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MAIZE METAMORPHOSIS: THE ROLE OF FERMENTATION IN AMINO ACID TRANSFORMATION

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Abstract: Maize (Zea mays L.) is a globally significant cereal grain known for its nutritional contributions to both humans and animals. Its versatile applications range from staple human foods like tortillas, porridge, popcorn, and barbecues to animal forage and silage. Additionally, maize serves as a valuable source of industrial products, including starch, vitamins, fiber, oil, weaning food, porridges, and ethanol. In tropical Africa, maize plays a pivotal role as a source of dietary energy, particularly among low-income consumers in both rural and urban settings. However, maize's potential is constrained by its notably low protein content, contributing to nutritional deficiencies in some regions. This study explores the enhancement of maize utilization through various processes such as fermentation, malting, cooking, and fortification. Such techniques have been recognized for their capacity to improve the quality and nutritional value of maize-based food products. Food fermentation, a time-honored method of food processing and preparation, plays a central role in this context. The transformative effects of fermentation, orchestrated by desirable microorganisms, contribute to the development of desirable flavors, textures, and nutritive attributes in fermented foods. Fermentation is known to reduce the dry matter content in food products while increasing the concentrations of vitamins, minerals, and protein. Moreover, it has been shown to diminish the presence of antinutritional factors, thus enhancing the overall nutritional quality of fermented foods. For instance, lactic fermentation of maize meal has been observed to significantly decrease phytate phosphorus levels, a key antinutritional factor. These improvements open the door for various applications of fermented maize flour in the production of infant foods, composite flours, gruels, and sour food products.

The objective of this study is to evaluate the transformative potential of fermentation in enhancing the nutritional quality of maize-based food products, offering insights into how this traditional food processing method can be harnessed to address malnutrition and contribute to improved food security.

Keywords: Maize, Food fermentation, Nutritional enhancement, Antinutritional factors, Food security

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INTRODUCTION

Maize (Zea mays L.) is an important cereal grain in the world, providing nutrients for humans and animals (FAO, 1992; Vassal et al., 1993). Maize is used as human food in the form of tortillas, porridge, popcorn and barbecues and as forage and silage for animals. It is also a good source of industrial products such as starch, vitamin, fiber, oil, weaning food, porridges and ethanol (Abiose and Ikujenlola, 2014). Maize is a major source of dietary energy for low income consumer in many parts of tropical Africa, including major urban areas (Adeoti et al., 2013). However, utilization of maize generally is limited by its extremely low protein content and the consumption of its products has been implicated in malnutrition (Adeoti et al., 2013). Processes such as fermentation, malting, cooking and fortification had been reported to improve the qualities of food products (Odunfa, 1988; Onilude et al., 1999; Onyeka and Dibia, 2002). Food fermentation is regarded as one of the oldest ways of food processing and preparation (Achi, 2005). Fermentation by desirable organisms impart flavor, bouquet and texture to the fermented foods thereby adding to their nutritive value, flavor and other qualities associated with edibility (Ihekoronye and Ngoddy, 1985; Oloyede et al., 2013). Fermentation was observed to lower the proportion of dry matter in the food and increases the concentrations of vitamins, minerals and protein (Adams, 1990; Sahlin, 1999). However, reduction in antinutritional factors of food during fermentation had been reported (Paredes-López and Harry, 1988). Lactic fermentation of maize meal decreased phytate phosphorus by 78% (Chompreeda and Fields, 1984). Fermented maize flour could find its application in infant food production, composite flour, gruel and in making sour food products. The objective of this work was to evaluate.

MATERIALS AND METHODS

Materials

The impact of fermentation process on the amino acid profile of blends of two cultivars of maize (Zea may). The maize (yellow) and popcorn grains were obtained at Igbona market, Osogbo, Osun State, Nigeria.

Methods

The popcorn and the maize grains were sorted, winnowed and ground into flour separately. Two hundred gram (200 g) of flour was weighed into sterilized conical flask and 50 ml of sterile water was added to each conical flask containing the flour to form damp composite. The mouth of each conical flask was plugged with cotton wool and covered with aluminum foil. It was allowed to ferment for 48 hrs after which the fermented flour was dried in the hot air oven at 50 ^{o}C for 18 hrs. The flour was milled and packaged in air tight container. Popcorn and maize (yellow) flours were mixed in proportion shown in Table 1.

Table 1: Proportion of Popcorn and Maize Blends

Sample	Popcorn (g)	Yellow maize (g)
AA	20	20
BB	25	15
CC	15	25

ANALYSES

Determination of Amino Acid Profile

The samples were dried to constant weight and defatted. A weight of the defatted sample was hydrolysed under vacuum with 7 mL of 6 N HCl in a sealed pyrex tube at 105°C for 22 h. Immediately after cooling, it was filtered

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through non-absorbent cotton wool. The filtrate was dried at 40°C using rotary evaporator. The amino acids in the flask were diluted with 5 mL of acetate buffer (pH 2.0) and 5 to 10 µL was loaded into the cartridge of Technicon Sequential Multisample Amino acid Analyzer (TSM). The absorbance of the mixture was monitored continuously in a colorimeter, the signals were magnified and traced on a two pen recorder using a linear chart to develop a chromatograph. The area under the peak was calculated as the concentration of each amino acid (Kaga et al., 2002).

RESULTS AND DISCUSSION

Table 2 showed the amino acid profile of fermented maize blends. Sample CC had higher asparagine content (8.31%), alanine (5.14 %), isoleucine (4.86%), lysine (4.87%), methionine (4.27 %) and threonine (3.24 %). Sample CC also had higher essential amino acids (35.81%) and non-essential amino acids (57.03%) than other samples. Addition of fermented popcorn flour caused reduction in the amino acid values of the flour. The flour with high percentage of yellow maize had higher amino acids. The amino acid contents of the fermented maize blends were higher than the values reported for maize meal (Adeoti et al., 2012; Abiose and Ikujenlola, 2014). This signified that fermentation process greatly contributed to increase in the amino acid compositions of the fermented maize flours. Amino acid compositions are affected by species, cultivars, geographical location and the acid digestion method used in preparation of samples (Bhatty et al., 2000; Wathelet, 1999). Amino acids are important components for healing and protein synthesis processes (Witte et al., 2002; Zuraini et al., 2006).

Table 2: Amino Acid Profile of Fermented Maize Blends

Amino acid	AA (%)	BB (%)	CC (%)
Asparagine %	6.78	7.28	8.31
Alanine %	4.87	3.96	5.14
Glycine %	7.18	6.96	5.88
Histidine %	3.67	3.74	3.28
Isoleucine %	4.38	4.59	4.86
Leucine %	6.92	6.69	6.77
Lysine %	3.95	4.13	4.87
Methionine %	4.11	3.86	4.27
Phenylalanine %	2.65	3.18	2.86
Proline %	1.98	2.15	1.89
Threonine %	2.89	3.07	3.24
Tryptophan %	5.74	4.92	5.66
EAA	34.31	34.18	35.81
NEAA	55.12	54.53	57.03
TAA	89.43	88.71	92.84

EAA-Essential amino acids, NEAA-Non essential amino acids, TAA-Total amino acids Amino acid scores of fermented maize blends are shown in Table 3-5. The amino acid scores for histidine which is majorly important for infant were more than 100 % in all the fermented maize blends with higher value (196.84%) in sample BB. The limiting essential amino acids in the maize blends were lysine, aromatic amino acids and threonine. The three

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amino acids had lower values less than 100% for children but the values were higher for adult (above 100%). Sample CC had higher isoleucine, sulphur containing amino acid, lysine and threonine contents than the other two samples. Essential amino acids that support growth and repair worn out tissue must have amino acid score greater than 100 % (Chinyere and Obasi, 2011). This showed that the amino acids of the fermented maize blends could not support growth of school age children but repair the worn out tissues in adult. Sample CC (15 g popcorn and 25 g maize flour) was considered as the best blend due to the presence of higher amino acid composition.

Table 3: Amino Acid Score of Sample AA

Essential amino acid	WHO Ideal protein concentration		Amino acid	Percentage Amino acid score	
	Children[A]	Adult[B]	(g/100 g)	Children	Adult
Isoleucine	2.8	1.3	4.38	156.43	336.92
Leucine	6.6	1.9	6.92	104.85	364.21
Lysine	5.8	1.6	3.95	68.10	246.87
Total sulphur Amino Acid	2.5	1.7	4.11	164.40	241.76
Total aromatic amino acid	6.3	1.9	2.65	42.06	139.47
Threonine	3.4	0.9	2.89	85.00	321.11
Histidine	1.9	1.6	3.67	193.15	229.37

[A]WHO/FAO/UNU ideal protein for pre-school children aged 2 to 5 years; [B]WHO/FAO/UNU idea protein for adult. Percentage (%) amino acid score = (amino acid in sample/ideal) × 100. Source: WHO/FAO/UNU (1985).

Table 4: Amino Acid Score of Sample BB

Essential amino acid	WHO Ideal protein concentration		Amino acid	Percentage Amino acid score	
	Children[A]	Adult[B]	(g/100 g)	Children	Adult
Isoleucine	2.8	1.3	4.59	163.92	353.08
Leucine	6.6	1.9	6.69	101.36	352.10
Lysine	5.8	1.6	4.13	71.21	258.13
Total sulphur Amino Acid	2.5	1.7	3.86	154.40	227.06
Total aromatic amino acid	6.3	1.9	3.18	50.48	167.37
Threonine	3.4	0.9	3.07	90.29	341.11
Histidine	1.9	1.6	3.74	196.84	233.75

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[A]WHO/FAO/UNU ideal protein for pre-school children aged 2 to 5 years; [B]WHO/FAO/UNU idea protein for adult. Percentage (%) amino acid score = (amino acid in sample/ideal) × 100.
Source: WHO/FAO/UNU (1985).

Table 5: Amino Acid Score of Sample CC

Essential amino acid	WHO Ideal protein		Amino acid concentration	Percentage Amino acid score	
	Children[A]	Adult[B]	(g/100 g)	Children	Adult
Isoleucine	2.8	1.3	4.86	173.57	372.85
Leucine	6.6	1.9	6.77	102.58	356.32
Lysine	5.8	1.6	4.86	83.79	303.75
Total sulphur amino Acid	2.5	1.7	4.27	170.80	251.18
Total aromatic amino acid	6.3	1.9	2.86	45.40	150.53
Threonine	3.4	0.9	3.24	95.29	360.00
Histidine	1.9	1.6	3.28	172.63	205.00

[A]WHO/FAO/UNU ideal protein for pre-school children aged 2 to 5 years; [B]WHO/FAO/UNU idea protein for adult. Percentage (%) amino acid score = (amino acid in sample/ideal) × 100. Source: WHO/FAO/UNU (1985).

CONCLUSIONS

The research work evaluates the impact of fermentation on the amino acid profile of maize blends. Fermented maize blends were limiting in some essential amino acids (lysine, threonine and aromatic amino acids) needed for growth of infant but adequate for adult. In order to make these products useful for children, the product could be enriched or fortified with other flour containing high content of lysine, threonine and aromatic amino acid. Sample CC showed higher composition of essential amino acid needed for growth than the other two samples.

RECOMMENDATIONS

Maize is one of the major staple foods in the world and has the largest seeds among the cereal crops. Fermentation processes improved the amino acid composition of the maize flour, therefore, more research work could be done on the fermented maize flour especially in the area of utilization. Moreover, fortification and enrichment with legumes could be done to improve the nutrient composition of the products.

REFERENCES

Abiose S. H. & Ikujenlola A. V. (2014). Comparison of chemical composition, functional properties and amino acids composition of quality protein maize and common maize (Zea may L). African Journal of Food

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Science and Technology, 5(3): 81-89 Adams, M.R. (1990): Topical aspects of fermented foods. Trends in Food Science & Technology, 1: 141-144.

Adeoti, O.A., Elutilo, O.O., Babalola, J.O., Jimoh, K.O, Azeez, L.A & Rafiu, K.A (2013). Proximate, mineral, amino acid and fatty acid compositions of maize tuwo-cirina forda flour blends. Greener Journal of Biological Sciences, 3 (4): 165-171

Achi, O.K. (2005). The potential for upgrading traditional fermented foods through biotechnology. African Journal of Biotechnology, 4 (5): 375-480

Bhatty, N., Gilani, A.H. & Nagra, S.A. (2000). Effect of coking and supplementation with different kinds of meats on the nutritional value of mash (Vigna Mungo). International Journal of Food Sciences and Nutrition, 51: 169 – 174.

Chinyere, G. C. & Obasi, N. A. (2011). Changes in the amino acids contents of selected leafy vegetables subjected to different processing treatments. African Journal of Biochemistry Research, 5(6): 182-187

Chompreeda, P.T. & Fields, M.L. (1984): Effects of heat and fermentation on the extractability of minerals from soybean meal and corn meal blends. Journal of Food Science, 49: 566-568.

FAO (1992). Food and Agriculture organization: Maize in Human, nutrition FAO. Rome Italy, 159- 169.

Ihekoronye, A.I. & Ngoddy, P.O. (1985). Integrated food science and technology for the tropics. Macmillian Education LTD, London and Oxford.

Kaga, B.I., Abudullahi, S.A. & Dynek, N.D. (2002). Proximate Composition and amino acid profiles of two varieties of Beniseed (Sesamum indium and Sesamum radiatum) Journal of Agriculture and Technology, 10 (2): 6–10.

Oloyede, O.O., Ocheme, O.B. & Nurudeen, L.M. (2013). Physical, sensory and microbiological properties of wheat-fermented unripe plantain flour. Nigerian Food Journal, 31 (2): 123-129

Onilude, A.A., Sanni, A.I. & Ighalo, M.I (1999). Effect of process improvement on the physic-chemical properties of infant weaning food from fermented composite blend of cereals and soybeans. Plant Foods for Human Nutrition, 54: 239-250

Onyeka, U. & Dibia, I. (2002). Malted weaning food made from maize, soybean, groundnut and cooking banana. Journal of the Science of Food and Agriculture, 82 (5): 513-516

Paredes-López, O. & Harry, G.I. (1988): Food biotechnology review: traditional solid-state fermentations of plant raw materials - application, nutritional significance and future prospects. CRC Critical Reviews in Food Science and Nutrition 27, 159-187. Sahlin, P. (1999). Fermentation as a method of food processing;

production of organic acids, pH-development and microbial growth in fermenting cereals. Licentiate thesis. Lund Institute of Technology. Pp 1-65

Vassal, S.K., Srinivasan, G. , Pandey, S., Gonzalez, F.C., Crossa, J. & Beck, D.L. (1993). Heterosis and combining ability of CIMMYT's quality protein maize germplasm. Crop Science 33:46—51.

Wathelet, B. (1999). Nutritional analysis for proteins and amino acids in beans (Phaseolus sp). Biotechnology Agronomy, Society and Environment, 3: 197 – 200.

WHO/FAO/UNU (1985). Report: Energy and protein requirements. WHO technical report series No. 724. WHO, Geneva., pp. 220-223.

Witte, M. B., Thorton, F. J., Tantry, U. & Barbel, A. (2002). L-arginine Supplementation enhance diabietic wound healing: Involvement of the nitric oxide synthase and arginase pathways. Metabolism, 51 (10): 1269-1273.

Zuraini, A., Somchit, M.N., Solihah M.H., Gol, Y.M., Arifah, A.K., Zakaria, M.S., Somchit,

N., Rajian, M.A., Zakaria, Z.A. & Matjals A.M (2006). Fatty Acid and Amino Acids Composition of three local Malaysian Channa Fish Spp. Food Chemistry, 4(97):674-678.