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Short Communication

Comparative Studies on the Physico-chemical Properties of Degermed Flours of White and Yellow Maize (*Zea mays*)

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Abstract. Flours of degermed grains of white and yellow maize (*Zea mays*) varieties were analyzed for their proximate compositions, physico-chemical properties, mineral compositions and pasting behaviours. The results of their proximate composition showed that the degermed white maize flour was a better source of dietary protein and energy than degermed yellow maize flour. Degermed white maize flour exhibited higher values of water absorption capacity, least gelation concentration, swelling power and solubility than degermed yellow maize flour. The increasing order of abundance of minerals in the flour samples was Zn<Fe<Na<P<Ca<K. Appreciably high value of stability (7.58 RVU) at 83.30°C in 7.00 mins made degermed white maize flour stand out in pastry, bakery and weaning food applications.

Keywords: maize, degermed flour, pasting behaviours

Maize grains have great nutritional value and are used as raw material for manufacturing many industrial products (Afzal *et al.,* 2009) and for the production of oil, starch and glucose (Niaz and Dawar, 2009).

This study compares the intrinsic potentials of degermed flours of white and yellow maize (*Zea mays*) for their possible industrial applications in pastries, weaning food and noodles production.

The grains of white and yellow varieties of maize (*Zea mays*) were purchased in Akure, Nigeria. The flour samples were produced by cleaning, steeping, degerminating, drying, winnowing and milling the cereal grains. The resulting flours were sieved through a sieve with mesh size 400 μm to give fine flours, which were packaged in an air-tight polyethylene bags, labelled and kept in a refrigerator at 4°C prior to analysis. The moisture, ash and crude fibre contents of the flour samples were determined using the standard chemical methods described by AOAC (1990). Soxhlet extraction technique was used to evaluate the fat contents of the flour samples (Pearson, 1976) while Kjedahl method was used to determine the crude protein (N x 6.25) contents of the samples as described by AOAC (1990). The contents of carbohydrate of the samples were estimated by difference (% Carbohydrate = 100% - sum of percentages of moisture, ash, fat, crude fibre and crude protein contents). pH values of the samples were evaluated using the method described by AOAC (1990). The standard chemical method described by Coffman and Garcia (1977) was adopted in evaluating the least gelation concentrations of the samples. The method as described by Akintayo *et al.* (2000) for the determination of water absorption capacity was adopted. Amylose contents of the samples were determined as described by the chemical method of Song and Jane (2000) while the amylopectin contents of the samples were deduced arithmetically as Amylopectin content = 100% - % Amylose content. The swelling power and solubility of the samples were evaluated using the standard chemical method described by Leach *et al.* (1959). The mineral contents were analyzed as reported by Pearson *et al.* (1981) and the contents of phosphorus using vandomolybdate method (AOAC, 1990). A Rapid Visco-Analyzer (Model: 3-D, Newport Scientific, Australia, 1995) with Thermocline for windows software was used to evaluate the pasting properties of the samples. Test runs were conducted following standard profile 1 which included 1 min of mixing, stirring, and warming up to 50°C, 3 min and 42 sec of heating at 12°C/min up to 95°C, 2.5 min of holding at 95°C, 3 min and 48 sec of cooling down to 50°C, at the same rate as the heating (12°C/min) and 2 min holding at 50°C, where the process ended after 13 min (Deffenbugh and Walker, 1989). Gelatinization (pasting) curves were recorded

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on RVA and viscosity was expressed in terms of Rapid Visco Units (RVU) which is approximately equal to 12 centipoises.

Table 1 shows the proximate compositions of degermed flours of white and yellow maize (*Zea mays*) varieties. Comparatively, in terms of crude protein, ash and fat contents, degermed white maize flour significantly higher ($p<0.05$) in values than degermed yellow maize flour while opposite trend is obtained for the flour samples in terms of percentage moisture content, crude fibre and carbohydrate by difference. Lower percentage of moisture content of degermed white maize flour (10.29±0.02) than that of yellow maize flour (10.54±0.03) suggests higher resistance of the former to microbial activity than the latter. The percentage crude fibre obtained for degermed white maize flour (2.08±0.03) is in close range to 2.28±0.03% reported for peanut (*Arachis hypogea*) seed flour by Amoo and Asoore (2006).

From Table 2, the pH, water absorption, least gelation concentration, amylose and amylopectin contents, swelling power and solubility values of the degermed flour samples are significantly ($p<0.05$) different with the flour of white maize exhibiting higher values in terms of water absorption capacity, least gelation concentration, amylopectin content, swelling power and solubility. However, appreciably corresponding increase in the values of water absorption capacity and least gelation concentration may suggest a relationship between the two intrinsic functional properties, which serve as indices of quality characterization of flour for industrial purposes. Thomas and Atwell (1999) have observed that differences in amylose and amylopectin contents contribute to significant differences in the flour properties and functionality. The degermed white maize flour possesses 18.40±0.01% amylose content while degermed yellow maize flour has 19.20±0.01%. This difference may account for high values of swelling power and solubility obtained for degermed white maize flour. This is in line with the observation of Tester and Karkalas (1996) and Zeleznak and Hoseney (1987) that amylose acts as both diluent and inhibitor of swelling by forming insoluble complex with available lipids.

The increasing order of minerals in the degermed flour samples is zinc<iron<sodium<phosphorus<calcium< potassium (Table 3). Potassium is abundantly available in the degermed yellow maize flour (401.20±0.30 mg/100g). This is in agreement with Olaofe and Sanni (1988) that potassium is the predominant mineral in Nigerian agricultural products. Lake and Waterworth (1980) have reported that K/Na ratio serves as maintenance of a correct osmotic pressure and fluid pH in the body, which is essential for the movement of metabolites across the cell membrane and around the body. Hussaini *et al.* (2008) showed that nitrogen fertilizer application up to 60 kg N/ha significantly increased the concentrations of N, P, Ca and Mg in maize grain. Hence, the differences in the mineral composition may be due to genetic factors or environmental factors like irrigation frequency, soil composition and fertilizer used.

Table 1. Proximate composition of the degermed flour samples

Sample	Moisture content	Crude protein	Ash content	Fat content	Crude fibre	Carbohydrate by difference
			(%)			
White maize	10.29^{a}±0.02	10.61^{b}±0.03	1.93^{b}±0.03	2.11^{b}±0.03	1.78^{a}±0.02	73.28^{a}±0.05
Yellow maize	10.54^{b}±0.03	9.23^{a}±0.04	1.64^{a}±0.03	2.07^{a}±0.03	2.08^{b}±0.03	74.44^{b}±0.04

Results are the means of triplicate determinations ± standard deviation. The analysis of variance (ANOVA) is $p<0.05$ for all the samples

Table 2. Selected physicochemical properties of the degermed flour samples

Sample	pH	WAC (%)	LGC (%)	Amylose content (%)	Amylopectin content (%)	Swelling power (g/g)	Solubility (g/g)
White maize	5.93^{a}±0.01	98.50^{b}±0.01	25.00^{b}±0.01	18.40^{a}±0.01	81.60^{b}±0.01	7.92^{b}±0.01	7.55^{b}±0.00
Yellow maize	6.33^{b}±0.01	88.51^{a}±0.03	18.00^{a}±0.01	19.20^{b}±0.01	80.80^{a}±0.01	7.50^{a}±0.01	7.33^{a}±0.01

Results are the means of triplicate determinations ± standard deviation. The analysis of variance (ANOVA) is $p<0.05$ for all the samples. WAC = water absorption capacity; LGC = least gelation concentration

Table 3. Mineral compositions of the degermed flour samples

Sample	Ca	Na	K	P	Zn	Fe
	(mg/100g)					
White maize	306.00[a]±0.04	18.44[b]±0.01	395.40[a]±0.05	248.30[a]±0.02	2.54[b]±0.01	6.77[b]±0.02
Yellow maize	344.30[b]±0.07	16.74[a]±0.01	401.20[b]±0.03	248.50[a]±0.03	2.32[a]±0.01	5.83[a]±0.03

Results are the means of triplicate determinations ± standard deviation. The analysis of variance (ANOVA) is $p<0.05$ for all the samples

Table 4. Pasting properties of the degermed flour samples

Sample	Pasting time (mins)	Pasting temp (°C)	Viscosity (RVU)	Stability (RVU)	Retrogradation RVU)
White maize	7.00	83.30	71.17	7.58	52.25
Yellow maize	7.10	81.20	83.50	7.25	58.17

The paste of degermed yellow maize flour attains stability (7.25 RVU) at 81.20°C in 7.10 mins while that of degermed white maize is 7.58 RVU at 83.30°C in 7.00 mins. The paste of degermed yellow maize flour is more viscous (83.50 RVU) at 81.20°C than that of degermed white maize flour (71.17 RVU) at 83.30°C (Table 4).

The degermed white maize flour stands a better change for application in confectionary than the degermed yellow maize flour owing to appreciably higher stability and correspondingly lower retrogradation.

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