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Proximate Composition and Functional Properties of Dehulled African Nutmeg (*Monodora myristica*)

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Abstract. The proximate composition and functional properties of dehulled African nutmeg (*Monodora myristica*) were determined. Crude protein, ash, fat and fibre contents were: 14.67%, 2.27%, 24.06% and 30.04%, respectively. Gelation concentration was 4%. Water and oil absorption were 160% and 256%, respectively. The emulsion capacity and emulsion stability were 45.6% and 42% while the foaming capacity and foaming stability were 50.0% and 4%, respectively. Minimum solubility was observed at pH 4.0 and maximum, at pH 10. Total essential and total non-essential amino acids amounted to the average values of 48.4% and 51.60%, respectively.

Keywords: African nutmeg, proximate composition, functional properties, amino acid

Introduction

African nutmeg (*Monodora myristica*) belongs to the family Ananacea; it is a climber tree, grows well in the evergreen forests of West Africa and is most prevalent in the southern part of Nigeria (Adegoke and Akinsanya, 1970). Investigations reveal that almost every part of the tree has economic importance. However, the most economically important part is the seed which is embedded in a white sweet-smelling pulp. On an average, 119-122 seeds can be found in one fruit (Okon, 1983). The harvesting period is between April to September. Various processing methods such as fermentation, washing, drying and cracking are employed before consumption or storage (Ejiofor *et al*., 1998). It is used to make a popular condiment for souring. It is also used in the treatment of mild fever and as a diuretic; and as an antiseptic (Fagbemi and Oshodi, 1991). The objective of this work is to evaluate proximate, amino acid composition and functional properties of dehulled African nutmeg (*Monodora myristica*) seeds.

Materials and Methods

The African nutmeg (*Monodora myristica*) was obtained from old Garage market in Ado-Ekiti, Ekiti State, Nigeria. The seeds were screened and the good ones were later dehulled, sun dried and then dry-milled into flour and kept in freezer for the analyses.

The proximate analysis of the sample for total ash, moisture, crude fibre and ether extract was carried out using the method of AOAC (2005). Nitrogen content was determined by micro Kjeldahl method (Pearson, 1976) and was converted to crude protein by multiplying by 6.25. Carbohydrates were determined by the method of difference i.e.

{100-(ash + moisture + crude protein + crude fibre + ether extract)}.

All tests were carried out in triplicate.

The method described by Sathe *et al*. (1982) was used to determine gelation property with slight modification and that described by Beuchat (1977) for water and oil absorption capacities. The emulsion capacity and stability were determined as stated by Inklaar and Fortuin (1969) while foaming capacity and stability as by Coffmann and Garcia (1977). The protein solubility as a function of pH was determined according to AOAC (2005) and the graph of protein solubility against pH was plotted using the data obtained.

For amino acid profile, the sample was dried to constant weight, defatted using soxhlet extractor and hydrolysed in sealed glass ampoule at 105 °C ± 5 °C for 22 h using 7 mL of 6M HCl (Spackman *et al*., 1958). The hydrolysate was evaporated in a rotary evaporator and loaded into the Technicon sequential multisample amino acid analyser (TSM, Taryton, USA).

Results and Discussion

Proximate composition. Proximate composition of dehulled African nutmeg, *M. myristica*, is presented in Table 1. The sample had high level of crude fibre (3.04%) and low ash content (2.27%). The average crude protein

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(14.67%) was higher than that of millet (11.4%) reported by Oshodi *et al*. (1999), but lower than those of lima bean flour (22.7%; Oshodi and Adeladun, 1993) and of pigeon (22.4%; Oshodi and Ekperigin, 1989). Thus dehulled African nutmeg, *M. myristica*, has higher protein content and somewhat more balanced amino acids than those of the most of cereals e.g. millet and sorghum (Oshodi *et al*., 1999). It can be inferred from this result that African nutmeg can be used as supplement to foods that have higher amounts of carbohydrate but low protein content (Ogungbenle, 2003). It is also a very cheaper source of protein than animal products like meat, fish, egg etc. Protein is responsible for the repairs of worn-out tissues and body building. The crude fibre content of African nutmeg was 3.04% which is very high. It is higher than those of pigeon pea (3.8%) reported by Oshodi and Ekperigin (1989) and cowpea (2.6%; Aletor and Aladetimi, 1989), pearl millet (3.1%; Oshodi *et al*., 1999), cooked walnut (3.03%; Ogungbenle, 2009), gourd seed (2.80%; Ogungbenle, 2006) and groundnut cake (2.7%; Oyenuga, 1968). Dietary fibre has a number of beneficial effects related to indigestibility in the small intestine (Asp, 1996). Therefore, the high value of fibre content of African nutmeg can improve the digestibility and the absorption processes in the large intestine. It has an ash content of 2.27% which is comparable to that of sorghum flour (2.29%; Awadalkareem *et al*., 2008) and higher than that of wheat flour (1.50%; Ahmed *et al*., 2008). The ash content of African nutmeg is lower than the value for scarlet runner bean flour (4.71%) and those of bambara groundnut (4.30%; Aremu *et al*., 2005), cowpea (3.7%; Olaofe *et al*., 1994), soy bean (4.12%; Temple *et al*., 1991) and milk powder (4.70%; Ahmed *et al*., 2008).

The moisture content of African nutmeg was 11.11% (Table 1). This value is favourable as compared to that of scarlet runner bean flour (10.96%; Aremu *et al*., 2005) and lima bean (12.0%; Oshodi and Adeladun, 1993) but higher than that of kidney bean(8.80%; Olaofe *et al*., 2010). This implies that African nutmeg has good shelf life, since it has low level of moisture and will not allow the growth of microorganisms.

The fat content of African nutmeg (24.06%) is lower than the value obtained for groundnut (43.0%) and Calabash seeds (43.0%) as reported by Apata and Ologhobo (1994). However, it is higher than that of scarlet runner bean (10.85%; Aremu *et al*., 2005) and soy bean (18%; Paul and Southgate, 1988).

The carbohydrate content of African nutmeg is 17.85%. This value is higher than those of pumpkin flour (6.93%; Fagbemi and Oshodi, 1991) and gourd seed (9.89%; Ogungbenle, 2006; Olaofe *et al*., 1994), scarlet runner bean (48.36%; Aremu *et al*., 2005), *Terminalia catappa* (16.02%; Nzikou *et al*., 2010) and kidney bean (40.0%; Olaofe *et al*., 2010). This shows that African nutmeg is also a better source of energy like scarlet runner bean.

Table 2 presents the functional properties of dehulled African nutmeg. The water absorption capacity (160%) is higher than those of lima bean (142.2%; Oshodi and Adeladun, 1993), soy flour (130%; Lin *et al*., 1974), lupin seed (120%; Sathe *et al*., 1982) fluted pumpkin seed flour (85%; Fagbemi and Oshodi, 1991) and dehulled *Afzelia africana* seeds (128.31%; Ogungbenle and Omaejalile, 2010). This indicates that African nutmeg is suitable for the production of gravies.

The oil absorption capacity of African nutmeg is 256% which is higher than those of wheat and soy flours with values of (84.2%) and (84.4%), respectively as reported by Lin *et al.* (1974) and some Nigerian oil seeds like conophor nut (108.13%; Ige *et al*., 1984) and *Bombacopsis glabra* (91.8%; Olaofe *et al*., 2006), but lower

Table 1. Proximate composition of dehulled African nutmeg (*M. myristica*)

Component	%
Ash	2.27
Moisture	11.11
Crude protein	14.67
Fat	24.06
Crude fibre	3.04
Carbohydrate by difference	44.85

Table 2. Functional properties of dehulled African nutmeg (*M. myristica*)

Parameters	%
Water absorption capacity(WAC)	160.0
Oil absorption capacity(OAC)	256.0
Emulsion capacity(EC)	45.6
Emulsion stability(ES)	42.0
Foaming capacity(FC)	50.0
Foaming stability (FS)	4.0
Least gelation concentration (%W/V)	4.0

than that of cowpea flour (281-321%; Olaofe *et al*., 1994). This high value of oil absorption capacity makes African nutmeg a better flavour retainer and improves the mouth feel of foods (Kinsella, 1976).

The emulsion capacity (45.6%) was higher than those of African yam bean dehulled seed flour (10.0-20.0%; Oshodi *et al*., 1997), soy flour (18.0%; Lin *et al*., 1974) and dehulled *Afzelia africana* seeds (35.25%; Ogungbenle and Omaejalile, 2010). The emulsion stability of African nutmeg (42%) is highly comparable to that of pigeon pea (49.40%; Oshodi and Ekperigin, 1989) and quinoa flour (45.0%; Ogungbenle, 2003). This implies that African nutmeg may be useful as a food additive/extender, for binder formulation and for stabilization of colloidal foods.

The value of least gelation concentration of African nutmeg (4% W/V) is low when compared to other seed legumes such as lupin seed flour (14% W/V; Sathe *et al*., 1982), great northern bean seed flour (10% W/V; Sathe and Salunkhe, 1981), pigeon pea flour (12% W/V; Oshodi and Ekperigin, 1989) and dehulled *Afzelia africana* (6.00% W/V; Ogungbenle and Omaejalile, 2010) but higher than the value of *B. glabra* flour (2.0% W/V; Olaofe *et al*., 2006). This low value of dehulled African nutmeg may be an asset in its use as an additive to other gel forming materials in food products.

The foaming capacity and stability of dehulled African nutmeg are 50% and 4%, respectively. The former is low when compared to that of soy flour (68%) and sunflower (600%) as reported by Lin *et al*. (1974) and that of pigeon pea flour (68%; Oshodi and Ekperigin, 1989). The foaming stability of African nutmeg (4%) is lower than that of soy flour (14.6%) and sunflower flour (9.0%; Lin *et al*., 1974) but higher than those of quinoa flour (2.0%; Ogungbenle, 2003) and 3.0% for dehulled *A. africana* (Ogungbenle and Omaejalile, 2010).

Figure 1 shows the variation of protein solubility of African nutmeg with pH. It indicates minimum protein solubility at pH 4 and maximum protein solubility at pH 10. The minimum value of pH 4.0 is comparable with that of cowpea protein (Olaofe *et al*., 1994).

It is also comparable with African yam bean (Oshodi *et al*., 1997) with minimum solubility at pH 4.5 moth bean (Sathe *et al*., 1982) and full fat fluted pumpkin seed flour (Fagbemi and Oshodi, 1991) while lower than those scarlet runner bean flour (pH 5.0; Aremu *et al*., 2006) and pigeon pea (pH 5.0; Oshodi and Ekperigin,

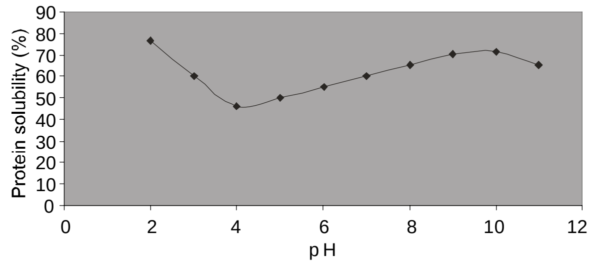

Fig.1. Variation in protein solubility with pH.

1989). It is interesting that the present result is similar to that obtained for kidney bean (Olaofe *et al*., 2010) for minimum solubility (pH 4) and the maximum(10).

With minimum solubility at pH 4, African nutmeg would probably be useful in the formulation of protein rich carbonated beverages (Ogungbenle, 2003) and low acid foods such as meat products and milk analogue products (Kinsella, 1979). There is a steady increase in protein solubility after pH 4.0 upto a maximum at pH 10 and after pH 10, there is a drop in the protein solubility. This observation is similar to that of Ige *et al*. (1984) for conophor seeds and Fagbemi and Oshodi (1991) for full fat fluted pumpkin.

Table 3 presents the amino acid composition of dehulled African nutmeg. The result shows that glutamic acid has the highest value, followed by leucine and aspartic acid, whereas cystine has the least value. Total essential amino acids (313.9 mg/g crude protein) are lower than those of soy bean (444.00 mg/g, Biswas *et al*.,1991), *Adenopus breviflorus benth* (537.29 mg/g; Oshodi, 1996), pigeon pea (436.10 mg/g; Oshodi *et al*., 1993) and dehulled *A. africana* (796.6 mg/g; Ogungbenle and Omaejalile, 2010). The value 313.9 mg/g of the sample (Table 4) is moderate and not on the high side of the range (408-588 mg/g) of the requirement for infants (FAO/WHO, 1973).

Table 4 reveals the values of essential, non-essential, acidic, basic, and neutral amino acids of African nutmeg. The amount of total amino acids (648.9 mg/g) is lower than those reported by Adeyeye (1997) for the dehulled African yam bean (917.48 mg/g crude protein)and cooked walnut (757.1 mg/g protein) reported by Ogungbenle (2009) but higher than those of kidney bean seed (388 mg/g crude protein; Olaofe *et al*., 2010) and some legumes such as cream coat cowpea (280.9 mg/g protein), white coat cowpea (284.2 mg/g protein), red coat scarlet runner bean(317.8 mg/g protein), white coat scarlet runner bean(344.3 mg/g protein) reported by Aremu *et al*. (2006) and germinated pearl millet

(464 mg/g protein) reported by Adeyeye (2009) but higher than 327 mg/g protein reported for kersting's groundnut (Aremu *et al*., 2006).

The value of total non-essential amino acids (335.0 mg/g protein) is comparable with that of African yam bean (327 mg/g protein; Adeyeye, 1997) and cooked walnut (312.5 mg/g protein; Ogungbenle, 2009) but lower than that for kidney bean (407 mg/g protein; Olaofe *et al*., 2010). The amount of histidine in African nutmeg is within the required range recommended for infants by FAO/WHO (1985). Thus, if consumed in appropriate quantity per day, it could supply the missing essential amino acid (histidine) in a regular diet that lacks the amino acid.

Table 3. The amino acid composition of dehulled African nutmeg (*M. myristica*)

Amino acid	Concentration crude protein (mg/g)	Infant requirement range crude protein (mg/g)
Lysine*	33.5	53 - 76
Histidine*	21.9	18 - 36
Arginine*	42.4	-
Aspartic acid	72.0	-
Threonine*	25.4	40 - 50
Serine	36.3	-
Glutamic acid	85.8	-
Proline	23.3	-
Glycine	38.0	-
Alanine	40.0	-
Cystine	9.1	29 - 60
Valine*	36.4	44 - 77
Methionine*	9.9	29 - 60
Isoleucine*	28.3	41 - 53
Leucine*	73.3	83 - 107
Tyrosine	30.5	58 - 118
Phenylalanine*	42.8	58 - 118

FAO/WHO (1985); *essential amino acids

Table 4. Percentage of the essential, acidic, basic and neutral amino acids of dehulled African nutmeg (*Monodora myristica*), (mg/g crude protein)

Amino acids	Crude protein (mg/g)	Percentage
Total amino acid	648.90	100
Total non-essential amino acid	335.0	51.60
Total essential amino acid with histidine	313.90	48.40
Total essential amino acid without histidine	292.0	44.90
Total Acidic amino acid	157.80	24.30
Total basic amino acid	97.80	15.10
Total neutral amino acid	393.30	60.60

Total non-essential amino acids (51.6%) formed the bulk of the amino acids. The value of total essential amino acids (313.9 mg/g protein with histidine) is lower than that of melon seeds (534.4 mg/g protein; Olaofe *et al*., 1994) but higher than that of raw pearl millet (224 mg/g protein; Adeyeye, 2009) while that without histidine (292.9 mg/g protein) is higher than the value of steeped pearl millet (194 mg/g protein; Adeyeye ,2009) soy flour (444 mg/g protein; Paul and Southgate, 1988), and *Cajanus cajans* (426 mg/g protein; Oshodi *et al*., 1993). The amounts of total essential and non-essential amino acids indicate that African nutmeg (*Monodora myristica*) is nutritionally comparable to soy bean, pigeon pea, African yam bean, kidney bean and scarlet runner bean. Total neutral amino acids were 393.3 mg/g crude protein (60.6%). Total acidic amino acids were 157.8 mg/g crude protein (24.3%) while total basic amino acids were 97.8 mg/g crude protein (15.1%) were the least concentrated in the sample.

Conclusion

It can be concluded that the nutritional status of African nutmeg (*Monodora myristica*) is comparable with many protein-rich legumes. It also does not have harmful effects when consumed and the high availability of essential amino acids indicate its potential for future supplement/formulation of foods and as alternative source of protein for human consumption.

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