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Full Length Research Paper

Functional properties and anti-nutritional factors of some selected Nigerian cereals

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Functional characteristics and certain anti-nutritional factor of some selected Nigerian cereals were investigated using various analytical methods to assess their potentiality as protein and fibre sources .The functional characteristics were water absorption and oil absorption capacity. They were found to be in the range of 14.0-17.0% and 18.0-10.0% respectively. While least gelation concentration, foaming capacity, foaming stability, swelling power, swelling solubility and bulk density were found to be 0.20-0.20g, 9.62-0.00%, 1.92-0.00%, 156.05-211% and 27.5-14.2% and 0.87-1.11g/cm^3, respectively. The anti-nutritional factors had values in Mg/100g were in the range of phytic acid (121.76-27.19), oxalates (5.35-1.76) and tannins (0.41-0.09). The functional characteristics of the cereal flours showed that they could be used as thicker in food systems, binder in meat emulsion and in colloidal food system as emulsion stabilizer.

Keywords: Colloidal, water absorption capacity, oil absorption capacity, cereals, gelatin concentration, swelling power.

INTRODUCTION

Cereal grains are grasses, members of the monocot families *Poacecae* or *Gramineae*. Cereal grains are grown in greater quantities and provide more food energy worldwide than any other type of crop. They are a rich source of vitamins, minerals, carbohydrate, fat, oils and protein. The amount of crude protein found in grain is measured as Grain Crude Protein Concentration (GCPC) (Vogel, 2003).Wheat (*Triticum Spp.*) is a grass (Cauvain and Cauvain, 2003) originally from the Fertile Crescent region of the Near East, but now cultivated worldwide. Wheat is the leading source of vegetable protein in human food, having a higher protein content than either maize (corn) or rice, and other major cereals (Cauvain and Cauvain, 2003). It is currently second to rice as the main human food crop, and ahead of maize, although maize is more extensively used in animal feeds. Wheat is a key factor enabling the emergence of city-based societies as the start of civilization. This is because it is one of the first crops that could be easily cultivated on a large scale. It also has the additional advantage of yielding a harvest that provides a long-term storage of food. Wheat grain is staple food used to make flour for leavened, flat and steamed breads, biscuits, cookies, cakes, breakfast cereal, pasta, noodles, couscous (Palmer, 2001). Wheat is planted to a limited extent as a forage crop for livestock and its straw can be used as a construction material as thatch for roofing (Smith, 1995). The whole grain is a concentrated source of vitamin, minerals and protein (Lev-Yadun *et al.,* 2000).

On the other hand, maize (*Zea mays)* which is also known as corn in many English- speaking countries is a grain domesticated by indigenous people in Mesoamerica in prehistoric times. The Aztecs and Mayans cultivated it

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in numerous varieties throughout Central and Southern Mexico, to cook or grind in a process called nixtamalization. Maize spreads to the rest of the world due to its popularity and ability to grow in diverse climates. Most commercially grown maize has been bred for a standardized height of 2.5 meters (Karl, 2008). Maize is a major source of corn starch (maize flour), which is a major ingredient in home cooking and in many industrialized food products. Maize is also a major source of cooking oil and of maize gluten. Maize starch can be hydrolyzed and enzymatically treated to produce syrups, a sweetener; which is also fermented and distilled in order to produce grain alcohol. Starch from maize can also be processed into plastics, fabrics, adhesives and many other chemical products. (Karl 2008). Rice (*Oryza sativa)* is the seed of the monocot plants. As a cereal grain, it is the most important staple food for a large part of the world's human population, especially in East and South Asia, the Middle East. It is the grain with the second highest worldwide production. After maize (corn), rice is the most important grain with regard to human nutrition and caloric intake (Douangboupha *et al.,* 2006). It provides more than one fifth of the calories consumed worldwide by the human species (Crawford, 1998).

Our research work aimed at determining the functional properties and anti-functional factors of selected cereals, which can be used for food formulation, especially for infant food and in allied industries.

MATERIALS AND METHODS

Sample collection and treatment

The selected cereals, corn, rice and wheat were purchased at Igbona market, Osun State, Nigeria. The dried samples were sorted, grinded into powdery form using Marlex Excella Mixer Grinder with 3S.S jars (Model: Excella Qty), packaged and labeled in a polythene bag and then kept for further analysis.

METHODOLOGY

Assessment of functional properties

The bulk density of the samples was determined according to the method described by Akpanunam and Markalis (1981).Water and oil absorption capacities of the flour were also carried out according to the modified method of Prinyawiwatkul *et al.* (1997).

Swelling power and solubility of flours were determined by method described by Muhammad *et al.* (2011). The modified procedure of Coffman and Garcia (1977) were also used to determine gelation proportion. The method of Muhammad *et al. (*2011) was employed in the study of foaming capacity and stability.

Determination of anti-nutritional factors

Tannic acid content was determined by the method described by Kadhakrishna and Sivaprasad (1980). Phytic phosphorus was determined according to the method described by Nelson (1968). Oxalate was also determined by the permanganate titration method of Dye (1956).

RESULTS AND DISCUSSION

Table 1 reveals the functional properties of the selected cereals. They are discussed below.

WAC-water absorption capacity
OAC-Oil absorption capacity
LGC-Least gelation concentration
Fc-Foaming capacity
FS-Foaming stability
SP-Swelling power
SS-Swelling solubility
BD-Bulk density

Fig 1: shows the statistical measurement of the functional characteristics of the selected cereals using table 1. The Least Gelatine Concentration does not show on the column because of its low values.

Water and oil holding capacities of the selected cereals were: wheat; 14.0 and 18.0, maize; 14.0 and 15.0, rice; 17.0 and 10.0 respectively. Wheat was found to possess less water and oil holding capacity than cashew nut flour (WAO 240 and OAC 220%) as reported by Ibrahim *et al.* (2011). The water and oil holding capacities are essential functional properties of cereal which may be defined as the amount of water or oil retained by a known weight of flour under specific conditions. The water holding capacity depends on capillary, pore size and charges of the protein molecules. This is due to strong correlation of extent of protein hydration with polar constituents along with the hydrophilic interaction through hydrogen bonding. The higher protein content in the flour might be responsible for high hydrogen bonding and high electrostatic repulsion (Altschul and Wilcke, 1985). The oil holding capacity is also due to enhanced hydrophobic character of proteins in the flours.

Least gelation concentration of the selected cereals was wheat 0.2g, maize 0.3g and 0.2g. These values were found to be lower than those reported by Muhammad *et al.* (2011) which was 18%). For rhizomes of lotus, the concentration is considered as the gelling ability of flour which provide structural matrix for holding water and other water soluble materials like sugars and flavors. The LGC of different flours may vary depending on the relative ratios of different constituent like protein carbohydrates and lipid (Sathe *et al.,* 1982). It also serves as a good binder in food preparations especially

Table 1. Functional properties of the selected cereals

Properties*	Rice	Maize	Wheat
Water Absorption capacity (WAC) (%)	17.0±0.05	14.0±0.10	14.0±0.10
Oil absorption capacity (OAC) (%)	10.0±0.25	15.0±0.10	18.0±0.01
Least gelation concentration (LGC) (g)	0.20±2.00	0.30±0.210	0.20±0.01
Foaming capacity (FC) (%)	0.00	0.00	9.62±0.10
Foaming stability (FS) (%)	0.00	5.77±0.12	1.92±0.11
Swelling power (SP) (%)	211±0.05	111±0.11	156±0.13
Swelling solubility (SS) (%)	14.2±1.11	31.1±0.13	27.5±0.14
Bulk density (BD) (g/cm^3)	1.11±0.11	0.98±0.12	0.87±0.14

*Results are presented as mean ± standard deviation of triplicate determination

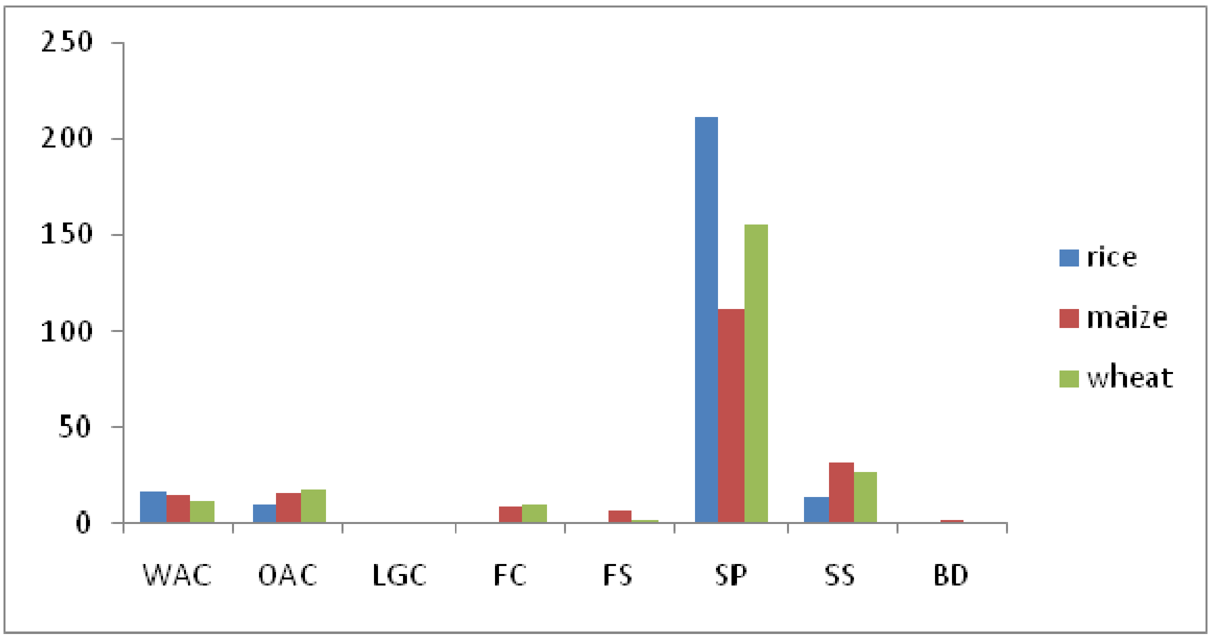

Fig 1. Statistical measurement of functional characteristics of the selected cereals

the semi-solid product (Adeyemi and Umer, 1994). The increasing concentration of protein in the flour facilitates the gelation properties, which may be due to the enhanced interaction among the binding forces (Lawal *et al.,* 2004).

The results revealed the foaming capacity and foaming stability of selected cereal flours which were found to be wheat 9.62, maize 0.00 and Rice 0.00 and wheat 1.92, maize 5.77 and Rice 0.00 respectively (all in %). The values of FC and FS were found to be low compare with those reported by other workers for different flours as reported in the work of Muhammad *et al.* (2011) (FC,18% and FS, 5.23%). The low formability of the selected cereals flours indicates the presence of highly ordered globular protein molecules which increase the surface tension. Foaming properties are much important in the maintenance of the texture and structure of different food product (ice creams and bakery products) during and after processing. The foam ability of the flour depends on the presence of the flexible protein molecules which may decrease the surface tension of water (Sath *et al.,* 1982)

The bulk density of flour were found to be (g/cm^3) wheat 0.87, maize 0.98 and Rice 1.11 .These values were found to be comparable to those reported for Jack fruit flour (Odoemelam, 2005) Raw flour 0.6 and Processed flour 0.54g ml -l). The low values of bulk densities make the flour suitable for high nutrient density formulation of foods

Nutrient density formulation of foods

Swelling power and swelling solubility values of the flour were found to be wheat 156.05, maize 111 and Rice 211 and wheat 27, maize 31 and rice 14.2 respectively (all in %). The swelling power of the cereal flours was found to be higher while swelling solubility was found to be lower than those reported by Muhammad *et al.,* (2011) for

Table 2. Anti-nutritional factors of the selected cereal flours

Parameters* (Mg/100g)	Rice	Maize	Wheat
Phytic Acid	27.19 ± 0.1	82.81 ± 0.1	121.76 ± 0.1
Phytic Phosphorus	7.66 ± 0.4	23.33 ± 1.0	34.30 ± 1.0
Oxalates	1.76 ± 0. 1	3.71 ± 0.4	5.36 ± 0.2
Tannins	0.09 ± 0.2	0.26 ± 0.1	0.4 ± 0.4

*Results are presented as mean ± standard deviation of triplicate determination

rhizomes of lotus. Swelling power and Swelling capacity are 48.93 and 96.43% respectively. The swelling power determines the maximum amount of oil that can be emulsified by protein dispersion; on the other hand, swelling solubility determines the swelling capacity with a specific composition to remain unchanged.

Table 2 illustrates the content of different anti-nutritional factors concentrated in the different cereals flours.

One of the anti-nutritional factors which occurred within the range of 27.19 and 121.76 Mg/100g is phytic acid. This range is a bit higher to that found in the wheat, rice, barley and oat bran that are within the range of 27.69 Mg/g and 42.82 Mg/g (Savita et *al.,* 2011). Wheat had the highest amount of phytic acid (121.54Mg/100g) followed by maize (82.81Mg/100g) and rice (27.19 Mg/100g) respectively. The variation in phytate content may be attributed to the difference in milling, extraction rate, genotype and environmental effects (Sharma *et al.,* 2004). Phytic acid also has a strong binding capacity and forms complexes with multivalent cation, including Ca, mg, Fe and Zn and render them biologically unavailable (Reddy *et al.,* 1982). Thus, the phytic acid present in the cereal is a nutritional concern. The adverse effects of high phytate content in the cereals on Ca absorption have been demonstrated by several workers (Casey and Lorez, 1977).

Tannin content (Mg/100g) of all the selected cereals used ranged from 0.09 to 0.40 Mg/100g. Percentages of tannins in different cereals as reported by Juliano (1985) are oat 1.1%, barley 0.7%. Tannins are concentrated mainly in the seed coat, preliminary de-hulling constitutes the simplest method for their removal. Significant differences in the tannin content were seen among rice, wheat, barley and oat bran.

Table 2 revealed that the whole wheat exhibited the highest level of oxalates (5.36Mg/100g) followed by maize (3.71Mg/100g) and rice (1.76 Mg/100). This was compared with the oxalate constant of oat bran 37.0 Mg/100g as reported by Boontaganon *et al.* (2009). The data suggested that a daily portion of bran product, particularly wheat bran, would supply a constant intake of soluble and insoluble oxalate but this would be a relatively small intake compared to other oxalate containing food that may be eaten in the diet. The oxalate content was found to be higher in the whole grain than in refined grain cereals. This suggests that oxalic acid is primarily located in the outer layers of cereal grains (Satinder *et al.,* 2011).

CONCLUSION

The flour possesses appreciable functional properties which can be an advantage of being used in bakery and food products. Good swelling power, water absorption capacity makes it useful to be as thickener in liquid and semi-liquid food. It also possesses good foaming capacity and foaming stability and therefore found to be more effective in increasing the shelf life of product and can be used in formulation of food products. Higher values of bulk density provide packing advantage and can be made use of in the preparation of high nutrient density weaning food. The anti-nutritional factor present in the cereal flour can be reduced or removed by cooking.

REFERENCES

Adeyemi A, Umer S (1994). Effect of method of manufacture on quality characteristics of
kunu Zaki, millet-based beverages. *J. Niger. Food. 12: 944-947.*

Agarwal K (2004). Physico-chemical characteristics of rice bran processed by dry heating and extrusion Cooking. *Int. J. Food Prop.* 7: 603-614.

Altschul M, Wilcke AL (1985). New protein food, *J. Food Sci. Technol.* Orlando FL. Acad. press.

Akpapunam MA, Markakis P (1981). Physicochemical and nutritional aspects of cowpea flour. *J. Sci.* 46: 972-273 Detarium microcarpum (Gil and sperr T). Biol. Sci: 4 (6): 711-7445

Bootaganon P, Jehano E, Savage GP (2009). Total soluble and insoluble content of bran and bran product. *J. Food Agric. Environ.* 7: 204-206

Cauvain SP, Cauvain PC (2003). Bread making. CRC Press. P. 540 ISBN 1 – 85573 – 553 – 9.

Casey P, Lorenz K. (1977). Millet functional and Nutritional properties bakers Digest. 51-45.

Coffman AW, Garcia VV (1977). Functional properties and acid contents of protein
isolate from Mung bean flour. *J. Food Technol.*12:473-484.

Crawford, G. W., Shen, C. (1998). The origin of rice agriculture: Recent progress in East Asia, Antique 72: 858 – 866.

Douangboupha BK, Khamphoukeo S, Inthavong JS, Jahn GC (2006). Pests and diseases of the rice production systems of Laos. 17: 265–281. Schiller JM, Chanphengxay MB, Linquist B, Appa Rao S, editors. Rice in Laos. Los Baños (Philippines): IRRI. ISBN 978-971-22-0211-7.

Ibrahim TA, Omosulis V, Oloye DA, Aladekoyi G, Ogundowole O (2011). Functional properties of roasted and defatted cashew nut

(Anarcadium occidentale) flour. EJEAFche 10(4): 2135-2138. ISSN:1579-4377.

Dye WB (1956). Studies on Halogeton glomerulus weeds. 4:55-59.

Kahkakrishna MR, Sivaprasad J (1980). Tannins content of sorghum varieties and their role in ion bioavailability. *J. Agric Food Chem.* 28:55-57

Karl J. (2008). Maize is not a Day Neutral Plant. From Wikipedia, the free encyclopedia

Lawal OS, Adebowale KO, Oderinde RA (2004). Functional properties of amylopectin and amylose fractions isolated from bambara groundnut (*Voandzela subterranean*) starch. *Afr. J. Biotechnol.* 31(8): 399-404.

Lev-yadun S, Gopher A, Abbo S (2000). The Cradle of Agriculture! Science 288 (5471): 1602 -3 doi:10,1126/science.288.5471.1602.PMID10858140.

Muhammad AS, Haq N, Mazhar H, Beena V (2011). Proximate composition and

functional properties of Rhlzomes of Lotus (*Nelumbo nucifera*) from punjab, *Pakistan pat. J. Bot.* 43(2): 895-904.

Nelson TS, Ferrara LW, Stover NL (1968). Phytate phosphorus content of feed ingredient, derived from plant sci. 47:13 72-1378

Odoemelam SA (2005). Functional properties of raw and heat processed jackfruit *(Artocarpus heterophyllus) flour. Pakistan J. Nutr.* 4(6): 366-370

Prinyawiwatkul W, Beuchat LR, McWatters KH, Philips RD (1997). Functional

Properties of cowpea (*vigna unguiculata*) flour as affected by soaking, boiling and fungal fermentation. *J. Agric. Food Chem.* 45: 480-486.

Palmer JJ (2001). How to brew. Defenestrative Pub Co. 233. ISBN: O-97105790-7

Reddy NR, Sathe SK, Salunkhe DK (1982). Phytates in legumes and cereals *Adv. Food Res.* 28(1)

Smith AE (1995). Handbook of weed management systems. Marcel Dekker. 411. ISBN: 0–8247-9547– 4.

Sathe KD, Salunke DK (1982). Functional properties of lupin seed (*Lupinus mutabilis*) protein and protein concentrates. *J. Food Sci.* 47: 491-497.

Savita S, Satinder K, Nagi HPS (2011). Functional properties and anti-nutritional factors in cereal bran. *Asian J. Jood Agro-industrial* 4(2): 122-131. ISSN: 1906-3040.

Sharma HR, Chauchan GS, Agarwal K (2004). Physico-chemical characteristics of rice bran

processing by dry heating extrusion cooking. *Int. J. Food Prop.* 7: 603-614.

Vogel S (2003). Prime mover – A natural history of muscle. W.W. Norton and Company, Inc, USA, 301. ISBN 0393324631.