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A comparative study of the nutrient compositions of some common cereal grains consumed in eastern Nigeria

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ABSTRACT

The nutrient compositions of some of the most common cereal grains consumed in Eastern Nigeria were determined. The cereal grains used were white corn, yellow corn, popcorn and sorghum. The cereal grains had very reasonable values of carbohydrate. The carbohydrate values ranged from 66.30% in sorghum to 76.19% in popcorn. The protein values were low, ranging from 7.82% in popcorn to 14.99% in sorghum. They had very low values of crude fat, ranging from 3.03% in Sorghum to 5.01% in yellow corn. Sorghum had a better source of potassium (350.27±0.23mg/100g) and calcium (22.71±2.30mg/100g). Phosphorus was comparatively higher in white corn (279.45±1.24 mg/100g), yellow corn (288.85±0.26 mg/100g) and popcorn (289.78±0.83 mg/100g) than in sorghum. White corn, yellow corn and popcorn had very low values of copper and manganese while these minerals were not detected in sorghum. Popcorn (131.2±1.39 mg/100g) and yellow corn (126.4±1.39 mg/100g) had high values of magnesium while sorghum had the least value (4.00±1.39 mg/100g).The cereal grains had Na/K ratios less than one implying that their consumption would probably reduce blood pressure disease. The cereal grains had very low values of Vitamin C. Vitamin E was found in trace amounts in white corn, yellow corn and popcorn but vitamins A and E were not detected in Sorghum. Thiamin and riboflavin were present in the cereal grain samples in small amounts. However, yellow corn had the highest value of niacin (3.45±0.01 mg/100g). The anti-nutritional principles in the various cereal grains were very low. The very low values of these principles imply that their consumption will have no adverse health implications. Generally, blending of the various cereal grains in food processing will be of great benefit to human nutrition and health.

Introduction

Cereals are the edible seeds or grains of the grass family *Graminae* [1]. A number of cereal grains such as rice, rye, oats, barley, maize, sorghum, millet are grown in different countries. *Zea mays L*. also referred to as corn, originated in the Western Hemisphere [2]. Maize is an important source of food [3] and a major source of energy, protein, B-vitamins and minerals. It is a cheap form of starch and a major energy source for animal feed [4]. There are hundreds of different varieties of corn. The most common varieties include: white corn, yellow corn, popcorn and others.

Popcorn is used as snack and serves as food. It is highly relished by many. Yellow and white corns and their corn meals constitute a staple food in many regions of the world. Corn meal is used as a replacement for wheat flour, to make cornbread and other baked products. It is also a major source of cooking oil (corn oil). It is sometimes used as an adjunct; source of starch for beer brewing.

Sorghum (Guinea corn) is a genus of grasses and in the subfamily *Panicoideae*. It has about 30 species, one of which is raised for grain and many of which are used as fodder plants, either cultivated or as part of pasture. The commonest tropical species, *sorghum bicolor*, is an important food crop (as grain and in sorghum syrup or "sorghum molasses"), in Africa, Central America and South Asia. *Sorghum bicolor* is the fifth-most important cereal crop grown in the world [5, 6]. It is very important in the world's human diet, with over 300 million people dependent on it [7]. The seed is used as food and in brewing. The stalk is used as an animal feed.

This study is aimed at comparing the nutrient compositions, as well as the anti-nutritional factors present in the different cereal grains: white corn, yellow corn, popcorn and sorghum.

Materials and Methods

The cereal grain samples (white corn, yellow corn, popcorn and sorghum) were obtained from Umuahia main market. The grains were first sorted to remove dirt and diseased ones. They were sun-dried for four weeks, hammer milled to reduce the particle size and subsequently milled. The milled samples were sieved through 1mm test sieve to obtain the powdery samples of the cereal grains used for the study. The moisture and crude protein contents of the samples were determined according to AOAC method [8].The ash, crude fat, crude fibre, sodium and potassium ions and Total carbohydrate were determined according to the various methods as described by James [9]. The Vitamins A and E were determined according to the methods of the Association of Vitamins Chemists described by Kirk and sawyer [10].Thiamin, Riboflavin and Niacin were also determined according to the methods of Barakat *et al*., [11].

Calcium and magnesium ions were determined using EDTA titrimetry methods as described by Pearson [12]. Phosphorus was determined using the Colorimetric method described by Udo and Ojewole [13]. The trace elements; iron (Fe), zinc (Zn), copper (Cu) and manganese (Mn) as well as HCN were

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determined according to the various methods of AOAC [14].The alkaloids, saponins and flavonoids were determined by the gravimetric methods as described by Harborne [15].

Results and Discussion

The proximate compositions of the cereal grains are presented in table 1. The cereal grain samples have very reasonable values of carbohydrate. The carbohydrate values range from 66.30% in Sorghum to 76.19% in pop corn. Carbohydrate supplies energy to cells such as the brain, muscles and blood. It contributes to fat metabolism and spares protein as an energy source. Carbohydrate acts as mild natural laxative for human beings and generally adds to the bulk of the diet [16].

Table 1: Proximate compositions of the cereal grain samples

Parameters	Compositions			
	White corn	Yellow corn	Popcorn	Sorghum
Moisture content (%)	7.40	9.00	7.60	10.20
Ash content (%)	2.67	3.59	2.27	2.59
Carbohydrate (%)	74.69	70.47	76.19	66.30
Protein (%)	10.09	10.62	7.82	14.99
Fat (%)	3.82	5.01	4.21	3.03
Dry matter (%)	92.60	91.00	92.40	89.80
Fibre (%)	1.33	1.31	1.91	2.89

The cereal grain samples used for the study have low values of fibre, ranging from 1.31% in yellow corn to 2.89% in sorghum and low values of ash (2.27% in popcorn- 3.59% in yellow corn). Dietary fibre has been known to reduce blood cholesterol level in the body thus, promoting cardiovascular health [17]. Food material with high percentage of ash is quite encouraging because it is highly needed by children and pregnant/lactating meteors for substantial supply of calcium and magnesium needed for bone formation [18].

The protein values are low, ranging from 7.82% in popcorn to 14.99% in sorghum. They have very low values of crude fat, ranging from 3.03% in sorghum to 5.01% in yellow corn. Carbohydrate, protein and fat play important roles in human nutrition and health.

With considerable low moisture contents, the different cereal grains can be processed and stored since they dry very well.

Result of the Mineral compositions of the cereal grain samples is presented in table 2. The result shows that sorghum is a better source of potassium (350.27±0.23mg/100g) and calcium (22.71±2.30 mg/100g). The phosphorus content is higher in white corn (279.45±1.24 mg/100g), yellow corn (288.85±0.26 mg/100g) and popcorn (289.78±0.83 mg/100g) than in sorghum.

Table 2: Mineral compositions of the cereal grain samples

Minerals	Compositions (mg/100g)			
	White corn	Yellow corn	Popcorn	Sorghum
Sodium (Na)	5.13±0.12	35.0±0.20	4.13±0.12	6.20±0.20
Phosphorus (P)	279.45±1.24	288.85±0.26	289.78±0.83	71.28±0.49
Potassium (K)	314.93±0.46	287.33±0.23	301.33±0.23	350.27±0.23
Magnesium (Mg)	92.8±1.39	126.4±1.39	131.2±1.39	4.00±1.39
Calcium (Ca)	9.35±2.30	6.68±2.30	13.36±2.30	22.71±2.30
Zinc (Zn)	1.70±0.10	2.27±0.06	3.43±0.06	0.53±0.12
Copper (Cu)	0.4±0.06	0.3±0.10	0.43±0.06	Not detected
Iron (Fe)	2.37±0.06	2.73±0.06	2.63±0.06	4.43±0.06
Manganese (Mn)	0.5±0.06	0.5±0.1	0.97±0.12	Not detected
Na:K	0.016	0.123	0.014	0.018
Ca:P	0.033	0.023	0.046	0.319

White corn, yellow corn and popcorn have low values of copper and manganese while these minerals were not detected in sorghum. Popcorn (131.2±1.39 mg/100g) and yellow corn (126.4±1.39 mg/100g) have high amounts of magnesium while sorghum has the least value (4.00±1.39 mg/100g). The Na/K ratios of the cereal grains have good health implication and would probably reduce blood pressure disease since they have Na/K ratios less than one.

Result of the vitamin compositions of the cereal grain samples is presented in table 3. The cereal grains have very low values of Vitamin C. Vitamins A and E were not detected in sorghum but vitamin E was found in trace amounts in white corn, yellow corn and popcorn.

Table 3: Vitamin compositions of the cereal grain samples

Vitamins	Compositions			
	White corn	Yellow corn	Popcorn	Sorghum
Vitamin A (IU/100g)	3.1±0.35	213.95±0.17	196.10±0.18	Not detected
Vitamin C (mg/100g)	9.9±1.02	12.91±1.02	9.39±1.02	23.47±1.02
Vitamin E (mg/100g)	0.42±0.05	0.49±0.05	0.28±0.05	Not detected
Niacin (mg/100g)	3.43±0.01	3.45±0.01	3.26±0.01	2.91±0.01
Thiamin (mg/100g)	0.38±0.003	0.39±.003	0.037±0.004	0.24±0.003
Riboflavin (mg/100g)	0.26±0.01	0.29±0.01	0.34±0.01	0.17±0.01

Thiamin and riboflavin are present in the cereal grain samples in small amounts. However, yellow corn has the highest value of niacin (3.45±0.01mg/100g). The various vitamins play specific roles in human nutrition and health. Niacin, as nicotinic acid has been shown to be effective in curing pellagra [19].

Notwithstanding the high nutrient status of the different cereal grains, there is presence of phytochemicals with established anti-nutritional activities. Result of The phytochemical compositions of the cereal grains is presented in table 4. Alkaloids, saponins, flavonoids, tannins and hydrogen cyanide (HCN) were found in varying concentrations.

Table 4: Phytochemical compositions of the cereal grain samples

Phytochemicals	Compositions			
	White corn	Yellow corn	Popcorn	Sorghum
Alkaloids (%)	0.11±0.02	0.13±0.01	0.11±0.01	0.15±0.01
Saponins (%)	0.35±0.01	0.27±0.01	0.23±0.01	0.43±0.02
Flavonoids (%)	0.23±0.03	0.29±0.03	0.33±0.01	0.37±0.01
Tannins (%)	0.16±0.002	16±0.002	16±0.002	0.22±0.00006
HCN (mg/kg)	6.91	10.52	6.13	6.52

Sorghum has the highest concentration of alkaloids (0.15±0.01%), saponins (0.43±0.02%), flavonoids (0.37±0.01%).Yellow corn (16±0.002%) and popcorn (16±0.002%) have the same and as well, the highest values of tannins.

The useful health implications of saponins have severally been reported [20, 21, 22].Toxicity studies indicate that only very low levels of saponins absorption occur. Saponins toxicity is presumably due to their ability to disrupt membranes and cause haemolysis of red blood cells. However, they can be used in medicines.

The amounts of flavonoids present in the different cereal grains are low. Flavonoids have an established antioxidant and strong anti-cancer activities, and even help to lower the risk of heart disease [22]. Flavonoid-containing plants have been reported to have diuretic, antibacterial and anti-fungal properties [23].Most (but not all) alkaloids are toxic to animals. Many have been exploited as drugs. In spite of the medicinal uses of alkaloids, they cause gastro-intestinal upsets and neurological disorders.

The tannin contents of the different cereal grains used for this study are very low when compared to the reported tannin contents of legumes which range from 2000mg/100g (2%) in faba beans to as low as 45mg/100g (0.045%)in soybeans. The very low value of tannin in soybean has been virtually ignored in terms of its possible anti-nutritional significance [24]. Therefore, the very low values of tannin in the different cereal grains will possibly, have no anti-nutritional significance.

The HCN value of 10.52mg/kg for yellow corn is the highest amongst all the cereal grains used for the study. The hydrogen cyanide values of the cereal grains have no toxic significance as they are quite below the value of 50-60mg/kg considered to be toxic to adult man [25].This implies that the consumption of the cereal grains will have no negative effect associated with HCN toxicity in human nutrition and health.

However, most of these anti-nutrients are known to be reduced or eliminated by food processing techniques such as cooking, soaking, etc.

Conclusion

There are variations in the nutrient compositions of the different cereal grains. Some of the nutrients are rich in some of the cereal grains but low in some. Although that there are variations in their compositions of the various food nutrients, they represent good sources of nutrients necessary for human nutrition and health. Thus, blending of the various cereal grains in food processing will be of great benefit to human nutrition and health.

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