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Evaluation of Chemical and Fatty acid Constituents of Flour and Oil of Walnut (*Juglans regia*) Seeds

Ogungbenle, H.N. and Anisulowo, Y.F.

Ekiti State University, Department of Chemistry, P.M.B. 5363, Ado-Ekiti, Nigeria

*Corresponding author e-mail: httphenryo@yahoo.com

ABSTRACT

Objectives: The purpose of the study was to evaluate the minerals, physico chemical properties and fatty acid profile of walnut flour and oil.

Methods: The minerals were determined using Atomic Absorption Spectrophotometer, standard classical methods were used for physico chemical properties and the fatty esters were analyzed using a PYE Unicam 304 gas Chromatography fitted with a flame ionization detector and PYE Unicam computing integrator.

Results: Sodium was found to be the highest mineral with the value of 114 mg/kg while copper was the least with value of 0.41 mg/kg in the flour. The results of physicochemical properties of the oil determined were: specific gravity (1.17), refractive index (1.470), acid value (10.67mg KOH/g), saponification value (67.32 mg KOH/g), peroxide value (45.0mg Equiv.O_2/Kg) and unsaponifiable matter (7.48 %) and iodine value (9.52 mg I_2/100g). Linoleic ($C_{18:2}$) was the highest fatty acid in walnut oil with the value of 72.87 % while stearic acid ($C_{18:0}$) was the lowest.

Conclusions: Walnut is nutritionally good for consumption and the oil desirable for cooking since it contains moderate levels of unsaturated fatty acids.

Keywords: Minerals, Physico chemical, Fatty acid, Walnut, Flour, Oil.

INTRODUCTION

Food is an essential ingredient for sustenance of life either of animals or plants. Its demand therefore, can not be over emphasized[1]. Walnut generally is about 20 species of deciduous trees, comprising the genus '*Juglans*' of the family Julandaceae[2]. This edible nut has a husk that does not split open and usually a hard shell. The tree produces fine quality nuts only on fertile and well drained soils. The tree has also been reported to have good economic values especially for furniture, paneling and gun stocks[2]. The nut is an important food for people in tropical countries and some part of Africa. Ogungbenle[3] reported that considerable quantity of oil can be extracted from the kernel which is used for cooking and industrial purposes. The determination of nutritional facts and edibility of walnut is of great importance to the food scientists and consumers. For any food product to be incorporated into food system its physico chemical properties of both flour and oil must be known. Ogungbenle[3] reported the proximate, functional properties, anti nutrients and amino acid composition of walnut flour. In order to further know more about its nutritional quality and industrial applicability, the present study was undertaken to determine the minerals, physico chemical properties and fatty acid profile of flour and oil of walnut seeds.

MATERIALS

The walnut seeds were obtained from Aramoko-Ekiti, Ekiti State, South West of Nigeria in Africa. The seeds were screened to remove the bad ones and the good ones were sun dried and kernels were removed after some days and then sun dried again for several days and later milled into fine flour with the aid of Marlex Excella grinder, packaged in rubber container and kept in freezer at -4^{o}C prior to analyses.

METHODS

Extraction of oil from the flour

The flour was then defatted using Sochlet extractor with petroleum ether (solvent) of analytical grade (British Drug House London) boiling point range 40 – 60^{o}C as described by AOAC[4] to extract the oil for fatty acid analysis.

The minerals composition of the flour was determined using method of Pearson[5] while the physico chemical properties of the oil such as acid, peroxide, iodine and saponification values were determined using the methods described by Ogungbenle[6] while specific gravity was determined by conventional displacement method and refractive index was determined using Abbe's refractometer. The fatty acid profile was determined using a method described by Hall[7]. The fatty esters were analyzed using a PYE Unicam 304 gas Chromatography fitted with a flame ionization detector and PYE Unicam computing integrator. Helium was used as carrier gas. The column initial temperature was 150^{o}C rising at 5^{o}C min^{-1} to a final temperature of 200^{o}C respectively. The peaks were identified by comparison with the standard spectral libraries.

RESULTS

See Tables 1, 2 and 3.

DISCUSSIONS

The result of mineral composition is presented on Table1. The most abundant mineral was potassium (114 mg/kg). The present observation also corroborates the observation of Olaofe and Sanni[8] which reported that potassium is the most abundant mineral in agricultural products. Calcium was the next highest mineral (80 mg/kg) while the least was copper (0.41 mg/kg). Consumption of walnut would alleviate the deficiency of these minerals such as calcium, magnesium, zinc and phosphorus which can lead to abnormal development of bone. The value of phosphorus (8.72 mg/kg) in walnut was lower than those of *Parinari curatellifolia* (19.6 mg/kg)[9] and raw African mango kernel (24.3%) [10]. Phosphorus also assists calcium in many body reactions although also has independent functions, many moderate diets which are rich in animal protein and phosphorus may promote the loss of calcium in the urine[11,12]. This leads to the concept of the calcium to phosphorus ratio. If the Ca/P ratio is low (low calcium, high phosphorus intake) more than the normal amount of calcium may be lost in the urine, decreasing the calcium levels in bone. Food is considered "good" if the Ca/P ratio is above one and "poor" if the ratio is less than 0.5[13]. The Ca/P ratio in the present study suggests that the sample would aid the absorption of calcium in the body. Sodium and phosphorus are required in the body to maintain the osmotic balance of fluid and pH. The Na/K in the body is of great concern for prevention of high blood pressure. Na/K ratio less than one is recommended. The value obtained indicates a Na/K ratio of 0.68[13]. Hence, the intake of walnut meal would not promote high blood pressure in the body. The value of calcium (83.2 mg/kg) in walnut was comparable to the value reported for *Terminalia catappa* (82.7 mg/kg)[14]. Calcium assists in teeth and bone development[15].

Table 2 presents the values of the physico chemical properties of walnut. The free fatty acid (FFA) (10.7 %) of the sample was higher than values obtained for cream Bambara groundnut (4.85 %)[16] and kidney bean oil (0.46 %)[12]. Free fatty acid can stimulate oxidation and determination of oils by enzymatic actions to form off flavor components[17]. The iodine value (95.2 mg I_2/100g) was higher than those of quinoa oil (54.0 mg I_2/100g)[6] and kidney bean oil (89. 4 mg I_2/100g)[12]. The value of iodine obtained place walnut oil in the non-drying group, since drying oils have iodine value greater than 100[12,18]. The iodine value is related to proximate amount of the unsaturated fatty acids present[6]. High level of iodine indicates high level of unsaturation. Since fatty acids can either be saturated or unsaturated, a knowledge of the level of unsaturated component via the iodine number will invariably provide a comparative idea of the saturated component[6,19]. The iodine value obtained shows that walnut contains moderate amount of unsaturated fatty acids which makes it an edible oil and less liable to oxidative rancidity. Nutritionally, a moderate level of unsaturated oil can be advantageous and desirable for cooking. The saponification value of the sample was 67.3 mg KOH/g. This value was lower than those reported for calabash kernel oil (159 mg KOH/g)[20], coconut oil (200-250 mg KOH/g)[21] and quinoa oil (192 mg KOH/g)[6]. The low saponification value obtained for walnut suggests that it would not be suitable for production of soaps. The refractive index of the extracted oil obtained was 1.4741 and found to be comparable with that obtained for pumpkin seed oil[17]. The result presently reported shows that walnut oil is less thick when compared with most drying oils whose refractive indexes were 1.475 and 1.485. The specific gravity of the walnut obtained was 1.17 and this value was higher than the value reported for bottle gourd oil[12] and that of fluted pumpkin seed oil (0.955)[22]. The value shows that the oil is less dense than water as generally expected. The acid (6.40 mg KOH/g) and peroxide (4.50 mg Equiv.O_2/Kg) values were higher than that of quinoa oil[6] indicating that the oil would not easily go rancid when properly stored in a container free from atmospheric oxygen and contaminants.

Table 3 presents the fatty acid composition (%) of the oil from walnut seeds. Linoleic acid (72.87%) was the highest concentrated fatty acid in walnut oil, This value was higher than those of bottle gourd seed oil (65.80%), *citrullus lunatus* oil (61.62%) and calabash seed oil (58.2%) [20]. The palmitic acid was the second highest fatty acid in walnut oil with the value of 12.19% and found to be lower than those for kidney bean oil (16.8%)[12], cowpea oil (28.4%), lima bean oil (22.3%)[23] and pigeon pea oil (21.4%)[24], but higher than that of soy bean oil (10.0%)[21]. The palmitic acid ($C_{16:0}$)

has been established as one of the most important of the dietary risk factors of coronary heart disease. The value of capric acid in walnut oil (0.0022%) was higher than that of lump-in-neck bottle gourd seed oil (0.0013%)[20]. The value of stearic acid (5.08%) in the sample was also higher than those of soy bean oil (4.0%)[21] and kidney bean oil (2.3%)[12], but lower than those of pigeon pea oil (7.6%)[24] and lima bean oil (7.1%) [23]**.** This makes walnut oil to serve as precursor of hormones. Due to the value of the ratio of oleic to linoleic, walnut oil may not be used as frying oil because it may loose its nutrients at very high temperatures. Table 3 also shows fatty acid distribution according to saturation and unsaturation of components (%). The total percentage unsaturated fatty acid was higher than the saturated fatty acid. Hence walnut oil would help to reduce the level of cholesterol in the body thereby reducing the risk of heart diseases in adults. The ratio of linoleic to α-linoleic acid in the diet should be between 15.1 and 10.1. The value presently reported (8.02) falls outside this range. It has been observed that relative to carbohydrate the saturated fatty acids (SFA) elevate serum cholesterol. While the polysaturated fatty acids lower serum cholesterol. The three protein-lipid complexes (lipoproteins) in the blood are low density lipoprotein (LDL), high density lipoproteins (HDL), very low density lipoproteins (VLDL). High levels of total blood cholesterol are associated with the incidence of heart diseases as well as saturated fatty acids (SFA). A diet comparising of myristic and palmitic acids may raise low density lipoprotein cholesterol in the body.

CONCLUSIONS

It can be concluded that walnut oil contains high amount of unsaturated fatty acid and some nutritionally valuable minerals which makes it edible and industrially good. The high nutrient density of walnut is an added advantage in fortification and formulation of food products. Therefore, cultivation and consumption of walnut seeds are highly encouraged.

REFERENCES

1. Amusa, N.A. and O.A. Odunbaku (2009). Microbiological and nutritional quality of hawked kunun (a sorghum based non-alcoholic beverage) widely consumed in Nigeria, *Pak. J. Nutri*.8, 20-25.
2. Encyclopedia Britannica (2012). Britannica concise encyclopedia of science and technology, published by Encyclopedia Britannica inc. en.wikipedia.org/wiki/encyclopedia Britannica/
3. Ogungbenle, H.N.(2009).Chemical and Amino acid composition of cooked walnut (*Juglans regia*). *Pak.J.Sci. Ind. Res*. Vol.52,No.3,130-133
4. AOAC. (2005). Official methods of analysis, 18th ed. Association of Official Analytical Chemistry, Washington DC.
5. Pearson, D.(1976) Chemical analysis of foods,7th ed.Churchill Livingstone, London.
6. Ogungbenle, H.N.(2003). Nutritional evaluation of quinoa flour, *International Journal of Food Science and Nutrition.* 54, 153-158.
7. Hall, G.M.(1982).Silage from tropical fishes: Lipid behavior, J. Food Technol., 21, 45-54.
8. Olaofe O and Sanni O. (1998): Mineral Contents of Agricultural products. Food Chem. 30, 73-77
9. Ogungbenle, H. N. and Atere, A.A. (2014). The chemical, fatty acid and sensory evaluation of *parinari curatellifolia* seeds. *British Biotechnology Journal*, 4(4), 379-386.

10. Ogungbenle, H.N,(2014). Chemical and amino acid composition of raw and defatted African mango kernel. *British Biotechnology Journal*,4(3) 244-253.
11. Shills, M.Y.G. and Young, V.R. (1992). Modern nutrition in health and disease. Niemann, D.C., Butterworth, D.E. and Niemann, C.N.(eds). Nutrition. Wm.C. Brown publisher, Dubugue,U.S.A. pp. 276-282.
12. Olaofe, O., Famurewa, J.A.V. Ekwagbere, A.O. (2010). Chemical functional properties of kidney bean seed flour. *International Journal of Chemical Sciences* 3, 51-69.
13. Niemann, D.C., Butterworth, D.E., Niemann, C.N. (1992). Nutrition-Winc. Brown publication, Dubugue, U.S.A. pp 237-312
14. Nzikou,J.M.,MvoulaTsieri,N.P.G.PambouTobi,C.B.Ndangui,A.Kimbongui,Th.Silou,M.Linder, J.Scher and S.Desobry (2010). Proximate composition and physic chemical characteristics of seed and seed oil from *Terminalia catappa L.* and the kinetic of degradation of the oil during heating. *Austr. J.Basic Appl.Sci*. 4, 2039-2047.
15. Brody, T. (1994). Nutritional Biochemistry, San Ojego, CA: Academic Press, 2nd Ed. pp: 761-794
16. Aremu, M.O. (2006). A comparative study on the chemical and amino acid composition of some Nigeria under utilized legume flour. Pak.J.Nurt,5.34
17. Akintayo, E.T. and Bayer, E.(2002). Characteristion and some possible uses of *Plukenetia conophora* and *Adenopus breviflorus* seeds and seed oils. Bioresour. Technol.,85, 95-97.
18. Duel, H.J.Jnr. (1951). The lipids: Their chemistry and biochemistry. Vol. 1 New York Interscience Publishers.
19. Quackenbush, F.W., Firch, J.G., Brunson, A.M. and House, L.R. (1963). Carotenoid, oil and tocophenol content of corn in breds. Cereal Chem. 40,250-259.
20. Olaofe, O, Ogungbenle, H.N., Akhadelor, B.E., Idris, A.O., Omojola, O.V., Omotehinse, O.T. and Ogunbodede, O.A. (2012). Physico chemical and fatty acids composition of oils from some legume seeds. *IJBPAS*, 1, 355-363.
21. Paul A.A. and Southgate D.A.T.(1985). McCance and Widdowson's The composition of Foods, 4th edition. The Royal Society of Chemistry, HMSO, London, UK.
22. Akintayo, E.T. (1997). Chemical composition and physico chemical properties of fluted pumpkin seed and seed oil. 74, 13
23. Osagie, A.U., Muzguiz, M., Burbano,C. Cuadrano, C., Ayet, G., Castano, A. (1996). Some anti nutritional constituents in ten staple food items grown in Nigeria. Tropical Sci. 36, 109-115
24. Oshodi, A.A., Olaofe, O., and Hall, G.M (1993). Amino acid, fatty acid and mineral composition of pigeon pea (*Cajanus cajan*). *Int. J.Fd. Sci. and Nutr.*,43, 187-191.

Table 1. Mineral composition of walnut flour

Parameter	Value (mg/kg)
Calcium	83.2
Sodium	78.0
Potassium	114.0
Magnesium	60.0
Phosphorus	8.72
Zinc	2.49
Copper	0.41
Ca/P	9.0
Na/K	0.68

Table 2. Physico chemical properties of walnut Oil

Parameter	Value
Free fatty acid (%)	10.7
Acid value (mg KOH/g)	6.40
Peroxide value (mg Equiv.O_2/Kg)	95.2
Iodine value (mg I_2/100g)	67.3
Saponification value (mg KOH/g)	7.48
Unsaponifiable matter (%)	0.930
Specific gravity	1.4741
Refractive index	9.0

Table 3. Fatty acids composition of walnut oil (%)

Fatty acid	Concentration (%)
Caprylic Acid (C8:0)	0.0021
Capric Acid (C10:0)	0.0022
Lauric Acid (C12:0)	0.0004
Myristic Acid (C14:0)	0.08
Palmitic Acid (C16:0)	12.19
Palmitoleic Acid (C16:1)	0.36
Stearic Acid (18:0)	5.08
Linoleic Acid (C18:2)	72.87
Linolenic Acid (C18:3)	9.09
Arachidic Acid (C20:0)	0.10
Bechenic Acid (22:0)	0.18
Erucic Acid (C22:1)	0.00142
Lignoceric Acid (C24:0)	0.00141
Saturated Fatty Acid	1.2552
Monounsaturated Fatty Acid	0.3600
Polyunsaturated Fatty Acid	9.09