashes in man. All the uses put together consume less than 25% of the oil that can be realized from this plant annually. This study was therefore undertaken to discover other uses especially commercial uses for sheabutter oil (SBO). The study involves using various blends of sheabutter oil (SBO) and palm kernel oil (PKO) to prepare soap and analyzing the soaps so produced. Palm kernel oil is a lauric oil containing saturated acids of chain length C6-C18. It is hard and brittle at low temperature but with sharp melting point when heated. Soap making is a worldwide industry using 10-15% lauric oil in all high quality soaps (Berger and Ong, 1985).

Experimental

Analysis of Oil

(i) **Specific gravity:** The oil was passed through a column (2 cm diameter) packed with sodium sulphate (5 g) and this was done inside an oven at 40°C. An empty specific gravity bottle was weighed, filled with water and weighed again. The bottle was then filled with the filtered oil and the weight recorded. The specific gravity of the oil was then calculated using the well-known equation.

(ii) **Refractive index:** The refractive index was determined with Abbey refractometer, $B^{+}S$ model, number A76184.

(iii) **Saponification value:** A sample of the oil (4 g)) was weighed into a flask and 50 cm^3 of 0.1N alcoholic potassium hydroxide solution was added. The mixture was refluxed until saponification was completed. The excess potassium hydroxide was then titrated against 0.1N hydrochloric acid using phenolphthalein as indicator. The same process was repeated but without oil sample (blank titration) (AOAC, 1980).

(iv) **Unsaponified Matter:** A sample of the oil (5 g) was refluxed with 50 cm^3 of 0.1N alcoholic potassium hydroxide solution on a water bath for about an hour. When saponification was completed, the content of the flask was transferred to a separating funnel and the flask was washed with 50 cm^3 of distilled water into the separating funnel. Then 50 cm^3 diethyl ether was used to extract the water insoluble matter (unsaponified matter) (AOAC, 1980). This extraction was repeated and the average was calculated.

(v) **Iodine value determination (Wij's method):** A sample of the oil (0.3 g) was placed in a thoroughly dry flask and 20 cm^3 of carbon tetrachloride was added to dissolve the oil. After this 25 cm^3 of Wij's iodine solution was added. The flask was covered and shaken and kept in the dark for 50 minutes at room temperature. Then 20 cm^3 of potassium iodide solution and 200 cm^3 of distilled water were added. The liberated iodine was slowly titrated against 0.1N sodium thiosulphate solution until the yellow colour just disappeared. At this point, about 2 cm^3 of starch solution was slowly added and titration continued until the blue colour was discharged. This process was repeated but without oil added (blank titration) (AOAC, 1980)

(vi) **Acid value and free fatty acid (FFA):** The determination of free fatty acid (FFA) involved boiling 50 cm^3 of alcohol on water bath for few minutes, and then adding 2 cm^3 of phenolphthalein and 0.1N NaOH solution to produce a permanent pale pink colour. Then oil (5 g) was added to 50 cm^3 of this neutralized solution and the mixture boiled on a water bath. While still hot the solution was titrated against 0.1N or 0.25N NaOH until the pink colour returns. Free Fatty acid is expressed as oleic acid for sheabutter and as lauric acid for palm-kernel oil (AOAC, 1980)

Saponification

The oil was melted and titrated before being used for saponification. The blended oil samples used for saponification were prepared by varying the weight of the sheabutter and palm-kernel oil but the combined weight of the mixture was kept constant at 500 g for example, the blend containing 500 g of sheabutter oil and 0 g of palm kernel oil was labeled as A, the blend containing 450 g sheabutter oil and 50 g of palm-kernel oil was labeled B etc. The blends give SBO : PKO ratios of 10:0, 9:1. 8:2, 7:3 etc, as presented in table 2. Caustic soda solution weighing 125 g (41.187M NaOH) was then added to 500 g of the blended oils for saponification. The cold process method was used for the saponification and the soap produced did not contain any additive (Chalmers and Bathe, 1978).

Analysis of Soap

Soap analysis was carried out immediately after production and then three months after production.

(i) **Total Fatty Matter (TFM):** A sample of the scrapped soap (10 g) was put into a 250 cm^3 beaker, 100 cm^3 of water was added and the mixture was heated on a water bath until the soap melted. 10 cm^3 of 20% H_2SO_4 was added with continued stirring then 5 g of candle wax and heating was continued until the wax melted. The whole content was allowed to cool to room temperature. The TFM was then calculated.

(ii) **Free Alkali as Na_2O:** A sample of the scrapped soap (10 g) was placed in a conical flask and 100 cm^3 of neutralized alcohol was added. The flask and the content therein was placed on a water bath and heated until the soap dissolved. The 10 cm^3 of 10% Barium chloride solution and 2 to 3 drops of phenolphthalein indicator were added. The whole content was titrated against 0.1N H_2SO_4 until the solution became colourless. The free alkali as Na_2O was then calculated (AOAC, 1980).

(iii) **Moisture content:** A sample of the scrapped soap (10 g) was put into a dish and placed in an oven for 1 hour at 110°C. It was allowed to cool down and then weighed. The moisture content in percentage was calculated.

(iv) **Foam stability and Hardens of soap:** The soap produced was used to form lather in water and the time taken for the foam to collapse was determined using a stopwatch. The hand feel hardness was determined relatively to each other.

Results

Table 1: Physiochemical analysis data for sheabutter oil and palm-kernel oil

	Sheabutter Oil (SBO)	Palm-kernel Oil (PKO)
Specific gravity	0.90	0.91
Saponification value	175.30	249.18
Iodine value	65.04	18.58
Unsaponified matter (%)	3.60%	1.23%
Free fatty acid	5.499	1.713
Acid value	11.76	3.60

Table 2: Property of soap immediately after production

Oil blend Sample	Blend composition SBO:PKO	Foam Stability	TFM (%)	Moisture Content (%)	Hardness	Free Alkali
A	500:00	2.00	83.6	8.20	2	Nil
B	450:50	1.35	84.6	12.30	3	Nil
C	400:100	3.00	81.9	10.10	4	Nil
D	350:150	3.60	81.4	11.20	6	Nil
E	300:200	2.83	82.6	11.30	8	Nil
F	250:250	1.90	86.9	10.60	9	Nil
G	200:300	1.70	79.5	10.70	10	Nil
H	150:350	1.30	78.2	11.40	5	Nil
I	100:400	2.30	79.8	9.60	7	Nil
J	50:450	2.70	85.2	9.20	11	Nil
K	00:500	3.70	74.4	8.20	1	Nil

Table 3: Property of soap after Three month of production

Oil blend Sample	Blend composition SBO:PKO	Foam Stability	TFM (%)	Moisture Content (%)	Hardness	Free Alkali
A	500:00	2.45	81.03	3.70	2	Nil
B	450:50	3.38	81.05	4.30	5	Nil
C	400:100	4.28	80.35	5.50	4	Nil
D	350:150	4.55	82.02	2.70	3	Nil
E	300:200	2.83	81.63	4.90	8	Nil
F	250:250	3.20	70.13	4.70	9	Nil
G	200:300	2.53	70.95	5.50	10	Nil
H	150:350	1.85	73.02	7.00	6	Nil
I	100:400	1.15	67.42	4.20	7	Nil
J	50:450	1.98	66.74	4.60	11	Nil
K	00:500	4.15	79.30	7.40	1	Nil

Discussion of Results

Table 1 contains the physicochemical analytical results for both (SBO) and (PKO), while tables 2 and 3 summarised the properties of the soap immediately after production and three months later respectively.

The physicochemical results obtained for the oils agreed with those published in literature (Chalmers and Bathe, 1978). The specific gravity of PKO reported by earlier workers (Chalmers and Bathe, 1980) was between 0.860 and 0.873. Our own findings reported in table 1 showed 0.91 for PKO and 0.90 for SBO. The saponification value for PKO from literature (Chalmers and Bathe, 1978) is between 245-255 and the value from our own study (table 1) is 249.18. The iodine value for PKO is between 14 and 23 from literature while in table 1 the value is 18.58. The specific gravity of the two blended oils are almost the same, 0.90 for SBO and 0.91 for PKO. The saponification value for SBO oil is 175.30 which is also between the reported the reported value of 178-198 in Cocks and Anovan (1966), while that of PKO is 249.18. The iodine values are 65.04 and 18.58 respectively and these values agreed with those found in literature (Chalmers and Bathe, 1978; Cocks and Anovan, 1966). It is evident from the above that the saponification and iodine values of the oil are complementary. The oil with high saponification value has low iodine value and vice-versa. Therefore, we expect this blend to produce good quality soap with the combined properties of the two oils, particularly for the blend ratio in samples E, F and G. Usually, oils with low iodine values produce hard soaps. For example, coconut oil and PKO give hard soaps with large bubbles which is short lived. Oils with medium iodine values e.g. palm oil (PO) and Beef tallow oil (BTO) give short lived bubbles (Chalmers and Bathe, 1978)

Kuntom and co-workers (1996) in a soap manufacturing study done in Malaysia using blends of distilled fatty acids of palm oil (PO) and palm-kernel oil (PKO), showed that there is an increase in acid value and hardness, while the iodine value decreases as the ratio of PKO increases. It is not surprising therefore, that the soap from hundred percent PKO is the hardest in term of hand feel amongst the soaps produced from the different blends we studied. PKO is made up of over 80% saturated fatty acids by composition, hence the low iodine value recorded in table 1. It is however surprising that the remaining oil blends do not follow this pattern. For example sample A which is pure 500:00 SBO placed second in the order of hardness whereas it is expected to be the softest, because of the high iodine value of the SBO. This suggests that other factors other than unsaturation must be responsible for this observation. Possibly, a reaction at the double bond centers of the SBO occurs before saponification through thermal oxidation and hydrolysis when the oil was heated for filtration (Permanyer *et al*, 1985; Viola, 1972).

The unsaponifiable matter values are 3.60% and 1.23% for SBO and PKO respectively (table 1). These values fall within the range given in literature. These oils can be used for saponification without refining, although, phytosterol, cinnamic acid, karitene etc that are responsible for high values of unsaponified matter can be removed by boiling in water and ethanol (Sietz and Jeger, 1949). Deterioration caused by hydrolysis of the triglycerides during storage of the oil and its seeds produce free fatty acids which are determined as acid value or percentage free fatty acid. The FFA of SBO is 5.499 while that of PKO is 1.713 and the acid values are 11.76 and 3.60 respectively. These data suggest that PKO is purer than SBO used for this study (Permanyer *et al*, 1985; Viola, 1972).

The foam stability was determined by measuring the time it takes for the lather formed by the soap with pure water to collapse. Sample D has the longest time for lather collapse hence it has highest foam stability value of about 3.70 minutes for the fresh soap and 4.55 minutes for the three month old soaps. Generally, all the three month old soaps have longer foam stability time than the fresh soap. This observation corroborates moisture loss, that is, as the moisture content reduces, the foaming strength increases.

The TFM measures the quality of soap and the accepted percentage value for toilet soap is between 76-77% while that of laundry soap is between 45-50% (Chalmers and Bathe, 1978). There is decrease in TFM values as the soaps age particularly soap samples labeled F to J which coincidentally are the ones that fall within the accepted TFM standard for toilet soaps. All the fresh soaps have TFM values that are higher than the recommended standard. Excess caustic soda that is incorporated in the soap was determined by measuring the free alkali as Na_2O. Undetected or low free alkali values of the soaps both immediately after production and three months after production show that the soap would not be corrosive to the skin. The foam stability for the soaps in tables 2 and 3 do not follow a regular pattern. Table 2 shows a decrease followed by an increase and again a decrease, then another increase. Table 3 shows initial increase on to sample D before a decrease and then a sharp increase in sample K. The TFM (%) values follow an irregular pattern as in foam stability but the range for table 2 is between 74.40 and 86.90% while that of table 3 is between 66.74 and 82.02%. Generally, there is a decrease in TFM values as the soap ages. There is great moisture loss also as the soap ages, for example, the moisture content of sample A soap is 8.20% when freshly prepared and 3.70% after three months. This great moisture loss has not affected the position of this soap in the hardness table since moisture loss is noticed for all the soap samples. Sample K has a decrease in moisture content from 8.20% (table 2) to 7.40% (table 3), although the ranking in hardness have not changed. A good number of the soap samples have their positions in the hardness table maintained e.g. samples A, C, E, F, G, H, I, J and K. Sample D is of particular interest, the moisture content is 11.20% but it is sixth in position of hardness in table 2. However, this sample has its moisture content reduced to 2.70% in table 3 and its position of hardness has improved to the third place. The loss of moisture may have been responsible for the increase in hardness and consequent decrease in size. By harvesting all these results, we are persuaded to recommend that sample H blend with little variations may be suitable for large scale production of soap. However, if foam stability is considered the most desirable soap quality, then sample D emerges the most suitable blend in the present study.

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