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Full Length Research Paper

Storage influence on the functional properties of malted and unmalted maize (*Zea mays* L ssp mays) and soybean (*Glycine max* L Merrill) flour blends

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The complementary blends of maize (*Zea mays* L ssp mays) and soybean (*Glycine max* L Merrill) were stored for a period of 12 weeks. The maize grains were malted by subjecting it to cleaning, washing, steeping, sprouting, drying, desprouting, milling and packaging. A portion of the maize flour was blended with soybean flour at the ratio of 70:30 (malted maize flour: soybean flour; unmalted maize flour: soybean flour). The resulting products were stored in polyethylene and plastic containers. The functional properties (Bulk density, viscosity, water and oil absorption capacity, swelling capacity, peroxide value and least gelation concentration) of the products were determined. The result showed that the bulk density and the peroxide value of both malted and unmalted maize flour reduced significantly (P>0.05) when blended with soybean. The swelling capacities of the malted products were lower than those of the unmalted blends and it also decreased though not significantly (P>0.05) with the period of storage. The malting process reduced the viscosity of the products, however; inclusion of soybean flour increased the viscosity. The viscosity and the peroxide value increased significantly (P>0.05) in the two storage containers as the storage period increased. The result revealed that the packaging materials had no significant effects on the parameters assessed.

Key words: Unmalted maize, malted maize, soybean blends, bulk density, swelling capacity, water absorption capacity.

INTRODUCTION

Complementary foods, in most developing countries, are mainly from cereal with animal protein being used as supplements. However, because of the high cost of the animal protein, attempts have been made to look into alternative sources (Obatolu and Cole, 2000). In order to improve the nutrition of children in region of chronic and acute malnutrition, various kind of economical protein-rich plant mixtures are used for different area in Africa (Mosha and Svanberg, 1990) . The combination of such food ingredients often alter the food composition of the food product and may change the functional and sensory properties (Kinsella, 1976). It has been recommended that, for long period of conservation, flour should be stored in closed atmosphere. In this condition, flour acidity increases owing to accumulation of a linoleic and linolenic acids, which are slowly oxidized; solubility of gluten protein decreases (Kent, 1978). The hazards to flour in storage include mould and bacterial attack, insect infestation, also oxidative rancidity. The optimum moisture content of the storage of flour must be in relation to the length of storage envisaged, and to the prevailing ambient temperature and relative humidity, remembering that due to hygroscopicity, flour will gain or lose moisture to the surrounding atmosphere, unless packed in hermetically sealed containers (Kent, 1978). Package is a means of providing the correct environmental conditions for food or any other product, in order to protect the product against any deterioration be it microbiological, chemical or physical in nature (Komolafe, 2005).

Previous workers in the field of nutrition and food science and technology had worked on the effects of malting on the quality parameters of complementary food, however, scanty information is available on the effect of storage on the quality parameters of malted maize and soybean blends. The aims of this work were therefore to

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evaluate the quality parameters of malted and unmalted maize and soybean blends and also to determine the effect of storage in polyethylene and plastic container on the qualities of the blends, because these are the common storage containers readily available to greater populace of Nigeria.

MATERIALS AND METHODS

Maize (*Zea mays* L ssp mays) and soybean (*Glycine max* L Merrill) grains used for this work were purchased from 'Oja Oba' market in Akure, Ondo state. The maize grains were malted using the method described by Kulkarni et al. (1991) for cereal germination with some modifications. The maize was soaked for 12 h in a volume of water three times its weight and drained. It was spread on a wide wooden box for germination under ambient temperature (30± 2^{0}C) for 72 h and watered twice daily. The germinated grains were washed and dried to a moisture content of 10%. It was then milled using hammer mill. The unmalted maize grains were washed and dried to a moisture content of 10% and were milled using hammer mill.

The soybean flour was also produced according to the method of Kulkarni et al. (1991). The soybean seeds were cleaned and washed. They were boiled for 30 min and later soaked for 24 h with the changing of soaking water at 4 h interval. The testa on each grain was removed and the seeds were dried. The dried soybean seeds were milled into powder using hammer mill.

It was formulated thus: unmalted maize 100% (Umm); 70% unmalted maize + 30% soybeans (Umms); malted maize 100% (Mm); 70% malted maize + 30% soybeans (Mms). The formulations were divided into two each. One part was stored in polyethylene bag while the other was stored in a plastic container for 12 weeks at room temperature of 30±2^{0}C. The functional and the physicochemical properties were determined every three weeks during the storage period. All determinations were done in triplicates.

The bulk density was determined according to the method described by Okaka and Potter (1977). The bulk density was calculated as mass of flour per unit volume (g/cm^3). The water and oil absorption capacity (WAC) and (OAC) were determined using the method described by Beuchat (1977). A sample (1 g) each was mixed with 10 ml of distilled water for WAC and 10 ml of oil for OAC and blended for 30 s. The samples were allowed to stand for 30 min and centrifuged at 3500 x g for 30 min at room temperature. The supernatant was decanted. The weight of water or oil absorbed by the flour was calculated and expressed as WAC or OAC. The method of Ukpabi and Ndimele (1990) was used for the swelling capacity. Flour (20 g) was put into a washed, dried and weighed graduated measuring cylinder. 100 ml of distilled water was added and allowed to stand for one hour. The supernatant was discarded and the cylinder with its content weighed to obtain the weight of the net sample. The difference in final to initial volume of the sample gave the swelling capacity on volume basis. The method of Coffman and Gracia (1977) was used in the determination of least gelation concentration. Appropriate sample suspensions were weighed into 5 ml distilled water each to make 2-20% (w/v) suspension. The test tubes containing these suspensions were heated for 1 h in boiling water (bath) followed by rapid cooling under running tap water. The test tubes were further cooled for an hour under the running water, the least gelation concentrations (LGC), were determined as concentration when the sample from the inverted test tube did not fall or slip. The viscosity was determined using the Association of Official Analytical Chemists AOAC (1990) method. Ten grams of the sample was mixed with 150 ml of deionized water (heated to 95^0 C for 5-10 min) to gelatinize, it was cooled and the viscosity was measured using the Ostwald viscometer. The Pearson (1976) method of analysis was used for the pH analysis, the sample (1 g) was taken in separate test tube and 10 ml of distilled water was added. It was then shaken properly and measured with the aid of Iso-electric pH meter. The peroxide value was determined according to the method of AOAC (1990).

Statistical analysis

Data collected were subjected to the analysis of variance (SAS, 2002). Mean separation were done where there were significant differrences using Duncan multiple range test procedure as described in the SAS software. Significance was accepted at P>0.05.

RESULTS AND DISCUSSION

The results presented in Table 1 showed that the bulk density of the flour from both malted and unmalted maize decreased after it had been blended with soybean flour Umm from 0.77 to 0.66 g/m^3 while Mm from 0.83 to 0.81 g/m^3. This result agrees with the finding of Akubor and Obiegbuna (1999) . They reported that the bulk density of flour from malted maize and soybeans blend reduced significantly. As the storage period increased, the bulk density reduced in the two storage containers. There was no significant difference (P>0.05) in the bulk densities of the samples during the 12 weeks period of storage in the two storage containers. The reduction in the bulk density of the germinated flours would be an added advantage in the preparation of supplementary foods (Akubor and Obiegbuna, 1999). Low bulk density food is desired where packaging is a serious problem (Ikujenlola, 2008).

Swelling capacity is the volume of expansion of molecule in response to water uptake which it possessed until a colloidal suspension is achieved or until further expansion and uptake is prevented by intermolecular forces in the swelled particle (Houssou and Ayernor, 2002). The swelling capacity (SWC) of the malted and unmalted maize increased after it had been blended with soybean. The SWC of the unmalted maize blend (1.0 cm^3) was higher than the malted maize blend (0.50 cm^3). This result differs from the observation of Ikujenlola and Fashakin (2005) that there was reduction in the swelling capacity of the diet prepared from germinated and ungerminated maize cowpea bean blend. The increase in the swelling capacity could be attributed to the increase in the carbohydrate content of the blend because the carbohydrate content of the soy bean might have caused the increase in the carbohydrate content of the blend. The SWC decreased though not significantly (P>0.05), during storage in the two containers under observation for the 12 weeks storage period.

Gelation is one of the most important functional properties which determine the suitability of incorporation of a particular substance into food products (Adebowale and Adebowale, 2008). The least gelation concentration (LGC) of the flour increased after the maize (malted and unmalted) had been blended with soybean Umm 6-8 w/v and Mm 4- 8 w/v. Obatolu and Cole (2000) observed reduction in the LGC of cowpea and malted maize blend. The LGC was not consistent in storage but remained the

Table1. Bulk density, swelling capacity and least gelation concentration of malted and unmalted maize soybean blend.

Parameters	Week 0		Week 3		Week 6		Week 9		Week 12	
	Plastic	Polyethylene	Plastic	Polyethylene	Plastic	Polyethylene	Plastic	Polyethylene	Plastic	Polyethylene
Umm	0.77(a)a	0.77(a)a	0.70a	0.70a	0.80a	0.78a	0.68a	0.68a	0.76a	0.74a
BD Umm	0.66(b)a	0.66(b)a	0.60a	0.70a	0.80a	0.72a	0.61a	0.60a	0.62a	0.64a
g/cm^3 Mm	0.83(a)a	0.83(a)a	0.76a	0.78a	0.80a	0.76a	0.77a	0.73a	0.72a	0.76a
Mms	0.81(a)a	0.81(a)a	0.76a	0.78a	0.70a	0.76a	0.67a	0.70a	0.69a	0.72a
Umm	0.80(b)a	0.80(b)a	0.60a	0.30a	0.80a	0.80a	0.60a	0.60a	1.00a	0.60a
SWCUmms	1.00(a)a	1.00(a)a	0.70a	0.60a	0.80a	0.60a	0.60a	0.60a	0.80a	0.60a
cm^3 Mm	0.40(b)a	0.40(b)a	0.40a	0.30a	0.60a	0.40a	0.80a	0.80a	0.50a	0.40a
Mms	0.50(b)a	0.50(b)a	0.30a	0.80a	0.60a	0.60a	0.60a	0.80a	0.60a	0.50a
Umm	6(b)a	6(b)a	6a	6a	4a	6a	6a	6a	4a	6a
LGCUmms	8(b)a	8(b)a	8a	8a	6a	8a	8a	8a	6a	6a
w/v Mm	4(c)a	4(c)a	4a	4a	8a	6a	6a	6a	6a	6a
ms	8(a)a	8(a)a	8a	8a	6a	8a	4a	6a	4a	6a

Value represents mean of triplicate. Values with the same letter along the same row are not significantly different (P>0.05) while value with the same letter inside bracket along the column are not significantly different (P>0.05). Umm-Unmalted maize 100%, Umms- 70% Unmalted maize + 30% soybean, Mm- Malted maize 100%, Mms-70% Malted maize + 30% soybean. BD- Bulk density, SW- Swelling capacity, LGC- Least gelation concentration.

Table 2. Water absorption capacity and oil absorption capacity of malted and unmalted maize soybean blend.

	Plastic	Polyethylene	Plastic	Polyethylene	Plastic	Polyethylene	Plastic	Polyethylene	Plastic	Polyethylene
Umm	240(b)a	240(b)a	220a	260a	240a	220a	240a	240a	240a	240a
WACUmms	280(a)a	280(a)a	240a	260a	260a	260a	240a	240a	240a	240a
% Mm	200(d)a	200(d)a	240a	260a	180a	220a	220a	240a	240a	260a
Mms	220(c)a	220(c)a	240a	220a	200a	200a	220a	240a	240a	260a
Umm	220(a)b	220(a)b	220a	200a	220a	220a	240a	240a	280a	280a
OACUmms	160(c)b	160(c)b	260a	260a	240a	240a	260a	240a	260a	280a
% Mm	120(d)b	120(d)b	280a	200a	240a	220a	240a	220a	280a	280a
Mms	180(b)b	180(b)b	200a	200a	240a	220a	220a	220a	280a	280a

Value represents mean of triplicate. Values with the same letter along the same row are not significantly different (P>0.05) while value with the same letter inside bracket along the column are not significantly different (P>0.05). Umm-Unmalted maize 100%, Umms- 70% Unmalted maize + 30% soybean, Mm- Malted maize 100%, Mms-70% Malted maize + 30% soybean. WAC- Water absorption capacity, OAC- Oil absorption capacity.

same in the first 6 weeks; though there was no statistical significant difference (P>0.05) in the values in the two storage containers.

Water absorption capacity is important in the development of ready to-eat-food cereal grains, since a high water absorption capacity may assure product cohesiveness (Houssou and Ayernor, 2002). The water absorption capacity (WAC) as shown in Table 2 was higher in the unmalted maize (240%) than malted (200%). These values were higher than the value reported by Yusuf et al. (2007) for snake gourd seed flour (130%). The reduc-tion in the WAC of malted maize agreed with the findings of Tatsadjieu et al. (2004) in the study of germination of sorghum. The WAC increased after the maize had been blended with soybean, Umms-280% and Mms-220%. This could be attributed to the added protein from the soybean since protein are mainly responsible for the bulk of the water uptake and to less extent the starch and cellulose at room temperature (Houssou and Ayernor, 2002). The unmalted blends had a higher WAC than the malted blends. This result agreed with the report of Badifu and Ebegonye (1999) and Ikujenola and Fashakin (2005). When the flour was stored for 12 weeks in plastic container and polyethylene, it was observed that there was no statistical significant difference (P>0.05) in fresh samples of week 0 and stored samples week 12.Oil absorption capacity is a critical assessment of flavour retention and increases the palatability of foods (Kinsella, 1976). The oil absorption capacity (OAC) of the flour of unmalted maize (220%) was higher than that of the malted maize (120%). The values reported in this work was higher than the OAC value of snake gourd seed flour (54%) (Yusuf et al., 2007). The OAC reduced in unmalted maize blends while it increased in malted maize blend, also the OAC of malted maize blend 180% was higher than the unmalted maize blend 160%. This result con-forms to the findings of Padmashree et al. (1987), Mosha and Svanberg (1990) and Obatolu and Cole (2000) that

Table 3. Viscosity, PH and Peroxide value of malted and unmalted maize soybean blend.

Parameters	Week 0		Week 3		Week 6		Week 9		Week 12	
	Plastic	Polyethylene	Plastic	Polyethylene	Plastic	Polyethylene	Plastic	Polyethylene	Plastic	Polyethylene
Umm	3.69(b)b	3.69(b)b	3.86b	4.11b	4.36b	4.90a	5.96a	6.32a	6.25a	6.66a
VIS Umms	4.16(a)b	4.16(a)b	3.96b	4.62b	4.36b	4.76b	6.10a	6.67a	6.18a	6.76a
g/m2 Mm	3.12(c)d	3.12(c)d	3.62b	3.72b	4.06c	4.21c	5.14a	5.70a	6.36a	6.40a
Mms	3.46(c)c	3.46(c)c	3.51b	3.57b	3.82b	4.18b	5.11a	5.92a	6.75a	6.82a
Umm	6.13(a)a	6.13(a)a	5.69a	5.99a	6.11a	6.14a	5.97a	5.99a	5.88a	5.93a
PH Umms	6.01(a)a	6.01(a)a	5.98a	5.93a	6.04a	6.06a	5.85a	5.93a	5.98a	5.57a
Mm	5.78(a)a	5.78(a)a	5.77a	5.72a	5.74a	6.76a	5.57a	5.51a	5.56a	5.53a
Mms	5.83(a)a	5.83(a)a	5.78a	5.80a	5.83a	5.86a	5.66a	5.69a	5.60a	5.67a
Umm	42.50(a)c	42.50(a)c	56.16a	52.16b	48.17b	49.38b	60.14a	50.16b	62.15a	60.16a
PVUmms	23.45(b)c	23.45(b)c	26.14c	50.36a	30.10b	40.31a	40.34a	40.38a	41.26a	43.26a
Mm	44.76(a)b	44.76(a)b	28.56d	60.14a	36.13c	38.36c	50.11a	49.37b	51.26a	50.17a
Mms	24.67(b)d	24.67(b)d	30.28c	33.14c	30.36c	33.18c	48.36b	50.33a	50.18a	52.56a

Value represente mean of triplicate. Values with the same letter along the same row are not significantly different (P>0.05) while value with the same letter inside bracket along the column are not significantly different (P>0.05).Umm-Unmalted maize 100%, Umms- 70%Unmalted maize + 30% soybean, Mm- Malted maize 100%, Mms- 70% Malted maize + 30% soybean. VS- Viscosity, PV- Peroxide value.

showed increase in OAC of germinated base blends. During storage in two containers, the OAC increased significantly (P>0.05) in the first 3 weeks of storage but there was no significant difference in the OAC of the flour of week 3 to week 12.

The viscosity of unmalted maize flour (3.69 g/m^2) was significantly higher (P>0.05) than the malted maize flour (3.12 g/m^2). This result agreed with the finding of Ayernor and Ocloo (2007) in the study of malted rice. The decrease in the viscosity could be attributed to the action on the starch by the hydrolyzing enzymes that were producing during malting (Ayernor and Ocloo, 2007). However, Badifu and Ebegonye (1999) reported increase in the viscosity of germinated melon kernel flour. Table 3 showed that the viscosity of the unmalted and malted maize products increased after blending with soy bean (Umm: 3.69 – 4.16 g/m^2, Mm: 3.69 – 4.16 g/m^2). The viscosity also increased significantly (P>0.05) as the storage period increased in the two storage containers.

The result of the pH showed that there was no significant (P>0.05) difference in the pH values of the flour from both unmalted and malted maize reduced after it has been blended with soybean, Umm- 6.13, Umms-6.01, Mm- 5.78 and Mms- 5.83. There was no significant (P>0.05) difference in the P^H values of both unmalted and malted maize blends in the two storage containers throughout the storage periods.

Peroxide value usually used as an indicator of deterioration of fats. As oxidation takes place, the double bonds in the unsaturated fatty acid break down to produce secondary oxidation products which indicate rancidity (Ihekoronye and Ngoddy, 1985). After blending of the maize (malted and unmalted) with soybean, the peroxide value decreased significantly, Umm: 42.50 - 23.45 while Mm: 44.76 - 24.67. During storage, the peroxide value increased significantly (P>0.05) in the two storage containers as the storage period increased. This agreed with the observation of Gahlawat and Sehgal (1994) that the peroxide value and fat acidity of weaning food developed from locally available food stuffs increased with increase in storage period.

Conclusion

It was observed during this work that the two storage containers used behaved similarly, therefore the use of these storage containers has no significant effect on the parameters estimated at the end of the storage period. It is therefore concluded that malted and unmalted maize blends can be stored in plastic or polyethylene container and there will be no compromise on the functional and physicochemical properties of the blends. It is also recommended that work should be done on the microbial content of the blends in storage.

REFERENCES

Adebowale YA, Adebowale KO (2008). Evaluation of the gelation characteristics of Mucuna flour and protein isolate. Electronic J. Environ. Agric. Food Chem. 7(9):3202-3222.

Akubor PI, Obiegbuna JE (1999). Certain Chemical and functional properties of ungerminated and germinated millet flour. J. Food. Sci. Technnol. 36: 241-243.

AOAC (1990) Official methods of analysis 14th Edition. Association of Official Analytical Chemist. Washington DC, USA.

Ayernor GS, Ocloo FCK (2007). Physicochemical changes and diastatic activity associated with germinating paddy rice (PSB.RC 34). Afr. J. Food. Sci. 1:37-41.

Badifu GIO, Ebegonye GM (1999). Effect of germination on chemical, physical and functional properties of defatted flour of melon (*Cirullus vulgaris*) kernel. J. Food Sci. 36(1):63-66.

Beuchat LR (1977). Functional and electrophoretic characteristics of succinylated peanut flour proteins. J. Agric. Food. Chem. 25, 258-

261.
Coffman CW, Garcia VV (1977). Functional properties and amino acid content of a protein isolate from mung bean flour. J. Food Technnol. 12: 473-484.
Gahlawat P, Sehgal S (1994). Shelf life of weaning foods developed from locally available food stuffs. Food. Human Nutr. 45(4):349-355.
Houssou P, Ayernor GS (2002). Appropriate processing and food functional properties of maize flour. Afr. J. Sci. Technnol. 3(1):126-131.
Ihekoronye AI, Ngoddy PO (1985). Integrated food science and Technology for the tropic. Macmillan publishers limited, London and Basinstoke. pp.253-257
Ikujenlola AV, Fashakin JB (2005). The Physico-chemical properties of a complementary diet prepared from vegetable proteins. J. Fd. Agric. Environ. Finland. 3(3&4): 20-22.
Ikujenlola, AV (2008). Chemical and functional properties of complementary food from malted and unmalted Acha (*Digitaria exilis*), Soybean (*Glycine max*) and Defatted asesame seeds (*Sesamun indicuml*). J. Eng . App. Sci. 39(6): 471- 475
Kent, NL (1978). Cereal technology with special reference to wheat, 2nd edition. Editor N. L Kent. Publisher Macmillan. 540pp
Kinsella, JE (1976). Functional properties of proteins in food. A survey. Crit .Rev. Food Sci. Nutr. 9: 219.
Kulkarni, KD, Kulkarni DN, Ingle UM (1991) Sorghum malt bases weaning food formulation. Functional properties and Nutritive value. Food Nutr. Bull. 13(4): 322-327
Komolafe, EA (2005). Food packaging. A monograph. Publisher: Biotidara press and computers, Akure. p. 81
Mosha AC, Svanberg UI (1990). The acceptance and intake of bulk reduced weaning food. Nutr. Bull. 12(1): 69-74
Obatolu VA, Cole AH (2000). Functional property of complementary blends of soybean and cow pea with malted or unmalted Maize. Food Chem. 70:147-153
Okaka JC, Potter NN (1977). Funtional and Storage properties of cowpea – wheat flour blends in bread making. J. Food Sci. 42 :828-833.
Padmashree TSN, Viyayakshami L, Puttarj E (1987). Effect of traditional processing on the functional properties of cowpea. J. Food Sci. Technol. 24 (5): 221-225.
Pearson D (1976). The Chemical Analysis of Foods. 7th edition. Churchill Livingstone. London UK.
SAS (2002) Statistical Analysis System Proprietary software. Release 8.3. SAS Institute Inc., Cary, NC USA.
Tatsadjieu NL, Etoa FX, Mbofung CMF (2004). Drying kinetics, physico-chemical and nutritional characteristics of Kindimu, a fermented milk based-sorghum-flour. J. Food. Technol. Afr. 9(1): 17-22
Ukpabi U, Ndimele C (1990). Evaluation of the quality of Gari produce in Imo State Nigeria. Niger. Food J. 8: 106.
Yusuf AA, Folarin OM, Bamiro FO (2007). Chemical composition and functional properties snake gourd (*Trichosanthes cucumerina*) seed flour. Niger. Food J. 25(1): 36-45.