

Refining And Characterization Of Palm Kernel Oil Using Activated Charcoal

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ABSTRACT

The concept of refining crude palm kernel oil with the aim of reducing the non-glycerides, its colour pigment and odour using physical refining method (activated charcoal) is what this research is about. Carbonized charcoal was subjected to chemical activation process using standard potassium hydroxide for activation (KOH). Characterization of the crude palm kernel oil was carried out before and after refining with the activated charcoal. Results obtained showed that specific gravity remained unchanged, 0.921. However, the free fatty acid (FFA) content of the oil reduced from 5.6mg (KOH)g to 2.81mg (KOH) g. other properties evaluated were iodine value, Acid value and moisture content.

KEYWORDS: Refining, palm kernel, activated charcoal, free fatty acid, iodine value

I. INTRODUCTION

Oil palm (*Elaeis Guineensis*) produces two different types of oil which are palm oil and palm kernel oil. The fruit of oil palm yields about 20-22% of its oil from the fibrous mesocarp and 10% of the total yield is from the white flesh [1]. The application of palm oil and palm kernel oil are very limited in their origin form due to their specific chemical composition. To diversify the functions and usage of fats and oils, modifications is done especially to improve the physiochemical characteristics and stability.

Palm kernel oil (PKO) is black viscous oil extracted from the kernel oil palm in its raw form. It contains impurities such as organics pigments, oxidation metals, trace metals and race of soaps. For PKO to be used effectively in most industrial processes these impurities has to be extensively removed. Thus making bleaching inevitable [2] [3] [4].

Palm kernel oil consists mainly of glycerides, and like other oils in their crude form, may consist of small and variable portion of non-glycerides component as well. In order to render the oils to an edible form, some of these non glycerides needs to be either removed or reduced to an acceptable level so as to meet the demand of the buyers.

The refining of crude palm kernel oil (from a traditionally extracted source) is converting it to quality edible oil reducing objectionable impurities to the desired levels in an efficient manner, where possible losses in the desirable components are kept minimal.

II. MATERIALS AND METHOD

The materials and equipment used in the refining of crude palm kernel oil (C.P.K.O) include:

- Beakers
- Pipette
- Separating funnel
- Burette
- Conical flask
- Retort stand
- Weighing balance
- Measuring cylinder
- Heating mantle
- Thermometer
- Furnace
- Distilled water
- Mortar and pestle
- Water condenser

- Reflux condenser
- Electric heater
- Bag filter
- Oven
- Magnetic stirrer
- Still pot
- Density bottle (25ml)

Reagents used

The reagents used in characterization and refining includes; Phenolphthalein, standard thiosulphate solution; Ethanol, standard KOH, Wij's solution (Iodine monochloride) and neutral alcohol, petroleum ether, carbon tetrachloride (CCl₄). Starch solution, sodium hydroxide and sodium chloride, benzene, 0.1N potassium hydroxide

III. EXPERIMENTAL METHODS

Preparation of reagents

- 0.5ml solution of alcohol was prepared by weighing 28.5g potassium hydroxide and was diluted to 1 litre with 95% alcohol in a volumetric flask
- 0.5ml of hydrochloric acid (HCL) was prepared by measuring 10.8ml of concentrated HCL into 250ml volumetric flask and was diluted to 25ml with dilute water.
- 0.1 sodium thiosulphate, $N_{a2}S_2O_3 \cdot 5H_2O$ solution was prepared by dissolving 28.4g of sodium thiosulphate in freshly boiled water and diluted up to 1 litre of the volumetric flask.
- C.P.K.O AND NaOH (CAUSTIC SODA): The acid treated oil is then dosed with caustic soda. The concentration and the amount of alkali used vary with the free acid (FFA) content of the oil. Intimate contact between the oil and the alkali is ensured by the choice of a well designed mixer. The alkali result with the FFA forming precipitate soaps is removed through centrifuge.
- 0.5M alcoholic potassium hydroxide: 14g of potassium hydroxide was poured in to a volumetric flask and 500ml of ethanol was used to dissolve it.
- 0.5M potassium hydroxide: 28g of potassium hydroxide was weighed using a weighing balance and poured into a 1 litre volumetric flask and was dissolved with distilled water up to 1 litre

Chemical Activation of the adsorbent (charcoal)

Activation stage: The pretreated adsorbent (charcoal) was activated using chemical activation method. The process is mainly divided into two stages namely; the carbonization and activation stage. The pre-treated charcoal was reacted with 0.25M of potassium hydroxide [5]. The mixture which was exothermic was continuously stirred for two proper contact of the base with the pre-treated carbonized charcoal and then mixed with distilled. [6]. The dried residue was then carbonized in a furnace at 420⁰C for 30 minutes after which it was allowed to cool.

Refining of Crude Palm Kernel Oil

The crude palm kernel oil was refined mainly in three stages namely: the degumming stage, neutralization stage, odour and colour removal stage.

The Degumming stage

The approach adopted was that of [7] where 500ml of crude palm kernel oil put in a separating funnel and 500ml of distilled water at 100⁰C was added. The resulting solution was mixed vigorously for about 10minutes and allowed to settle. Two layers were obtained, the oil layer and the water layer containing the gumming materials. Using density differences, the oil of lesser density settled at the upper part and the gumming materials with water was decanted off.

The Neutralization stage

For the neutralization, about 500ml of the degumming oil was poured into a beaker and heated to 80⁰C, after which 40ml of 0.1M of NaOH was added and stirred to a uniform solution. Sodium chloride (about 10% of the weight of the oil) was added to help settle out the soap formed. 0.5M sodium hydroxide was mixed with the degumming oil as done by [7]. The resulting mixture was well shaken after which it was filtered to obtain the neutralized palm kernel oil.

Odour and Colour Removal Stage

The bleaching process was done using a hollow measuring cylinder of 46mm × 610mm as the adsorption column. The cylinder was packed with filter cloth at the bottom to ensure that the adsorbent did not move together with the oil. The activated charcoal was put above the filter cloth to a fixed height of 10cm and another filter cloth were placed just on top of the adsorbent to prevent impurities from entering with the oil. The measuring cylinder was supported with the retort stand and a beaker was placed at the bottom for the collection of the refined or purified oil. Distilled water was passed through the purifying bed before passing the oil through the bed. The collected water from the bed was compared with pure distilled water until it was clear. The set up was allowed to dry for about 30 minutes and the oil was passed through it. The oil that was collected at the base of the bed was then characterized.

Characterization of Palm Kernel Oil

Saponification Value:

1ml of crude palm kernel oil sample was measured into a conical flask; 25ml of alcoholic potassium hydroxide (KOH) was added to the oil. It was heated with the aid of heating mantle for 30minutes and 1ml of phenolphthalein solution was added as an indicator. 0.5M of hydrochloric acid was titrated against the solution and the volume of the acid used was noted at end point.

$$\text{Saponification value} = 56.1N \times (B - S)/W$$

Where: N is the normality of the KOH, B is the titre value of the blank solution, S the titre value of the sample containing the oil, W is the weight of the oil sample.

Specific Gravity:

Density bottle was used determining the density of the oil. A clean dry bottle of 25ml capacity was measured (W0) and then filled with the palm kernel oil, stopper inserted and reweighed to give (W1). The oil was substituted with water washing and drying the bottle and weighed to give (W2).

The expression for specific gravity is $= (W1-W0)/(W2-W0) = \text{mass of the substance}/\text{mass of equal volume of water}$.

Free Fatty Acid (FFA) Content

2.8ml of crude palm kernel oil with unknown FFA content was put into a conical flask and 25ml of ethanol was added. Two drops of phenolphthalein indicator was added to the mixture. 0.1M potassium hydroxide was titrated against the resulting solution until a pink colour was observed.

$$\text{FFA} = V \times M \times N \times W$$

Where: V is volume of KOH, M is the molecular weight of oil sample used, W is the weight of the sample, N is concentration of KOH.

Iodine Value

0.5g of oil was weighed and poured into a conical flask. 25ml of both carbon tetrachlorides (CCl₄) and Wij's solution was measured accurately and mixed well. The solution was then added to the oil in the conical flask. The mixture in the flask was shaken well to ensure complete mixing. Standardized sodium thiosulphate solution is taken in a burette and titrated against the contents of the iodine flask as starch was used as the indicator [7].

$$\text{Iodine Value} = (B-S) \times N \times 0.1269 \times 100 / W$$

Where: B is the volume of the standard thiosulphate solution blank, S is the volume of standard thiosulphate solution, N is normally of standard thiosulphate solution, W is weight of oil sample in grams.

Moisture Content

A beaker and a stirring rod were weighed while empty. It was reweighed after 10g of the crude palm kernel oil sample was added into the beaker containing the stirring rod. The oil was heated using the heating mantle at a constant temperature until there was no bubbles again which indicate the absence of water. The beaker and its content were allowed to cool after which it was reweighed. The difference in weight indicated the weight of water that has evaporated during heating. Hence the moisture content can be calculated by 370.

$$\text{Moisture content (\%)} = \text{weight of moisture weight of crude palm kernel oil} \times 100$$

Acid Value

0.1N KOH solution was prepared by dissolving 5.61g KOH (pellet) with 1000ml distilled water. Furthermore, a mixture of 99.7% pure ethanol and 98% pure benzene in the ratio of 1:1 by volume was prepared by mixing 10ml of benzene and 10ml of ethanol. About 1g of the oil sample was weighed and dissolved in mixture of ethanol and benzene. The solution was titrated against 0.1N KOH solution in the presence of two

drops of phenolphthalein as an indicator until the end point with the appearance of a pale permanent pink. The titre volume of 0.1N KOH (V) was noted. The total acidity (acid number) in mg (KOH)/g was calculated using the following equation.

$$AV \text{ (mgKOH/g)} = MW \times N \times V/W$$

Where: MW is the molecular weight of the potassium hydroxide (56.1).

N is the normality of the potassium hydroxide used in titration W is the weight of oil sample.

IV. RESULT OF TEST AND DISCUSSION

Table: Physio-chemical properties of the P.K.O before and after refining using activated charcoal

Characteristics	Crude Palm kernel oil	Refined palm kernel oil using activated charcoal
Saponification value 6/100g]	338.0	249.6
Iodine value (g/100g)	16.0	12.5
Acid value (mgKOH/g)	11.22	5.61
FFA (mgKOH/g)	5.61	2.81
Specific gravity	0.92	0.92
Moisture content (%)	3.85	2.88

Discussion of Result

At the beginning of the experiments a certain quantity of crude palm kernel oil (C.P.K.O) of about 500ml was measured and poured into a beaker, the same quantity of water at 100°C was mixed with the C.P.K.O then was separated into two different layers (oil and water) in a separating funnel (water degumming process). The aim is to remove gums, waxes and phosphatides.

The degummed oil was neutralized using 0.1M of NaOH, in order to reduce the FFA content and the acid value of the oil. The FFA was reduced from 5.61mgKOH/g to 2.81mgKOH/g thereby increasing the edibility of the oil as reported by [8].

It was also shown that the effect of activated carbon was negligible on the specific gravity of the palm kernel oil which remains 0.921 before and after the refining of the oil. The acid value of the crude palm kernel oil is 11.22mgKOH/g is comparable with 12.34mgKOH/g [9]. The iodine value of the C.P.K.O is g/100g is comparable with 47.2g/100g as reported by [9]. The decrease in the iodine value of the refined oil is an indication of low level unsaturation of the oil [10].

V. CONCLUSION

From the result obtained it can be concluded that the activated carbon was a good adsorbent by reducing the colour pigment and impurities from the oil. Revealing an acid value of 2.81 (mmKOH/g) instead of the 5.61 mmKOH/g recorded for the raw crude.

REFERENCES

- [1]. Berger, K.G. and Noraini, I. (2005): *Formulation of zero trans fatty acid shortening and margarines and other food fats with products of palm oil*. Journal of American Oil Chemists' Society 86: 775-782.
- [2]. Young F.V.K (1982). "The refining of palm oil", PORIM Technology, P 13-24, www.fullerserch.com, 2005.
- [3]. Macrae, R. (1993) "Encyclopedia of food Science, Food technology and Nutrition" vol.7 Spectroscopy7, Harcourt Brace, Jovanovich publishers, Sandiego, pp 4676-4700.
- [4]. Campbell, E. et. al., (1999), "Food fats and oil", Institute of shortening and edible oils available at www.iseo.org/
- [5]. Hernandez – Montoya, V., Garcia-Servin, J. And Bueno-Lopez, J.J (2010): *Thermal Treatments and Activation Procedures in the preparation of Activated Carbon*. ISBN 978-953-510197-0 Dof: 10.5772/3736
- [6]. Osoka, E.C and Kamalu, C.I.O (2010): *Optimum Parameters for Bleaching of Crude Palm Kernel oil Using Activated Snail Shell*. Journal in Engineering and Applied Sciences 1 (5): 323-326
- [7]. Ibeawuchi, B.E.C (2012): *Refining of Palm Kernel Oil Master Thesis*, Caritas University, Amorji-Nike, Enugu
- [8]. Viele et al, Chukwuma FO, Uyigue L (2013). *Esterification of high free fatty acid crude palm kernel oil as feedstock for base-catalyzed transesterification reaction*. International Journal of Application or Innovation in Engineering and Management 2(12):361-365.
- [9]. Azeez O.S Olatunde, O.N, Adewolu O., Olutoye M.A (2015): *Refining and Charaterization of Palm International and Engineering Conference*: 367-372 Federal University of Technology, Minna.
- [10]. Atasie, V.A and Akinhanmi, T.F. (2009): *Extraction, Compositional Studies of Physio-chemical characteristics of palm kernel oil*. Pakistan Journal of Nutrition, 8:800-803, Doi: 3923/pjn.800.803.