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Effect of Malting African Breadfruit, (Respectiviely*Treculia african*) Seeds on Flour Properties and Biscuit Sensory and Quality Characteristics as Composite

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Abstract: African breadfruit seeds were divided into two portions. One portion was steeped for 36 h at room temperature while the other was unmalted. Seeds were allowed to germinate for 72 h after which the sprouts were destroyed. Malting yield and loss were determined. Malted and unmalted seeds were blanched at 100°C for 15min, dried at 60°C for 24 h and milled into flours in a commercial attrition mill. The resulting flours from malted and unmalted African breadfruit seeds were evaluated for composition, functional, pasting characteristics and biscuit making potentials with or without wheat flour as composite. These investigations were to assess the suitability of African breadfruit for biscuit making as sole and as composite flour with wheat as well as evaluate effect of malting on these parameters. Malting yield and loss of 81.38 and 18.60% , respectiviely were obtained. Crude protein increased with malting by 30.52% while fat and carbohydrate decreased by 29.63 and 2.93%, respectiviely. Malting decreased water absorption capacity, bulk density and gelatinization temperature but increased oil absorption and flour viscosity on cooling to 50°C. It improved sensory characteristics of biscuit made from African breadfruit flours but not to the extent of the more familiar and popular biscuit from wheat formulation. A weight range of 0.55-0.60 kg and 0.35-0.63 kg were required to break biscuits made from malted and unmalted breadfruit flour composite while biscuit dough made with the composite (20-80%) increased by 42.50 and 64.53% in volume, respectiviely.

Key words: African breadfruit, biscuit break strength, biscuit spread/flow, composite flour, functional properties, malting, pasting characteristics, *sensory* properties, *Treculia africana*

INTRODUCTION

Increasing urbanization in African countries is changing the food habit and preferences of the population towards convenience foods. Consumption of biscuits and similar foods made from wheat has become so popular in Nigeria that its total elimination from the dietary pattern could have nutritional and socio-economic implications.

Unfortunately, wheat cannot be grown in Nigeria, leaving sourcing to importation paid with scarce foreign currency. The ban on importation of wheat into the country has contributed immensely to the present high cost of bakery and confectionery products. Partial or complete substitution of wheat flour with flours from tropical crops such as roots and tubers (cassava, yam and sweet potatoes) could tremendously reduce importation of wheat (Morton, 1988 and Satin, 1988).

African breadfruit (*Treculia africana*) grows naturally in most parts of rain forest and savanna areas of Nigeria. It is also found distributed from Senegal to Southern Sudan and Southwards to Angola and the Islands of Principe and Sao Tome (Ajiwe *et al*., 1995). The crop is beneficial to the producers in the sense that it produces its globoid or slightly ellipsoid fruit heads during the *hungry* season (March-July) when most staples have been cultivated.

Each fruit head, which ranges from 20-40cm in diameter, weighs between 18-20 kg. It contains numerous brown seeds embedded in its spongy portion. Each seed is rounded at one end and pointed at the other. It constitutes the edible portion of African breadfruit with an average length of 0.9 cm. The seeds are extracted from the fruit head using the traditional processing method.

Potentials of African breadfruit as an immense nutrient contributor to the diet of Nigerians had been reported in literature (Iwe *et al*., 2001). Its combination with soybean alone or soybean and corn to produce acceptable and improved protein quality products through fermentation and germination (Ariahu *et al*., 1999). and extrusion cooking (Nwabueze, 2006).had been reported.

In addition the potential for producing non-alcoholic beverage (Ejiofor *et al*., 1988). and as raw material for bread making, cake and cookies (Lwal and Bassir, 1986). had earlier been reported. In this research, effect of malting African breadfruit seeds on the proximate composition, functional properties and pasting

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characteristics of the flour was investigated. The objective was to evaluate the suitability of the flour and its composite with wheat flour for biscuit making and investigate effect of malting on the *sensory* and some quality parameters of the biscuit.

MATERIALS AND METHODS

Materials: Seeds of African breadfruit were purchased from Ndoro market while commercial wheat flour and other baking ingredients were obtained from Umuahia main market, Abia State, Nigeria.

Seed malting: The breadfruit seeds were divided into two batches of 3 kg each. One batch was malted while the other was unmalted. The seeds to be malted were sorted, washed and steeped in tap water three times seed volume at 28±1°C for 36 h. The water was changed every 6 h with an hour air- rest before re- steeping.

This method was to reduce microbial load and to prevent suffocation of respiring embryo due to reduction of oxygen in the water (Odoemelam, 2000). At the end of 36h steeping period, the seeds were spread on a jute bag previously washed and sterilized with 0.10% sodium hypochlorite in hot water (≈100°C) to prevent mould growth. The seeds were allowed to germinate for 72 h during which they were washed every 24 h to prevent mouth growth. At the end of germination the seeds were manually separated from the sprouts.

Flour production: Both batches of malted and unmalted seeds were parboiled at 100°C for 15 min and dried in the oven at 60°C for 24 h. They were milled and sieved to obtain either malted or unmalted breadfruit flours. The flours were stored in airtight plastic containers and kept in the refrigerator until needed.

Determination of malting characteristics: Malting characteristics such as germination percentage, malting yield and loss were determined. Germination percentage was determined on the relationship of germinated to ungerminated seeds. Malting yield was determined by the method described by Lasekan (1991). It involved relating weight of dry raw seeds to the weight of dry malt. Malt yield was calculated as:

$$\frac{\text{Weight of drymalt}}{\text{Weight of dry raw grain}} \times 100 \qquad (1)$$

Malting loss was determined by the method described by Briggs *et al*. (1981). as the percentage reduction in dry weight occurring in the conversion of breadfruit seeds to the finished malt, thus:-

$$\text{Malt loss} = \frac{\text{Weight of raw grain} - \text{weight of dry malt}}{\text{Weight of dry raw grain}} \times 100 \qquad (2)$$

Proximate analysis of the flour: The proximate composition of malted and unmalted breadfruit seed flours were determined by the method described by AOAC (1984). for the moisture, crude protein (N x 6.25), fat, ash and crude fibre. Carbohydrate was determined by difference.

Functional properties of flours: Functional properties determined on flours included water and oil absorption capacities and bulk density.

Water and oil absorption capacities were determined on both malted and unmalted flours by the methods described by Beuchat (1997). using 1g of flour samples. The flours were mixed with 10ml of distilled water/oil and shaken for 1min. They were kept at room temperature for 30min and then centrifuged at 3000rpm for 30min. The supernatant liquids were measured and the volumes of water/oil absorbed were determined. Water/oil absorption capacities were expressed as volume of water/oil absorbed/g flour.

Bulk density was determined as described by Nwabueze and Iwe (2006). A 10 mL-graduated cylinder previously tarred was gently filled with each sample. The bottom of the cylinder was gently tapped on a laboratory bench several times until there was no further diminution of the sample level after filling to the 10 mL mark. Bulk density was calculated as weight of sample per unit volume of sample.

Pasting characteristics: The pasting characteristics of the flours were determined using the method reported by Damardjati and Luh (1987). The suspension prepared from 45g of the sample and 450 mL of distilled water was heated in a rotating bowl of the Brabender Amylograph (800140 OHG, Diusburg, Germany). The thermoregulator controlled the heating from 30°C to 95°C with the heating rate of 2.5 °C min^{-1}. The sensor inside the rotating bowl was deflected against the force of the measuring spring and that deflection was recorded on a line recorder to obtain the graph. At the end of the test, pasting characteristics such as gelatinization temperature, peak viscosity, temperature at viscosity, viscosity at 95°C after 15 min were calculated from the graph. The paste was cooled down to 50°C with cold water.

Biscuit making: Biscuits were made from 100% breadfruit flours (malted or unmalted), 100% commercial wheat flour and composite flours containing 20, 40, 50, 60 and 80% breadfruit (malted or unmalted) and commercial wheat.

Table 1: Recipe for biscuit making

Ingredients	Quantity (g)	Ingredients	Quantity (g)
*Flour	200.00	Baking powder	2.00
Sugar	50.00	Vanilla	0.20
Salt	0.20	Egg	One whole
Fat	100.00	Milk	3 tablespoonfuls

*Wheat, breadfruit (malted/unmalted) or composite flour

Biscuit making formulation described by Oyewole *et al.* (1996). was adopted Table 1. Fat and sugar were mixed until fluffy. Egg and milk were added while mixing continued for 40 min. Appropriate flour, baking powder, vanilla flavour and salt were slowly introduced into the mixture.

The thin paste obtained was rolled on a flat rolling board sprinkled with the flour to a uniform thickness of 0.4cm using a wooden pin. Rectangular biscuit doughs with dimensions 6×3.5cm (length by width) were cut, perforated, placed on greased baking trays and baked at 160°C for 15 min. Biscuit samples were cooled and stored in polyethylene bags until needed.

Biscuit quality parameters: Biscuit quality parameters tested included the biscuit flow or spread and biscuit break strength as described by Okaka and Isieh (1990). Biscuit flow or spread was determined in triplicates over the unbaked, stamped-out dough of known dimensions. Biscuit spread was calculated as the increase in volume of dough at the end of baking over the original volume thus:

$$\text{Biscuit spread} = \frac{\text{Increase in volume of biscuit dough}}{\text{Original volume of biscuit dough}} \times 100 \quad (3)$$

Biscuit break strength was determined by slightly modifying the biscuit break strength device reported by (Okaka and Isieh, 1990). A commercial biscuit (Nasco biscuits, Nigeria Plc.) of known thickness (0.45-0.65 cm) was placed centrally between two parallel wooden bars with the dimensions 21×13×0.70 cm. Another wooden bar of dimensions 21×13×2.0 cm (0.3 kg) was then placed on the biscuit. Weights were added on the bar in increments until the biscuit snapped. The least weight that caused the breaking of the biscuit was taken as the break strength of the biscuit. An average of three such determinations was recorded.

Sensory evaluation: The acceptability tests for all biscuit samples were done using 20 semi-trained Panelists drawn from students of Michael Okpara University of Agriculture, Umudike. Biscuit characteristics evaluated included colour, taste, texture, flavour and general acceptability on a 9- point Hedonic scale as described by Ihekoronye and Ngoddy (1985). Members of the Panel were asked to score the coded samples with the scale of the range 9 = like extremely, 5 = neither like nor dislike and 1 = dislike extremely.

Statistical analysis: Analysis of variance was used to test statistically, the significance of any change in all the samples at 95% confidence level (Steel and Torie, 1981). This was done for biscuit volume, break strength and sensory quality.

RESULTS AND DISCUSSION

Malting characteristics: African breadfruit seed germination percentage at the end of 72 h after the 36 h-steeping period was 84% while malting yield and loss were 81.38 and 18.60%, respectiviely. The viability of seeds as well as malting conditions of temperature, air and moisture are important factors affecting germination percent. Briggs *et al.* (1981) attributed malting loss to rootlet growth and other factors such as respiration of embryo and leaching out of some materials from the seed during steeping. In addition, malting loss, which increased with germination period, could have been affected by steeping energy required for respiration and germination.

Proximate composition: Table 2 shows the proximate composition of malted and unmalted breadfruit flours. Malting while resulting in decrease in fat and carbohydrate content of the flour by 29.63 and 2.93%, respectiviely, increased moisture, crude protein, ash and crude fibre by 22.22, 30.52, 10.0 and 17.86%, respectiviely. Similar observation of effect of malting on proximate composition of flours had been reported in cowpea, (Apapunam and Achinewhu, 1985, Giami, 1993).

Although the direct effect of malting on the protein amino acids was not carried out in this research, literature search showed that increase in crude protein amounted to increase in amino acids. Wang and Fields (1978) reported an increase in level of lysine, methionine and tryptophan in corn and sorghum with malting. The decrease in fat reported in this research agrees with similar reports of effect of malting on fat content of some legumes such as lentils, mung bean and soybeans, (Kylen and Ceady, 1975).

Water and oil absorption capacities: Water absorption capacity decreased with malting by 33.33% while oil absorption capacity showed a reverse effect of malting, increasing by 100% (Table 2). This observation suggests that carbohydrate contributes more positively to the oil absorption capacity than protein.

Table 2: Proximate composition (%) and some functional properties of malted and unmalted African breadfruit flours

Sample	mc	cp	ash	fat	cf	carb	wc (mL g^{-1})	oc (mL g^{-1})	ρ_b (g mL^{-1})
Malted	11.00	13.00	2.75	9.50	3.30	60.32	2.00	4.00	0.57
Unmalted	9.00	10.06	2.50	13.50	2.80	62.14	3.00	2.00	0.59

mc = moisture content, cp = crude protein (N x 6.25), cf = crude, carb = carbohydrate (by difference), wc = water absorption capacity, oc = oil absorption capacity and ρ_b = bulk density

Table 3: Pasting properties of malted and unmalted breadfruit flours

	T_g (°C)	V_m (Bu)	T_m (°C)	V_r (Bu)	Ve (Bu)	V_e-V_r (Bu)	V_m-V_r (Bu)	V_e-V_m (Bu)
Malted	65.00	100	95	100	300	200	0.00	200
Unmalted	72.50	109	90	105	260	155	4.00	151

T_g = gelatinization temperature, V_m = peak viscosity, T_m= temperature at peak viscosity, V_r = final viscosity at 95°C after 15min, V_e= viscosity on cooling to 50°C, V_e-V_r =index of gelatinization, V_m-V_r = stability, V_e -V_m = set back value, BU = Brabender unit

Water absorption capacity is a necessary functional property that predicts the ability of a product to associate with water under conditions where water is limiting. The high water absorption capacity of African breadfruit flours (malted or unmalted) suggests the possibility of presence of some hydrophilic proteins or polar amino acid residue in the flour (Odoemelam, 2000). It was also suggested that African breadfruit flour probably contains some hydrophobic proteins with superior binding properties, hence the high oil absorption capacity. Oil absorption capacity is an important property in food formulations. Oils improve flavour and increase the mouth feel of foods.

Bulk density: Malting lowered the bulk density by 3.39% Table 2. Bulk density is a functional property of food that is of relevance in food formulations. It is important relative to sensory acceptability, handling and packaging requirements and shipping costs (Mega and Kim, 1989). Compositional changes in breadfruit seeds especially in protein and carbohydrate during malting could be responsible for the observed difference in bulk density.

Pasting characteristics: Table 3 shows the pasting characteristics of malted and unmalted African breadfruit seed flours. Generally, the gelatinization temperatures of the flour were low (65-72°C) and stability of the viscous material was poor (0-4BU). Although the peak viscosities were low, viscosity on cooling to 50°C ranged between 260BU (unmalted) to 300 BU (malted). Malting positively influenced temperature of peak viscosity, viscosity on cooling to 50°C, index of gelatinization and the set back value.

The contribution of the structural and compositional constituents such as protein, starch and lipids in the malted and unmalted flours can not be overlooked. It is highly possible that the imbibitions of water by protein and carbohydrate polymers vary with malting. Further more formation of starch -lipid and starch -protein complexes which delay swelling of the granules lend

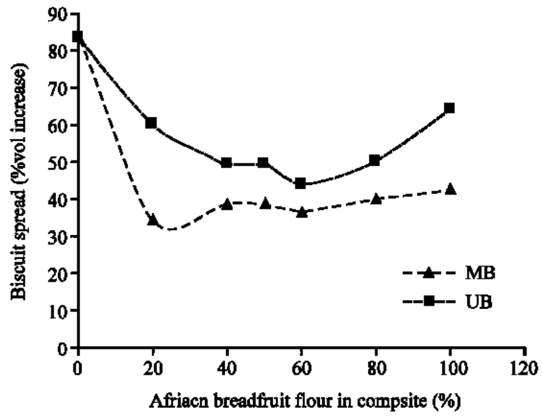

Fig 1: Biscuits spread (MB = malted breadfruit and UB = unmalted breadfruit). 0 = 100%commercial wheat biscuit, 20-80% composite (breadfruit/wheat) biscuit, 100 =100%breadfruit biscuit

additional contribution to the observed gelatinization and viscosity behaviours of the two flour sources. This behaviour produced serious syneresis, which might be a set -back in the use of African breadfruit flours in formulations that require stability. Similar observations had been reported in literature (Damardjati Luh, 1987, Adeyemi and Idowo, 1990).

Biscuit flow or spread: Biscuit spreads for biscuit dough made from malted and malted African breadfruit is shown in Fig. 1. Biscuit spread is the increase of biscuit dough after baking. Wheat flour biscuit dough increased in volume by 83.78%. Biscuit dough from African breadfruit flour showed 42.50% (malted) and 64.53% (unmalted) increase in volume. African breadfruit dough spread was 22.98 and 49.27% lower than commercial wheat dough. Biscuit dough spread is a function of dough sugar content. In a molten state during baking sugar exhibits flow or spread property within the dough matrix. On cooling, sugar sets and confers rigidity to the much-expanded biscuit. While (Addo *et al*., 1984). reported that pigeon pea and wheat flour biscuits had similar spreading characteristics, (Okaka and Isieh,1990). reported higher wheat flour biscuit flow (70.5%) than biscuits containing 50-90% cow pea flour (64-80%).

In this research, biscuit dough containing 20-80% African breadfruit increased in volume by 34. 35-40.24% (malted) and 43.87-60.42% (unmalted). Malting reduced biscuit dough volume probably due to its effect on flour composition especially the carbohydrate.

Biscuit break strength: The weight required to break the biscuits are shown in Fig. 2. A weight of 0.40 kg was required to break wheat flour biscuit. Wheat flour biscuit had higher break strength than biscuit made from African breadfruit flour. Fig. 2. showed that 0.28 and 0.35 kg weight were required to break biscuit from malted and unmalted breadfruit seed flours, respectiviely. The difference in composition of African breadfruit and wheat flour especially the gluten content of wheat flour could be responsible for the difference in biscuit strength. In this research, breadfruit flour had a reasonable amount of protein and fat (malted and unmalted) (Table 2).

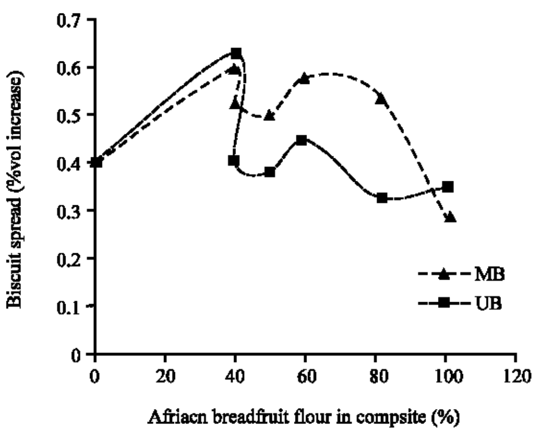

Fig 2: Biscuits break strength (MB = malted breadfruit and UB = unmalted breadfruit) 0 =100%commercial wheat biscuit, 20-80% composite (breadfruit/wheat) biscuit, 100 = 100%breadfruit biscuit

Commercial wheat flour supplementation with African breadfruit flours (80-20%) increased biscuit break strength from 0.55-0.60 kg (malted) and 0.35-0.63 kg (unmalted). Similar effect of wheat substitution with cowpea flour in biscuit formula on biscuit strength had been reported in literature (Okaka and Lsieh, 1990).

Sensory characteristics: Sensory characteristics of biscuits made from wheat, breadfruit (malted and unmalted) and composites are presented in Table 4. Biscuit from commercial wheat flour represented a familiar and popular biscuit formulation. This was shown in the high level of acceptability (7.10) by the Panelists. All the sensory characteristics evaluated were higher in the wheat flour biscuit ranging from 6.90 (colour) to 7.45 (texture) than in the unfamiliar and rather new biscuit products from African breadfruit flours which ranged from 4.15 (flavour) to 5.70 (colour) in the malted and 3.75 (taste) to 5.35 (colour) in the unmalted flour formulation.

Wheat flour is unique in the baking of bread and other products because it is the only crop possessing gluten in appreciable quantity to permit substantial increase in volume of baked products, which are both palatable and digestible.

Malting the African breadfruit seeds improved sensory characteristics of biscuit made from the flour over the unmalted. In malting, enzymes bring about the much-needed biochemical changes in the raw grain, which also alters the physical state so that the originally hard grain becomes friable. (Fasominu *et al*., 2001). reported that in that state, enzyme activities resulted in the conversion of the reserve starch to fermentable sugars. Substituting commercial wheat flour with 20-80% malted or unmalted breadfruit seed flour improved the biscuit sensory characteristics. The 20% substitution was the most liked and acceptable to the Panelists. Biscuit acceptability was 4.75 and 5.0 at 80% wheat substitution (malted/ unmalted breadfruit flour , respectiviely). These values increased to 5.85 and 6.45 when wheat substitution was reduced to 20% breadfruit flour (malted/ unmalted) in the composite. (Okaka and Isieh, 1990). suggested that new products

Table 4: Sensory evaluation of the biscuits

Sample (%)	Colour UB	Colour UB	Taste MB	Taste UB	Texture MB	Texture UB	Flavour MB	Flavour UB	Acceptability MB	Acceptability UB
100*	5.70^{cd}	5.35^{d}	4.20^{ef}	3.75^{f}	4.50^{d}	4.65^{cd}	4.15^{e}	4.20^{e}	4.35^{e}	4.15^{e}
80	5.65^{cd}	5.65^{cd}	4.90^{cde}	5.00^{cde}	5.35^{bcd}	5.00^{cd}	4.95^{cde}	4.65^{de}	4.75^{de}	5.00^{cde}
60	5.90^{bcd}	6.10^{abcd}	5.50^{bcd}	5.60^{bcd}	5.45^{bc}	6.00^{b}	5.25^{cd}	5.20^{cd}	5.45^{cd}	5.55^{bcd}
50	6.35^{abc}	6.00^{abcd}	5.65^{bc}	5.5^{bcd}	5.40^{bcd}	5.45^{bcd}	5.25^{cd}	4.95^{cde}	5.35^{cd}	5.45^{cd}
40	6.15^{abcd}	5.95^{bcd}	5.60^{bcd}	4.75^{def}	5.5^{bc}	4.70^{cd}	5.80^{bc}	5.10^{cde}	5.70^{bcd}	4.95^{cde}
20	6.70^{ab}	6.75^{ab}	5.80^{bc}	6.50^{ab}	6.25^{b}	6.20^{b}	5.75^{bc}	6.35^{ab}	5.85^{bc}	6.45^{ab}
0**	NM	6.90^{a}	NM	7.20^{a}	NM	7 .45^{a}	NM	7.25^{a}	NM	7.10^{a}

*100% breadfruit flour biscuit, **100% commercial wheat flour biscuit, NM= not malted, MB = malted breadfruit biscuit, UB = unmalted breadfruit biscuit. Samples 20-80 (%) composite flour (breadfruit/wheat) biscuit unfamiliar to consumers need to be properly advertised to educate the minds of consumers prior to introduction into the market especially where a popular and more familiar competitor product already existed.

CONCLUSION

African breadfruit seed has the potentials for biscuit making either as malted, unmalted or as composite with commercial wheat. Malting affected the nutritional, functional and pasting properties in some way. It improved crude protein, oil absorption and viscosity properties on cooling to 50°C but decreased fat, carbohydrate, bulk density and gelatinization temperature of the flour. Flour from malted seeds resulted into biscuit as whole or composite with better sensory characteristics and flow, being at its best at 20% combination with wheat flour.

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