International Journal of Scientific Engineering and Research (IJSER)
ISSN (Online): 2347-3878
Index Copernicus Value (2015): 56.67 | Impact Factor (2017): 5.156

Adsorptive Bleaching of Crude Palm Oil Using Activated Plantain (Musa Paradisiacal) Peel Ash

Wuraola A. Raji[1], Solola S. Abiodun[2], Sufyan A. Adam[3], Said S. Muhammad[4]

[1, 3 & 4] Department of Chemical Engineering, Igbinedion University Okada, Nigeria

[2]Department of Chemical Science, Igbinedion University Okada, Nigeria

Abstract: ***This study examined the bleaching process parameters that contribute greatly to the refining of palm oil using low cost, natural and eco-friendly adsorbent. Activated plantain peel ash was utilized to provide the concept for the adsorptive analysis. The process parameters studied include; temperature, contact time and adsorbent dosage. A constant gram of palm oil was used to form Adsorbent dosage to oil ratio of 0.00,0.01,0.02 ,0.03 and 0.04 at contact time of 15min,30min,45min and 60min for different temperatures of 140°c,150°C,160°C,170°C and 180°C. The batch method of adsorption was conducted and the extent of adsorption was measured through UV- spectrophotometer. The results showed that the optimum bleaching parameters are at temperature 160°C,contact time of 60min and adsorbent dosage of 1wt%.***

Keywords: Bleaching, Activated plantain peel ash, Adsorption, UV-spectrophotometer

1. Introduction

Palm oil is an edible vegetable oil, produced from the fresh fruits of oil palms. It is palmitic- oleic rich semi solid fat containing fat-soluble minor components, vitamin E (30% tocopherols and 70% tocotrienols), carotenoids and sterols (Sambanthamurthi *et al.*,2000). It is pressed from the fleshy fruit of the oil palm which serves as an important ingredient for the food industry because of its superior characteristics and attributes. Palm oil in its raw form contains impurities such as organic pigments, oxidation metals, trace metals and trace soaps [1]. For palm oil to be edible these impurities which negatively influence the taste and smell of the oil as well as its appearance and shelf life stability must be removed through the bleaching process.

Bleaching is a treatment that removes the colour substances and other impurities such as fatty acids, gums, trace metals, phosphatides from crude palm oil [2,3,4]. The usual method of this process is the adsorption of the impurities by bringing the oil into contact with a surface-active micro porous adsorbent material or bleaching agent [5]. Thus the refining of palm oil through adsorptive bleaching remains inevitable in the oil refining industry [1,6,7,8,9,10,11]. Adsorptive bleaching is mostly affected by temperature and humidity, but structure and type of adsorbent also plays an important role [12] .

Activated bleaching earths and activated carbon are widely used as adsorbents in the refining industry for bleaching of edible oils which helps in raising the smoke point and storage durability of the oil due to its large specific surface area and high adsorption capacity [9,13,14,15,16]. It is worthy to note that the choice of an adsorbent generally depends on cost, activity and oil retention; cost being the most important factor for any production makes the use of the above mentioned adsorbents not to be cost effective when used as adsorbents despite their efficiency.

The utilization of agro-wastes as adsorbents is currently receiving wide attention because of their abundant availability and low cost owing to relatively high fixed carbons and presence of porous structures [17].

Plantain (Musa paradisiacal) is a staple food in Nigeria and its peels are considered as waste. Unripe plantain peel is a carbonaceous material that is currently disposed of either by burning in the open or left in the field to decay. Both disposal methods contribute to environmental degradation [18]. Bleaching of edible oils with activated unripe plantain peel ash (APPA) therefore merits more investigations in order to combat environmental pollution. It can as well serve as a source of foreign exchange for any nation. This study examines the effect of bleaching with APPA on the pigment in the crude palm oil. This is achieved by studying the effects of temperature, time and adsorbent dosage on the bleaching performance of APPA on crude palm oil. The percentage bleached oil could be determine using equation 1 [19].

$$\%\, Bleached = \frac{A_0 - A}{A_0} x100 \quad (1)$$

Where, A_0 = absorbance of unbleached palm oil and A = absorbance of bleached palm oil.

2. Materials and Method

2.1 Materials and Equipment

100grams of plantain peels and 5litres of the CPO were obtained from the open market at Benin City, Edo State, Nigeria. All reagents used were of analytical grade which includes phosphoric acid, ethanol, potassium hydroxide, hexane, were obtained from LUCO-Consult Limited, Benin City. The equipment used for the analysis include the beam balance, heating furnace, Beaker, Stop watch, filter paper, electric oven with thermoset, UV spectrophotometer, test tubes.

2.2 Preparation of the Activated Plantain Peel Ash (APPA)

The plantain peel which was obtained from the plantain seeds, was cut into pieces. The cut peels was air-dried in the open field towards reducing the moisture content .The dried peels are then further dried in an oven at 100 degree celcius for two(2) hours. A total of 20 g of the peel was loaded in crucible and charged into a heating furnace at a temperature of 500℃ for ashing. The crucible was removed from the furnace after 1 hour and was allowed to cool. 10grams of the unripe plantain peel ash was mixed with 400 ml of 4 M H_2SO_4 and the slurry was agitated at 250 rpm in a flask at room temperature for 60 min for activation. After the activation, the slurry was filtered. The filtered ash was washed with deionised water several times at room temperature until the pH was 6.5. Thereafter, the ash was dried in an oven at 100°Cfor 48 h. Fig 1a-c depicts the pictures of unripe plantain peel, dried and pulverised plantain peel ash and activated plantain peel ash respectively.

Figure 1: (a) Plantain peel (b) Plantain peel ash (c) Activated Plantain Peel Ash

2.3 Experimental Procedure

100 g oil of Crude Palm Oil was weighed into a 250 ml conical flask and placed on a constant temperature magnetic stirrer. The palm oil was agitated at 250 rpm heated at 180^{0}C on a heating mantle and the oil temperature was allowed to remain stable at 180^{0}C for a 60 minutes. After which 0 g, 1 g, 2.0 g, 3.0 g and 4.0 g, of activated plantain peel ash (APPA) was charged into the flask to form APPA/OIL ratio of 0.0, 0,01, 0.02, 0.03, and 0.04.The slurry was heated at varying temperatures and time such as 170^{0}C, 160^{0}C, 150^{0}C and 140^{0}C and 60min, 45min, 30min, 15min, respectively. Thereafter, the slurry was allowed to cool at room temperature in a water bath and filtered with Whatman's no. 1 filter paper to seperate out the bleached oil for analysis. Fig.2.2 depicts the filtration process.

.

Figure 2: Filtration process of the oil

3. Results and Discussion

3.1 Samples of Oil produced after Bleaching

Figure 3 depicts some of the samples of bleached oil obtained after bleaching process was completed. It is worthy to note that bleaching is greatly influenced by temperature and adsorbent. it was clearly seen that heating the oil to a high temperature without any addition of adsorbent at (0g) did not have significant effect on the oil not until an adsorbent (APPA) was added for effective bleaching. Therefore, both temperature and adsorbent at constant time have a vital role to play in the bleaching process.

Figure 3: Bleached oil samples

3.2 Effect of temperature on the bleaching performance

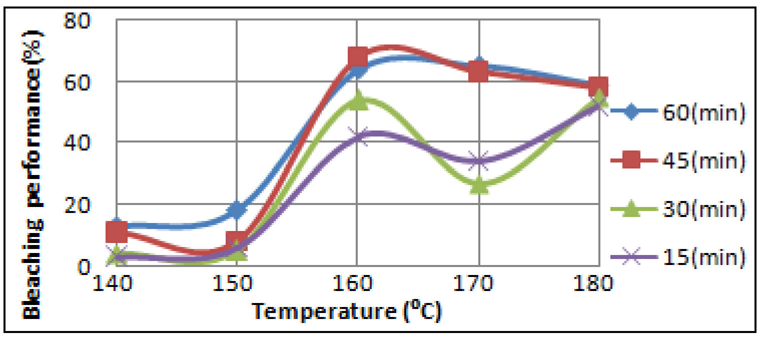

Figure 4: Effect of temperature on the bleaching performance at constant adsorbent dosage

Bleaching temperature is one of the factors that affect the performance of the bleaching processes of crude palm oil. Fig.4 depicts the effect of temperature on the bleaching performance at constant adsorbent dosage of 4g, varying contact time of 60min, 45min, 30min and 15min. it was observed that bleaching temperature has a great positive effect on the bleaching efficiency of the oil being processed. A slight increment was seen at temperatures between 140°C and 150°C but as the temperature reached 160°C ,the effect of temperature became obvious as the percentage bleaching performance increased attaining optimum value of 70% owning to the fact that temperature affects oil viscosity and adsorption kinetics causing the viscosity of the oil to reduce resulting in better dispersion of bleaching adsorbent. Any further increase in temperature above 160°C as seen in fig.4 has no significant effect on the bleaching performance.

3.3 Effect of contact time on the bleaching performance

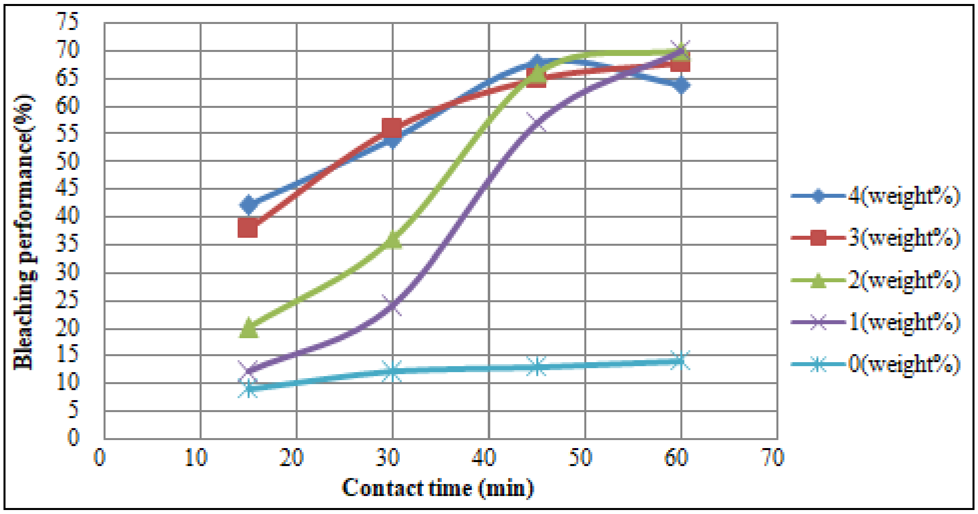

Figure 5: Effect of contact time on the bleaching performance of oil at constant temperature

Fig.5 shows the effect of contact time on the bleaching performance of crude palm oil at constant optimum bleaching temperature of 160^{o}c as obtained in fig.4 and varying adsorbent dosage ranging from 0g to 4g. The bleaching performance increases as the contact time increases owning to the fact that the adsorbent and oil have more interfacial contact which accelerates the binding of the adsorbent active sites to the pigment present in the oil. An optimum contact time was observed to be at 60mins having bleaching performance of 70%. It can be deduced that higher bleaching performance than 70% can still be achieved as the contact time increases as shown in fig.5.

3.4 Effect of Adsorbent Dosage on the Bleaching Performance of Oil

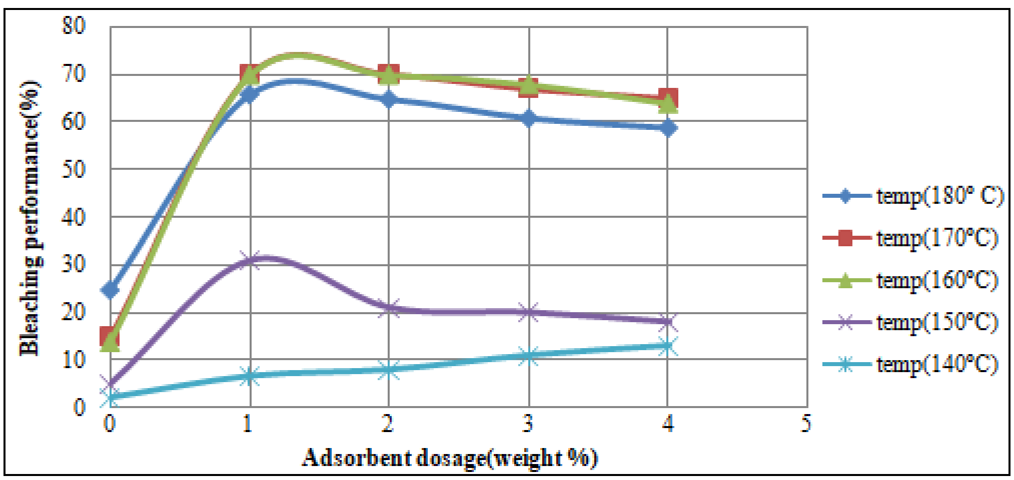

Figure 6: Effect of variation in adsorbent dosage in wt.% Vs bleaching performance

Figure 6 represents the plot of bleaching performance against adsorbent dosage at varying bleaching temperatures. The APPA dosage was varied from an adsorbent oil ratio of 0.00,0.01,0.02, 0.03 and 0.04. It was observed that increasing the APPA dosage increased the bleaching performance. However, it is observed that at adsorbent oil ratio of 0.00, the percentage performance was low due to the fact no adsorbent was added but bleaching of the oil was still noticed because of the application of heat. It is worthy to note that as soon as APPA was introduced ,effective bleaching was observed to an optimum value 70% at adsorbent dosage of 1wt% at temperature 160^{o}C. Further increase in adsorbent dosage beyond 1wt% has not seem to improve the percentage bleaching performance owning to the fact that adsorption equilibrium has been reached between the adsorbent/oil mixture, thereby, preventing further pigment removal by the excess adsorbent dosage.

4. Conclusion

The adsorptive purification of crude palm oil using activated plantain peel ash (APPA) was successfully investigated. The adsorption of pigments onto the APPA surfaces increased with temperature, adsorbent dosage and contact time. The experimental results showed that the optimum bleaching condition was equivalent to a bleaching performance of 70% at working temperature of 160^{o}C,contact time of 60mins and adsorbent dosage of 1wt% thus indicating that APPA has potential as bleaching adsorbent. The results of this study had showed that APPA could be converted into potential adsorbents for bleaching of crude palm oil, which can serve as a means of improving the economy by generating revenue.

References

[1] Usman M.A., Ekweme V.I., Alaye T.O. and Mohammed A.O.,(2012). "Characterization, Acid Activation and Bleaching performance of Ibeshe Clay".ISRN Ceramics, vol.2012, Article ID 658508: 5 pages.

[2] Foletto E. L.,. Colazzo G. C, Volzone C. and Porto L. M. . (2011). Sunflower Oil Bleaching by Adsorption onto Acid-Activated Bentonite. Brazilian Journal of Chemical Engineering, vol. 28(1), pp. 169 – 174.

[3] Salawudeen T.O., Arinkoola A.O., Jimoh M.O. and Akinuwade B.A.(2014). Clay Characterization and Optimization of Bleaching Parameters for Palm Kernel Oil Using Alkaline Activated Clays. Journal of Minerals and Materials Characterization and Engineering,vol. 2: pp 586-597.

[4] Egbuna S.O., Mbah C.N. and Chime T.O.(2015). Determination of the Optimum Process Conditions for the Acid Activation of Ngwo Clay in the Bleaching of Palm Oil. International Journal of Computational Engineering Research, vol.5(8): pp 17-29.

[5] Usman M.A., Oribayo O., Adebayo A.A (2013). "Bleaching of Palm Oil by Activated Local Bentonite and Kaolin Clay from Afashion, Edo –Nigeria" . Chemical and Process Engineering Research, vol.10, ISSN 2225-0913.

[6] Bockisch, M., Fats and Oils Handbook, AOCS Press, pp. 613-615, 1997

[7] Aziz B.K., Abdullah M.A. and Jubrack K.J. (2011). "Acid activation and bleaching capacity of some local clays for decolourizing used oils". Asian Journal of Chemistry. Vol. 23,no.6; pp' 2449-2455.

[8] Nwankwere E.T., Nwadiogbu J.O.,Yilleng M.T.,Eze K.A. (2012). "Kinetic Investigation of the Adsorptive Removal of β- Carotene Pigments from Palm Oil using Unmodified Natural Clay". Advances of Applied Science Research, vol.3(2) :pp.1122-1125.

[9] Ajemba R.O. and Onukwuli O.D. (2012). Response surface optimization of palm oil bleaching using hydrochloric acid activated Ukpor clay. European Journal of Scientific Research, 82(3), 325-339.

[10] Okolo J.C and Adejumo B.A. (2014). Effect of Bleaching on Some Quality Attributes of Crude Palm Oil. International Organization of Scientific Research, vol.4(12), pp 25-28.

[11] Simone M.,S., Sampaio K.A., Ceriani R. Verhe R. Steven C., De greyt W., Meirelles A.J.A. (2014). Effect of type of bleaching Earth on the Final Color of Refined Palm Oil. Food Science and Technology, vol. 59(2): pp 1258-1264.

[12] Gibon.V., De Greyt W. and Kellens M. (2007). ''Palm Oil Refining". European Journal of Lipid Science and Technology. 109(4), pp 373-379.

[13] Rossi M., Gianazza M., Alamprese C. and Stanga F. (2001). The Effect Bleaching and Physical Refining on Color and Minor Components of Palm Oil. Journal of the American Oil Chemists Society, vol. 78(10): pp 1051-1055.Christian Agatemor, (2008). "Some Aspects of Palm Oil Bleaching with Activated Plantain Peel Ash". *Food Sci. Technol. Res.*, vol.14 (3), pp. 301 – 305.

[14] Ekebafe M. O., Okieimen F. E., Ekebafe L. O.(2010). Powdered Activated Carbon From Plantain Peels (musa paradisiaca) For Uptake of Organic Compounds From Aqueous Media. Journal Of Chemical Society Of Nigeria, vol. 35(2).

[15] Monte Mauricio L., Monte Micheli L., Ricardo P.S., Crexi S., Valeria T. and Luiz A.A. (2014). Bleaching with Blends of Bleaching Earth and Activated Carbon reduces color and Oxidation Products of Carp Oil. European Journal of Lipid Science and Technology, vol.117(6).

[16] Strieder M.M., Pinheiro C.P.. Borda V.S., Pohndorf R.S.,Tito R.S.C. and Pinto A.A.L. (2017). Bleaching Optimization and Winterization Step Evaluation in the Refinement of Rice Bran Oil. Seperation & purification Technology, vol. 175(72): pp 72-78.

[17] Mohammed S.G., Ahmed S.M., Badawi A.F.M. and El-Desonki D.S.(2015). Activated Carbon Derived from Egyptian Banana Peels for removal of Cadmium from Water. Journal of Applied Life Science International, vol.3(2): pp.77-88.

[18] Christian Agatemor, (2008). "Some Aspects of Palm Oil Bleaching with Activated Plantain Peel Ash". *Food Sci. Technol. Res.*, vol.14 (3), pp. 301 – 305.

[19] Nwabanne, J.T.,(2013). "Experimental Design Methodology Applied to Bleaching of Palm Oil Using Local Clay". International Journal of Applied Science and Technology, Vol. 3(4),pp.69-77.