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Comparative Evaluation of the Nutritive and Functional Attributes of Some Traditional Nigerian Snacks and Oil Seed Cakes

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Abstract: The proximate composition, the content of nutritionally valuable minerals and functional properties of some traditional Nigerian snacks: peanut ball *(Kulikuli)*, maize-groundnut ball *(Donkwa)* and melon ball (Robo) were analyzed along with some oilseed cakes: groundnut cake (GNC), palm kernel cake (PKC) and soya bean cake (SBC). On the average the samples contained 31.7 g/100 g DM crude protein (range, 25.2-34.3 g/100 g DM); 20.6 g/100g DM crude fat (range, 9.2-29.6 g/100g DM); 8.0 g/100g DM crude fibre(range, 2.5-22.4g/100g DM) and ash 10.5 g/100g (range, 2.0-20 g/100g DM) The protein content of the snacks were generally similar to those of the oilseed cakes, while the fat content of the snacks were much higher. The crude fibre content was least in *kulikuli* while PKC had the highest value. The ash content of the snacks were generally much higher than those of the oilseed cakes. The gross energy ranged between 310.8 kcal/100 g in PKC to 559.2 kcal/100 g in *kulikuli*. Ca, Mg, P, K and Na were the most abundant minerals in both the snacks and oilseed cakes, while the Zn, Cu and Mn were the least abundant. The snacks were particularly much higher in their Na content. Among the functional attributes, the water absorption capacity (WAC) ranged from 70 to 220% in the traditional snacks, and from 200 to 260 % in the oilseed cakes. Foaming absorption capacity (FAC), varied from 128 to 147% in the snacks while it varied from 184 to 221% in the oilseed cakes. The least gelation concentration of *Kulikuli, Robo* and palm kernel cake were identical. Fat emulsion capacity and emulsion stability were also similar in all the products. All the samples had varying solubilities with change in pH. The proteins generally had multiple maxima and minima in their solubilities.

Key words: Nigerian snacks, oilseed cakes, palm kernel cake

Introduction

It is well documented that most leguminous plant seeds are rich in nutrients such as digestible protein with a good array of amino acids and minerals (Fagbemi *et al*., 2004; Agbede and Aletor, 2003). It is also regarded as the cheapest source of proteins especially in the diets of resource-poor classes of the population in West Africa (Altschul and Wilcks, 1985; Oshodi and Aletor, 1993; Fagbemi *et al*., 2006). It has been suggested that more than anything else, the lack of adequate information on the composition and processing effects on the food value of the many and varied protein sources indigenous to the tropics is the major problem, rather than a real shortage of protein feed resources (Aletor and Aladetimi, 1989; Adeyeye, 1995; Agbede and Aletor, 2003)

Apart from the indigenous tropical edible legumes which serve as dietary protein sources for a large segment of the population in Nigeria, there are also a wide variety of traditional snacks and appetizers which contribute to the overall dietary protein intake. These include *Kulikuli* (Pea nut ball), *Donkwa* (Maize-peanut ball) and *Robo* (Melon ball). Although these snacks and appetizers are popular food items, with a long history of consumption especially among the low income populace, there exists a paucity of information on their nutritive and functional attributes. While the nutritive potentials of the oilseed cakes such as groundnut cakes (GNC), palm kernel cake (PKC) and soya bean cake (SBC) commonly used as components of livestock feed are well documented (Aletor and Aladetimi, 1989; Amefule and Obioha, 1998), their functional properties like those of traditional Nigerian snacks remain lesser-known. It was therefore the objective of this study to characterize these traditional Nigerian snacks and oil-seed cakes with regard to their proximate constituents, nutritionally valuable mineral content and physico-chemical (functional) properties.

Materials and Methods

Sample collection: The oil seed cakes – Groundnut cake (GNC), palm kernel cake (PKC) and soya bean cake (SBC) were all purchased in fresh condition from Olukayode Feedmill – a commercial feedmill located in Akure metropolis.

Preparation of the Nigerian traditional snacks: These snacks were prepared in simulation of the methods used in most homes as follows:

***Kulikuli* (Peanut ball):** About I kg of groundnut is first roasted and milled, 20 ml of savoil oil is added and make into a paste, this is followed by addition of about 2 grams of pepper (*Capsicum spp*.) this is optional. The paste is moulded into different shapes and sun-dried. It is ready for consumption.

Table 1: Proximate Composition (g/100g DM) and Energy Values (kcal/100g) of Some Traditional Nigerian Snacks and oilseed cakes

Traditional Snacks	DM	CP	EE	CF	Ash	NFE	GE
Peanut ball *(Kulikuli)*	91.8±0.2	32.4± 0.2	31.1±0.1	2.5±0.2	6.0±0.3	19.8	559.2
Maize-groundnut ball *(Donkwa)*	92.0±0.1	28.5±0.2	23.9±0.2	6.2±0.1	20.0±0.1	13.4	443.3
Melon ball*(Robo)*	94.0±0.3	32.4±0.1	29.6±0.2	5.3±0.2	20.0±0.2	6.7	493.0
Oil Seed Cakes							
Groundnut cake (GNC)	97.0±0.1	34.2±0.3	16.5±0.1	6.9±0.5	5.0±0.3	34.4	489.4
Palm kernel cake(PKC)	85.0±0.2	25.2±0.2	9.2±0.4	22.4±0.1	10.0±0.1	18.2	310.8
Soy bean cake (SBC)	95.0±0.2	34.3±0.1	13.3±0.6	4.9±0.2	2.0±0.2	40.5	483.7
Mean	92.5	31.7	20.6	8.0	10.5	22.2	463.2
SD	4.1	3.6	8.9	7.2	7.8	12.8	85.5
CV (%)	4.4	11.4	43.2	90.0	74.2	57.7	18.0

Means are for triplicate determinations. DM, dry matter; CP, crude protein; EE, ether extract; CF, crude fibre; NFE, nitrogen free extract; GE, gross energy.

***Donkwa* (Maize-groundnut ball):** About 1kg of maize and 200g of groundnut are roasted and milled together into powdery form. About 3g of ground pepper (*Capsicum spp.*), 20g of granulated sugar and 2g common salt are added to taste. About 20 ml savoil is added to form a paste and then rolled into ball shape or any other desired shape and ready for consumption.

***Robo* (Melon balls):** To about 1kg of melon is added 20g of onion, 5g of ground pepper (*Capsicum spp.*) and milled. About 25 ml of oil savoil is added and the paste formed is rolled into ball shape and deep-fried in savoil and ready for consumption.

Sample preparation: About 500 g each of the oil seed cakes and traditional snacks were finely milled using a hammer mill to pass through 0.5 mm sieve size. The milled samples were packed in airtight containers and refrigerated prior to analysis.

Chemical and physico-chemical analyses: Proximate analysis of the samples was carried out in triplicate, using method described by AOAC (1995). Nitrogen was determined by micro-kjeldahl method, described by AOAC (1995) and percentage nitrogen was converted to crude protein by multiplying by 6.25. The minerals were analyzed after dry-ashing at 550^{0}C in a Muffle furnace and dissolved in de-ionized water to standard volume. Sodium and potassium were determined by flame photometry while phosphorus was determined by the vanado-molybdate method (AOAC, 1995). The other minerals - Mg, Ca, Zn, Mn, Fe and Cu - were determined using an atomic absorption spectrophotometer (AAS; Vogel, 1962). The gross energy content of the different samples was computed from the proximate constituents as described by Ng and Wee (1989).

Determination of the functional properties: The variation of protein solubilities with pH was determined as described by Oshodi and Aletor (1993) while the water absorption capacity (WAC) and fat emulsion stability (FES) were determined by the procedure of Beuchat (1977). The fat absorption capacity (FAC) was determined as described by Sosulki (1962). Similarly, the lowest gelation concentration (LGC), foaming capacity (FC) and foaming stability of the samples were determined using the technique of Coffman and Garcia (1977).

Data analysis: All data used were means of triplicate (n = 3) determinations. The coefficients of variation (CV) between the different products were also determined (Steel and Torrie, 1980).

Results and Discussion

Table 1 presents the result of proximate composition, carbohydrate fraction and gross energy values of the traditional snacks (peanut ball, maize-groundnut ball and melon ball) and oilseed cakes (groundnut cake, palm kernel cake and soy bean cake). The mean crude protein (CP) content of the samples were 32.4 ± 0.2 g/100 g DM for *kulikuli*; 28.5 ± 0.2 g/100 g DM Donkwa; 32.4 ± 0.1 g/100g DM for *Robo,* while groundnut cake was 34.2 ± 0.2 g/100 g DM; palm kernel cake 25.2 ± 0.2 g/100 g DM and soy bean cake, 34.3 ± 0.1 g/100 g DM. The similarity in these values is attested to by low coefficient of variation (CV) of 11.4%. These results compare favourably with, and even surpassed those of most edible legumes such as lima bean and cowpeas reported by Aletor and Aladetimi (1989); Oshodi and Adeladun (1993). The fat content of the traditional snacks was markedly high, and ranged from 23.9±0.2 g/100 g DM in *Donkwa* to 31.1±0.1 g/100 g DM in *Kulikuli.* Among the oil seed cakes, the fat content ranged from 9.2±0.1 g/100 g DM in PKC to 16.5±0.1 g/100 g DM in GNC. The high fat content of the snacks were results of the processing techniques which generally involved the addition of cooking oils and, or deep frying. The fat values were generally below those of *Adenopus breviflorus, benth* seed (51.1±0.2 g/100 g DM) reported by Oshodi (1992). The crude (CF) ranged from 2.5±0.2 g/100 g DM in *Kulikuli* to 22.4±0.1 g/100 g DM in PKC. The high fibre content in PKC has generally been implicated for low protein digestibility of PKC especially in monogastric animals, including humans. The NFE (carbohydrate) content of the traditional snacks

Table 2: Major and trace mineral components (mg/kg) of some Traditional Nigerian Snacks and oilseed cakes

Traditional Snacks	Major minerals						Trace minerals		
	Ca	Mg	P	K	Na	Fe	Zn	Cu	Mn
Peanut ball (*Kulikuli*)	124.8±0.3	82.5±0.5	171.2±0.2	247.3±0.2	195.7±0.4	12.6±0.3	4.2±0.1	1.7±0.2	0.6±0.1
Maize-groundnut ball (*Donkwa*)	122.7±0.2	60.0±0.0	114.2± 0.2	302.3±0.5	364.5±0.2	22.3±0.2	4.8±0.1	-	0.8±0.2
Melon ball (*Robo*)	130.7±0.1	100.5±0.2	216.3±0.2	322.2±0.3	369.5±0.1	14.8±0.1	5.1±0.1	0.2±0.2	0.9±0.3
Oil Seed Cakes									
Groundnut cake (GNC)	132.7±0.2	185.0±0.1	198.2±0.4	311.5±0.5	117.5±0.4	9.7±0.3	8.0±0.2	0.3±0.1	1.0±0.1
Palm kernel cake(PKC)	163.0±0.2	76.4±0.2	198.2±0.3	72.0±0.1	134.0±0.1	14.7±0.2	4.6±0.1	-	0.8±0.4
Soy bean cake (SBC)	327.3±0.5	73.4±0.6	165.4±0.4	288.0±0.3	170.0±0.6	11.2±0.4	6.5±0.7	-	0.7±0.3
Mean	166.9	96.3	177.3	257.2	225.2	14.2	5.5	0.7	0.8
SD	79.9	45.4	36.2	94.4	113.2	4.4	1.4	0.8	0.1
CV (%)	47.9	47.1	20.4	36.7	50.3	31.0	25.5	14.3	12.5

Means are for triplicate determinations; CV, coefficient of variation

Table 3: Water and Fat absorption capacities, Bulk density and Least gelation capacity of some Traditional Nigerian Snacks and oilseed cakes

Traditional Snacks	Water absorption (%)	Fat absorption (%)	Bulk Density	Least gelation capacity
Peanut ball (*Kulikuli*)	120.0±0.1	147.2±0.2	0.7±0.2	2.0±0.2
Maize-groundnut ball (*Donkwa*)	220.0±0.1	128.0±1.6	0.6±0.2	3.0±0.3
Melon ball (*Robo*)	70.0±1.2	128.8±0.7	0.9±0.1	2.0±0.2
Oil Seed Cakes				
Groundnut cake (GNC)	225±0.1	184.0±0.2	0.5±0.3	4.0±0.2
Palm kernel cake (PKC)	200.2±0.5	202.0±0.9	0.5±0.1	2.0±0.1
Soy bean cake (SBC)	260.0±0.2	220.8±0.2	0.4±0.1	8.0±0.1
Mean	182.5	168.5	0.6	3.7
SD	72.2	39.4	0.2	2.1
CV (%)	39.6	23.4	33.3	56.8

Means are for triplicate determinations; CV, coefficient of variation.

was generally lower than the oil seed cakes. This is attributed to the higher fat content of the snacks relative to the oil seed cakes. The GE values were least in PKC (310.8 kcal/100 g) and highest in *Kulikuli* (559.2 kcal/100 g). Apart from PKC, both the snacks and the oil seed cakes had similar energy values. The similarities in energy value between the snacks and the cakes is attributed to the fact that while the snacks generally had higher high fat content, the oil seed cakes generally had much higher carbohydrate values. These two food constituents are associated with high calorific values of foods.

Table 2 presents the mineral contents of these products. The values compared well with those reported for leguminous seeds (Oke *et al*., 1995; Agbede and Aletor, 2003). Of all the nutritionally valuable minerals analyzed, K and Na were most abundant while Cu was the least abundant, or not detected in some of the products. Apart from the effect of processing on the traditional snacks which brings about increase in Na content, K was also relatively high, especially in the snacks and in agreement with earlier observation of Olaofe and Sanni (1988) that K is an abundant mineral in Nigerian agricultural products.

Table 3 shows the data on the functional properties of the traditional snacks and the oil seed cakes. The water absorption capacity (WAC) ranged from 70±1.2 to 220±0.1% in the traditional snacks and from 200±0.3 to 260±0.2% in the oil seed cakes. This compares favourably with the (180±0.5%) reported by (Tagode and Nip, 1994) for Taro (*Colocasia esculenta*) flour. The high WAC in this study suggests that all the traditional snacks (except melon ball with 70±1.2%) and oil seed cakes may be suitable in the formulation of some foods such as sausages, doughs and soups (Oshodi *et al*., 1997). The FAC ranged from 128±0.7 to 147.2±0.2% in the selected snacks while it ranged from 184±0.2 to 147.2±0.2% in the oilseed cakes. These values were higher than (138 %) reported for soy bean (Ogunsipe, 2000), and suggests that these products may be useful in food formulation especially as flavour retainers. The least gelation concentration of *Kulikuli, Robo* and PKC showed identical value of 2.0% while soybean cake had a much higher value of 8.0±0.2%. This value was higher

Table 4: Foaming Capacity, Foaming Stability, Emulsion Capacity and Emulsion Stability of Some Traditional Nigerian Snacks and oilseed cakes

Traditional Snacks	Foaming Capacity (%)	Foaming Stability (%)	Emulsion Capacity (%)	Emulsion Stability (%)
Peanut ball *(Kulikuli)*	6.0±0.3	3.0±0.6	49.5±0.1	45.7±0.4
Maize-groundnut ball*(Donkwa)*	4.0±0.3	0.0±0.0	49.5±0.7	45.7±2.0
Melon ball *(Robo)*	5.0±0.2	3.0±0.9	44.7±1.2	44.7±0.9
Oil Seed Cakes				
Groundnut cake (GNC)	4.0±0.2	0.0±0.0	45.7±1.5	45.7±0.5
Palm kernel cake (PKC)	4.0±0.1	0.0±0.0	44.0±0.4	44.0±0.6
Soy bean cake (SBC)	20.0±0.1	10.0±0.5	46.5±0.6	45.7±1.5
Mean	7.3	86.3	3.9	46.7
SD	6.3	2.7	144.4	2.4
CV (%)	5.1	45.3	0.1	1.5

Means are for triplicate determinations; CV, Coefficient of variation.

than the 2% reported for soybean (Ogunsipe, 2000) but lower than the 12% reported for Pigeon pea by (Oshodi and Ekperingin, 1989). The low gelation may be an asset in the use of these oil seeds cakes and traditional snacks as additives to other gel forming materials in food product (Altschul and Wilcks, 1985; Fagbemi *et al*., 2006). The foaming capacity of all these products were generally lower than those reported for soy bean flour (70%) and sunflower (230%) by (Ogunsipe, 2000). The foaming stability (Table 4) of these products were also low, which suggests their unsuitability as a whipping agent in food systems. The fat emulsion capacity and fat emulsion stability were relatively high in all the products with a means of 46.7±2.4% and 45.3±0.7%, respectively. This is an important attributes in their potential use for the stabilization of fat emulsion such as in the production of mayonnaise, milks, commuted meats and salad dressings (Adeyeye, 2004).

These products have variable solubilities with varying pH ranges, in both the acidic and alkaline regions which could be useful in industrial applications. *Donkwa* had maximum solubility at pH 1, and maximum solubility at pH 11 while SBC had minimum solubility at pH 5 and maximum solubility at pH 1.

Conclusion: Judging from the proximate composition, mineral contents, gross energy and functional properties, it is of interest that these Nigerian snacks compare well with the oil seed cakes frequently used in Animal feed industries. They also compare favourably with animal protein sources and also implies that they may be useful as supplements to low nitrogen foods such as cereals, tubers and maize gruel.

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