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OPTIMIZATION OF SOAP PRODUCTION USING MANGO PEELS ASH AS ALKALI SOURCE

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ABSTRACT
The use of mango peels ash as alkali source for soap production was examined. The blends of oils used comprised of Palm Kernel Oil (PKO) and Beef Tallow (BT) oil mixtures in the ratios of 3:1,1:1 and 1:3 and the physicochemical characterization of the oil blends were analyzed. The soaps were prepared using the oil blends (PKO:BT) and alkali extract from mango peels ash using standard methods and by varying the proportions of the oil blends and the alkali extract in the ratios of 1:1, 1:2 and 2:1. The soaps produced were analysed by testing its yield, foam ability, foaming stability, total fatty matter **(**TFM), total fatty acid (TFA), free caustic alkali **(**FCA) and free carbonate alkali. The alkali content and pH of the mango peel ash extract were found to be 12.13g/dm^3 and 10.9 respectively. From the varying proportions of the oil mixture, the soaps produced from PKO:BT in the ratio 1:3 showed optimum soap yields at 85.1%, 85.8% and 83.7% for oil blends and alkali extract in the ratios of 1:1, 1:2 and 2:1 respectively and are the most economical for the soap production process. However, the soaps produced from PKO:BT in the ratio 1:1 showed very good properties with the highest values for foam ability and foam stability at 21.50 ml and 7.35 mins respectively.

Keywords: Mango peels, Palm Kernel Oil, Beef Tallow, Soap, Saponification.

INTRODUCTION

Soap is a common cleansing agent well known to everyone. Warra, (2013) regarded it as any cleaning agent, manufactured in bars, granules, flakes, or in liquid form, made from a mixture of sodium or potassium salts and fatty acids of natural oils and fats. Soap comprises of the metallic salts of long chain monocarboxylic acids and are mainly used as surfactants for washing, bathing, and cleaning, but they are also used in textile spinning and are important components of lubricants (Okolie*et al.*, 2014).

The production of crude soap was initiated 3000 years ago in the Nile valley and other early centres of civilisation. The Romans were also known to be considerable users of soap to the extent that urine was used as a source of ammonium carbonate for cleaning purposes (Osagie and Fekarurhobo, 2014).

Generally, soap making is based on alkaline hydrolysis of fat and oil in a reaction known as saponification according to equations (1.1) and (1.2).

$$C_3H_5(OOCR)_3 + 3NaOH \rightarrow 3NaOOCR + C_3H_5OH \quad \ldots(1.1)$$

(Fat) (Sodium Hydroxide) (Soap) (Glycerol)

OR

$$C_3H_5(OOCR)_3 + 3KOH \rightarrow 3KOOCR + C_3H_5OH \quad \ldots(1.2)$$

(Fat) (Potassium Hydroxide) (Soap) (Glycerol)

The making of soaps from ash-derived alkalis has been an age-old craft in Nigeria and many West African countries (Nwoko, 1982). Local soap production has been achieved using alkalis derived from the ashes of agricultural wastes such as plantain peels as reported by Nwoko, (1980) and Onyegbado *et al.* (2002).

Potash has been described as a white crystalline residue that remains after aqueous extract from ashes is evaporated (Kelvin, 2003). According to Irvine (1965), agricultural wastes contain a good percentage of potash. These agricultural wastes include plantain peels, cassava peels, palm bunch, wood, and many others. When these agricultural wastes are burnt in air, the resulting ashes contain oxides of potassium and sodium which when dissolved in water yield the corresponding hydroxides according to equations (1.3) and (1.4).

$$Na_2O + H_2O \rightarrow 2NaOH \quad \ldots(1.3)$$

$$K_2O + H_2O \rightarrow 2KOH \quad \ldots(1.4)$$

The local production of alkali oxide (Na_2O and K_2O) from these agricultural wastes has been observed to be a cheaper alternative source of this much needed chemicals used in the production of soap and other alkalis based products (Adewuyi *et al.*, 2008).

Manufacture of soap and detergents in Nigeria with the use of imported caustic potash as a source of alkali for soap production has caused the price of soap to become very high and expensive due to high exchange rate (Osagie and Enyi, 2015).

In developing countries such as Nigeria, small scale industries are encouraged through micro financing to source for local substitutes for imported raw materials (Osagie and Enyi, 2015). Although at present, oils for soap making in Nigeria are readily available while nearly all the alkalis for soap making are imported (Onyegbado *et*

al., 2002). This has become an impediment for the survival of most soap making industries in Nigeria.

However, several of the agricultural resources required for production of alkalis are wastes and are littered all over the environment posing a serious health hazard apart from being an eyesore. Disposal of some of these agricultural wastes is a waste of resources which might be a potential source of raw materials needed for soap production. Hence, such agricultural wastes could be converted to alkalis for soap production. Therefore, mango peels which are wastes (usually in large amounts) from mango fruit processing and yet to be exploited as a source of alkali could be converted to alkalis and utilized in soap production.

The alkali extracted from the ash derived from peels of mango which is renowned for its excellent flavour, fragrance and high nutritional value (Pleguezuelo *et al.*, 2012) would add fragrance and quality scent to the soaps produced when utilized for soap production. This will hence reduce the use of additives such as perfumes in soap production.

Soaps produced with alkalis from mango peels ash provide a cheaper alternative to soaps produced with imported caustic soda due to its low production cost and it characteristically provide fulfillment to the important need of man for maintaining cleanliness.

Also, the production of homemade soap using mango peels ash is a very viable business entrepreneurship for self employment, which graduates can exploit.

This research work is therefore undertaken to explore the production of solid laundry soap from Beef Tallow (BT) and Palm Kernel Oil (PKO) blends using mango peels ash as alkali source.

MATERIALS AND METHODS

Sample collection

The mango fruits were collected from a nearby mango plantation in Dutsin-Ma town, Katsina State and the oils (Beef Tallow and Palm Kernel oils) were collected from Dutsin-Ma market in Dutsin-Ma town, Katsina State, Nigeria.

Sample preparation

The collected mango fruits were carefully peeled using sharp knife and dried in the air for thirty days to ensure adequate removal of moisture from the sample until the mango peels become brittle.

Preparation of mango peel ash

The brittle mango peels were charred for 2 hours to ensure uniform combustion and the charred mango peels were further burnt in a muffle furnace set at a temperature of 550 ^{o}C for proper ashing which lasted for about 4 hours. The ashed sample was weighed and homogenized by crushing between fingers and then sieved with an analytical sieve to obtain uniform particle size.

Extraction of alkali from mango peel ash

About 20 g of the ash was placed in a 1000 ml round bottom flask and 600 ml of distilled water was added. The flask was placed on an electric heating mantle and boiled continuously to about 100 ^{o}C for 2 hours. The flask was allowed to stand for 6 days and the content was filtered and re-filtered with Whatman filter paper to obtain a clearer extract. The filtrate was poured into a reagent bottle and then stored for further analysis.

Standardization of the mango peel ash extract

The standardization of the mango peel ash extract was carried out according to Zauro *et al.* (2016). The standardization was carried out using primary standard solution of 0.1 M KHP. 5 ml of 0.1 M KHP solution was accurately measured in a clean conical flask and 2 drops of phenolphthalein indicator was added. The mango peel ash extract was filled in the burette and titrated against 5ml of 0.1 M KHP solution in the conical flask until the first faint pink colour appeared. The titration was repeated two more times using a fresh sample of 5ml of 0.1 M KHP solution and the average titre value was determined. The molarity of the mango peel alkali extract was then determined from the titration.

Determination of the alkali content of the mango peel ash

From the results obtained above, the alkali content of the mango peel ash was calculated according to Zauro *et al.* (2016). The amount of KOH in the extract was calculated from the equation below:

$$V_{KOH} = \frac{FW_{KOH} N_{KOH} . V_{ex}}{100\, ml}$$

Where:
V_{KOH} = Amount of KOH in a given volume of extract
FW_{KOH} = Formula weight of KOH
N_{KOH} = Normality of KOH
V_{ex} = Volume of extract

Determination of pH of the mango peel ash extract

The pH of the mango peel ash was determined according to Zauro *et al.* (2016). The pH of a sample is the measure of the acidity or alkalinity of a sample. It is also a measure of the H^+ or OH^- of the sample.10ml of the mango peel ash extract was measured in a beaker and a calibrated pH meter electrode was dipped in the sample and reading began by pressing the measure button on the pH meter. The pH of the alkali extract was recorded.

Test for basicity of the mango peel ash extract

The basicity of the mango peel ash extract was tested using a red litmus paper and the observation was recorded.

Preparation of oil blends

The blends of oils were comprised of Beef Tallow (BT) and Palm Kernel Oil (PKO). The first oils blend contains 75 % PKO and 25 % BT in a ratio of 3:1. The oils were melted by heating and were thoroughly stirred so as to obtain a perfect blend of the oils. The oils blends were re-weighed to ascertain an accurate weight (100 g) which was required for the optimization of soap production. The same procedure was followed to obtain the various blends with different oil mixture ratios of 1:1 and 1:3 respectively.

Physicochemical characterization of oil blends

Determination of saponification value

Saponification value is the number of milligrams of KOH needed to saponify 1 g of oil or fat. The saponification values of the oil blends were determined according to Pearson, (1973).

Exactly 2 g of the oil blend was weighed in a 100 ml round bottom flask and 25 ml of 0.5 M alcoholic KOH was measured into the flask to disolve the oil. The flask was fitted to a reflux condenser set up with continuous stirring and heat for about 45 minutes (or until clear). The solution was allowed to cool and two drops of phenolphthalein indicator was added and then titrated with 0.5M H_2SO_4 until the pink colour just dissappeared. The titre value was recorded and the experiment was repeated with a blank (without the oil blend).

The saponification value (SV) was determined using the equation below:

$$SV = \frac{(B - A) \times 0.02805 \times 1000}{W\ (g)}$$

Where:
A = Volume of H_2SO_4 used for the oil sample
B = Volume of H_2SO_4 used for the blank
W = weight of the oil used

Determination of acid value

The acid values of the oil blends were determined according to Pearson, (1973).

Exactly 1 g of the oil was weighed in a clean dried 250 ml conical flask and 50ml of propan-2-ol was added to ensure complete dissolution. 5 drops of 1 % phenolphthalein indicator was added and mixed thoroughly. The mixture was titrated against 0.1 M KOH to a faint pink colour end point. The acid value was calculated using the formula below:

$$AcidValue = \frac{56.1 \times V \times C}{W\ (g)}$$

Where:
V = Volume of KOH
C = Molar Concentration of KOH
W = Weight of oil

Determination of percentage free fatty acid (%FFA)

The percentage free fatty acid values of the oil blends were determined according to Pearson, (1973). The free fatty acid was determined by the calculation as described below:

$$FFA\ (\%) = \frac{AcidValue}{2}$$

Determination of ester value

The ester values of the oil blends were determined according to Pearson, (1973). The ester value was determined by the calculation as described below:

$$Ester\ Value = Saponification\ Value - Acid\ Value$$

Optimization studies of soap production

The saponification process adopted was the semi-boiled method as described by Schuman and Siekman (2005). The procedure was modified with the exemption of NaOH.

Exactly 10 g of the oil blend was added to 20 ml of the purified alkali extract solution in a 100 ml beaker and heated to about 60 ^oC with stirring for about 30 mins. 2 ml of NaCl solutions was added to the mixture to separate the soap mass from the glycerol. The soap formed a cake on the surface of the beaker while a solution of glycerol was below. The solution of glycerol was removed by means of separating funnel. The soap was poured into a mould for cooling and stored for further analysis.

The procedure was repeated by varying the proportions of the oil blends and the purified alkali extract in different ratios such as 1:1 and 2:1 respectively and 9 different samples of soaps were produced.

The weight of all the 9 soap samples prepared were taken after they were cooled and the yields of the soap samples were calculated by the formula below:

$$Yield\ (\%) = \frac{Weight\ of\ soap\ sample}{Weight\ of\ the\ oil} \times 100\%$$

Physicochemical analysis was carried out on the soap samples with optimum yield among the 3 ratios of oil blends as they were the most economical in the soap production process.

Physicochemical analysis of the soaps produced

Foamability tests on the soap samples

About 2.0 g of the soap sample was dissolved in a measuring cylinder containing 10ml of distilled water. The mixture was shaken vigorously so as to generate foams. After shaken, the cylinder was allowed to stand for some time. The height of the foam in the solution was measured and recorded. The procedure was repeated a second time and the average of the height was calculated and recorded as the foamability of the soap sample.

Foam stability tests on the soap samples

About 2.0 g of the soap sample was dissolved in a measuring cylinder containing 10ml of distilled water. The mixture was shaken vigorously so as to generate foams. After shaken, the cylinder was allowed to stand for some time. The time taken for the foam/lather to completely disperse/disappear was recorded. The experiment was repeated and the average time taken for the foam/lather to completely disperse/disappear was recorded as a measure of the foam stability.

Determination of total fatty matter (TFM) of the soap samples

About 2 g of soap sample was weighed into 250 ml beaker and 100 ml of hot water was added to completely dissolve the soap. 40ml of 0.5 M HNO_3 was added to the mixture until the contents were slightly acidic. The mixture was heated over water bath until the fatty acids were floating as a layer above the solution. Then the mixture was cooled suddenly in ice water in order to solidify the fatty acids and separate them. 50 ml of chloroform was added to the remaining solution and transferred into a separating funnel. The solution was shakened and allowed to separate into 2 layers and the bottom layer was drained out. 50ml of chloroform was added to the remaining solution in the separating funnel. The fatty acid dissolved chloroform was again separated as in the previous case and it was transferred to the collected fatty matter. The fatty matter was weighed in a previously weighed porcelain dish. From the difference in weight, the percentage of fatty matter was calculated in the given soap sample using the formula below:

$$\% \, TFM = \frac{B - A}{C} \times 100\%$$

Where:
A = weight of the porcelain dish, g
B = weight of the porcelain dish + soap after drying, g
C = weight of the initial sample of soap, g

Determination of total free alkali (TFA) of the soap samples

About 2 g of soap sample was added to 20ml of neutralized ethanol in a conical flask on a steam bath until the soap sample was dissolved. The solution was heated to boiling and 2 ml of 0.1 M Barium chloride as well as 2 drops of phenolphthalein was added to the solution and then titrated with 0.1 M H_2SO_4 to end point where the solution becomes colourless. The Total Free Alkali was calculated as Na_2CO_3 oxide using the relationship:

$$TFA = Molarityofacid \times Molarmassofoxide \times Volumeofacidused$$

Determination of free caustic alkali (FCA) of the soap samples

About 2.0 g of the soap sample was dissolved in a 100ml volumetric flask containing 50 ml of distilled water. 2 ml of 0.1 M $BaCl_2$ solution and 2 drops of phenolphthalein solution was added to the solution respectively and mixed. The precipitate was allowed to settle and 25 ml of the clear liquid was drawn off and titrated with 0.1 M H_2SO_4. The amount of Free Caustic Alkali in the soap was calculated using the relationship:

$$FCA = Molarityofacid \times MolarmassofBaCl_2 \times Volumeofacidused$$

Determination of free carbonate alkali of the soap samples

The Free Carbonate Alkali was determined by subtracting the Free Caustic Alkali from the Total Free Alkali.
Mathematically,

$$Free\ Carbonate\ Alkali = TFA - FCA$$

RESULTS AND DISCUSSION

Results

Alkaline content and pH of the mango peel ash extract

Table 1 shows the alkali content, pH and basicity of mango peel ash extract.

Table 1: Alkaline content and pH of the mango peel ash extract

Parameters	Concentration	Indication
Molar content	0.1272 mol/dm^3	-
Alkaline content	12.13 g/dm^3	-
pH	10.9	-
Test with red litmus paper	-	Turns red litmus paper blue

The molar and alkaline contents of the mango peel ash extract are 0.1272 mol/dm^3 and 12.13 g/dm^3 respectively. The alkali content was observed to be lower in comparison to that of plantain peel ash extract which is 64.57 g/dm^3 but higher than that of cassava peel ash extract which is 4.82 g/dm^3 as reported by Umeh-Idika and Maduakor (2013). The molar and alkaline contents were also found to be lower in comparison to that of plantain peels which are 0.23 mol/dm^3 and 28.5 g/dm^3 respectively as reported by Onyegbado*et al.* (2002).

The pH of the mango peel ash showed 10.9. The pH was observed to be lower in comparison to that of plantain peel ash extract which is 11.31 but higher than that of cassava peel ash extract which is 9.17 as reported by Umeh-Idika and Maduakor (2013).

The mango peel ash extract was tested using a red litmus paper and it was observed that it turned red litmus paper to blue which further confirmed its alkalinity.

Physicochemical characterization of oil blends

Table 2 shows the saponification values, ester values, acid values as well as the free fatty acid values of the ratio of oil blends.

Table 2: Physicochemical characterization of oil blends

SAMPLE	RATIO OF BLENDS (PKO:BT) (w/w)	SAPONIFICATION VALUE (mgKOH/g)	ESTER VALUE (mgKOH/g)	ACID VALUE (mgKOH/g)	FREE FATTY ACID (mgKOH/g)
1	3:1	87.66	79.13	8.53	4.26
2	1:1	110.80	103.55	7.25	3.62
3	1:3	131.52	128.11	3.14	1.71

Saponification value

The saponification values of the oil blends (PKO:BT) in the ratio 3:1, 1:1 and 1:3 were found to be 87.66 mgKOH/g, 110.80 mgKOH/g and 131.52 mgKOH/g respectively. The saponification values were observed to be lower in comparison to that of coconut oil and castor oil blends in the ratio 3:1 which is 230.4 mgKOH/g as reported by Debesh (2019). The saponification values obtained for the oil blends also fall below the standard limits for soap production oils which is 189 - 199 mgKOH/g (FAO, 2015).

The low saponification values recorded might be due to high level of impurities as indicated by Kirschenbauer (1965) that high saponification values recorded for almond seed oil suggested low level of impurities. These impurities are generally fatty acids, phosphatides, metal ions, colour bodies, oxidation products, solid particles, and volatiles that include objectionable odour (Debesh, 2019). It was however observed that the saponification value of the oil blends increased with increase in composition of Beef Tallow (BT) oil. This indicates that the Palm Kernel Oil (PKO) has undergone rancidification and increasing the composition of Beef Tallow (BT) oil helps to improve the saponification value of the blends for soap production.

Ester value

The ester values of the oil blends (PKO:BT) in the ratio 3:1, 1:1 and 1:3 were found to be 79.13 mgKOH/g, 103.55 mgKOH/g and 128.11 mgKOH/g respectively. It was observed that ester value of the oil blends increased with increase in the composition of the Beef Tallow oil.

Acid value

The acid values of the oil blends (PKO:BT) in the ratio 3:1, 1:1 and 1:3 were found to be 8.53 mgKOH/g, 7.25 mgKOH/g and 3.41 mgKOH/g respectively. The acid values were observed to be lower in comparison to that of coconut oil and castor oil blends in the ratio 3:1 which is 1.92 mgKOH/g as reported by Debesh (2019). The acid values obtained for the oil blends however fall within the standard limits for soap production oils which is ≤ 30 mgKOH/g (FAO, 2015).

High acid value indicates a stale oil or fat stored under improper conditions as indicated by Debesh (2019). It was also observed that the acid values of the oil blends decreased with increase in the composition of the Beef Tallow oil. This indicates that the Palm Kernel Oil (PKO) is stale or stored under improper conditions and increasing the composition of Beef Tallow (BT) oil helps to improve the acid value of the blends for soap production.

Free fatty acid

The free fatty acid (FFA) of the oil blends (PKO:BT) in the ratio 3:1, 1:1 and 1:3 were found to be 4.26 mgKOH/g, 3.26 mgKOH/g and 1.71 mgKOH/g respectively. The free fatty acid values were observed to be lower in comparison to that of coconut oil and castor oil blends in the ratio 3:1 which is 0.96 mgKOH/g as reported by Debesh (2019). The free fatty acid values obtained for the oil blends also fall below the standard limits for soap production oils which is ≤ 0.5 mgKOH/g (FAO, 2015). It was also observed that the free

fatty acid values of the oil blends decreased with increase in the composition of the Beef Tallow (BT) oil. This indicates that increasing the composition of Beef Tallow (BT) oil to Palm Kernel Oil (PKO) in the blends helps to improve the free fatty acid value of the blends for soap production.

Optimization studies of soap production

The 9 different soap samples produced by varying the proportions of oil blends and alkali extract in the ratios of 1:1, 1:2 and 2:1 were observed to have undergone incomplete saponification as there were traces of unsaponified oils in the samples.

The incomplete reaction of the oil and alkali was as a result of the low saponification values of the oils, reaction time and temperature. Corrective measures were therefore taken to correct this by the continuous addition of the alkali extract until saponification is completed and completely saponified soap samples were produced. The alkali extract was added quantitatively to the incompletely saponified soap samples until saponification was completed and the amount of alkali extract that was added to each of the samples was recorded as well as the yield of soaps as shown in Table 3.

Table 3: Amount of alkali extract added to complete saponification and soap yields

Ratio of oil blends (PKO:BT) (w/w)	Ratio of Oil to Alkali (Oil:Alkali) (w/v)	Amount of alkali extract added (ml)	% Yield
3:1	1:1	140	71.5
	1:2	131	73.2
	2:1	152	68.8
1:1	1:1	125	79.1
	1:2	119	80.6
	2:1	138	76.9
1:3	1:1	116	85.1
	1:2	109	85.8
	2:1	130	83.7

It was observed that the amount of alkali extract added to complete saponification decreases as the saponification values of the oil blends increases. The soap yields were also observed to increase with increase in the composition of Beef Tallow (BT) oil in the oil blends and the oil blends of (PKO:BT) in the ratio 1:3 showed optimum yields and are the most economical for the soap production process. The yield of soap depends on the soap making oil used, the particular carboxylic acid as well as the alkali that make up the soap and the higher the yield, the more economical is the soap production process (Debesh, 2019).

Physicochemical analysis of the soaps produced

Tables 4 and 5 show the physical and chemical analysis of the soaps produced respectively.

Table 4: Physical analysis of the soaps produced

Ratio of oil blends (PKO:BT) (w/w)	Foamability (ml)	Foam Stability (mins)
3:1	19.00	5.45
1:1	21.50	7.35
1:3	20.40	6.30

Table 5: Chemical analysis of the soaps produced

Ratio of oil blends (PKO:BT) (w/w)	Total Fatty Matter (TFM) (%)	Total Free Alkali (TFA) (%)	Free Caustic Alkali (FCA) (%)	Free Carbonate Alkali (%)
3:1	58.5	3.18	2.08	1.10
1:1	55.0	4.24	4.16	0.08
1:3	54.0	7.24	5.21	2.21

Foamability

The results obtained from the analysis of the soap samples for foamability gave 19.00 ml, 21.50 ml and 20.40 ml for the blends of oils (PKO:BT) in the ratio 3:1, 1:1 and 1:3 respectively. It was observed from the results obtained that the soaps produced had asatisfiable foam ability and the oil blend in the ratio 1:1 gave the highest value for foamability at 21.50 ml.

Foam stability

The results obtained from the analysis of the soap samples for foam stability gave 5 mins 45 secs, 7 mins 35 secs and 6 mins 30 secs for the blends of oils (PKO:BT) in the ratio 3:1, 1:1 and 1:3 respectively. The results were observed to be higher in comparison to that of sheabutter oil (SBO) and palm kernel oil (PKO) blends in the ratio 1:1 which is 1.90 minutes immediately after production and 3.20 minutes eight weeks after production as reported by Zauro *et al.* (2016). The oil blend in the ratio 1:1 gave the highest value for foam stability at 7.35 minutes.

Total fatty matter

The results obtained from the analysis of the soap samples for TFM showed 58.5 %, 55.5 % and 54.0 % for the blends of oils (PKO:BT) in the ratio 3:1, 1:1 and 1:3 respectively. The results were observed to be lower in comparison to that of coconut oil and castor oil blends in the ratio 3:2 which is 76.8% as reported by Debesh (2019). The results however fall within the standard limits for TFM values of toilet soaps which is 45 – 55 % as reported by Debesh (2018). The oil blend in the ratio 3:1 gave the highest value for TFM at 58.5 %.

Total free alkali

The results obtained from the analysis of the soap samples for TFA revealed 3.18 %, 4.24 % and 7.24 % for the blends of oils (PKO:BT) in the ratio 3:1, 1:1 and 1:3 respectively. The results were observed to be similar in comparison to that of the soap produced from palm oil and cassava peels ash which is 6.7% as reported by Beetseh and Anza (2013). It was observed from the results that the presence of free alkali increased as the composition of Beef Tallow (BT) oil in the oil blend increased.

Free caustic alkali

The results obtained from the analysis of the soap samples for free caustic alkali showed 2.08 %, 4.16 % and 5.21 % for the blends of (PKO:BT) in the ratio 3:1, 1:1 and 1:3 respectively. The results were observed to be similar in comparison to that of the soap produced from palm oil and cassava peels ash which is 2.95% as reported by Beetseh and Anza (2013). It was observed from the

results that the presence of free caustic alkali increased as the composition of Beef Tallow (BT) oil in the oil blend increased.

Free carbonate alkali

The results obtained from the analysis of the soap samples for free carbonate alkali showed 1.10 %, 0.08 % and 2.21 % for the blends of (PKO:BT) in the ratio 3:1, 1:1 and 1:3 respectively. The results were observed to be similar in comparison to that of the soap produced from palm oil and cassava peels ash which is 3.8 % as reported by Beetseh and Anza (2013). It was observed from the results that the presence of free carbonate alkali increased as the composition of Beef Tallow (BT) oil in the oil blend increased. It was also observed from the results obtained that the soap sample of oil blend in the ratio 1:1 had the lowest value for free carbonate which is 0.08 %.

CONCLUSION

The production of soap from Palm Kernel Oil (PKO) and Beef Tallow (BT) oil blends with alkali extracted from mango peel ash showed optimal soap yield at the ratio of oil blends (PKO:BT) in the ratio 1:3 of the oil blends and the soaps produced from the alkali extracted from mango peel ash reported in this work were milky white in colour and the same colour as the imported caustic soda. Hence, this indicated that exploitation of these agricultural wastes to generate alkali for soap production is worthwhile. This would free our environment from those agricultural wastes that often render them untidy, it will also save the environment from the potential harmful effects of pollution that is commonly associated with synthetic chemicals and would drastically reduce the heavy dependence on synthetic chemicals for soap production.

The results also indicated that blending of oils of low saponification values with oils of high saponification values gives an oil blend which is good for soap production to produce better quality soaps. The results of this research work also revealed that blending Palm Kernel Oil (PKO) and Beef Tallow (BT) oils in the ratio 1:1 gave a soap with similar characteristics and washing efficiency as soaps produced with imported caustic soda and also with good lathering ability, good foam stability and soap that is suitable for laundry and ready for domestic and industrial cleaning.

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