PJN
ISSN 1680-5194

PAKISTAN JOURNAL OF NUTRITION

ANSInet
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan
Mob: +92 300 3008585, Fax: +92 41 8815544
E-mail: editorpjn@gmail.com

Pakistan Journal of Nutrition 8 (6): 800-803, 2009
ISSN 1680-5194

Extraction, Compositional Studies and Physico-Chemical Characteristics of Palm Kernel Oil

V.N. Atasie[1] and T.F. Akinhanmi[2]
[1]Department of Chemical Science, Bells University of Technology, Ota, Ogun State, Nigeria
[2]Department of Chemistry, University of Agriculture, Abeokuta, Ogun State, Nigeria

Abstract: Proximate, physico-chemical and elemental analysis of palm Kernel nut were determined to contain fat/oil 42%, crude protein 7.01%, moisture 6.5%, crude fibre 11.09% and carbohydrate (by difference) 33.40%. The elemental composition (mg/100 g), included :Na (37.00±0.40), K (39.51±0.22), Mg (3.60±0.1), Ca (19.0±0.42), Fe (20.04±0.28), Zn (2.82±0.30), P (3.4±0.00). The result of the physico-chemical properties of the palm kernel oil are:-saponification value (232.815 mgKOH/g), refractive index (1.453), iodine value (41.24g/100g), acid value (11.60 mgKOH/g) and peroxide value (1.70meq/kg).

Key words: Crude fibre, moisture, carbohydrate, acid value

INTRODUCTION

Oil nut palms are commonly planted in four tropical regions; Africa, South East Asia, Latin America and South Pacific. The main objective of these palm industries is to generate oil. Palm kernel cake from the nuts of palm fruits are generated as by-products, along with oil as a main product. Palm Kernel Meal (PKM) are found in large quantities in a number of tropical countries and are available at competitive prices. Four million Mt of palm kernel cake were produced in the world in 2002 with annual growth of 15% of PKM within the last two decades (FAO, 2002). PKM have been widely used in ruminant feed (Broderick *et al*.,1988; Moss and Givens, 1994; Umunna *et al*., 1994; Chandrasekariah *et al*, 2001), Pig diets (Thorne *et al*., 1989; Agunbiade *et al*., 1999; Kim *et al*., 2001) and rabbit diets (Aduku *et al*., 1988; Aganga *et al*., 1991). The palm kernel have high fibre, low palatability and lack several essential amino acids, coupled with some nutritional problems such as several anti-nutritional properties such as mannan, galactomannar, Xylan and arabinoxylan which makes the inclusion in the poultry diet very limited. Much research have been undertaken to determine the quality of PKM and the maximum level in poultry diets (Wignjosoesastro *et al*., 1972 and Perez *et al*., 2000) and to replace other feedstuffs such as groundnut (see Onwudike, 1986) and Soybean (Dingle, 1995; Pluske *et al*., 1997). However, few studies have been done to cope with their physical and nutritional handicaps. The efforts to improve PKM are through supplementation with biotin (Oloyo, 1991), NaoH (Nwokolo *et al*., 1976, 1977) and enzymes (Dingle, 1995 in Pluske *et al*. (1997). The palm Kernel is a good source of potassium (Ekpa, 1995). This oil palm contains organic food substances and inorganic elements, upon which life and industries depend. The fruit yields two oils, palm oil and kernel oil, each exhibiting differences in composition, properties and applications. Palm kernel oil is similar to coconut oil in composition and both are the only source of lauric oil available in the world market (Berger *et al*., 1991) The cake residue obtained after extracting oil is used in livestock feeds, while the palm and kernel oil are used in soap production, vegetable oil and margarine. (Ekpa, 1995). Besides industrial applications, these oils are used locally as body creams, cooking oils and medicinally, as antidotes for poisoning and as surface protectants for minor wounds. Palm oils from the *dura* and *tenera* varieties of the oil palm differ in their percentage fatty acid composition (Ekpa, 1995) and their interaction with lauric acids oils. Both species exhibits markedly different characteristics in their melting point and free fatty acid formation on exposure to light. Little information is available on the toxicant and mineral composition of palm kernel oil and palm kernel cakes

This study is therefore aimed at investigating further the physico-chemical characteristics of palm kernel oil, the chemical component of the oil, Proximate analysis and elemental component of the palm kernel oil in order to ascertain the suitability in consumption, ability to meet local and international market demands and lipid oxidation.

MATERIALS AND METHODS

Sample collection and preparation of samples: The palm kernels nuts that served as sample for analysis were obtained from palm kernel processing industry in Ogun State, Nigeria. The nuts were thoroughly screened to remove the bad ones and stones. The kernel nuts were broken, the nuts were collected, washed. dried in an oven at 40°C, for 4 h. The dried clean nuts were milled using manual blender because of the hardness of the nut. The ground samples were stored in polythene bags, kept in a desiccator inside a refrigerator at 4°C until used for proximate analysis.

Extraction of oil: The oil sample was extracted from the crushed sample by soxhlet extractor using petroleum ether of analar grade (BDH, London) boiling range 60-80°C for 10 h (James, 1996).

Physico-chemical properties determination: The physico-chemical determination of the palm kernel oil for saponification value, peroxide value, acid value and specific gravity were carried out using the methods of AOAC (1990).

Mineral analysis: The minerals were analyzed by dry ashing the samples at 550°C to constant weight and dissolving the ash in volumetric flask using distilled, deionized water with few drops of concentrated hydrochloric acid.

Sodium and Potassium were determined using flame photometer (Model, 405, Corning, UK) using NaCl and KCl to prepare the standards. All other metals were determined by Atomic Absorption Spectrophotometer (Perkin –Elmer Model 403, Norwalk CT,USA). Determination were in triplicate. Chemicals used were of analytical grade (BDH, London). The detection limits of the metals had been determined according to Teshtron (1975). Optimum analytical grade was 0.1-0.3 absorbance units with a coefficient of variation (0.78-2.18%). The minerals were reported in mg/100 g.

Amino acid analysis: 3.0 g of the crushed kernel nut was defatted with chloroform/methanol mixture using soxhlet extraction apparatus while the extraction lasted for 18hours. About 50-70 mg of the defatted sample was weighed into glass ampoule, 7ml of 6 MHCl was added and Oxygen expelled passing nitrogen into the ampoule was put in an oven at 108±50°C for 28 h and later allowed to cool before the content was filtered. The filtrate was evaporated to dryness at 40°C under vacuum in a rotary evaporator, residues was dissolved with 7ml acetate buffer (pH 2.0) The method of amino acid employed in this analysis was by ion exchange chromatography (IEC) (FAO/WHO, 1991) using the Technicon sequential Multi sample Amino Acid analyzer (TSM) (Technicon, Instruments Corporation, New York). Other analysis carried out, were determination of iodine value using the WIJ's method as described in Pearson (1976). The refractive index was at 26°C using Abbe refractometer.

RESULTS AND DISCUSSION

Proximate composition of defatted palm kernel is shown in Table 1. The moisture mean value was (6.5%), fat /oil (42%), crude protein (7.01%), crude fibre (11.09%) and carbohydrate (by difference (33. 40%). The moisture and fat content is in good agreement with the results of Akpanabiatu *et al.* (2001) who reported 7.2%-6.0% range for moisture, 49-42% range for fat, crude fibre 14.7-15.5 (g/100g). our result for crude fibre was 11.09 (g/100g).The slight disparity may come from the specie of palm kernel used. Crude protein of 7.01% agrees with earlier reports of Akpanabiatu *et al.* (2001), 8.1-7.5% range. The low protein content is indicative that the nut is not very suitable for animal feeds or to improve nutritional values. The carbohydrate value of 33.40% is expected. The high carbohydrate value by difference is indicative that the palm kernel nut has less protein and as such could not be used for nutritional replenishment in children and adults. The fat/oil content is high and therefore agrees with the earlier reports of Bogert *et al.* (1994), who claimed that fat is important in diets as it promotes fat soluble vitamin absorption. It is a high energy nutrient and does not add to the bulk of the diet. The crude fibre was 11.09%. Maintenance of internal distention for a normal peristaltic movement of the intestinal tract is the physiological role which crude fibre plays. Okon (1983) reported that a diet low in fibre is undesirable as it could cause constipation and that such diets have been associated with diseases of colon, like piles, appendicitis and cancer. The carbohydrate value (by difference), of 33.40% is acceptable, the result thus gave an indication that the palm kernel nut oil is a rich source of energy and capable of supplying the daily energy requirements of the body. Results of the physico-chemical properties of palm kernel oil is presented in Table 2, with refractive index (1.453), iodine value (41.24 g/100 g), free fatty acid value (5.85mgKOH/g), Acid value (11.60mgKOH/g), saponification value (232.815mgKOH/g) and peroxide value (1.70meq/kg). Low iodine value indicated low level of unsaturation in the oil, saponification value of 232.815 mgKOH/g is close to coconut oil of 253 mgKOH/g and butter fat 225mgKOH/g (Aremu *et al.*, 2006). Pearson (1976) reported that high saponification value contains high proportion of lower fatty acids. This quality in the oil quantifies its use in soap production. The iodine value of (41.24 g/100 g) of palm kernel oil is comparable to that of cashew oil (44.4±0.1mg iodine) by Aremu *et al.* (2006), indicating low decree of unsaturation. Duel (1951) proposed that iodine value above 100, makes oil drying and below 100 is non-drying. The peroxide value of 1.70 meq/kg detected in this analysis is a good property which gives more resistant to oxidation, with better shelf- life.

The mineral content of palm kernel oil is contained in Table 4. The profile showed Na (37.00±0.40), K (39.51±0.22), Mg (3.60±0.10), Ca (19.0±0.42), Fe

Table 1: Proximate composition (%) of palm kernel nut

Composition	Percentage
Oil content	42
Moisture content	6.5
Crude protein	7.01
Crude fibre	11.09
Carbohydrate	33.40

Table 2: Physico chemical characteristics of palm kernel oil

Parameter	Value
Free fatty acid	5.83 mgKOH/g
Acid value	11.60 mgKOH/g
Saponification value	232.81 mgKOH/g
Iodine value	41.24 g/100g
Peroxide value	1.70 meq/kg
Refractive index	1.453

Table 3: Mineral content(mg/100g) of the palm kernel oil

Elements	Concentration (mg/100g)
Na	37.00±1.90
Mg	3.60±0.01
K	39.51±0.22
Ca	19.0±0.42
Fe	20.04±0.20
Zn	2.82±0.30
P	3.40±0.00

Table 4: Fatty acid profile of palm kernel oil

Fatty acids	Percentage
Myristic	72.33
Palmitic	25.76
Stearic	0.64
Oleic	1.07

(20.04±0.20), Zn (2.82±0.30), P (3.4±0.00). The least abundant minerals were Mg, Zn and P while K was found to be the most abundant mineral. This is in close agreement with the observation of Aremu *et al.* (2006) who reported that K is the most predominant mineral in Nigerian Agricultural products. Calcium mean value of (19.0-0.42 mg/100 g) in this study is low, but in agreement with Aremu *et al.* (2006). Calcium in conjuction with magnesium, manganese, phosphorus, Vitamins A, C and D and protein are involved in strong bone formation (Fleck, 1976). Calcium is essential in blood clothing muscle contraction and in certain enzymes in metabolic processes. Phosphorus mean value of 3.40±00 is low. Phosphorus is always found with calcium in the body both contributing to the blood. Low Ca/P ratio facilitates calcinations of the calcium in the bone while the Ca/P ratio in this work is 5.58, indicating that it would serve as good source of mineral for bone formation. The Na/K ratio is very important in the body, for prevention of high blood pressure. Na/K ratio less than one is recommended (Nieman *et al.*,1992). The Na/K ratio from this investigation is 0.936 which falls within the acceptable value. This showed that palm kernel oil would probably reduce high blood pressure diseases and therefore recommended as cooking oil. Table 4. depicts fatty acid profile of the palm kernel oil which included myristic (72.33%), palmitic (25.76%), Stearic (0.64%) and Oleic (1.07%). The oil contained therefore high proportion of lower fatty acids.

Conclusion: The present study showed that palm kernel oil is rich in important food properties compared to some other oil seeds and nuts. The high quality protein showed its reliability as a good source of amino acids for children and adults. The physico-chemical properties indicated that it is edible, non drying. The value of Na/K ratio, is very important to the body, for prevention of high blood pressure. It could be substituted with other meals as, animal feeds. The oil is used for margarine, cooking, soap production etc. However further work is in progress to determine the amino acid profile of other nuts and comparing the results with that of palm kernel.

ACKNOWLEDGEMENT

We thank our various institutions for financial support especially the chemistry department of the University of Agriculture Abeokuta where this research work was carried out.

REFERENCES

Aduku, A.O., N.I. Dim and A.A. Aganga, 1988. Note on a comparative evaluation of palm kernel meal peanut meal and sunflower meal in diets of weaning rabbits. J. Appl. Rabbit Res.,11: 264-266.

Aganga, A.A., A.O. Aduku, M. Abdulmalik and A. Sekoni, 1991. The effect of different protein sources and their levels on the production of breeding rabbits. J. Appl. Rabbit Res., 14: 30-33.

Agunbiade, J.A., J. Wiseman and D.J.A. Cole, 1999. Energy and nutrient use of palm kernel, palm kernel meal and palm oil in diets for growing pigs. Anim. Feed Sci. and Technol., 80: 165-181.

Akpanabiatu, M.I., O.D. Ekpa, A. Mauro and R. Rizzo, 2001. Nutrient Composition of Nigerian palm kernel from the dura and tenera varieties of the oil palm. J. Food Chem., 72: 173-177.

AOAC, 1990. Official methods of Analysis 15th Edn, Washignton, DC.

Aremu, M.O., A. Olonisakin, D.A. Bako and P.C. Madu, 2006. Compositional studies and physico-chemical characteristics of cashew nut flour. Pak. J. Nutr., 5: 328-333.

Berger, K.G., W.T. Andaner and T.H. Applewhite, 1991. The Lauric oils medium chain fatty acids source champaign, IL, American Oil Chemists Society.

Bogert, J.L., G.M. Briggs and D.H. Galloway, 1994. Nutrition and physical fitness. Int. J. Food Sci. Nutr., 45: 223-230.

Broderick, G.A., R.J. Wallace, E.R. Orskov and L. Hansen, 1988. Comparison of estimates of ruminal protein degradation by *in-vitro* and in-situ methods. J. Anim. Sci., 66: 1739-1745.

Chandrasekariah, M., K.T. Sampath, A. Thulasi and S. Anandam, 2001. Insitu protein degradability of certain feedstuffs in cattle. In. J. Anim. Sci., 71: 261-264.

Dingle, J.G., 1995. The use of enzymes for better performance of poultry. In Queensland Poultry Science Symposium. The University of Queensland, Gatton.

Duel, H.J., Tr, 1951. The Lipids: Their Chemistry and Biochemistry vol. 1. New York Inter Science Publishers, pp: 53-57.

Ekpa, O.D., 1995. Bio-inorganic constituents and possible uses of the female influorescence of the oil palm. W. Afr. J. Biol. and Appl. Chem., 40: 13-18.

FAO/WHO, 1991. Protein quality evaluation. Report of joint FAO/WHO Export consultant, FAO Food Nutrition paper; 51, FAO/WHO, Rome, pp: 19-21.

FAO, 2002. FAOSTAT Agriculture Data. Http://apps.fao.org.

Fleck, H., 1976. Introduction to Nutrition, 3rd Edn, Macmillan, New York, USA, pp: 207-219.

James, C.S., 1996. Analytical chemistry of foods. New York Chapman and Hall.

Kim, B.G., J.H. Lee, H.J. Jung, Y.K. Han, K.M. Park and I.K. Han, 2001. Effect of partial replacement of soybean meal with palm kernel meal and copra meal on growth performance, nutrient digestibility and carcass characteristics of finishing pigs. Asian Aust. J. Anim. Sci., 14: 821-830.

Moss, A.R. and D.I. Givens, 1994. The chemical composition, digestibility, metabolisable energy content and nitrogen degradability of some protein concentrates. Anim. Feed Sci. and Technol., 47: 335-351.

Nieman, D.C., D.E. Butter Worth and C.N. Nieman, 1992. Nutritions: Wm.C. Brown Publisher Dubugue, pp: 9: 540.

Nwokolo, E.N., D.B. Bragg and H.S. Saben, 1976. The availability of amino acids from palm kernel, soybean, cotton seed and rape seed meal for the growing chick. Poult. Sci., 55: 2300-2304.

Nwokolo, E.N., D.B. Bragg and H.S. Saben, 1977. A nutritive evaluation of palm kernel meal for use in poultry rations. Tropical Sci., 19: 147-154.

Okon, B.D., 1983. Studies on the Chemical composition and nutritive values of the fruits of African star apple. M.Sc. Thesis, Universitry of Calabar, p: 67.

Oloyo, R.A.,1991. Responses of broilers fed guinea corn palm kernel meal based ration to supplemental biotin. J. Sci. Food and Agric., 55: 539-550.

Onwudike, O.C., 1986. Palm kernel as a feed for poultry; Diets containing palm kernel meal for starter and grower pullets. Anim. Feed Sci. and Technol., 16: 187-194.

Pearson, D., 1976. Chemical analysis of foods (7th Edn.) London. ChurchHill Livingstone.

Perez, J.K., A.G. Gernat and J.G. Murillo, 2000. The effect of different levels of palm kernel meal in layer diets. Poult. Sci., 79: 77-79.

Pluske, J.R., P.J. Moughan, D.V. Thomas, A. Kumar and J.G. Dingle, 1997. Releasing energy from Rice bran, copra meal and canola in diets using exogenous enzymes. In; 13th Annual symposium. Alltech, pp: 81-94.

Teshtron, V., 1975. Basic Atomic Absorption Spectroscopy; a modern Introduction, Dominican Press Victoria, Australia, pp: 104-106.

Thorne, P.J., J. Wiseman, D.J.A. Cole and D.H. Machin, 1989. The digestible and metabolisable energy value of copra meals and their prediction from chemical composition. Anim. Prod., 49: 459.

Umunna, N.N., I.Y. Magaji, I.F. Adu, P.C. Njoku, T.F. Balogun, J.P. Alawa and P.A. Iji, 1994. Utilization of palm kernel meal by sheep. J. Appl. Anim. Res., 5: 1-11.

Wignjosoesastro, N., C.C. Brooks and R.B. Herrick, 1972. The effect of coconut meal and coconut oil in poultry rations on the performance of laying hens. Poult. Sci., 51: 1126-1132.