Nigerian Journal of Technology (NIJOTECH)
Vol. 31, No. 1, March, 2012, pp. 63–67.
 ISSN 1115-8443

LIQUID SOAP PRODUCTION WITH BLENDS OF RUBBER SEED OIL (RSO) AND PALM KERNEL OIL (PKO) WITH LOCALLY SOURCED CAUSTIC POTASH (KOH)

E.A. Aiwize[a], J.I. Achebo[b]

[a]Department of Chemical Engineering, Edo State Institute of Technology and Management, Usen, P.M.B 1104, Benin City, Edo State. ***Email:*** *aiwize@yahoo.co.uk*
[b]Department of Production Engineering, University of Benin, Benin City, Edo State.
Email: *josephachebo@yahoo.co.uk*

Abstract

The production of liquid detergent using locally sourced palm fruit bunch (Elaeis Guineesis) waste saponifier has been investigated. An optimum blend ratio of rubber seed oil to palm kernel oil RSO:PKO 20:80 being constituent elements used for the production of the soap; was obtained using the Duncan Multiple Range Test. The black pigmentation in the oil was removed by bleaching and passing compressed air through it using laboratory grade activated carbon. Saponification values of 130.5 and 126.3 were obtained for the local KOH and laboratory grade respectively. From expert test results, good quality soap was produced using local KOH comparable to laboratory grade KOH.

Keywords: liquid soap, local and laboratory grade KOH, rubber seed and palm kernel oil, saponification value

1. Introduction

Laszio [1] defined soap as anionic surfactants used in conjunction with water for washing and cleaning. It consist of sodium or potassium salts of fatty acids and is obtained by reacting common oils or fats with a strong alkaline solution in a process known as saponification. Soap belongs to the family of detergents which is a substance which improves the cleaning properties of water. 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 [2].

Fats and oils obtained from animals, olive oil, and vegetable oils, have been the source of raw materials in modern soap making [1]. Although local tallow was the major source of fat used in England [2,3], the development of chemical industries has led to the use of alkalis (such as sodium carbonate and sodium hydroxide) for complete saponification in soap making.

The basic processes for making soap have remained unchanged for the past 200 years. However a major change observed was the initiation of pre-treatment of fats and oils. This lead Procter and Gamble to install an automatic high pressure hydrolysis for continuous neutralisation process of these fatty acids in 1937. However, the supply of vegetable oil used for soap production from Africa and the Eastern territories of Nigeria increased the availability of the palm material (palm and coconut) which eventually replaced tallow and other animal fats.

Panduranga et al. [4] reported the extraction of potassium hydroxide from leaching wood ash. They also stated that the glycerides which react with alkali in soap making are contained in animal and vegetable fats and oil (such as beef tallow, grease, coconut oil, palm oil, palm kernel oil linseed oil, rubber seed oil, soybean oil, and corn oil. These fats and oils contain various properties of the fatty acid usually having 6-22 carbon atoms in the paraffin chain. These include caprylic acid ($C_8H_{16}O_3$), lauric acid ($C_{14}H_{32}O_2$), stearic acid ($C_{18}H_{36}O_2$), and linoleic acid ($C_{18}H_{32}O_2$) amongst others. Depending on different grades of soap for final consumption, various methods have been employed to produce soaps. Albright and Wilson [3] developed kalipol 18, a builder for liquid soap, which exhibited a superior property in terms of stain removal. Kinglake [5] stated that a good liquid soap must have fluidity at an ambient temperature range of 5-40°C, good foaming characteristics, and the ability to emulsify oils, fats, and grease. It should also be environmental friendly.

Manufacture of detergents in Nigeria with the use of imported caustic potash for soap production has caused price of soap to become very high and expensive, due to high exchange rate. In any developing country, small scale industries and sourcing for local substitutes for imported raw material are always advocated with available microfinance support from banks. However, depending on the saponification value of fatty acid, large quantity of the alkali will be used. Palm kernel oil has low saponification value but it is economically unviable due to the demand in the food industry as vegetable oil [6]. Therefore, it is necessary to explore a blending technique to blend palm kernel oil and other seed oil of high saponification value to produce good quality soap. Blending of palm kernel oil and rubber seed oil for soap making has not been reported in the literature [7]. Blends of soap making constituent elements can be read from Ekop et al [8].

In this paper, the objective of our study is to elucidate the optimum ratio of rubber seed oil to palm kernel oil for good quality liquid soap using locally produced caustic potash from palm fruit bunch in the tropical rain forest of Nigeria.

2. Experiment

2.1. Blending and bleaching

Rubber seed oil and Palm kernel oil (RSO/PKO) blends of 100:0, 80:20, 50:50, 20:80 and 0:100 were used for the saponification process. The palm kernel oil and rubber seed oil mixture was bleached. Thereafter 500ml each of the measured mixture of RSO/PKO, was fed into a round bottom flask. Compressed air was passed through the sample and heat was applied using the electric heater. While heating at an ambient temperature of 20°C, 5% w/w of laboratory grade activated carbon was added to the mixture and the temperature was increased to 30°C. The carbon and other impurities were filtered off the treated mixture using a conical flask through a funnel with 24cm diameter filter paper.

2.2. Saponification value

2 grams of oil was weighed and poured into a 300ml conical flask. 7.0ml of the prepared 0.5 Normal (standard solution) of KOH was pipetted into the flask at 55°C over a heated water bath. With continuous stirring and heating, the temperature was increased to 100°C (boiling temperature). At this temperature of 100°C, saponification took place. The mixture was left to boil for about 1 hour. The excess KOH was titrated against the mixture using phenolphthalein indicator and the saponification value, S_v was calculated as follows:

$$S_v = \frac{\text{Average volume of KOH} \times 28.056}{\text{Weight of oil sample}} \tag{1}$$

Where the weight of sample = (weight of cylinder + weight of content) - weight of cylinder.

2.3. Determination of density of oil

An approximate method was used for the determination of oil density, 20ml of oil sample was measured into a cylinder of known weight. The weight of the cylinder including its contents was measured and the density of the oil was calculated as;

$$\text{Density of oil} = \frac{\text{Weight of sample}}{\text{Volume of sample}} \tag{2}$$

2.4. Soap production

The volume of local caustic potash solution required for the complete saponification process of oil was calculated using the titration method [9]. From a known saponification value of the

RSO/PKO blend and the addition of concentrated local KOH solution; 100 grams of this mixture was measured into a beaker and heated up to 55°C. The mixture was stirred and heated up to about 100°C by passing steam through the vessel (beaker). The heating continued for about 1 hour until a homogeneous soap solution was obtained. The soap so formed was allowed to cool. It was poured into a plastic container and diluted with water to the required viscosity

2.5. Analysis of Palm kernel extracts, detection of cations in the extract

The test was conducted in two ways, using the chemical test and the flame test.

2.5.1. Chemical test

Apparatus: Test tubes.

Reagents: Nitric acid, Sodium Cobalt Nitrite, Test samples (local KOH).

Procedures: One drop of nitric acid and five drops of Sodium Cobalt Nitrate were added to 10ml of the palm kernel extract in a test tube and the mixture left to stand for two minutes. A yellow precipitate was formed.

A control experiment of laboratory KOH gave the same yellow precipitate indicating the presence of potassium ion (K^+) in the extract.

2.5.2. The flame test

A spatula was sterilized by dipping in to 0.5N HCl and dried over a Bunsen flame. The spatula was then dipped in to the palm kernel extract and placed over a Bunsen flame. A combination of violet and golden yellow color was observed, indicating the presence of potassium ion (K^+) and sodium ion (Na^+) respectively.

2.6. Extraction of KOH from Palm Kernel bunch

About 14.52g of the palm kernel bunch was burnt gradually in an open air (with adequate amount of bunch to prevent against loss of ash) and the ash was left to cool, collected and soaked in distilled water for two days. The ash was separated from the liquid extract by filtration using a conical flask, funnels, and 24cm diameter filter paper. The light brown color of the filtrate was bleached to an almost colourless liquid using activated carbon which was added to the solution at room temperature, and the mixture left to stand for 20 mins before the carbon was filtered off. The resultant extract was concentrated further by evaporating about 25% of the water.

Table 1: Saponification values of oil blend.

Oil blend PKO/KOH	Local KOH	Laboratory KOH
100:0	169.7	166.9
80:20	159.9	157.1
50:50	148.7	144.5
20:80	130.5	126.3
0:100	102.4	99.6

Table 2: Average volume of KOH to saponify 2g of oil blend.

Oil blend PKO/KOH	Local KOH	Laboratory KOH
100:0	12.1	11.9
80:20	11.4	11.2
50:50	10.6	10.3
20:80	9.3	9.0
0:100	7.3	7.1

* The values of KOH are in milligrams.

The reaction Equation is shown in Eqs (3) and (4)

$$K_2CO_3 \longrightarrow K_2O + CO_2 \quad (3)$$

$$K_2O + H_2O \longrightarrow 2KOH \quad (4)$$

3. Result and Discussion

The saponification values of both laboratory and local KOH grade are presented in Table 1. From Table 1, the ratio of 20:80 blend gave the lowest saponification values of 130.5 and 126.3 respectively. Also the average volume of both local and laboratory grade KOH to saponify 2g of oil blend are shown in Table 2.

The blending ratio was developed using the Duncan Multiple-Range Test model (see Table 3). The analysis showed that lower RSO content in 20:80 RSO:PKO produced a better quality of soap. The ratio RSO:PKO of 20:80 blend gave a total of 55.0 among all the mixtures tested, while

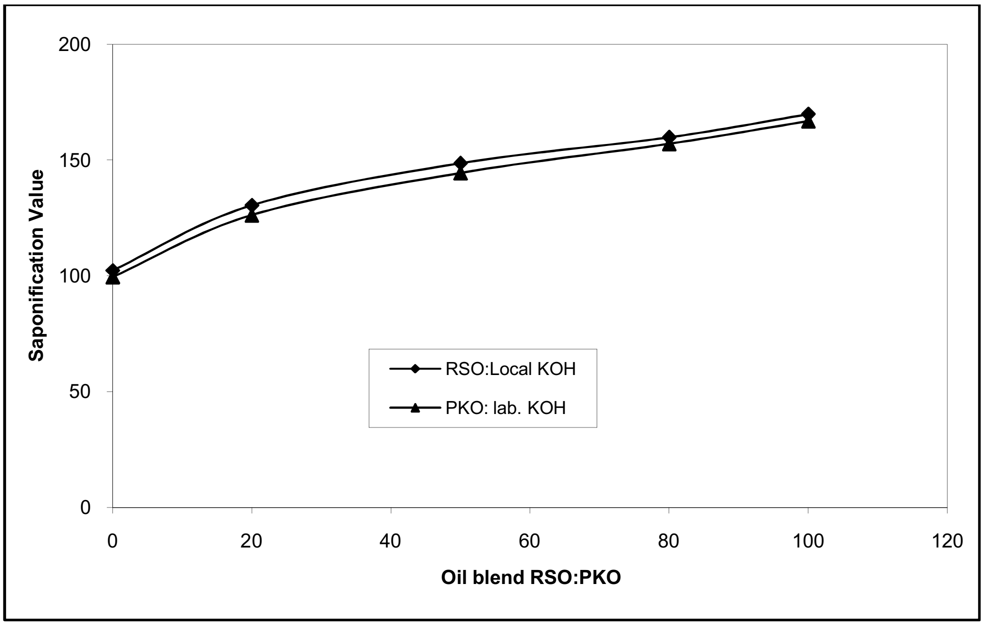

Figure 1: Saponification value for RSO:PKO blend.

Table 3: Duncan multiple-range test.

RSO=100% (100:0)	**80:20**	**50:50**	**20:80**	**0:100**
12.2	11.2	10.6	9.8	7.7
11.5	11.7	10.1	9.2	7.1
12.6	11.3	11.0	8.9	7.2
12.1	11.0	10.3	9.7	7.2
11.3	11.5	10.0	8.9	6.9
12.2	11.2	10.5	8.5	7.1
71.9	67.9	62.5	55.0	43.2

the ratios of 80:20, 50:50, 100:0 and 0:100 gave 67.9, 62.5, 71.9 and 43.2 respectively. The low values attributed to the ratio of 20:80 amongst other blends show that it is of the best quality with viable economic value.

As can be seen in Table 2, the lowest KOH values, 9.3 and 9.0 were obtained for the local and laboratory grade for the ratio RSO:PKO 20:80. To know the severity of effect of the oil mixture ratio on the foamability, we have to do more analysis using the Duncan multiple-Range test. This is concerned with the actual difference, between the various means of each pair and how each difference compares with a term known as the Least Significant Range (LSR). The factor means are declared to be significantly different if their values differ by more than the LSR.

Figure 1 illustrates the plot of the saponification values of local and laboratory grade of KOH. The values are almost the same, although that of the local KOH is higher compared to the laboratory grade. The difference observed may be attributed to traces of impurities such as carbon since the local caustic potash was not produced by a crystallisation method.

The hypothesis test on the treatment effect, block effect, and interaction effect gave the following results. For the block effect $F_{cal} = 2.74 < F_{Tab} = 4.35$ which showed a block effect. This is an indication that the type of KOH used (local or laboratory grade) does not have influence on the quality of the liquid soap produced. For the treatment effect, $F_{cal}129.65 > F_{Tab} = 2.87$, indicating that the blend ratio has effect on the quality of soap produced. This also confirms the ratio RSO:PKO of 20:80 that gave the lowest values of 9.3 and 9.0 for both local and laboratory grades of KOH.

The interaction effect gave values, $F_{cal} = 0.031 < F_{Tab} = 2.87$, which also indicates that there was no interaction effect.

Using the Anova analysis, for the two factor fixed effect model in a crossed design with replication, it was possible to prove that the liquid soap/detergent produced from local KOH is comparable to laboratory grade KOH.

4. Conclusion

The local KOH extracted from palm fruit bunch can conveniently form a substitute for the laboratory grade KOH. The blend ratio RSO:PKO 20:80 is suitable for good quality soap/detergent production which was also confirmed by the results obtained from the treatment effect analysis.

References

1. Laszio, V. World Consumption of Soap and Detergent. *Soap, Perfumery and Cosmetics.* Volume 53. 1970; 1978, pp. 581–585.
2. Wigner J. H. *Soap Manufacture: The Chemical Processes.* Chemical Publishing Co. Inc., New York, 1940, pp 37.
3. Albright and Wilson Chemicals. *Industrial Chemical Soap, Perfumery and Cosmetics.* Albright & Wilson Americas Inc., Glen Allen, Virginia, USA, 1974.
4. Panduranga, R., Thirumala S.D., and Reddy B.R., The Storage Behaviour of Decorticated and Undecortieated Safflower Oil, *Indian Oil Soap J.* Volume 36, Number 3, 1971, pp. 233–238.
5. Kinglake J., Formulating Liquid Detergent for Domestic Household Use. *Soap, Perfumery and Cosmetics*, Volume 54, 1998, pp 151–155.
6. Hayes, K.C. and Khosla, P. Cholesterolaemic Effect of Saturated Fatty Acids of Palm Oil. *Food and Nutrition Bulletin.* Volume. 15, Number 2, 1994, pp. 345–349.
7. Ekpa, O.D., Akpanabiatu, M., Mauro, A. and Renzo, R. Varietal Differences and Polymorphism in Palm Oil: A Case Study of Palm Oils Blended with Coconut Oil. *Global J. of Pure & Applied Science.* Volume 2, 2000, pp. 277–282.
8. Ekop, S.A., Etuk, B.A. and Eddy, N.O. Effect of Some Local Additives on the Chemical Constituent of Palm Oil, *J. Appl. Sci. Environ. Manage.* Volume 11, Number 1, 2007, pp. 85–89.
9. Finar, L. *Organic Chemistry.* The English Language Book Society and Longman Group. 6th ed. London, 2000.