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Research Article

The effect of Germination Time on the Physicochemical, Functional and Sensory quality of Masa produced from Malted Maize Flour

Onuoha, O.G[1], Okafor, T.D[2], Samuel, I. E[1], Yelmi, B[1], Adeosun, F. F[2]., Eduzor, E and Obi C.B[1]

[1]The Department of Food Science and Technology, Federal Polytechnic Bauchi, Bauchi State. PMB 0231. [2]The Department of Nutrition and Dietetics, Federal Polytechnic Bauchi, Bauchi state. PMB 0231. *Corresponding Author email: reachgideon@yahoo.co.uk

Abstract

This study was conducted to evaluate the effect of germination time on the physicochemical, functional and sensory quality of masa produced from malted maize. Maize grains were steeped in water for 8 hours and germinated for 0, 3, 6, 9 and 12 hours, oven-dried at 60^0C, dehulled, milled, open-hearth fried and designated as MIZ, MTK, MDQ, MKP, and MOT respectively. The control sample (Masa produced from paddy rice) was denoted MEF. The result showed for proximate composition masa from malted maize that the parameters measured increased with increase in germination time, moisture content (33.0%, 35%, 39.0% 43.5% and 45.0%), ash content (2.0%, 2.8%, 3.0%, 3.0% and 3.2 and 3.3|), fat content (15.50, 15.00, 15.50, 15.65, 15.75 and 16.0%), protein content (7.52, 9.10, 9.17, 9.30 and 10.12%), crude fibre content (2.00, 2.40, 2.60, 2.60 and 2.65%) for samples MIZ, MTK, MDQ, MKP and MOT respectively The carbohydrate content (38.10, 34.93, 30.51 and 25.65) however reduced as the malting hours increased respectively. The physical property showed the highest length observed for MOT (11.2cm) and lowest for MTK (9.2cm) and weight observed highest value in MIZ (87.0g) and lowest in MOT (84.5g).The average loaf volume was highest in MIZ ($125cm^3$) and lowest in MOT ($96.0cm^3$). Results of functional property showed that the water absorption index was highest in Sample MIZ (4.0) and lowest in Samples MDQ (3.0),

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bulk density was highest in MEF (0.8g/cm^3) and lowest in MOT(0.74 g/cm^3). Result of sensory property shoed for colour of masa produced from rice and malted maize (MEF, MIZ, MTK, MDQ, MKP and MOT) were 9.0, 8.0, 8.1, 7.9,7.9 and 8.0 respectively. The average mean score for texture of Masa produced from rice and malted maize (MEF, MIZ, MTK, MDQ, MKP and MOT) were 8.0, 7.4, 5.5, 4.3 and 3.6 respectively. The average mean score for flavour of masa produced from rice and malted maize (MEF, MIZ, MTK, MDQ, MKP and MOT) were 8.4, 7.4, 6.1, 4.8, 4.4 and 3.9 respectively. There was significant difference for general acceptability of masa produced from rice and malted maize in sample MEF and MIZ. Maize is cheaper than rice in terms of cost and can be used to produce masa, at optimal germination time of three (3) hours.

Keywords: Masa, Germination time, Malted, Maize flour

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Introduction

Food is one of the basic necessities of life, and traditional foods are a recognizable part of these necessities. In Nigeria, masa is one of such traditional foods consumed by all class of her ethnic divide (Maiangwa *et al.,* 2013 and Abdel *et al.,* 2009). Masa is a round shaped fermented bread-like product with a brown smooth body and crippling edges.It is like the Indian *idle* in shape and dosa in taste (Nkama and Malleshi, 1998), but different from the Mexican tortiller in preparation (Ayo *et al.,*2008).

Masa is a popular staple consumed by over 80%of the populace of Northern Nigerian(Ayo *et al.*, 2008). It is also consumed in BurkinaFaso, Niger and Mali, and prepared to create a variety in cereal based foods or for sale. It is one of the major sources of carbohydrates to the natives of Northern Nigeria (Nkama, 1998).

Malting is a simple traditional methods reported to be effective and convenient for improving nutritional value and reducing bulk density and viscosity of cereal foods through modification of grain starch (Uvere *et al*., 2002). Work has been done on malting as a means of improving the nutritional value of cereal grains like maize and modifying its starch structure, particularly in the developed countries. Malting and fermentation are used also to improve the quality of protein, as well as reduce the anti-nutritional factors that may affect the utilization of nutrients and health of consumers

(Oluwamukomi *et al*., 2013). Malting results in decrease in viscosity of malted paste due to conversion of starch to reducing sugars as a result of hydrolyzing enzymes produced during the malting process (Ayerno and Ocloo, 2009).

The traditional cereal used in the production of masa is rice. However, with the rising cost of rice, there is a need to investigate the potentials of other cheaper cereal grain like maize as an alternative in the production of masa. Moreover, rice is low in protein in comparison to maize protein.The aim of this work is to evaluate the effect of germination time on the physicochemical, functional and sensory quality of *masa* produced from malted maize

Materials and methods

Sources of raw materials

The raw materials (Rice and Maize) used for this project were purchased from Bayara market in Bauchi state.

Preparation of Malted Maize flour

The grains were sorted to remove stones, dust, light materials, broken, under sized and immature grains. They were cleaned thoroughly with water. They were then soaked in water for 8hours, drained and spread on a jute sack in the dark to germinate with periodic water during the controlled germination. Germinating grains were collected from the stock at hourly interval of 0, 3, 6, 9 and 12 hours, oven-dried at 60^0C. The vegetative parts were removed by rubbing the grains between the palms and then winnowed. The dried malted grains were dehulled and milled in an attrition mill and winnowed to remove the hulls. The milled samples were designated as MIZ, MTK, MDQ, MKP, and MOT respectively. The control sample was flour obtained from milled paddy rice and designated as MEF.

Production of Masa

The method of Ayo *et al*., (2009) with modification was adopted. The flours (Rice and malted maize sample) were each sieved to obtain grits and fine flour portions respectively. The grits portions were cooked until it set. Water was then added to the fine flour portions to form paste. The paste and cooked cooled grits were mixed together and the resulting batter was inoculated with baker's yeast and allowed to ferment at 20^0 C for 6 hour. Each fermented batter was diluted with trona in water and then sugar, salt and onion were added (Table 1). The batter was stirred vigorously to incorporate air. The batter was then fetched in medium sized spoon and placed in a hot

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pan with individual cup – like depression, with little oil on it over an earthen hearth oven frying on one side and later turned to frytheother(Figure 2).

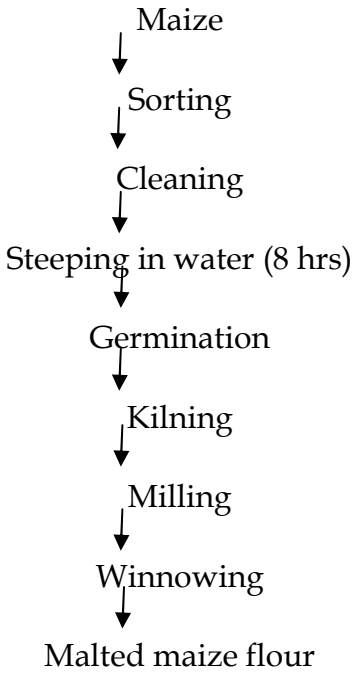

Figure 1. Flow charts for production of malted maize flour.

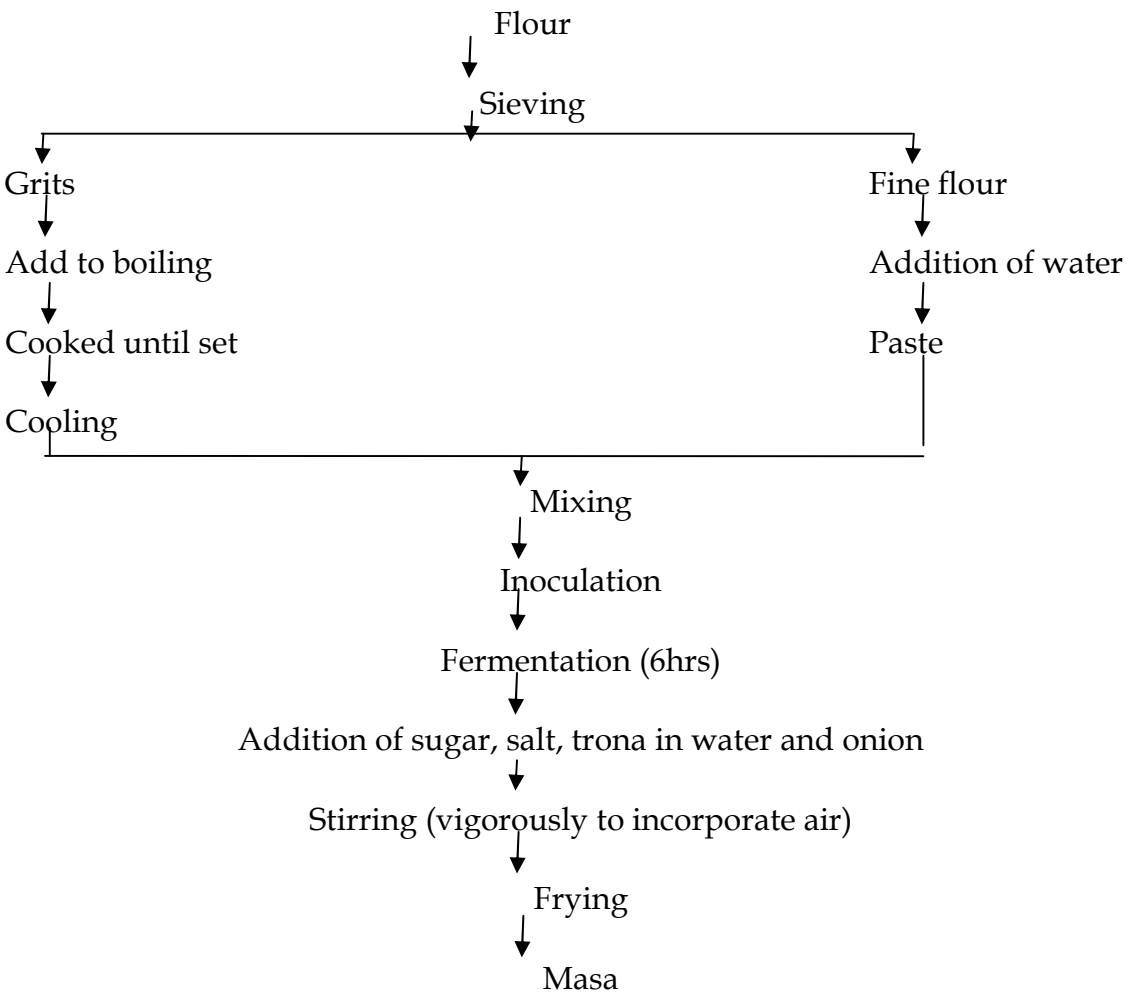

Figure 2.Flow chart for the production of masa from malted maize and rice flours

Proximate composition of *masa*

The proximate composition (moisture, protein, fat and ash) was determined using the method of AOAC (1995). Carbohydrate was calculated as the difference.

Physical quality of masa

The thickness and width of the Masaballs were determined by measured with a micrometer and ruler respectively (Ayo *et al.,* 2008).Loaf volume was determined using seed displacement method as describe by Ayo *et al.* (2008).Loaf volume index was calculated by dividing the loaf volume by the weight of the Masa as described by Ayo *et al.* (2003).

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Functional properties of the malted flour

Swelling capacity was determined by the method described by Okaka and Potter (1997). One hundred ml graduated cylinder was filled 10g of the sample to the 10ml mark. Then distilled water was added to a volume of 50ml. The suspension was inverted for 2 minutes and left to stand for a further 8 minutes, and the volume occupied by the sample was taken after the 8th minute.

$$S.C = \frac{\text{Weight of wet mass sediment}}{\text{Weight of dry matter in grams}}$$

Water absorption capacity of the flours was determined by the method of Sosaulki *et al.* (1976). 1g of the sample was mixed with 10ml of distilled water and allowed to stand at ambient temperature for 30 minutes, then centrifugal for 30 minutes at 3000 rpm.

$$WAC = \frac{\%\ \text{bound water}}{\text{Weight of the sample}}$$

Oil absorption capacity was determined by the Sosulki *et al.* (1976) with modification as oil was used instead of water.1ml of the sample was mixed with 10ml of olive oil and allowed to stand at ambient temperature for 30 minutes, then centrifugal for 30 minutes at 3000 rpm

$$OAC = \frac{\%\ \text{bound oil}}{\text{Weight of the sample}}$$

Bulk density was calculated using the method of Jones *et al.* (2000). 100g of flour by volume was measured in a 250ml measuring cylinder. Then tapped with a wooden plank until no visible decrease in volume was noticed. Based on the apparent weight and volume, the bulk density was calculated.

$$B.D = \frac{\text{Weight of sample}}{\text{Volume of sample after tapping}}$$

Sensory evolution

Masa samples prepared were served to 20 panelist who are trained with the product to evaluate the sensory qualities such as flavour, colour, texture, chewability and general (acceptability) using a 9 point hedonic scale.

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Statistical analysis
Data obtained were analysed using inferential statistical analyses to determine the least significant difference.

Results and Discussion

Table 1: Formulation For Masa Production

Raw material	A	B	C	D	E	F
Rice (g)	500					
Malted Maize(g)		500	500	500	500	500
Water (cm^3)	600	600	600	600	600	600
Yeast (g)	5	5	5	5	5	5
Trona (cm)	10	10	10	10	10	10
Salt	0.1	0.1	0.1	0.1	0.1	0.1
Frying oil	12	12	12	12	12	12
Onion	5.0	5.0	5.0	5.0	5.0	5.0
Sugar (g)	30	30	30	30	30	30

Source: Ayo *et al.,*(2009).

Table 2: Comparative evaluation of effect of malting on the proximate composition of the *Masa* produced

Sample	Moisture (%)	Ash (%)	Fat (%)	Protein (%)	Crude fibre (%)	CHO (%)
MEF	30.0^{c}	2.0^{a}	15.50^{a}	7.52^{b}	0.90^{b}	44.08^{a}
MIZ	33.0^{b}	2.8^{a}	15.00^{a}	9.10^{a}	2.00^{a}	38.10^{b}
MTK	35.0^{b}	3.0^{a}	15.50^{a}	9.17^{a}	2.40^{a}	34.93^{b}
MDQ	39.0^{ab}	3.0^{a}	15.65^{a}	9.24^{a}	2.60^{a}	30.51^{bc}
MKP	43.5^{a}	3.2^{a}	15.75^{a}	9.30^{a}	2.60^{a}	25.65^{c}
MOT	45.0^{a}	3.3^{a}	16.00^{a}	10.12^{a}	2.65^{a}	22.93^{c}

Key: MEF = Rice, MIZ= Maize germinated for 0 hours, MTK= Maize germinatedfor 3 hours MDQ = Maize germinatedfor 6 hours, MKP= Maize germinated for 9 hours and MOT= Maize germinated12 hours. All the samples with same superscripts down columns are not significantly different ($p \leq 0.05$)

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Table 3: Effect of Malting on the physical properties of masa

Sample	Length (cm)	Weight (g)	Loaf volume (cm^3)	Loaf volume index
MEF	10.0[a]	86.0[a]	130[a]	1.51[a]
MIZ	9.8[a]	87.0[a]	125[a]	1.43[a]
MTK	9.2[a]	86.6[a]	106[b]	1.22[b]
MDQ	9.5[a]	86.8[a]	100[b]	1.15[b]
MKP	10.3[a]	84.8[a]	98.0[b]	1.15[b]
MOT	11.2[a]	84.5[a]	96.0[b]	1.13[b]

Key: MEF = Rice, MIZ= Maize germinated for 0 hours, MTK= Maize germinated for 3 hours MDQ = Maize germinated for 6 hours, MKP= Maize germinated for 9 hours and MOT= Maize germinated 12 hours. All the samples with same superscripts down columns are not significantly different ($p \leq 0.05$)

Table 4: Effect of malting on the functional properties of Masa

Sample	WAI	OAI	SC	BD
MEF	3.5[b]	1.5[c]	17.0[a]	0.769[b]
MIZ	4.0[a]	2.0[b]	16.5[c]	0.800[a]
MTK	3.5[b]	2.5[a]	20.0[a]	0.769[a]
MDQ	3.0[c]	2.5[a]	18.0[b]	0.740[c]
MKP	3.0[c]	2.0[b]	17.0[a]	0.740[c]
MOT	3.0[a]	1.5[c]	16.0[a]	0.740[c]

Key: MEF = Rice, MIZ= Maize germinated for 0 hours, MTK= Maize germinated for 3 hours MDQ = Maize germinated for 6 hours, MKP= Maize germinated for 9 hours and MOT= Maize germinated 12 hours. WA1 = water absorption index, OAI = Oil absorption index. SC = swelling capacity, BD = bulk density. All the samples with same superscripts down columns are not significantly different ($p \leq 0.05$)

The moisture content of masa showed an increasing margin among masa produced from malted maize as the malting hour increased. Masa production from rice has a moisture content of 30.00%, while that produced from malted maize increased with germination time of 0, 3, 6, 9 and 12 hours were 33.0%, 35%, 39.0% 43.5% and 45.0% respectively. This is not unusual as cereal grains are relatively high in moisture content especially with soaking (Maiangwa *et al*, 2013). The high moisture content makes shelf

life to be shorter and may be liable to spoilage during storage Amadi and Adebola (2008).

There was a relative increase in ash content. The ash content of masa produced were 2.0%, 2.8%, 3.0%, 3.0% and 3.2 and 3.3% for samples MEF, MIZ, MTK, MDQ, MKP and MOT respectively. This finding agrees with the reports of Gernah *et al*., (2011) that observed increase in ash content with increase in malting time of the malt and attributed it to probably the action of hydrolytic enzymes existing in the maize grains, coupled with the mobilization of soluble materials into roots and shoots for germination, thus reducing the level of these nutrients in the seeds. There was increase in fat content which could be due to the oil used in frying and the tendency of the oil been absorbed by the batter (Ayo *et al*., 2008). The fat content for Masa produced from rice and malted maize (MEF, MIZ, MTK, MDQ, MKP and MOT) were 15.50, 15.00, 15.50, 15.65, 15.75 and 16.0% respectively. The relatively high oil content in Masa could predispose the product highten rate lipid oxidation thereby affecting the keeping

Table 5: Effect of Malting on the Sensory Quality of Masa

Sample	Colour	Texture	Flavour	Chewability	General acceptability
MEF	9.0^{a}	8.0^{a}	8.4^{a}	8.5^{a}	8.5^{a}
MIZ	8.0^{b}	7.4^{a}	7.4^{b}	7.6^{b}	7.2^{b}
MTK	8.1^{b}	5.5^{b}	6.1^{c}	6.7^{c}	6.1^{c}
MDQ	7.8^{c}	5.3^{b}	4.8^{d}	4.6^{d}	5.2^{d}
MKP	7.9^{c}	4.3^{c}	4.4^{d}	4.3^{d}	4.3^{e}
MOT	8.0^{b}	3.6^{d}	3.9^{d}	4.3^{d}	3.9^{e}

Key: MEF = Rice, MIZ= Maize germinated for 0 hours, MTK= Maize germinated for 3 hours MDQ = Maize germinated for 6 hours, MKP= Maize germinated for 9 hours and MOT= Maize germinated 12 hours. Values with the same superscript indicate that there is no significant difference. All the samples with same superscripts down columns are not significantly different ($p \leq 0.05$)

quality of the product. This could also bersonsible for the short shelf life of the products (Nkama, 1993;1998; Ayo *et al*., 2008).

The average protein content of masa produced from rice and malted maize (MEF, MIZ, MTK, MDQ, MKP and MOT) were 7.52, 9.10, 9.17, 9.30 and 10.12% respectively. This represented an increase in protein content with increase in malting hours. Malting has been reported to improving the malt quality characteristics and also improved the quality of the protein, which generally increased with increased malting time. Malting

increases the level of crude protein and crude fibre but reduces the ash(Oluwatoyin *et al*., 2012; Makokha *et al.,* (2002).

The crude fibre content of Masa produced from rice was 0.90%, while that of malted maize increased as the malting hours increased. The crude fibre content for sample for sample (MEF, MIZ, MTK, MDQ, MKP and MOT) was 2.00, 2.40, 2.60, 2.60 and 2.65% respectively. Fibre is reported to have beneficial effects on preventing cancer (Appiah *et al*., 2011), and (Shankar and Lanza, 1991). However, Ayo *et al.,* (2008) observed that low fibre of flour from rice cereal could improve baking quality. The carbohydrate content was showed to range from 44.08 in rice while is based masa to 25.65 in 12 hours malted maize masa. The carbohydrate content reduced as the malting hour increased. The carbohydrate content for (MEF, MIZ, MTK, MDQ, MKP and MOT) was 38.10, 34.93, 30.51 and 25.65 respectively.

The highest length was observed for MOT at 11.2cm and lowest for MTK at 9.2cm.The weight of the masa ranged from 86.0, 87.0, 86.8, 84.8 and 84.5 for MEF, MIZ, MTK, MDQ, MKP and MOT respectively. The average loaf volume of MEF, MIZ, MTK, MDQ, MKP and MOT were 130, 125, 106, 100, 98 and 96.0 respectively with a corresponding index of 1.51, 1.43, 1.22, 1.15, 1.15 and 1.13.

The water absorption index was observed to be highest in Sample MIZ (4.0) and lowest in Samples MDQ (3.0), MKP (3.0) and MOT (3.0). Sample MIZ is significantly different from the control sample MEF. Water absorption capacity represents the ability of a product to associate with water under conditions where water is limited (Singh, 2001).The highest value of OAI was observed for samples MTK and MDQ at 2.5, followed by samples MIZ and MKP at 2.0. Samples MEF and MOT had the least water absorption capacity at 1.5.The value of swelling capacity was found highest for MTK (20.00) and lowest in MOK (16.0). The swelling capacity of flours depends on the particle size, variety and processing method (Chandra and Samsher, 2013).The highest bulk density was observed for MEF (0.8g/cm^3) and lowest for sample MDQ, MKP and MOT (0.74 g/cm^3). Bulk density may depends on the particle size and initial moisture content of flours (Chandra and Samsher, 2013).

The effect of malting on the sensory quality of masa can be seen in the above Table 5. The average mean score for colour of masa produced from rice and malted maize (MEF, MIZ, MTK, MDQ, MKP and MOT) were 9.0, 8.0, 8.1, 7.9,7.9 and 8.0 respectively. There was a significant difference between sample MET (the control) and the rest of the samples. This could be attributed to nature of starch in the cereals. Ali *et al*., (2014)

attributed this to the color values in corn starch is yellowish white in color than rice starch. This difference may be attributed to their genetic makeup. And that the pigments present in the maize kernel like carotene and polyphenolic have also a considerable impact on starch quality of the product. The average mean score for texture of Masa produced from rice and malted maize (MEF, MIZ, MTK, MDQ, MKP and MOT) were 8.0, 7.4, 5.5, 4.3 and 3.6 respectively. Lowfibre content of flours generally has been observed to improve baking quality of the baked products which could be the reason for the rice based masa, with a fibre content of 0.9%, having the best texture at 8.0 (Ayo *et al*; 2008). There was significant difference between masa produced front rice and malted maize. The average mean score for flavour of masa produced from rice and malted maize (MEF, MIZ, MTK, MDQ, MKP and MOT) were 8.4, 7.4, 6.1, 4.8, 4.4 and 3.9 respectively. There was significant difference with rice having the highest mean score at 8.4 than the malted maize produced from rice and malted maize (MEF, MIZ, MTK, MDQ, MKP and MOT) were 8.5, 7.6, 5.7, 4.6, 4.3 and 4.3 respectively. Chewability was assessed based on the ability for easy fragmentation of the masa products in the mouth. This was good for the masa produced from rice Mo at 8.5.

There was significant difference for general acceptability of masa produced from rice and malted maize (MEF, MIZ, MTK, MDQ, MKP and MOT) with respected mean scores of 8.5, 7.2, 6.1, 5.2, 4.3 and 3.9 respectively. MEF (8.5) had the highest general acceptability while MOT (3.9) had the least general acceptability. This could be attributed to the bias observe for preference to the traditional grain use in the production of *masa.* Malting influenced the sensory appeal of masa, but at lower malting hours, masa can still be acceptable.

Conclusion and Recommendations

This study indicates that malting results in the enhancement of the nutritional quality of grains, as observed by the increase in protein, fat, ash and crude fibre. It reduces bulk density. Rice and maize can be used to produce masa, but rice is more preferred. Malting influenced the quality of Masa, as masa produced from malted maize received comparable general acceptability. Maize which is cheaper than rice can be used to produce masa, but malting hours should be about three (3) hours.

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