



Preparation of Soap from Mixture of Palm Kernel Oil and Ashes of Unripe Plantain Peels

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ABSTRACT

Soaps are the sodium salts or potassium salts of fatty acids. They are produced by the saponification process, which is, reacting the oil which contain triglycerides with caustic soda to give the soap. However different oils have different composition of fatty acids which are responsible for different properties of soaps made out of them. In this work, Soap production and Analysis from palm kernel oil and plantain peel ash was carried out. The soap was prepared using palm kernel oil and plantain peels. The alkali was extracted from the plantain peels ash and used to saponify the oils for the production of soap. The saponification values, free fatty acid value and the Acid value of the palm kernel oil were analyzed and their value were found to be 218.12 ± 0.65 mgKOH/g, 1.648 ± 0.015 and 2.72 ± 0.10 mgKOH/g respectively. One sample t-test analysis of the data obtained were conducted at 95% confident level using Minitab 17 statistical software. The results indicated that the p- values for saponification, free fatty acid and Acid value means obtained were 0.841, 0.591 and 0.522 respectively which were all greater than the alpha value ($\alpha = 0.05$) confident level. The soap produced was analyzed by testing its moisture content and foaming stability and the result were found to be $7.86 \pm 0.46\%$ and 3.52 ± 0.12 minute respectively. The results indicated that the soap produced using palm kernel oil has very good properties, hence regarded as better soap and better cleaning agent for domestic and industrial purpose.

Keywords: Soap, Palm kernel oil, Plantain peel, Saponification, Domestic, Fatty Acids

INTRODUCTION

There could be hundred different ways of explaining what really a soap is and what can be regarded as a soap. Soap can define as any cleaning agent, manufactured in bars, granules, flakes, or liquid form, made from a mixture of mostly sodium or potassium salts of various fatty acids of natural oils and fats (Warra, 2013). Soap is obtained from saponification reaction of fat and alkali. Various raw materials such as tallow, lard, coconut oil, palm oil, palm kernel oil, used for soap production. Soap are general used for hygiene purposes, it is a popular washing and cleaning product. They are therefore, indispensable items as a daily requirement in homes, offices, restaurants, hospitals, and so on. Soap can also be said to be any water-soluble salt of fatty acids containing eight or more carbon atoms. Zauro *et al.*, (2016). There are other types of soap which are soaps of metals other than sodium and potassium called metallic insoluble soaps that are not used as cleaning agents, but are used for other purposes. Examples are, calcium and magnesium soap used as lubricants and driers, aluminum and

chromium soaps for sizing paper, lithium stearate (a lithium soap) for thicken oils into grease etc. In addition to basic raw materials, other substances of medicinal importance are added as ingredient to produce medicated soaps; in this context, the discussion was being limited to soaps as cleaning agents.

Soap is a water-soluble salt fatty acid containing eight or more carbon atoms, the cleansing action of the soap is due to the negative ions on the hydrocarbon chain attached to the carboxylic group of the fatty acids (Okeke, 2009). The affinity of the hydrocarbon chain to oil and grease, while carboxylic group to water is the main reason soap is being used mostly with water for cleaning purposes (Adaku, 2013). The cleaning action of soaps because of their ability

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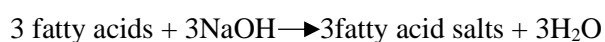
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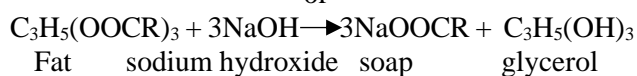
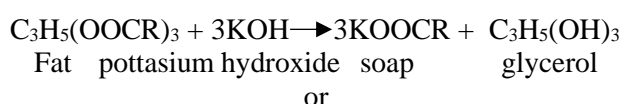
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to emulsify or disperse water-insoluble materials and hold them in the suspension of water.

In saponification reactions, esters are split into alcohols and salts of carboxylic acids (Figure 1). The word “Saponification” is derived from the latin word “saponins”, meaning ‘soap’. Saponification is also widely used in more general term to refer to alkaline hydrolysis of any type of ester. The overall reaction of triacylglycerol saponification can be thought of occurring in two steps. The first step is the hydrolysis of the ester linkages to produce glycerol and three fatty acid molecules: Fat or oil + 3H₂O → 3fatty acids + glycerol. The second step involves a reaction between the fatty acid molecules and base (usually NaOH) in the alkali solution. This is an acid-base reaction that produces water plus salts:



The salt of the fatty acid is called soap. The equations below represent typical saponification reactions



The active ingredient to initiate a saponification (soap making) reaction from oils is called caustic soda. In a village environment, potash is used as the caustic source. It is the nature of caustic to wish to split fatty acids from the glycerol and attach itself to the end of the fatty acid tail. This makes a new substance (SOAP!), which is like a snake with an oily, water hating tail and a caustic, water loving head. This love water/hate water aspect of soap is what creates lather. By understanding the basic principles of the reaction, that the caustic must leave water to find the end of the fatty acid and split it from the glycerol; it becomes clear why we must add our solution slowly and break up the stream allowing the caustic and oil to find one another. Heat and or time will facilitate the reaction (Warra, 2013). Oils + caustic soda + water combine to make soap.

Alkalis are water soluble base, usually hydroxide or oxide of potassium or sodium. Alkali can be produced locally from ashes as “potash” by extraction with water. It is generally believed that the highest soluble metal is potassium although this depends on the species

of the plant material and the type of soil where the plant grows (Onyegbado, Iyagba, and Offor, 2002).

Palm kernel oil is majorly lauric acid containing saturated fatty acids of C₆-C₁₈ chain. It has a sharp melting point when heated. Higher quality soap is produced using 10-15% lauric acid, (Olabanji, Oluyemi, and Ajayi, 2012). Palm Kernel oil is semi-solid at room temperature; hence it is suitable for making Margarine, Chocolate and some other related food products. Palm Kernel oil is further used at home for frying and cooking different types of food like Plantain Chips, Potatoes, Stew, and Fried Fish. (Hossain, M B, 2013). Palm kernel oil and their fractions are suitable for the production of confectionery fats as they are able to provide the required properties needed (Noor Lida, and Miskandar, 2017).

Plantain is a crop from the genus *Musa*, scientifically named *Musa Paradisiaca* is a very starchy. It is a fast-growing plant of 3-5m high with herbaceous stem. The fruits grow in bunches of up to 200 fingers each, edible and are process differently for consumption. It is different from the soft and sweet banana (which is often called dessert banana). Plantains are often firmer than dessert bananas; they also have less sugar. Plantains are among the staple food in tropical regions, treated similarly to potatoes. (Nelson, Ploetz, and Kepler, 2006). The plantain fruits are highly nutritious, containing large amounts of carbohydrates and minerals such as calcium, phosphorus, and potassium as well as vitamins A and C. (Olabanji, Oluyemi, and Ajayi, 2012; Noor Lida, and Miskandar, 2017).

Several studies have been carried out on the unripe plantain peel ((Onyegbado, Iyagba, and Offor, 2002), groundnut shell and sorghum chaff (Taiwo and Osinowo, 2001).

The used of ashes obtained from agricultural materials as source of industrial alkali have reported (Olabanji, Oluyemi, and Ajayi, 2012). Job creation is only vital if science education is carefully conducted in our schools, occupational skills which enable one to overcome the problem of unemployment (Jimbo, 2009; Hamiti and Wydler, (2014)).

Acquisition of relevant skills and knowledge is required for sustainable development and could be achieved through formal and informal education and for such knowledge to be relevant

to the society should be able to solve the unemployment challenges for the economic empowerment Ohunene and Ebele (2014).

The skills and techniques acquired in soap production and process will enable individual that want to establish the business can do so with even little income.

It is desirable for every individual to have some idea of a business enterprise market in terms of knowledge, skills, techniques and values needed to produce self-reliant individuals (Jimah, Jimah & Onuwka, 2010). It is important to determine how equipped the students are in order to create a niche for themselves, given little impetus in the labour market (Jimah, Jimah & Onuwka, 2010).

Akpmie (2009) asserts that no nation can move forward technologically, industrially and economically without developing a strong partner initiative in the creation of wealth, poverty reduction and employment generation with required skills.

Soap production using Palm Kernel Oil (PKO) and ash from plantain peels is imperative because the soap produced has low cost compared to the production of soap from tallow and coconut oil. Moreover, Palm Kernel Oil (PKO) and plantain peels are easily available in Nigeria at a low price. Nowadays in world of production, soap manufacturers are turning increasing to Palm Kernel Oil (PKO) (lauric acid) as replacements for tallow and coconut oil because of the greater availability while PKO contained mainly dodecanoic (lauric) acid. Lauric acid is inexpensive, non-toxic and safe to handle. Lauric acid is neutralized with sodium hydroxide to be sodium laurate which is soap. In the soap manufacturing processes will produce glycerol as a by-product. However, the glycerol is much more valuable than soap itself, so only a minimum glycerin is left in soap and via separation process, the soap can separate from the glycerol (called washing operation). It will be extracted, purified and sold. From that, the manufacturers will get some income. Furthermore, the quality of soap from palm kernel oil and plantain peels in aspects of physical properties such as the harness of soap, and formation of foams in water are really good.

The aim of the present studies was to produced soap using palm kernel oil and ash extract from plantain peels as a source of alkali used in the saponification process. The choice of the palm

kernel oil was based on its excellence properties needed for quality soap production.

METHODOLOGY

Materials

The materials/reagents used in this work are; palm kernel oil (PKO) and plantain peel which were sources randomly from Minna central Market, Niger State, Nigeria. Ethanol, ether, KOH, NaOH, anhydrous Na₂SO₄, glacial acetic acid. HCl, Sodium thiosulphate, phenolphthalene were obtained from BDH chemicals England. Distilled water was used throughout the period of experiment.

Methods

Sample pretreating

Small amount of caustic solution was added to 20 liters palm kernel oil container and was kept in the sun for the whole day, then it was used to make soap in the following day. Pretreating lightens the soap and makes it cleaner and easier to work with (Ellis, 2008).

Extraction of alkali from plantain peel ashes

Plantain peels were collected and sun dried for 7 days. The dried peels were heated on a combustion pan until the peels ignited. To ensure uniform combustion, a metallic rod with a wooden handle was used to turn the burning peel during combustion. The ignited sample was ashes crushed, homogenized and sieved to remove large particles. The sieved samples (100g) were placed in distilled water and agitated for 10 minutes and then allowed to stand for 8 hours. The slurry was then decanted and the filtrate was heated for 6 hours at 65°C and then the bleached alkali formed was filtered using Whatman No 44-filter paper to obtain the extract. The molarity of the extracted alkali was determined by titrating it against 0.1M hydrochloric acid using phenolphthalein indicator (Asiagwu, 2013).

Soap production procedure

A certain amount of oil (10g) was measured into a plastic container. It was then warmed in order to quicken the reaction between the alkali and the fat. The caustic soda was stirred thorough using a stirring rod until it blends with the fat. The caustic soda was poured gradually into it and stirred gently to enhance thorough mixing of the solution. The plastic container was insulated with pieces of cloths to prevent the fat from hardening before the soap mix properly. Small

amount of sodium carbonate, sodium sulphate and sodium silicate was added into the soap mixture and it was stirred properly until it blends. The heating is done at 110°C in a heating tub. Sodium sulphate was added during the soap is clarified but in the molten stage. It helps in the binding of the soap chemicals and it induces the foaming ability of the soap. Sodium silicate was added when the soap was being cooled down. Sodium silicate hardens the soap. It eases removal of dirt and prevents the deposition of dirt particles. (Aremu, Ibrahim and Bamidele, (2015).

After this the soap was mold into a proper shape and kept in a filter paper. This soap was kept in oven to dry up the moisture. Before kept in the oven the weight of soap was taken. Soap was kept for 12 hours in the oven maintained at 300-350°C. The weight of the soap is again taken.

Calculation of Yield:

For the soap samples prepared, weight was taken after they are taken out of the oven. Yield is calculated by dividing the weight of the soap by the weight of the oil taken multiplied by 100.

Saponification reactions using ash-extract and palm kernel oil

The manufacture of soap involved the following processes: Saponification reaction; "salting out" and what is called "fitting" process to obtain a neat soap. 120ml of the ashes plantain peel extract containing 214g of potassium hydroxide was concentrated to 50% KOH by evaporation. The saponification process adopted was semi-boiled method as described by Aremu, Ibrahim, and Bamidele, (2015). The oil was poured into a stainless-steel container and heated to 100°C. The purified alkali was added continuously with stirring until the mixture became sticky. 20ml of NaCl solutions was added for salting out and the soap was completely homogenized for 20 - 30 min (Zauro *et al*, 2016).

Analysis of the soap produced

Foam stability

The soap produced was used to form lather in water and the time taken for the foam-to-collapse was measured using a stopwatch.

Moisture content

Moisture content was determined by drying 12g of the sample to a constant weight at 105°C according to AOAC (2000). It was allowed to cool and then reweighed. The %

moisture content was calculated from the equation below;

$$\% \text{ Moisture contents} = \frac{W_1}{W_2} \times 100$$

Where

W1=weight of soap after drying

W2=weight of soap before dryings

Determination of Saponification Value

Saponification value is the number of mg of potassium hydroxide needed to saponify 1g of oil or fat. Exactly 1g of oil was weighed and placed into a 200ml conical flask, 0.2 M solution of KOH was added to the above solution and heated at 60°C over water bath with continuous stirring. The temperature was raised to 100°C to complete the saponification process. The mixture was allowed to boil for about 80 minutes. The excess KOH was titrated against the mixture using phenolphthalein indicator and the Saponification value was determined as follows:

$$\text{Saponification Value} = \frac{\text{Average volume of KOH} \times 28.056}{\text{Weight of oil (g)}}$$

Where the weight of sample = (weight of cylinder + weight of content) - weight of cylinder (Aiwizea and Achebob, 2012).

Determination of free fatty acid (FFA) value

To the 40ml of 95% ethanol/ether (50:50) mixture, 4ml of 1% phenolphthalein solution was added. To the above solution, 8g of oil sample was added and the resulting solution was titrated against 0.1M NaOH solution with constant shaking until a pink color was developed and persisted for 40 seconds (Mak-Mensah and Firempong, 2011). The process was replicated thrice for each of the detergent mixtures and the percentage free fatty acid expressed as its lauric acid content as given by the equation below:

$$\% \text{ FFA} = \frac{\text{NaoH (ml)} \times \text{molarity of NaoH} \times \text{Molecular Weight of NaoH(g)}}{\text{Sample Weight(g)}}$$

Determination Acid value

The acid value of highest limit of the acid content of the soap which is in agreement with the FOA standard which agreed that, the acid value of any useful soap should be ≤ 30 mgKOH/g (FAO, 2015). The lower the acid value the better the health condition of the soap.

Acid value = %FFA \times 1.99 (Zauro *et al.*, 2016).

Data Analysis

The results were analyzed using MINITAB 17 Statistical Software to determine the mean, standard deviation and p-value of the sample variables with statistically significant effect at 95% confidence level using 1-sample t-test (Kyari *et al.*, 2017). The results of the analysis were presented using Bar chart, Pie chart and Probability plot of the variables.

Moulding and Cutting

In this step, melted soap is poured into shaped-mould of wooden or metallic mould for it to “set” and harden in. The soaps are cut using cutting machine which can be made locally into different designs and size.

Stamping

This is the use of special stamp (either electric or manual) and trade marks on the products (soap products). Murjanatu Muhammad Abba illuminated the growing role of stamping in selling products in Nigeria when she wrote “This is very vital in selling products in Nigeria as most Nigerians buy name not the quality of the product” (Abba, 2008). Wooden or plastic, handmade stamp and stamp box or manual stamping machine are used.

Packaging

This is the use of special materials to package products to the market. The products are finally packed in cartons. Wrapping the soaps into nice paper or clean polythene will add greatly to its sales value. The cost associated with packaging material is an important factor in the cost of

production. The cost packaging could be high for consumer products. Therefore, it is always important for a soap producer to estimate his packaging cost in order to represent his operating expenses which have great impact on the selling prize and profit or gain (Abba, 2008).

RESULTS

Results are presented in form of Tables and Figures.

Table 1: Physicochemical Parameters of palm-kernel oil

Parameters	Palm kernel oil
Saponification Value (mgKOH/g)	218.12 \pm 0.65
Free Fatty Acid (mgKOH/g)	1.646 \pm 0.015
Acid Value (mgKOH/g)	2.72 \pm 0.10

Table 2: Properties of the Soap after Production

Soap properties	Palm kernel oil
Moisture contents (%)	7.86 \pm 0.46
Form Stability (min ⁻¹)	3.52 \pm 0.12

Result of the one sample t- test analysis of palm kernel oil (Table 3) which was conducted at 95% (0.05) confident shows the p- values for saponification value, free fatty acid and Acid value were 0.841, 0.591 and 0.522 respectively which were all greater than the alpha value ($\alpha = 0.05$) confident level.

Tables 1 showed the properties of the soap after production. The moisture content was determined according to the AOAC method and it indicate that palm kernel oil has high moisture content of 7.86 \pm 0.46 % after production and foam stability was determined by measuring the time it takes for the lather formed by the soap with pure water to collapse. Palm kernel oil has the long time for lather collapse hence it has high foam stability value of about 3.52 minutes. However, if foam stability is considered the most desirable soap quality and then palm kernel oil emerges the most suitable soap in the present study. The acid value of 2.72 \pm 0.10 mgKOH/g is in agreement with the FOA standard.

Table 3. Result of 1-Sample t- test Analysis of Palm Kernel Oil showing the Mean, Standard Deviation and p-values for the Variables.

Variable	Total Count	Mean	Std Deviation	P –value	Remark
Saponification	5	218.20	0.637	0.841	Significant
Free Fatty acid	5	1.6440	0.023	0.591	Significant
Acid Value	5	2.718	0.038	0.522	significant

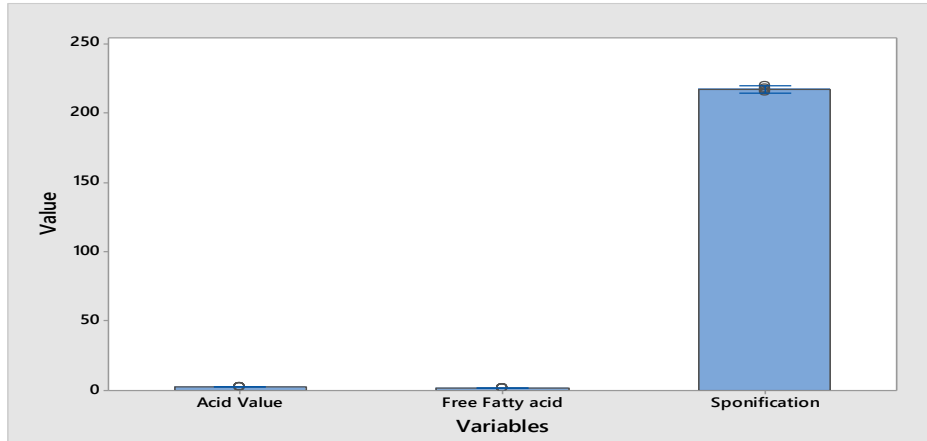


Figure 1: Summarized value of the composition for variables investigated

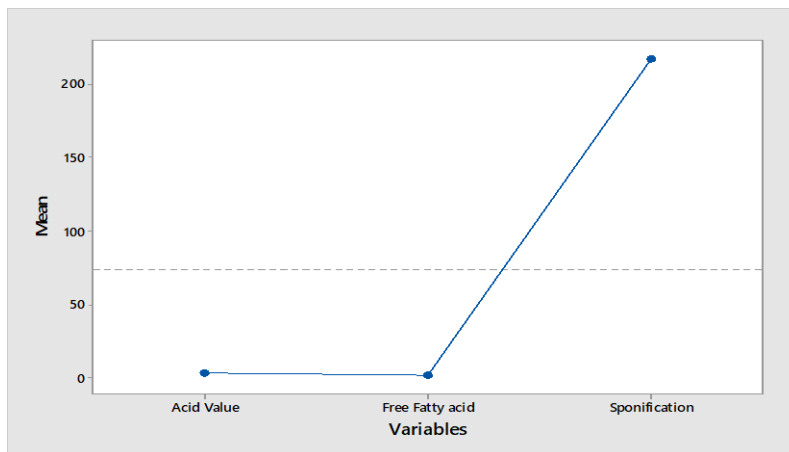


Figure 2: Main Effect plot for composition of the variables

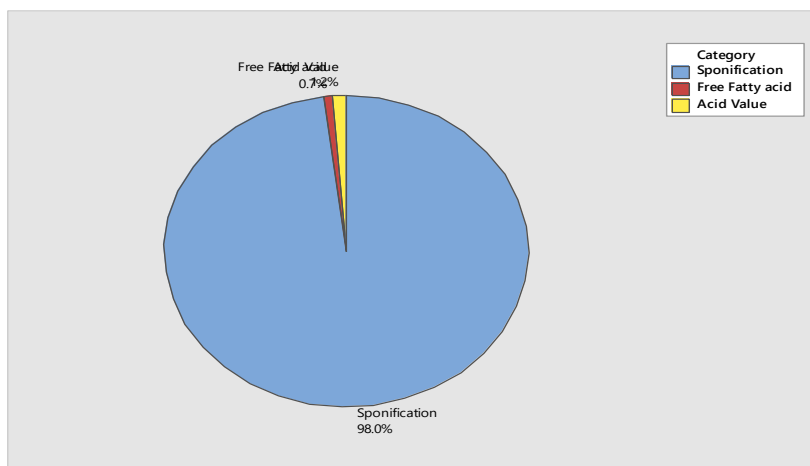


Figure 3: Percentage composition of the variables

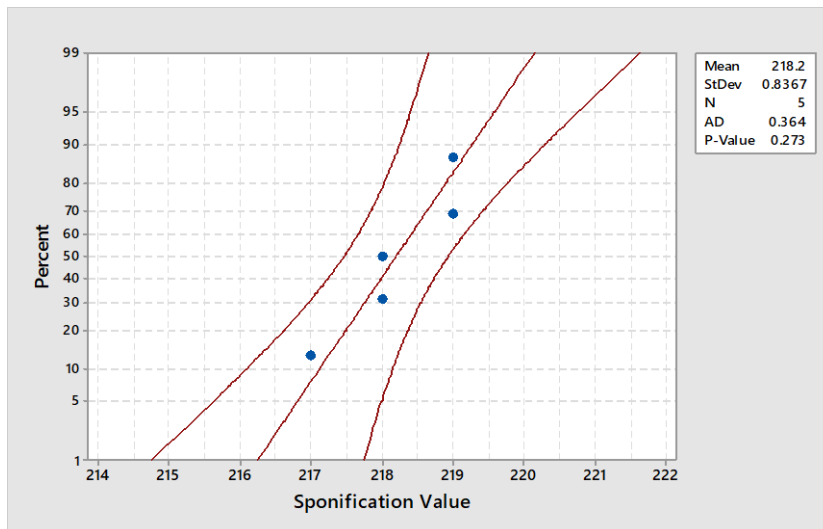


Figure 4: Probability plot of Saponification Values at 95% Confident level

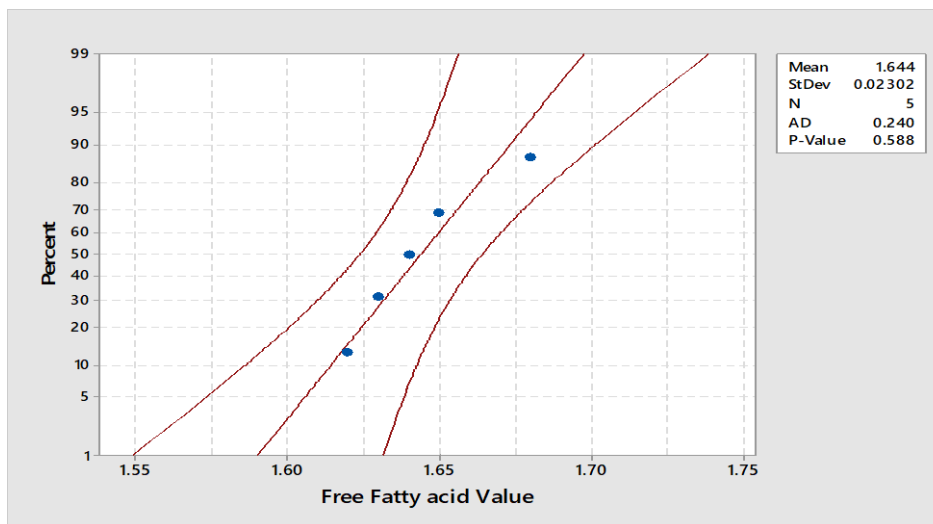


Figure 5: Probability plot of Free Fatty Acid Values at 95% Confident level

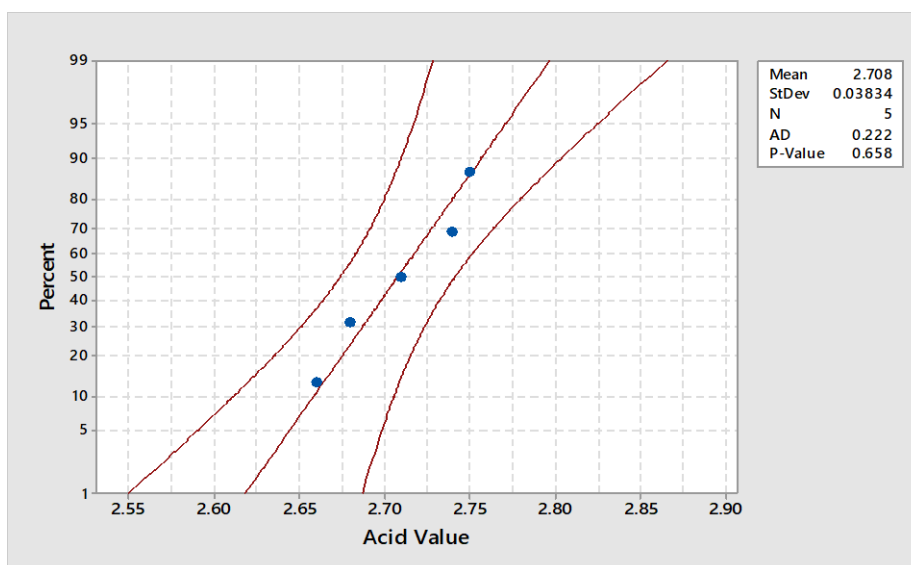


Figure 6: Probability plot of Acid Values at 95% Confident level

DISCUSSION

The physicochemical parameters of palm kernel oil (Table 1) show the saponification value of Palm kernel oil, The Free Fatty Acid (FFA) and Acid value of palm kernel oil which are the main parameters to determine quality of the materials used in soap making were analysed and compared with the standard value set aside by FOA. There is agreed limit of standard value for every material to be used as soap production must possess before accepted as a quality production. (FAO, 2015). All the values of parameter obtained in this work were within the limit value of FOA standard. The saponification value of Palm kernel oil obtained was $218.12 \pm 0.65 \text{ mgKOH/g}$ which is in agreement with 249.90 mgKOH/g for palm kernel oils reported by Aremu, and Amos. (2010), and also the Saponification Value of $218.12 \pm 0.65 \text{ mgKOH/g}$ is in agreement with the finding of Kyari, 2008. The saponification value of any quality soap should be $\geq 190 \text{ mgKOH/g}$ (FAO, 2015), the value of 190 mgKOH/g is the lowest limit for the saponification value for any quality accepted soap, the higher above the value of 190 mgKOH/g the better the quality of the material. The higher saponification value of the palm kernel oil indicated the suitability in soap making. The Free Fatty Acid (FFA) of palm kernel oil obtained was $1.646 \pm 0.015 \text{ mgKOH/g}$ which is in agreement with the limit value of not less than 0.5 mgKOH/g FOA standard, the higher value above 0.5 mgKOH/g as was obtained in this work, the better the quality of the soap material. Acid value measured the quality of fatty acids in oil. Low acid value in oil indicates that the oil will be stable over a long period of time and protect against rancidity and its suitability in soap making (Aremu, Ibrahim and Bamidele, (2015). The Acid Value obtained in this work is within the standard set by FAO. The acid value obtained for the palm kernel oil used in the soap production was $2.72 \pm 0.10 \text{ mgKOH/g}$ which is in agreement with the FOA standard of $\leq 30 \text{ mgKOH/g}$ (FAO, 2015), the acid value of any material used in soap production should be not exceed 30 mgKOH/g . The lower the acid value as obtained in this work the better the health condition of the soap. Usually, oils with low acid values produce hard soaps.

The moisture content and foam stability are the main properties that determine the quality of a

soap. The result of soap properties (Table 2) indicates that soap from palm kernel oil has high moisture content of $7.86 \pm 0.46\%$ when freshly prepared which is less than 10% of its contents, the lower the moisture content of the soap the better and more it lasts during its applications. Foam stability was determined by measuring the time it takes for the lather formed by the soap with pure water to collapse. Soap from Palm kernel oil has long time of 3.52 minutes for lather formed with water to collapse, hence it has high foam stability value of 3.52 minutes is considered as the most desirable quality soap. The higher the foam stability value the better the soap quality. The oil with high saponification value has low Acid value.

Result of the one sample t- test analysis of palm kernel oil (Table 3) which was conducted at 95% ($\alpha = 0.05$) confident levels shows the p- values for saponification value, free fatty acid and Acid value were 0.841, 0.591 and 0.522 respectively, which were all greater than the alpha value ($p > 0.05$). The sample mean for the saponification, free fatty acid and Acid value analyzed were 218.20, 1.646 and 2.718 respectively and the true mean of the sample population for the saponification, free fatty acid and Acid value were 218.20, 1.6440 and 2.72 respectively The value of the sample mean for all the parameters analyzed has no significant difference with that of the true mean of the sample population, hence the p-value all the parameters analyzed were greater than the alpha value ($\alpha = 0.05$) confident level, the null hypothesis (H_0) is accepted and the alternative hypothesis (H_1) is rejected. The probability plot for the parameters investigated has p-value $> \alpha$ - value of 0.05 level of significant, hence, the null hypothesis (H_0) is accepted which statistical confirmed that there is no significant difference between the sample mean and hypothesized mean.

The Bar chart, Main effect plot and Pie chart in Figure 1, 2 and 3 respectively, show that Palm kernel oil has higher composition of saponification value with very little composition of free fatty acid and Acid value which are good quality for soap material. The p- value for the probability plot of saponification, free fatty acid and Acid value were 0.273, 0.588 and 0.658 respectively as shows in Figure 4, 5 and 6 respectively.

Conclusion

The production of soap from palm kernel with purified alkali made from plantain ash was successfully achieved. Palm kernel oil and plantain peel ash are good local materials for the production of soap of good quality. The higher saponification value, high free fatty acid content and low acid value of the palm kernel oil indicated the suitability in soap production. The soap produced from palm kernel with purified alkali made from plantain ash has low moisture contents and high foam stability which make it quality soap for both domestic and industrial purpose. The qualities of soaps thus produced clearly indicated that exploitation of vegetable matter to generate alkali for soap production is worthwhile. Apart from the fact that our environment would be free of those agricultural wastes that often render them untidy, it will save the environment from the potential harmful effect on pollution that commonly associate with these synthetic chemicals. In addition, the heavy dependence on synthetic chemicals for soap production would drastically reduce if concerted effort is made on improving this locally source of raw material for soap making. Occupational skills of this kind enable one to overcome the problem of unemployment and also, job creation opportunities for unemployed youth that intend to established local business of soap making with little income.

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