FUDMA Journal of Sciences (FJS)
ISSN online: 2616-1370
ISSN print: 2645 - 2944
Vol. 6 No. 5, October, 2022, pp 140 - 145
DOI: https://doi.org/10.33003/fjs-2022-0605-1090

DETERMINATION OF THE PHYSICOCHEMICAL PARAMETERS, SATURATION AND UNSATURATION OF SOME BRANDED AND UNBRANDED VEGETABLE OILS SOLD IN SABO MARKET, KADUNA STATE BY FOURIER TRANSFORMED INFRARED (FTIR) ANALYSIS

Babatunde, O. A. and *Umoru, P. E.

Department of Chemistry, Nigerian Defence Academy, P.M.B 2109, Kaduna State, Nigeria.

*Corresponding authors' email: peumoru@nda.edu.ng

ABSTRACT

The present study determined the physicochemical parameters, saturation and unsaturation of twenty-four branded and unbranded vegetable oils sold in Sabo Market, Kaduna State by Fourier Transformed Infrared Analysis (FTIR) analysis. The branded vegetable oils were (U_1 - U_{13}), U_{14}- U_{17} = unbranded vegetable oils; U_{18}- U_{19} = branded palm oils; U_{20}- U_{24} = unbranded palm oils. Percentage moisture content, colour, odour and rancidity were the physicochemical parameters analyzed. The percentage moisture content was found to be within the ranges of 0.00 – 0. 33%. Higher moisture content was observed in samples U_{13} and U_{24}. The colours and odour are in line with the standard of SON except for sample U_{22} which had an objectionable odour. There were records of rancidity in four (4) vegetable oils U_1, U_5, U_{16} and U_{17} and two (2) palm oils, U_{20} and U_{22} analyzed. The FTIR analysis indicated that there is unsaturated C-H stretching vibration peak of the carbon chain at 3006 and 3648 cm^{-1} for the unheated samples, C=O stretching vibration peak at 1745 cm^{-1}. The triglycerides present in the oils before heating was not significantly affected even after heating at the smoke point. In comparison, peaks attributable to the presence of an aromatic group were not identified in samples before heating but were identified after heating. There was an increase in the peaks of sample U_5 from 3008 and 2925 cm^{-1} to 3853 and 3646 cm^{-1} in sample H_5. It should be noted that the class of organic compounds more dominant before and after heating is the esters. Heating of edible oils at the smoke point changes the composition of the oil slightly by the formation of new additional compounds.

Keywords: Physicochemical Parameters, Saturation, Unsaturation, Vegetable oils, Fourier Infrared Analysis

INTRODUCTION

The term oil is used in a generic sense to describe all substances that are fatty or oily fluid at room temperature (Buba, 2005). Generally, fats are considered as extracted triglycerides/lipids that are liquid under the same condition. Fats and oils belong to a larger group of naturally occurring substances called lipids. Because lipids serve as a convenient means of rapid heat transfer, they have found increasing use in commercial frying operations, they are non-volatile substance thst do not dissolve in water but dissolve in organic solvent (Andrew *et al.,* 2012). Fats and oils are obtained basically from two sources namely: animal and vegetables sources. Oils obtained from plant sources are termed vegetable oils. These include palm oil, cotton seed oil, ground oil, sunflower oil etc. vegetable oils had made an important contribution to the diet in many countries, serving as a good source of protein, lipids and fatty acids for human nutrition including the repair of worn out tissues, new cell formation as well as a useful source of energy (Aremu *et al.*, 2014). Oil has been an important part of people's regular dietary consumption all over the world and its usage has been found to increase over the years. The importance of using the appropriate vegetable and palm oil for cooking goes a long way in affecting the consumer's health. Improper methods of oil-aided cooking can lead to cardiovascular diseases and increased cholesterol in the blood. They have also been found to be cancer-inducing (Makni *et al.*, 2011). Hence, it is highly essential to use the right oil for cooking which has given rise to this research.

MATERIALS AND METHODS

Twenty-four (24) different branded and unbranded vegetable oil samples were purchased from Sabo market, Kaduna State and were stored in dark cupboards to prevent exposure to sunlight before analysis. The oils include, thirteen (13) branded vegetable oils (U_1-U_{13}), four (4) unbranded vegetable oils (U_{14}-U_{17}); two (2) branded palm oils (U_{18}-U_{19}) and five (5) unbranded palm oils (U_{20}-U_{24}). Distilled water was used for the analysis.

Physicochemical Analysis

Percentage Moisture Content

Moisture content (%) was determined by using the methods described by the Association of Official Analytical Chemists (AOAC, 2000). The crucible was weighed first and recorded and 5 g of each of the oil samples was added and weighed (W_1) again. They were subsequently dried at 105 °C for 3 h in a smart oven until constant weights were attained. After drying, they were cooled in a desiccator for 24 hours and re-weighed as (W_2). The % moisture content was calculated using the formula:

$$\text{\% Moisture Content} = \frac{(W_1 - W_2)\,g}{W_2} \times 100$$

Where W_1 = Weight of crucible + weight of vegetable oil before drying

W_2 = Weight of crucible + weight of vegetable oil after drying

Odour and Color Determination

The odour and colour determination was done by using the method reported by Verma (1994). The color of the oil samples was determined by visual comparison while the odour of the oil samples was determined using a glass stoppered bottle rinsed with 4 M HCl internally and rinsed with distilled water. The bottle was filled halfway with the oil sample and shaken vigorously for about 2 minutes. The stopper was then removed and odour was observed by putting nostrils near the tip of the bottle.

Determination of Rancidity

The rancidity of the oil samples was determined using Kries test according to Pearson (1970). The oil sample (5 cm^3) was placed in a 100 cm^3 test tube and vigorously mixed with 5 cm^3 of 0.1% phloroglucinol solution in 100 cm^3 diethyl ether and 5 cm^3 of concentrated HCl was added and allowed to stand for 10 minutes. The appearance of pink color indicates incipient rancidity.

Determination of Saturation and Unsaturation of Vegetable Oil

Ten (10) cm^3 of each vegetable oil sample was measured into a dry clean crucible and heated for 5 seconds on a hot plate until the oil gets to the point of emitting smoke known as the smoke point. This was dropped and allowed to cool and the heated samples were tested before heating (U) and after heating (H) using Fourier Transformed Infrared analysis.

RESULTS AND DISCUSSION

Table 1 presents the moisture content of the vegetable oils which ranged from 0.00-0.33%. When moisture content ranges from 0.05 to 0.30 in edible oils, it shows that rancidity is likely to occur (CODEX, 2001). Previous studies have found that oils that were produced using low technology displayed a higher moisture content (Okechalu *et al.,* 2011; Abbas and Al-Fatlawi 2010). The maximum allowed moisture content in edible vegetable oils is 0.2% (FAO, 2011). Sample U_4- U_5 had zero percent moisture content which indicates that the oils had good processing and will stay in storage for a long time without deterioration. Low moisture content in oils indicates that the oil will have longer stability and shelf life during storage (Udensi and Iroegbu 2007). Samples U_{13} and U_{24} had moisture content of 0.34 and 0.33% respectively were found to be higher than the permissible value of 0.29 % as recommended by SON (2000) and FAO (2011). The higher moisture content observed in samples U_{13} and U_{24} could be due to the poor moisture refining process as the companies could be using low technology for the oil production Orji and Mbata, 2008). The results obtained in this study are similar to the results obtained by Nwachukwu *et al.* (2019) and Udensi and Irogbu (2007). The colours of the vegetable oils ranging from light yellow – dark brown are acceptable colours of vegetable oils as reported by Anyasor *et al.* (2009). The colours of the palm oils ranged from pepper red-light red. All the vegetable oils had unobjectionable odours except for sample U_{22} whose odour was objectionable. There was a record of rancidity (deterioration of the oil) in four (4) of the vegetable oils U_1, U_5, U_{16} and U_{17} analyzed and two in the palm oils, U_{20} and U_{22} even though the oil samples were kept in a cool place and protected from sunlight and air. This can be attributed to the process of production and the method of storage. In addition, prolong storage of oils can lead to their rancidity if it contains some percentage of moisture.

Table 1: Some Physicochemical Parameters of vegetable oils.

Sample (Oil)	Moisture Content (%)	Colour	Odour	Rancidity
U_1 = Power	0.11	Light yellow	Unobjectionable	Positive
U_2 = Golden penny	0.10	Light yellow	Unobjectionable	Negative
U_3 = Sunola	0.00	Light yellow	Unobjectionable	Negative
U_4 = Grand	0.00	Light yellow	Unobjectionable	Negative
U_5 = Jode	0.23	Light yellow	Unobjectionable	Positive
U_6 = Turkey	0.11	Light yellow	Unobjectionable	Negative
U_7 = Laziz	0.24	Light yellow	Unobjectionable	Negative
U_8 = Bow	0.11	Light yellow	Unobjectionable	Negative
U_9 = Goya	0.18	Light yellow	Unobjectionable	Negative
U_{10} = Oki	0.11	Light yellow	Unobjectionable	Negative
U_{11} = Legacy	0.23	Light yellow	Unobjectionable	Negative
U_{12} = Kings	0.20	Light yellow	Unobjectionable	Negative
U_{13} = Mamador	0.34	Light yellow	Unobjectionable	Negative
U_{14} = Palm karnel	0.23	Light yellow	Unobjectionable	Negative
U_{15} = Kuli-kuli	0.12	Dark brown	Unobjectionable	Negative
U_{16} = Soya	0.28	Light yellow	Unobjectionable	Positive
U_{17} = Al-nur	0.19	Light yellow	Unobjectionable	Positive
U_{18} = Nsukka	0.11	Pepper Red	Unobjectionable	Negative
U_{19} = Banga	0.19	Pepper Red	Unobjectionable	Negative
U_{20} = Igala	0.22	Pepper Red	Unobjectionable	Positive
U_{21} = Edo	0.10	Pepper Red	Unobjectionable	Negative
U_{22} = Benue	0.24	Light red	Objectionable	Positive
U_{23} = Ondo	0.19	Reddish	Unobjectionable	Negative
U_{24} = Unknown	0.33	Reddish	Unobjectionable	Negative

Key: U_1 - U_{13} = branded vegetable oils; U_{14}- U_{17} = unbranded vegetable oils; U_{18}- U_{19} = branded palm oils; U_{20}- U_{24} = unbranded palm oils.

The absorption spectra peaks of the 24 vegetable oils analyzed before heating (U = unheated samples) and after heating to smoke point (H = heated samples) had unsaturated C-H stretching vibration peak of carbon chain at 3006 and 3648 cm^{-1} for the unheated samples, C=O stretching vibration peak at 1745 cm^{-1}, the bending vibration peak of methylene at 1465 cm^{-1} and 1377 cm^{-1}, the stretching vibration peak of C-O in triglyceride at 1164 cm^{-1}. The spectra of the peak position and peak shape are similar, thus the main components of the various kinds of vegetable oils before and after heating had slight differences.

C=O and C-O peaks can be assigned to the presence of an ester functional group. Unsaturated C≡C vibrations with peaks at 2359 cm^{-1} were observed in most of the samples before heating and after heating. The aromatic group was identified in sample U_4 at 1653 and 1558 cm^{-1} producing aromatic C-H and C=C bonds (Fig. 1) also aromatic C-H stretching vibration bands at 3856 – 3863 cm^{-1} samples H_3, H_4

and H_5 (Figs. 7- 9). The triglycerides present in the oils before heating was not significantly affected even after heating. In comparison, peaks attributable to the presence of an aromatic group was not identified in samples U_5 and U_{15} (Figs. 2 and 4) respectively but were identified in H_5 and H_{15} (Figs. 9 and 11) respectively. There was an increase in the peaks of sample U_5 (Fig. 2) from 3008 cm^{-1} and 2925 cm^{-1} to 3853 cm^{-1} and 3646 cm^{-1} in sample H_5 (Fig. 9). However, there was a decrease in the peaks of sample U_{15} from 3853 and 3648 cm^{-1} (Fig. 4) to 3006 cm^{-1} and 2854 cm^{-1} (Fig. 11) in sample H_{15} respectively. There was a slight difference of 1-2 cm^{-1} in peaks of H_{10} (Fig. 10) when compared with U_{10} (Fig. 3) and also a decrease of 2-8 cm^{-1} in H_{20} and H_{22} peaks after heating (Figs. 12 and 13) respectively. Sample U_{20} and U_{22} contained C-H at 3853 and 3648 cm^{-1}; 3006 and 3852 cm^{-1} (Figs. 5 and 6) respectively but after heating, it was observed that sample H_{20} and H_{22} had an appearance of N-H group at 3735 cm^{-1} and 3465 cm^{-1} (Figs. 12 and 13) respectively indicating that there was a production of an amine group after heating which was not present before heating. It should be noted that the class of organic compounds more dominant before and after heating is the ester group. Heating of edible oils at smoke point changes the composition of the oil slightly. These findings are similar to the results reported by Shi *et al.*, (2017).

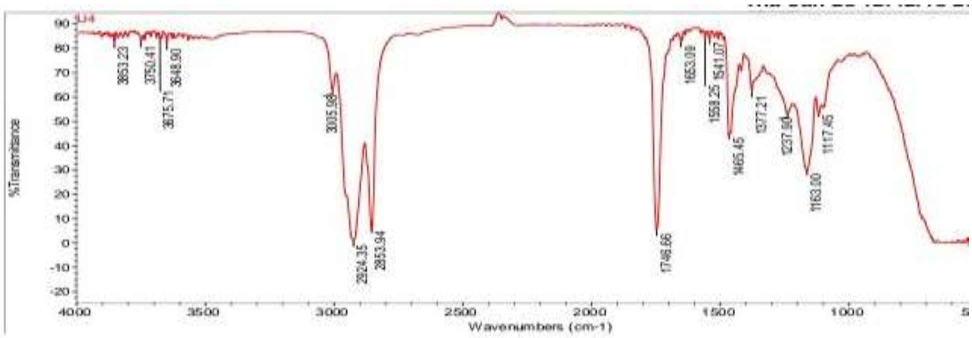

Figure 1: FTIR Spectrum for Sample U_4.

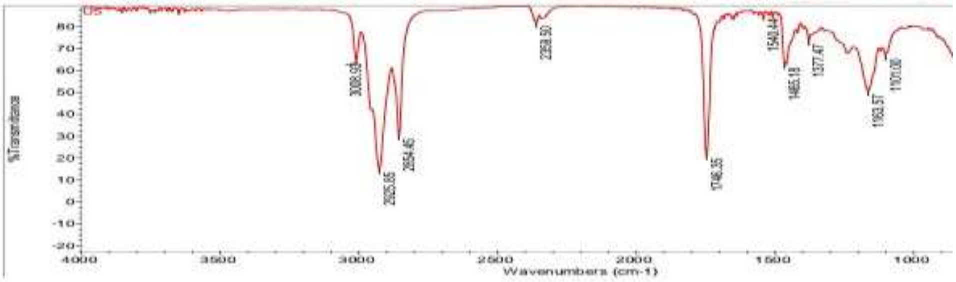

Figure 2: FTIR Spectrum for Sample U_5

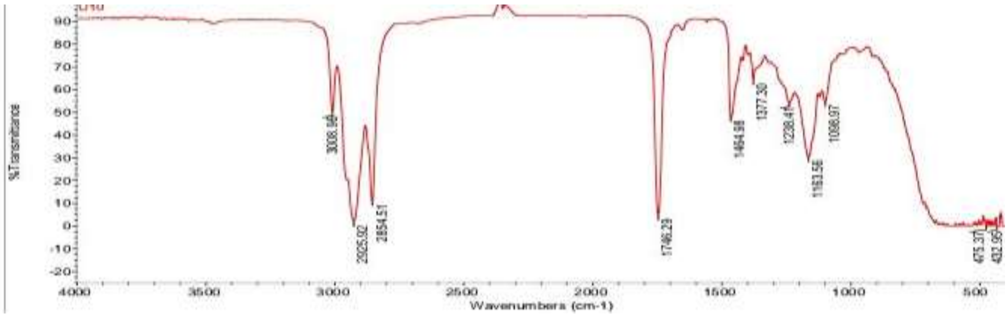

Figure 3: FTIR Spectrum for Sample U_{10}

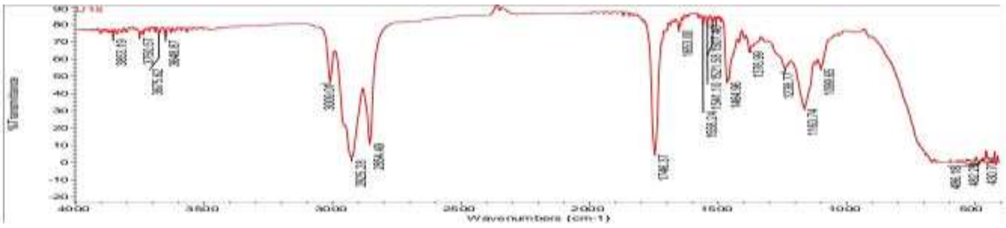

Figure 4: FTIR Spectrum for Sample U_{15}

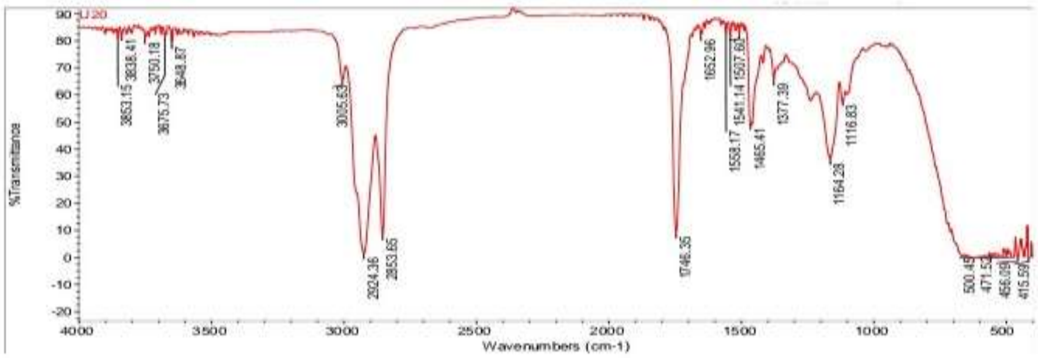

Figure 5: FTIR Spectrum for Sample U_{20}

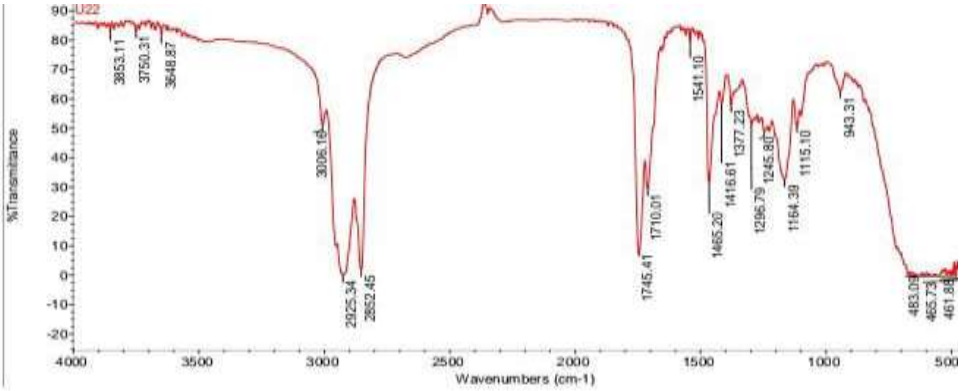

Figure 6: FTIR Spectrum for Sample U_{22}

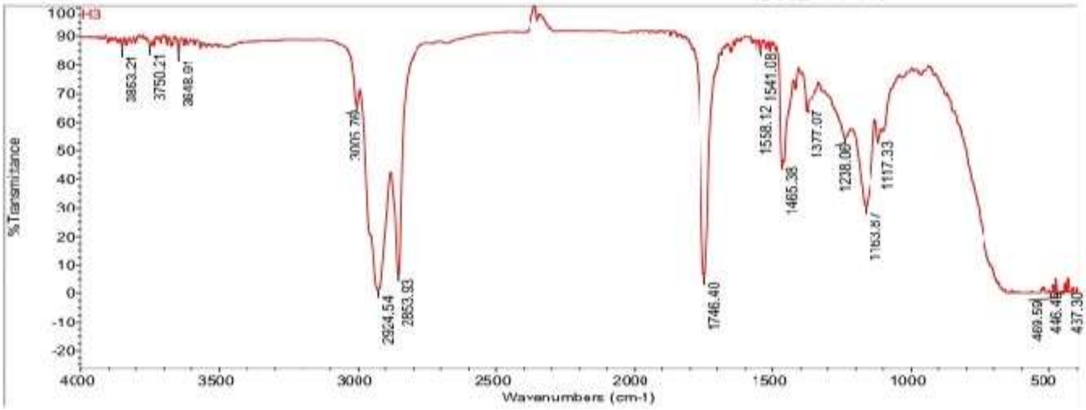

Figure 7: FTIR Spectrum for Sample H_3

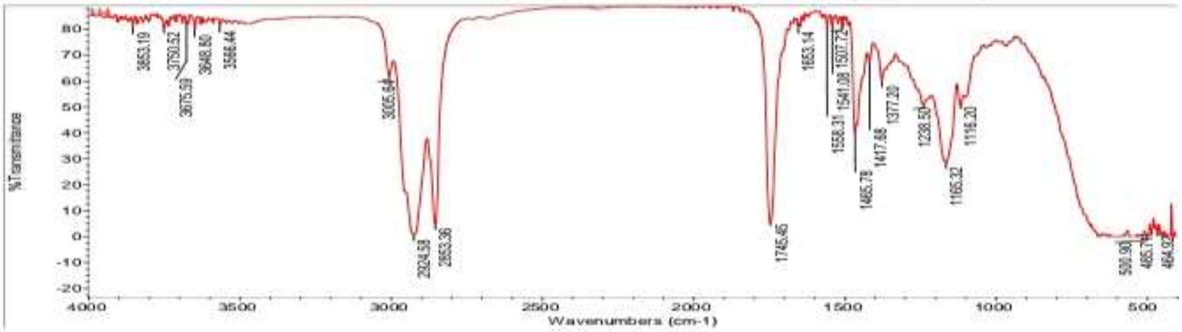

Figure 8: FTIR Spectrum for Sample H_4

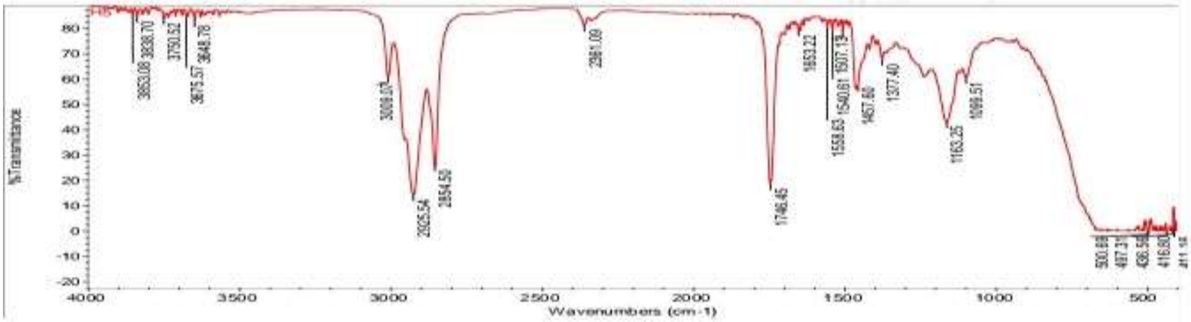

Figure 9: FTIR Spectrum for Sample H_5

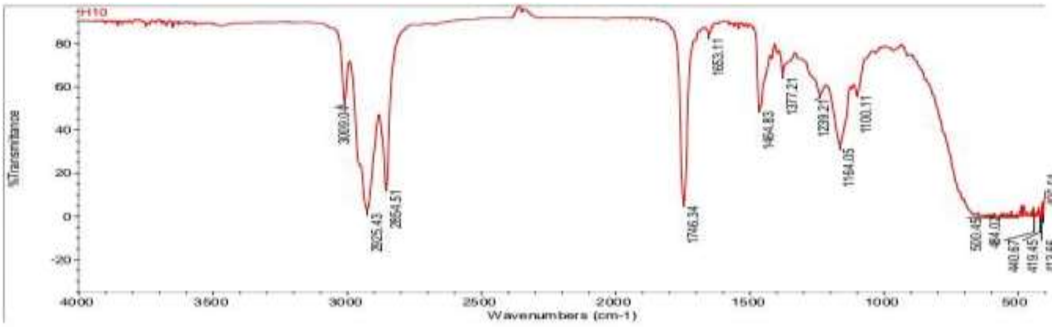

Figure 10: FTIR Spectrum for Sample H_{10}

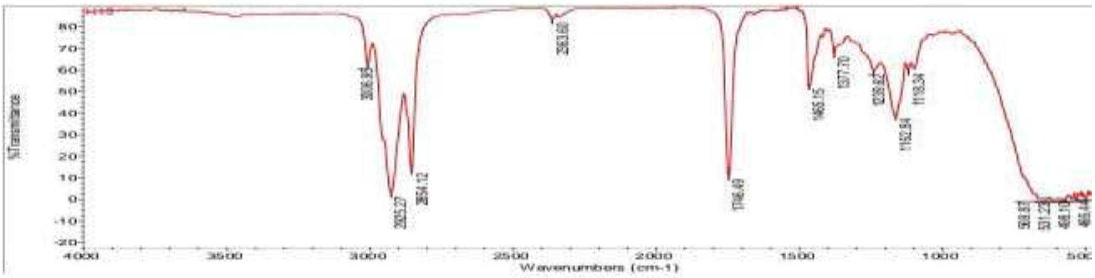

Figure 11: FTIR Spectrum for Sample H_{15}

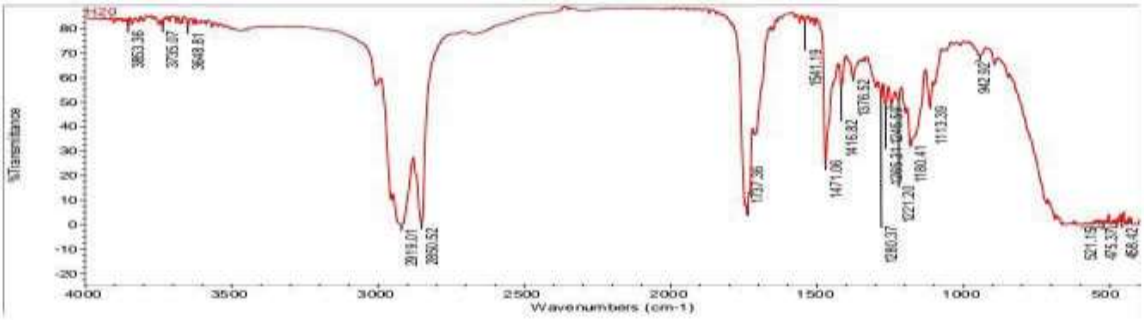

Figure 12: FTIR Spectrum for Sample H_{20}

CONCLUSION

The present investigation shows that the physico-chemical properties of vegetable oils sold in Sabo market met the stipulated standard. The moisture content was found to be within the ranges of 0.00 – 0. 33%. Higher moisture content was observed in samples U_{13} and U_{24} which is above the maximum allowable moisture content in edible oils (SON, 2000; FAO, 2011).). The colours and odour are in line with the standard of SON (2000) except for sample U_{22} which had an objectionable odour. There were records of rancidity in four (4) vegetable oils U_1, U_5, U_{16} and U_{17} and two (2) palm oils, U_{20} and U_{22} analyzed. There are O-H stretching vibration peak at 3471 cm^{-1}, unsaturated C-H stretching vibration peaks of carbon chain at 3006 and 3648 cm^{-1} for the unheated samples, saturated carbon chain C-H stretching vibration peaks at 2924 cm^{-1} and 2854 cm^{-1} for the C=O stretching vibration peak at 1745 cm^{-1}, the bending vibration peak of methylene at 1465 cm^{-1} and 1377 cm^{-1}, the stretching vibration peak of C-O in triglyceride at 1164 cm^{-1}. The spectra of the peak position and peak shape are similar, thus the main components of different kinds of vegetable oils before and after heating are roughly the same. C=O and C-O peaks can be assigned to the presence of an ester functional group. Unsaturated C≡C vibrations with peaks of 2359 cm^{-1} peaks were observed in most of the samples before heating and after heating. The aromatic group present was also identified in sample U_4 at 1653 and 1558 cm^{-1} producing aromatic C-H and C=C bond (Fig. 1). The triglycerides present in the oils before heating was not significantly affected even after heating. In comparison, peaks attributable to the presence of an aromatic group was not identified in samples U_5 and U_{15} Figs. 2 and 4 respectively but was identified in H_5 and H_{15} Figs. 7 and 9 respectively. There was an increase in the peaks of sample U_5 Fig. 2 from 3008 cm^{-1} and 2925 cm^{-1} to 3853 cm^{-1} and 3646 cm^{-1} in sample H_5 Fig. 7. However, there was a decrease in the peaks of sample U_{15} from 3853 cm^{-1} and 3648 cm^{-1} Fig. 4 to 3006 cm^{-1} and 2854 cm^{-1} Fig. 9 in sample H_{15} respectively. There was a slight difference of 1-2 cm^{-1} in peaks of H_{10} Fig. 8 when compared with U_{10} Fig. 3 and also a decrease of 2-8 cm^{-1} in H_{20} and H_{22} peaks after heating (Figs. 10 and 11) respectively. Sample U_{20} and U_{22} contained C-H at 3853 and 3648 cm^{-1}; 3006 and 3852 cm^{-1} (Figs. 5 and 6) respectively but after heating, it was observed that sample H_{20} and U_{22} had an appearance of N-H group at 3735 cm^{-1} and 3465 cm^{-1} Figs. 10 and 11 respectively indicating that there was a production of an amine group after heating which was not present before heating. It should be noted that the class of organic compounds more dominant before and after heating is the esters. Heating of edible oils at the smoke point changes the composition of the oil.

ACKNOWLEDGMENT

We wish to acknowledge the Nigerian Defence Academy and Tetfund for funding this research work, we say thank you.

REFERENCES

Abbas NM and Al-Fatlawi AM (2010). Investigating peroxides and acid value in used edible vegetable oils. Iraqi J Agric Sci.; 41(4):123–32.

Andrew C., Buba A. A., Itodo A. U. and Etim E. E. (2012). Thermoxidative degradation of Commonly used Vegetable oils. A Comparative Study. Journal of Emerging Trends in Engineering and Aplied Sciences.3(6): 924-928.

Anyasor N., Ogunwemo O., Oyelana A., Ajayi D. And Dangana J. (2009). Chemical Analysis of Groundnut Oil. Pakistan Journal of Nutrition. 8(3): 269-272.

AOAC, Association of Official Analytical Chemist (2000). Official Method of Analysis, 17th Edition. Association of Official Analyt Chemists, Maryland, USA. 9: 641.

Aremu M. O., and Akinwunmi O. D. (2014). Extraction, Compositional and Physico-chemical Characteristics of Cashew (Anarcadium Occidentale) nuts reject Oil. Asian Journal of Applied Science and Engineering. 3: 33-40.

Buba A.A (2005). The use of Spectroscopic, Viscometric and other techniques in the Evaluation of Vegetable oils. Ph.D Thesis, Federal University of Technology Yola, Nigeria.

CODEX (2001). Commission CA. Codex standard for named vegetable oils codex stan 210-1999. Report of the 17th session of the codex committee on fats and oils, London, Pp 19–23.

FAO, (2011) Food and Agricultural Organization of United Nations, Section 1: Quality Standards, Technical Information & Typical Analysis. Australian Oilseeds Federation, Australia Square. Pp40–45.

Makni M., Haddar A., Fraj A. B. and Zeghal N. (2011). Physico-chemical Properties, Composition and Oxidative Stability of Olive and Soybean OILs under Different Conditions. Internationa Journal of Food Properties. 18(1):194-204.

Nwachukwu I.N, Aamadi E.S, Umeh S.I, Opurum C.C., Ogueke C.C., Ogwo U.C., Eze I.O., chinakwe E.C., and Ogbuagu D.H. (2019). Microbial and Physicochemical Analysis of Edible Palm Oil Sold in Major Markets of South-Eastern Nigeria. Journal of Agricultural Science and Food Technology. 5(6): 117-1.

Okechalu JN, Dashen MM, Lar PM, Okechalu B, Gushop T. (2011). Microbiological quality and chemical characteristics of palm oil sold within Jos Metropolis. Nigeria: Plateau State.

Orji MU, Mbata TI. Effect of extraction methods on the quality and spoilage of Nigerian palm oil. Afr J Biochem Res. 2008;2(9):192–6.

Pearson D. (1970). The chemical Analysis of food. J. A Churchill London.

Shi, L. Liu, Z. *Li, J. and Qin, Z. (2017). Analysis of Edible Vegetable Oils by Infrared Absorption Spectrometry. Advances in Engineering Research, 86: 286-289.

Standard Organization of Nigeria (SON) (2000). Standard Organization of Nigeria. Standard for Edible oils and its processed.2-5.

Udensi E. A. and Iroegbu F.C. (2007). Quality Assessment of Palm oil sold in Major Market in Abia State, Nigeria. Journal of Agriculture, Food, Environment and Extension, 6(2): 25-27.

Verma R. M. (1994). Analytical chemistry: Theory and practice. CBS Publishers & distributors PVT. LTD ISBN: 81-239-0266-2.