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EFFECT OF FERMENTATION TIME ON THE ANTINUTRIENT COMPOSITION OF IMPROVED AND LOCAL MAIZE VARIETIES

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Abstract: **The effect of fermentation time on the antinutritional composition of the local and the improved maize varieties was carried out. The actual amount of antinutrients reduced for each day of fermentation were determined by standard methods. The values are recorded in mg/100g. The Phytate content for local maize variety reduced by 2.855, 2.340, 2.095, and 3.560 respectively from day 1 to 4 of fermentation time. While that of improved variety reduced by 1.870, 2.925, 3.510, and 0.000 respectively. The Oxalate content for the local maize variety was reduced by 4.0851, 0.2899, 0.8697, and 0.1115 respectively from day 1 to 4 of fermentation time. At the same time, that of improved variety was reduced by 1.6651, 1.0258, 0.1561, and 0.1080 respectively. The tannin content for the local maize variety was reduced by 1.720, 1.250, 1.042, and 0.020 respectively from day 1 to 4 of the fermentation period. In comparison, that of improved variety was reduced by 2.760, 1.223, 0.154, and 0.083 respectively. The results clearly show that the antinutrient is reduced in a specific time frame.**

Keywords: **Antinutrients, Fermentation, Improved, Local, Maize, Variety.**

1. INTRODUCTION

Maize (*Zea mays* L.) is a major staple food grain throughout the world, particularly in Africa, Latin America and Asia, and a major feedstuff in developed countries. The maize grain has many food (grain, flour, syrup, oil) and non-food usages (cosmetics, adhesives, paints, varnishes). Maize starch and oil are also major products (Ecocrop, 2010). The maize grain is a major feed grain and a standard component of livestock diets where it is used as a source of energy. Other grains are typically compared to maize when their nutritional value is estimated. Many by-products of maize processing for flour (hominy feed, bran, germs, oil meal), starch (corn gluten feed, corn gluten meal) and alcohol/biofuel industries (distillers' dried grains and solubles) can be fed to animals.

Maize is an excellent source of carbohydrate, but protein quality is relatively poor because it is deficient in the essential amino acids, lysine and tryptophan (paulis, 1982). Owing to nutritional importance of maize, significant efforts have been

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made to improve its protein quality. Fermentation is an inexpensive and simple method for improving the nutritive value of maize-based foods and reducing their anti-nutritional factors. Like other cereals, the nutritive value of corn is inadequate due to its deficiency and the presence of anti-nutritional factors such as phytate, oxalate, tannins. These antinutritional factors chelate dietary minerals in the gastrointestinal tract reducing their bioaccessibility and bioavailability as reported for millet (Abdel Rahaman *et al.*, 2007), sorghum (Idris *et al.*, 2005) and corn (Sokrab *et al.*, 2011). Minerals are involved in activation of intracellular and extracellular enzymes, in regulation of critical pH level in body fluids necessary for control of metabolic reactions and in osmotic balance between the cell and the environment. A deficiency of any one of the essential minerals can result in severe metabolic disorders, and compromise the health of the body. The presence of phytate in the human diet has a negative effect on mineral uptake. Minerals of concern in this regard include zinc, iron, calcium, magnesium, manganese and copper (Konietzny and Greiner, 2003). More than 60% of the phosphorus in corn meal is in the form of phytatephosphorus, which is poorly available for absorption and utilization in the gastrointestinal tract. The inhibitory effect of phytate on trace mineral absorption can also be predicted in vitro by the molar ratio of phytate to such mineral.

In developing countries, because of limited access to animal products (meat, egg and fish) that provide high intakes of heme iron, and zinc, the main dietary sources of minerals are cereals and legumes. These cereals and legumes contain anti-nutritional factors that reduce the bioavailability of nutrients and may lead to malnutrition.

Maize breeders have created many cultivars that correspond to specific climatic or agronomic conditions and uses. "Dent corn" maize is the most widely grown type of maize and the one typically used for feed. Other types (flint corn, popcorn, sweet corn, flour corn) are more intended for food uses. Some varieties have been created to improve the industrial or nutritional value: high lysine, high tryptophan, high oil, high amylose, low phytate, etc. Brown midrib maize has a lower lignin content resulting in an increased digestibility in livestock. Genetically-modified (GM) maize varieties have been designed to improve grain performances (herbicide resistance, pest resistance, higher yields).

The Institute for Agricultural Research (IAR), Ahmadu Bello University, Zaria, has secured approval to release three new high-yielding nutrient maize varieties for planting in Nigeria. The maize was developed by IAR in collaboration with the International Institute for Tropical Agriculture, IITA, Ibadan. The institute said that the maize varieties tagged: SAMMAZ 52, SAMMAZ 53 and SAMMAZ 54 were offshoots of extensive “on-station, multi-locational and on-farm” evaluations with strong farmer participation. It said that the varieties were desirable to many maize farmers, seed companies, and food processing entrepreneurs, agro-allied industries as well as consumers across Nigeria. SAMMAZ 52 is an improvement over previously released varieties as a result of bio-fortification with pro Vitamin A. This Vitamin A bio-fortified maize variety has yield potential of 6.0 ton/ha, about 24 percent higher than earlier released varieties in the same category. It has medium maturing period of between 110 and 120 days, tolerant to maize streak virus, rust, leaf blight and curvularia leaf spot (Premium Times, 2017).

The SAMMAZ 53 and SAMMAZ 54 varieties are bred for high grain yields up to 7.6 t/ha and 7.2t/ha. Both varieties are extra early maturity (80-85 days) and resistant to maize streak virus, rust, leaf blight and curvularia leaf spot. They perform very well in northern Guinea and Sudan savannah environments where climate changes are manifesting in the form of droughts, dry spells and in ecologies where parasitic Striga hermonthica attacks are severe owing to declining soil nitrogen. The institute added that the varieties were produced to strengthen farmers’ resilience in coping with the changing production environments in which irrigation water and rainfall had become increasingly scarce. It is said that the commercialisation and adoption of the varieties was expected to significantly improve food and nutrition security as well as the livelihood of actors along the maize value chain (Premium Times, 2017).

Fermentation is one of the methods that result in a significant reduction in the anti-nutritional factor and improves the nutritional quality of the end products. Fermentation is a desirable process of biochemical modification of primary food matrix brought about by microorganisms and their enzymes. Fermentation is used to enhance the bioaccessibility and bioavailability of nutrients from different crops and improves organoleptic properties as well as extending the shelf life. It makes food safe by not only inhibiting growth of pathogenic bacteria due to antimicrobial activity of lactic acid, but also detoxifies aflatoxin (Smith *et al.,* 2018).

This work is significant, given the fact that it will provide reference data on the effect of varying fermentation time on the antinutrients composition of maize grain. Since antinutrients are reduced with fermentation, this work tells us exactly how much antinutrient is reduced with specific time duration of fermentation.

2. MATERIALS AND METHODS

Sample Collection and preparation

The white local maize grains variety used in this study was gotten from Zaria city market while the variety SAMMAZ 54 (white) from The Institute for Agricultural Research (IAR), Ahmadu Bello University Zaria, Kaduna state, Nigeria. The two varieties were manually sorted and washed in order to remove the spoilt grains, dust, and extraneous matter from the grain. The sorted grains varieties were divided into 5 equal portions each. One portion was not fermented and served as a control. Each of the remaining 4 portions was sucked in distilled water at the ratio of 1:4(w/v) grain to water and allowed to ferment at room temperatures for 24, 48, 72 and 96 hours respectively. At the end of each fermentation period the grain was separated from the steeping water by decantation and grind to paste.

Anti-nutritional Analysis

Samples were taken at 24-hour interval throughout the maize grain fermentation process and subjected to anti-nutritional analysis which include phytate, tannins, and oxalate.

Determination of Phytic Acid

A 4g of the ground sample was soaked in 100ml of 2% HCl for 5hours and filtered. To 25ml of the filtrate, 5ml of 0.3% ammonium thiocyanate solution was added. The mixture was then titrated with iron (iii) chloride solution until a brown-yellow color that persisted for 5 min was obtained (Reddy and Love *et al.*, 1999).

Determination of oxalate

A 1g of the sample was weighed into 100ml conical flask. 75ml of 1.5N H_2SO_4 was added and the solution was carefully stirred intermittently with a magnetic stirrer for about 1hour and then filtered using Whatman no 4-filter paper. 25ml of sample extract (filtrate) was collected in a beaker and titrated hot (80 - 90^{0}C) against 0.1N $KMnO_4$ until a pink colour that persisted for at least 30 seconds was obtained (Day and underwood, 2015).

Determination of Tannins

Determination by the AOAC (2005) method. Sample (5g) was dispensed in 50 ml of distilled water and shaken. The mixture was allowed to stand for 30 minutes at 28°C before it was filtered through Whatman no.4 grade of filter paper. The extract (2ml) was dispensed into a 50 ml volumetric flask. Similarly, 2ml standard tannic solution (0.1 mg/ml tannic acid) and 2ml distilled water was put in a separate volumetric flask and served as standard. 2.5ml of saturated sodium carbonate (Na_2CO_3) solution and 1ml of Folin-C reagent was added to each flask and volume made up to 50ml and mixed well. After standing for 1½ hours, the sample was filtered using Whatman no.4 grade of filter paper and the absorbance was measured at 760nm against reagent blank

3. RESULTS

The results show a uniform decreased in anti-nutrients as the fermentation time increased. also, as expected, the values of antinutrients in the improved variety is generally lower than that of the local maize variety as shown in tables 1, 2 and 3 below.

Table 1. Phytate Concentrations (mg/100g) of Local and Improved Maize Varieties at various fermentation time (hours)

Fermentation Duration	Local variety (Mg/100g)	Improved Variety (Sammaz-54) (mg/100g)
24	9.945	8.580
48	7.605	5.655
72	5.510	2.145
96	1.950	2.145
Control	12.800	10.450

Table 2. Oxalate Concentrations (mg/100g) of Local and Improved Maize Varieties at various fermentation time (hours) 100 g)

Fermentation Duration	Local variety (mg/100g)	Improved Variety (Sammaz-54) (mg/100g)
24	1.4049	1.4049
48	1.1150	0.3791
72	0.2453	0.2230
96	0.1338	0.1150
Control	5.4900	3.0700

Table 3. Tannin Concentrations (mg/100g) of Local and Improved Maize Varieties at various fermentation time (hours)

Fermentation Duration	Local variety (mg/100g)	Improved Variety (Sammaz-54) (mg/100g)
24	2.590	1.550
48	1.340	0.327
72	0.298	0.173
96	0.278	0.090
Control	4.310	4.310

4. DISCUSSION

Fermentation is a metabolic process in which sugars are oxidized to produce energy; it also improves the absorption of minerals from plant-based foods. Fermentation is one of the processing methods, which is used in Africa to made cereals crops edible and also increase the nutritional quality as well as safety aspects of these foods, because cereals are not easy consumed in natural raw forms. In cereals, anti-nutrients have the capacity of decreasing the digestibility and palatability of protein because; they form insoluble complexes with them (Mbata *et al*., 2009).

This study shows a reduction in phytate content with increased in fermentation period. Wakil and Kazeem (2012) also observed a similar trend as fermentation time increases. For the local maize variety, there was decreased uniform reduction from day one to three then, a large reduction on day four. There was increased uniform reduction in the improved variety from day one to three and no reduction on day four. The reduction in the phytic acid content of formulated blends may be due to hydrolysis of phytate by the enzyme phytase (an endogenouse enzyme) into lower inositol phosphates which are believed to be activated during fermentation process by organisms (yeasts) whose hydrolyzing ability is enhanced by fermentation (Egwin *et al.,* 2011). Previous works have established that anti-nutrients have close negative relationship with the micronutrient bioavailability because higher contents of anti-nutrients reduce availability or absorption of minerals and could lead to nutrients deficiency or malnutrition. Phytate are known to form complexes with iron, zinc, calcium, and magnesium making them less available and thus inadequate in food samples especially for children.

Oxalate reduction decreased uniformly from day one to four for both the local and improved varieties. Plants and their products are the major sources of dietary oxalate, and it was reported that frequent consumption of foods with high levels of oxalate could inhibit calcium absorption and increase the risk of kidney stones. Foods with oxalate levels than 50mg/100g were categorized as oxalate−rich foods (Brigide.*et al*, 2019), while the lethal dose of oxalate for humans was reported to be 15−30g (Fronteras *et al.,* 2019). Using the values obtained for oxalate in both local and improved maize; it shows that they cannot be classified as an oxalate−rich food. The values obtained were below the levels to be classified as oxalate−rich foods and quite lower than the lethal dose of oxalate for humans.

The reduction in Tannin content decreased uniformly in both the local and the improved maize varieties. Tannins are naturally occurring plant polyphenols. Their main characteristic is to bind and precipitate protein interfering with its digestion and absorption. The tannin content of all the different fermented products in this study are generally low. Previous reports observed that several antinutrients including phytic acid and tannins were reduced due to fermentation for 12 and

24hrs (Coulibaly *et al*., 2011). Fermentation is such an important process, which significantly lowers the content of anti-nutrients such as phytic acid, tannins, and polyphenols of cereals (Simwaka *et al*., 2017). Tannin levels may be reduced as a result of lactic acid fermentation, leading to increased absorption of iron except in some high tannin cereals, where little or no improvement in iron availability has been reported (Ray and Didier 2014).

5. CONCLUSION

In conclusion, this study shows that a specific fraction of antinutrient is reduced at the end of each day of fermentation. This means that the nutritional qualities of the maize varieties were improved by specific fractions every day as the fermentation time progressed.

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