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Quality Characteristics of Some Tropical Legume Flours for Steamed Paste (Moin Moin) Production as Affected by Seed Sprouting

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ABSTRACT

The possibility of using other legumes in the family Fabaceae and the application of seed sprouting process for moin moin production were investigated in the study. The seeds of red kidney bean, pigeon pea and cowpea (control) were collected, sorted and the wholesome seeds were selected for the study. The seeds were divided into two portions and a portion was soaked in water at loading ratio of 1:4, seed: Water, steeped for 12 h and allowed to sprout at ambient condition for 72 h. The bean sprouts were dried in a dryer at an initial temperature of 60°C for 2 h and finished at 80°C to approximate moisture of 10%, dehulled and milled into flour. The second portion (non sprouted seeds) was also dehulled and dried to 10% moisture and milled into flour and finally stored in air tight containers. The resultant flours were evaluated for proximate, functional and sensory attributes using standard analytical methods and the values obtained were compared statistically. The sprouted flours performed better in protein content than the non sprouted, with the sprouted cowpea (CPS) having the highest, 23.4% which did not differ significantly ($p>0.05$) from sprouted red kidney beans, 23.3% while the non sprouted pigeon pea (PPR) had the least protein, 20.4%. Sprouted seeds scored higher than non sprouted in foam capacity and stability, oil and water absorption capacities while non sprouted flours were better in gelation capacity and bulk density. On the overall assessment of the steamed paste, the moin-moin from red kidney beans was preferred by the panelists.

Key words: Seed sprouting, protein improvement, water absorption capacity, gelation capacity, moin moin

INTRODUCTION

Moin moin is steamed bean cake, or bean sponge cake or steamed bean pudding and it is eaten all over Nigeria and beyond (Lasekan *et al*., 1987). Moin moin is rich in phyto-proteins, vitamins and other nutrients and it is a perfect weight loosing meal with good filing effect. Indeed it makes delicious combination with most meals; it can be eaten with jelloff rice, with bread or alone as snack (Dovlo *et al*., 1976). Moin moin preparation is basically the same all over Africa. The beans are soaked preferably overnight, gently squeeze and rub between palms to dehull and washed to remove adhering skin. The dehulled bean seeds are then ground into smooth pasty slurry. Onion, pepper, oil and salt are added to flavor and season; then, stirred with water to give a fairly runny consistency. The pasty slurry is then scooped into small cooking cups or wrapped in leaves or foil and boiled for about 40 min to produce a steamed bean cake called moin moin (Ihekoronye and Ngoddy, 1985).

However, the traditional method of preparing fresh cowpea paste from cowpea seeds is labour intensive and time consuming, indeed, the availability of ready to use bean flour eliminates the drudgery of soaking, dehulling and grinding of bean seeds domestically (Olapade *et al.*, 2005).

In addition to providing essential amino acids, bean proteins possess the requisite functional properties for their successful utilization in various food products. These functional properties are the intrinsic physio-chemical characteristics which affect their behaviour in food systems during processing, manufacturing, storage and preparation (Akobundu *et al.*, 1982).

Critical functional properties provided by protein rich ingredients include gelation capacity, emulsion capacity, protein solubility, water and fat absorption capacity, organoleptic properties and bulk density (Nwanekezi *et al.*, 1994).

Presently, only cowpea seeds are being utilized in the production of moin moin, despite the availability of other well-known legumes (Olapade *et al.*, 2005). Hence, there is need to ascertain the quality and consumer acceptability of steamed bean cake or moin moin produced from other legumes.

Also, there is need to popularize bean sprouting in moin moin production in view of the immense nutritional and health benefits derivable from bean sprouts.

This study investigates the influence of bean sprouting on the proximate, functional and sensory quality of moin moin and compares quality of steamed bean cake (moin moin) produce from some legumes.

MATERIALS AND METHODS

The study commenced from 12th October 2012 and lasted to 7th January, 2013. The legume seeds (cowpea, red kidney bean and pigeon pea) used for the study were purchased from Eke ukwu market Owerri. The seeds were cleaned, sorted and each variety was divided into two portions. One portion was subjected to sprouting while the second portion served as control. Bean sprouting, kilning and milling were carried out by soaking the seeds in water at loading ratio of 1:4 seed to water. The soaking lasted for 12 h, which comprised of 3 h soaking and 1 h air rest changing of the soak water every 3 h. Thereafter the bean seeds were spread thinly on a moist jute bag and kept under ambient conditions for 72 h to allow germination to take place. The sprouting was stopped when the length of the rootlets measured approximately 2.54 cm.

The bean sprouts were loaded in an air dryer (model, DHG-9109 by Life Care Medical Ltd), set at initial temperature of 60°C for 2.0 h and thereafter raised to 80°C. Drying was stopped when the moisture content of the cotyledon was found to be approximately 10%.

The rootlets and the hull were subsequently removed and the dried cotyledon milled into flour. The second portion (control) was dehulled and dried to 10% moisture and milled into flour. The milled flour was finally stored in air tight container.

ANALYSES OF THE LEGUME FLOURS

Proximate composition: The proximate composition (protein, fat, moisture, ash, carbohydrate and crude fibre) of the flours were analyzed as described by AOAC (1995).

FUNCTIONAL PROPERTIES OF THE LEGUME FLOURS

Foam capacity: The method described by Onwuka (2005), was followed in the determination of the foam capacity of the legume flours. Two grams of flour was weighed out into a warring blender (warring commercial blender, blender 8011, model HGB2WTGA) and 100 mL; distilled water was transferred into the blender. The resultant suspension was whipped at 1600 rpm for 5 min. Thereafter the whipped mixture was poured into a 250 mL measuring cylinder and the initial volume was obtained, subsequent readings were obtained at 30 sec interval:

$$\text{Foam capacity (\%)} = \frac{\text{Volume after whipping} - \text{volume before whipping}}{\text{Vol. before whipping}} \times 100$$

Bulk density: The bulk density of the samples was determined using the procedure described by Milson and Kirk (1980). Fifty grams of the sample was weighed into 100 mL graduated cylinder and the initial volume recorded. The cylinder was tapped repeatedly for 100 times to a constant volume and the final volume recorded. The bulk density was calculated as: Mass of the sample divided by the volume at the end of tapping:

$$\text{Bulk density (g mL}^{-1}\text{)} = \frac{\text{Weight of sample (g)}}{\text{Volume of sample (mL)}}$$

Emulsion capacity: The procedure described by Onwuka (2005) was followed for the determination of emulsion capacity. Two grams of the sample and 25 mL of distilled water were put in a warring blender. A complete dispersion was obtained by blending at 1600 rpm for 30 sec. Subsequently, 25 mL of vegetable oil (groundnut oil) was gradually introduced into the dispersion and blending action continued for another 30 sec. The dispersion was then transferred into a graduated centrifuge tube and centrifuged at 1,600 rpm for 5 min. The volume of oil separated from the sample after centrifuge was read directly from the centrifuge tube:

$$\text{Emulsion capacity (\%)} = \frac{\text{Height of emulsified layer}}{\text{Height of whole solution in the centrifuge tube}} \times \frac{100}{1}$$

Water/oil absorption capacity: The procedures described by Onwuka (2005) were followed for the determination of water absorption and oil absorption capacities. One gram of the sample was weighed into a graduated centrifuge tube to make a 10 mL dispersion with distilled water or vegetable oil and swirled for 30 sec. The 10 mL dispersion was allowed to stand for 30 min at room temperature and then centrifuged at 5000 rpm for 30 min.

The volume of free water or oil (the supernatant) was read directly from the graduated centrifuge tube. The amount of water or oil absorbed (total min free) is multiplied by its density for conversion to grams of water or oil.

Gelation capacity: The procedure described by Onwuka (2005) was used for the determination of gelation capacity. Suspensions of 2-20% (w/v) in 5 mL distilled water were prepared in test tubes. These were immersed in a boiling water bath and heated for 1 h, followed by rapid cooling under running cold tap water.

The least gelation concentration was taken as the concentration when the sample from the inverted test tube did not fall or slip.

Moin-moin preparation: The flours were used to prepare moin moin following the method described by Enwere (1998) with little adjustments. The recipe used for the moin moin production was: 500 g of flour, 1.5 L of water (50°C), 180 mL of vegetable oil, 30 g of pepper and 50 g of salt. These were mixed to obtain a homogenous smooth paste. The paste was rested at ambient temperature for 10 min. to allow the flour absorb water. Thereafter the suspension was stirred and dispensed into aluminum cups and steamed for 35 min and cooled thereafter.

The moin moin produced from each of the legume flour sample was used for sensory evaluation.

Sensory evaluation: Sensory evaluation was conducted to determine consumer preferences, using a 9-point hedonic scale as described by Watt *et al.* (1985) for the degree of likeness. Nine represented "like extremely", the midpoint, 5 represented "neither like nor dislike" and runs down to one which represented "dislike extremely". Twenty member panelists drawn from moin moin consumers were used and samples were presented to judges in clean dried plates.

The parameters assessed were: Texture, appearance, taste, aroma and general acceptability.

Statistical analysis: The data from the study obtained in triplicates, were subjected to Analysis of Variance (ANOVA) using the SAS software (SAS, 2000).

RESULTS AND DISCUSSION

Proximate composition of sprouted and non sprouted legume flours: The result of the proximate composition of both the sprouted and non-sprouted legumes flours are shown in Table 1. There were significant variations among the components investigated at $p = 0.05$.

The values obtained for carbohydrate shows that the raw cowpea flour (CPR) scored the highest, 62.4% while the sprouted pigeon pea (PPS) gave the least, 53.1%. It is evident that sprouting resulted in reduction of the carbohydrate content of the legume flours. The raw red kidney bean flour (RKR) scored 61.0%, which when compared to the sprouted red kidney bean flour, 56.0% amounted to 8.2% reduction in the carbohydrate content due to sprouting. The cowpea had 11.6% reduction in carbohydrate while pigeon pea had 7.3% reduction from 57.3% for PPR to 53.1% for PPS.

The observed reduction in carbohydrate content could be attributed to hydrolisation of complex carbohydrates like hemicelluloses, cellulose and lignins during sprouting. Also, the carbohydrate is broken down and used in the generation of germination energy during sprouting. The metabolism and transport of carbohydrate from the storage organs such as the cotyledons to the growing parts may explain the reason for carbohydrate depletion (Chen *et al.*, 1975).

The protein value of the flour RKS (23.3%) did not differ significantly ($p<0.05$) from CPS (23.4%) flour. The least protein value was recorded for PPR, 20.4%. The result indicates that sprouting increased the protein content of the samples. As can be seen from the values, the protein content of raw red kidney bean (RKR) gave 21.8% while that of RKS scored 23.3%. The increment in protein translates to 6.9%. The pigeon pea had the highest increase in protein 7.7% (PPR had 20.4% while PPS had 22.4%). A net synthesis of enzymic proteins during germination might possibly account for the protein increase Berry *et al.* (1988). However substantial increase in proteolytic activity found during germination may have brought the shift in protein distribution from high molecular weight (less soluble) to low molecular weight (more soluble) protein.

The fat content in Table 1 ranged from 1.1% in RKS to 1.9% in PPR. Sprouting resulted in significant variation ($p<0.05$) in the fat content of the legume samples. The there were general decline in fat content as a result of seed germination. RKR had 1.4% while RKS 1.1% fat (amounting to 21.4% fat reduction); CPR scored 1.53% while CPS had 1.30% (15% reduction). Also, PPR had 1.90 while PPS scored 1.50% (21% reduction). The decrease in fat value may be partly

Table 1: Mean values of proximate composition of sprouted and non-sprouted legume flours

	Proximate composition (% db)					
Sample	Carbohydrate	Protein	Fat	Ash	Crude fibre	Moisture
RKR	61.0^{b}	21.8^{d}	1.4^{b}	3.5^{c}	4.7^{d}	11.0^{a}
RKS	56.0^{d}	23.3^{a}	1.1^{d}	4.2^{b}	5.4^{b}	10.2^{b}
CPR	62.4^{a}	22.1^{c}	1.53^{b}	3.4^{c}	4.4^{e}	10.0^{b}
CPS	55.2^{d}	23.4^{a}	1.30^{c}	4.5^{a}	5.2^{c}	10.3^{b}
PPR	57.3^{c}	20.8^{e}	1.9^{a}	3.2^{d}	4.6^{d}	10.5^{b}
PPS	53.1^{e}	22.4^{b}	1.5^{b}	4.1^{b}	6.3^{a}	10.1^{b}
LSD	1.0373	0.177	0.1626	0.1779	0.1779	1.0373

Means are values of triplicate determinations, means with the same superscripts in a column did not differ significantly at p = 0.05, RKR: Non sprouted red kidney bean flour, CPR: Non sprouted cowpea, bean flour, RKS: Sprouted red kidney bean flour, CPS: Sprouted cowpea bean flour, PPR: Non sprouted pigeon pea flour, PPS: Sprouted pigeon pea flour

explained by the rapid use of fat for energy and synthesis of certain structural constituents in the young seedling (Olapade *et al.*, 2005). On the other hand the decrease may have resulted from increased lipase activity since several lipases were involved in lipid breakdown (Nwanekezi *et al.*, 1994).

There were significant variations ($p<0.05$) in the ash content of the legumes flours. Sprouted cowpea (CPS) scored highest (4.5%), followed by sprouted red kidney beans (4.2%) while the least ash (3.2%) was obtained for non sprouted pigeon pea (PPR). It is evident from the result that sprouting increased the ash content of the samples. The increase in ash is a reflection of mineralization, which occurs during germination of seeds (Vijaya, 1983).

The sprouted pigeon pea (PPS) gave the highest crude fibre, 6.3% while the least 4.4% was obtained for non sprouted cow pea. The crude fibre values differed significantly ($p<0.05$) with the exemption of crude fibre values for RKR (4.7%) and PPR (4.6%) which did not differ at the probability $p = 0.05$. Sprouting improved the crude fibre value in all the legume flours. Berry *et al.* (1988) reported a similar increase in crude fibre in germinated winged beans. The increase in crude fibre resulting from germination of seeds amounted to 14.9% for red kidney beans, 18.2% for cowpea and 36.9% for pigeon pea. The observed increase in crude fibre might be due to sugar utilization in the seed for metabolic sprouting activity and leaving behind fibrous seeds.

Functional properties of sprouted and non sprouted legume flours: The functional properties of sprouted and non spouted legume flours are shown in Table 2. All the parameters observed were significantly affected ($p<0.05$) by sprouting of the legume seeds.

Foam capacity and stability: The foam capacity and stability were improved by sprouting of the seeds. The highest foam capacity was obtained for the sprouted pigeon pea (PPS), 89.5%, which incidentally had the highest foam stability, 47%. On the other hand the least foam capacity was obtained for non sprouted red kidney beans (RPR), 68.2% as well as low foam stability, 20.7%. The obtained values are in agreement with the findings of Rahma *et al.* (1987) who observed improvements in the foam capacity of germinated legumes. The increased foam capacity of the germinated flour might not be unconnected with the high protein solubility associated with modification which occurred during germination (King and Puwastien, 1987).

Protein stabilized foams facilitate the production of aerated foods and are important in confectioneries, whipped toppings, ice cream etc.

Table 2: Mean values of functional properties of sprouted and non- sprouted legumes flours

Sample	Foam capacity (%)	Foam stability (%)	Water absorption (mL g^{-1})	Oil absorption (mL g^{-1})	Emulsion capacity (%)	Emulsion stability (%)	Gelation capacity (w/v)	Bulk density (g L^{-1})
RKR	68.2 ± 0.5^{e}	20.7 ± 1.6^{d}	133.1 ± 2.0^{e}	95.1 ± 2.5^{d}	52 ± 1.2^{e}	36 ± 1.1^{e}	26 ± 1.3^{d}	526 ± 1.8^{c}
RKS	86 ± 0.1^{b}	27 ± 0.6	181 ± 1.0^{a}	126 ± 1.8^{a}	68 ± 1.2^{b}	51 ± 0.3^{b}	17 ± 1.1^{a}	337.1 ± 0.3^{f}
CPR	74.9 ± 2.1^{d}	28.3 ± 1.6^{e}	128.3 ± 1.0^{f}	94.7 ± 0.2^{d}	58 ± 2.4^{d}	28.5 ± 1.7^{f}	23 ± 3.1^{e}	542.1 ± 0.3^{b}
CPS	84.1 ± 1.3^{c}	36 ± 1.1^{c}	167 ± 0.0^{b}	106.7 ± 1.7^{b}	75.1 ± 0.1^{a}	48.6 ± 2.1^{c}	$15.1.6^{b}$	411 ± 0.6^{e}
PPR	75.3 ± 0.1^{d}	40.1 ± 3.0^{b}	148.3 ± 1.2^{d}	89 ± 2.1^{e}	50 ± 0.3^{f}	39 ± 0.5^{d}	19.3 ± 1.6^{f}	548.1 ± 1.0^{a}
PPS	89.1 ± 1.1^{a}	47 ± 0.6^{a}	161.3 ± 1.3^{c}	98.5 ± 1.1^{c}	63 ± 1.7^{c}	56 ± 1.8^{a}	13 ± 1.5^{c}	437 ± 2.1^{d}
LSD	0.7442	1.264	1.779	1.2642	1.6256	1.4562	1.625	1.779

Means are values of triplicate determinations, Means with the same superscripts in a column did not differ significantly at $p>0.05$, RKR: Non sprouted red kidney bean flour, CPR: Non sprouted cowpea, bean flour, RKS: Sprouted red kidney bean flour, CPS: Sprouted cowpea bean flour, PPR: Non sprouted pigeon pea flour, PPS: Sprouted pigeon pea flour

Emulsion capacity and emulsion stability: Seed sprouting treatment improved the emulsion capacity of legume flours. The emulsion capacity of RKR was found to be 52% while RKS had 68% which represents 30.77% increase. The CPR recorded 58% while CPS gave 75.1% which is equivalent to 39.5% increase. Similarly, PPR which scored 50%, increased to 63% for PPS, which stands for 26% increase in emulsion capacity.

The emulsion stability witnessed similar increase due to seed sprouting. The sprouted red kidney beans (RKS) had 41; CPS, 75 and PPS, 43.6% increases in their emulsion stability. The observed increases might be explained by the fact that seed germination improved protein solubility and emulsification capacity is a reflection of the solubility of protein (Shanmugasundaram and Venkataraman, 1989).

Oil absorption capacity: There were significant variations ($p<0.05$) in the oil absorption capacity of the legume samples. The values indicate that sprouting increased the oil absorption capacity of the legumes flours. The highest oil absorption capacity, 126 mL g^{-1} was obtained for RKS while PPR, 89 mL g^{-1} had the least. The increase in oil absorption capacity might be attributed to enzymic modification which occurred during sprouting and resulted in disruption of the native protein structure to yield smaller protein aggregates and unmask the non-polar residues from the interior of the protein molecules since non-polar amino acid side chains bud with the paraffin chains of fat (Lukow and Bushuk, 1984). The ability of protein to bind fat is vital since fat acts as flavour retainer and also increases the mouth feel of foods (Eke and Akobundu, 1993). Oil absorption capacity is a very important functional property in meat formulations,doughnuts, pancakes and baked foods, moin moin and Akara.

Bulk density: The bulk density of the legumes flours were significantly decreased by sprouting with the non sprouted pigeon pea (PPR) flour having the highest bulk density of 548.1 g L^{-1} while PPS had the least 437 g L^{-1}. Plaami (1997) observed that bulk density is influenced by the structure of starch polymers and loose structure of starch polymers result in low bulk density. The lower the bulk density, the higher the floatation of the legume flour on top of water and hence may not soak and mix properly in water.

Gelation capacity: Sprouting of the legume seed resulted to significant reduction in the gelation characteristics of the flours. The least gelation concentration of the non sprouted red kidney (RKR) flour was 26% w/v while that of germinated red kidney RKS was 17% w/v. The observed decrease in gelation capacity might be attributed to break down of complex structures of protein and carbohydrates (Deshpande *et al*., 1982). Gelation capacity is a useful parameter in food systems like puddings and food products which are require thickening such as moin-moin (Eke and Akobundu, 1993).

Water absorption capacity: The highest value for water absorption capacity 181 mL g^{-1} was obtained for PPS while the CPR had the least, 128.3 mL g^{-1}. The observed increase in water absorption capacity by sprouting might be attributed to gradual degradation of starch by enzymic attack during sprouting; such starch is more susceptible to physical damage during milling (Lukow and Bushuk, 1984). This expected increase in the level of damaged starch content of the germinated flour might account for the higher uptake of water.

Sensory evaluation: The result of sensory evaluation of moin-moin samples produced from sprouted and non sprouted legume flours are presented in the Table 3.

The texture of the moin moin samples differed significantly ($p = 0.05$), however RKR was rated highest, 7.89 and followed by RKS, 7.83, while the texture of PPS was rated the least, 7.47. Sprouting was found to decrease the score for texture of moin moin.

The taste of moin moin from the sprouted red kidney beans (RKS) was rated highest 8.68, followed CPR, 8.62, while PPS had the least rating, 6.75. Thus with the exception of sprouted red kidney beans (RKS), others had their moin moin taste decreased by seed sprouting as adjudged by the panelists.

The appearance of moin moin from RKS was rated highest (7.68), followed by RKR (7.44), these values however differed significantly ($p<0.05$) but were superior to the rating for CPR, which is the usual legume seed for moin moin production.

The RKS also rated the best in terms of aroma, (8.64), which did not differ from the score for CPR, (8.53). While sprouting enhanced the aroma of the moin moin from RKS and PPS, it decreased the rating for sprouted cowpea (CPS).

The moin moin from sprouted red kidney beans (RKS) was adjudged the best overall acceptability (8.16), which differed significantly from the runner up CPR, (8.04). It has shown from the panelist's rating that quality moin moin can be produced from red kidney beans by seed sprouting. However, sprouting failed to improve the moin moin quality of CPS and that of PPS.

Table 3: Mean values of sensory attributes of steamed paste (moin moin) prepared from sprouted and non- sprouted legumes flours

	Sensory attributes				
Sample	Texture	Taste	Visual appearance	Aroma	Overall acceptability
RKR	7.89^{a}	7.62^{c}	7.44^{b}	7.51^{b}	7.74^{c}
RKS	7.82^{b}	8.68^{a}	7.68^{a}	8.64^{a}	8.16^{a}
CPR	7.74^{c}	8.62^{b}	7.36^{c}	8.53^{a}	8.04^{b}
fiCPS	7.59^{d}	6.68^{f}	7.11^{d}	7.16^{b}	7.60^{d}
PPR	7.54^{e}	7.41^{d}	6.86^{e}	7.18^{b}	7.50^{d}
PPS	7.47^{f}	6.89^{e}	6.75^{f}	7.32^{b}	6.25^{c}
LSD	0.0178	0.0178	0.0178	0.8325	0.0137

Means are values of triplicate determinations, Means with the same superscripts in a column did not differ significantly at $p>0.05$, RKR: Non sprouted red kidney bean flour, CPR: Non sprouted cowpea, bean flour, RKS: Sprouted red kidney bean flour, CPS: Sprouted cowpea bean flour, PPR: Non sprouted pigeon pea flour, PPS: Sprouted pigeon pea flour

CONCLUSION

- This study revealed that sprouting resulted to reduction in carbohydrate and fat contents of the legumes flours, while it improved the crude protein, crude fibre and ash contents of the legume flours
- Sprouting was found to increase the bio-availability of the mineral content of minerals investigated and also led to significantly reduction of the antinutritional contents of the legumes flours
- Functional properties such as foaming, emulsion, gelation, water and oil absorption capacities increased significantly while bulk density were however decreased as a result of sprouting
- Going by the panelist's rating, quality moin moin can be produced from red kidney beans by sprouting the seed, since sprouted red kidney flour was judged as best overall for sensory attributes for the cooked paste (moin-moin)

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