Journal of Food Technology 5 (3): 215-219, 2007

Effect of Storage of Millet Flour on the Quality and Acceptability of Millet Flour Porridge (Enyiokwolla)

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Abstract: The effect of storage of millet flour on the quality and acceptability of millet flour porridge was studied. Millet flours were produced from untreated millet grains, soaked millet grains, malted millet grains and an equal blend of malted millet grains and soaked millet grains. The flours were packaged in high density polyethylene and stored at ambient temperature and relative humidity (32±2°C and 65-70%RH, respectively) for 3 months. At monthly intervals, the flours were analysed for moisture content, pH, thiobabituric acid value and least gelation concentration while porridges made from the flours were subjected to sensory evaluation. The moisture content of the flours witnessed no significant (p>0.05) changes while the thiobabituric acid values increased significantly (p<0.05) after 2 months of storage. The least gelation concentration of the samples were constant through the period of storage while pH of the flours decreased insignificantly (p>0.05). Porridges made from the flours were acceptable up to 2 months and 3 months of storage for flours from malted millet grains and flours untreated and soaked millet grains, respectively.

Key words: Flour, porridge, polyethylene, thiobabituric acid, gelation, sensoryevaluation

INTRODUCTION

Millet is an indispensable food for millions of people inhabiting the semi-arid tropics. It is used primarily for human food and remains a major source of calories and a vital component of food security in the semi-arid areas in the developing world (FAO, 1995).

Millet is processed in so many ways for preparation of various food products. Some of the primary processes involved are dehulling and milling in order to produce flours, grits and dehulled whole grains (Nkama and Ikwelle, 1997). Other methods of processing include roasting, soaking, germination and fermentation (Mukuru, 1992). These intermediate products are used to prepare staple foods like cooked whole grains; thin and thick porridges etc.

One of such porridges-enyiokwolla-is a very popular diet among the Idomas and Tivs in Benue state, central Nigeria. It is usually taken as a breakfast diet alongside "okpa or akpukpa" which is steamed pudding produced from bambara groundnut.

"Enyiokwolla" production involves the cleaning of whole millet grains followed by the milling of the cleaned grains into flour. The flour is then made into slurry by adding cold water. Boiling water is added to the slurry to produce a gelatinized product: Enyiokwolla. The enyiokwolla may be further heated to increase the thickness if desired. Millet flour for 'enyiokwolla' production is usually produced as it is needed and is not often stored for long periods due to its (millet flour) tendency to turn rancid (FAO, 1995). The objective of this study is to determine how storage of millet flour affects the quality of 'enyiokwolla' with respect to rancidity and gelation.

MATERIALS AND METHODS

Pearl millet (*Pennisetum glaucum*), was obtained from Benue Agricultural and Rural Development Agency, Makurdi, Benue State, Nigeria.

Preparation of flour: Whole grain millet flours were produced from pearl millet by 4 different methods.

In the first method, 1 kg of millet grains were thoroughly cleaned by winnowing and discarding unviable seeds. The seeds were then washed with tap water and thoroughly rinsed with distilled water. They were dried in a local solar drier at a temperature range of 52-59°C for 8½ h. Seeds were milled using a local (Asiko A11 double grinding) attrition mill. The resultant flour was packaged in high density polyethylene in weights of 100 g.

In the second method, 1½ kg of millet grains were cleaned, washed with tap water and rinsed with distilled water. The grains were then soaked in 2½ L of distilled water for 12 h with the soak water being changed every

4 h. At the end of soaking, the water was drained off and the millet grains were solar dried. One kilogram was milled and packaged as in the first method while 0.5 kg was set aside.

In the third method, the same procedure was followed as in the second method except that at the end of soaking the grains were evenly spread on jute bags and covered with the same material in a dark secluded area and allowed to germinate at a temperature of 32+ 2°C for 48 h. The grains were watered at regular intervals of 12 h to prevent drying-out. After germination was terminated, the grains were dried, 1 kg was milled along with the rootlets and packaged as in the previous methods while the remainder was set aside.

The fourth flour sample was prepared by mixing 0.5 kg of the soaked millet grains and 0.5 kg of the malted millet grains. This was then milled and packaged as in the previous methods.

Packaging and storage: The flours were packaged in high density polyethylene in 100 g sizes and sealed using an electric sealer. The packaged samples were stored at ambient temperature and relative humidity (32±2°C and 65-70% RH) for three months. At monthly intervals, the Thiobabituric Acid (TBA) value, least gelation concentration, moisture content, pH of the flour samples were determined while porridges prepared from the flours were subjected to sensory evaluation.

Chemical and physico- chemical analyses: The moisture content, pH, TBA value and least gelation concentrations of the flour samples were determined as described by AOAC (2000), Vasconcelos *et al*. (1990), Kirk and Ronald (1991), Coffman and Garcia (1997), respectively.

Sensory evaluation: "Enyiokwolla" was prepared by making the 100 g packs of flours into slurries in plastic cups by the addition of cold water (20% w v^{-1}). These were then cooked by placing the cups in boiling water and stirring continuously for 10 min. Five gram of table sugar was added to enhance the tastes. The enyiokwolla from each flour was evaluated by a panel of 15 judges, made up of students of the Department of Food Science and Technology, University of Agriculture, Makurdi, Benue State, Nigeria who were familiar with the porridge. The parameters evaluated included appearance/colour, aroma, taste and overall acceptability. A nine point hedonic scale was used where one represented extreme dislike and 9 represented extreme like.

Statistical analysis: Experimental and sensory results were subjected to Analysis of Variance (ANOVA).

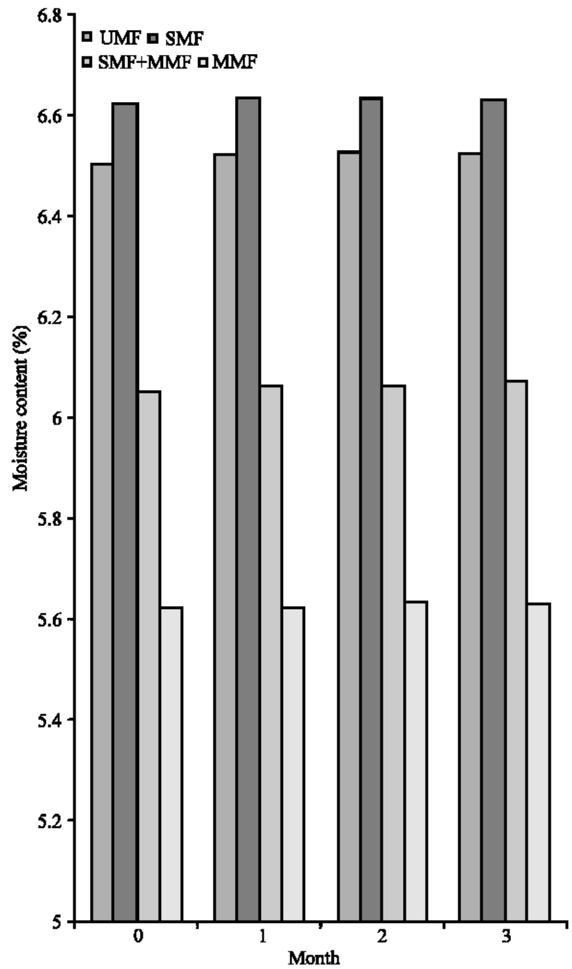

Fig. 1: Moisture content of millet flours in storage, UMF = Untreated Millet Flour, SMF = Soaked Millet Flour, SMF+MMF = 50:50 blend of soaked millet flour and malted millet flour, MMF = Malted Millet Flour

Means were compared using Least Significant Difference (LSD) as described by Ihekoronye and Ngoddy (1985).

RESULTS AND DISCUSSION

The result of the moisture content of stored millet flours are shown on Fig. 1. The moisture content of the untreated millet flour increased insignificantly ($p>0.05$) from 6.50-6.52% during the period of storage as was the case with the soaked millet flour (6.62-6.63%). The same trend was observed for the other samples. The insignificant increases in the moisture contents may

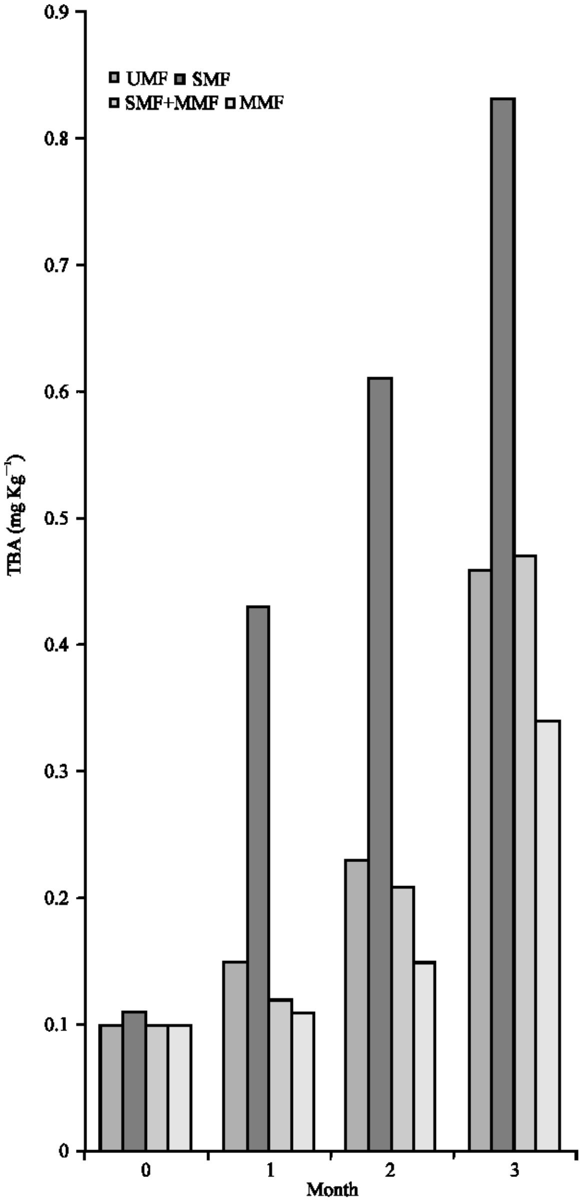

Fig. 2: TBA values of millet flours in storage, UMF = Untreated Millet Flour, SMF = Soaked Millet Flour, SMF+MMF= 50:50 blend of soaked millet flour and malted millet flour, MMF = Malted Millet Flour

be due to the thickness of the polyethylene used to package the samples as well as the relatively constant relative humidity of the storage environment.

The TBA values of the flour samples during storage are shown on Fig. 2. The TBA values for untreated millet flour and the 50-50 blend of soaked millet flour and malted millet flour increased significantly ($p<0.05$) after 2 months of storage while that of the soaked millet flour

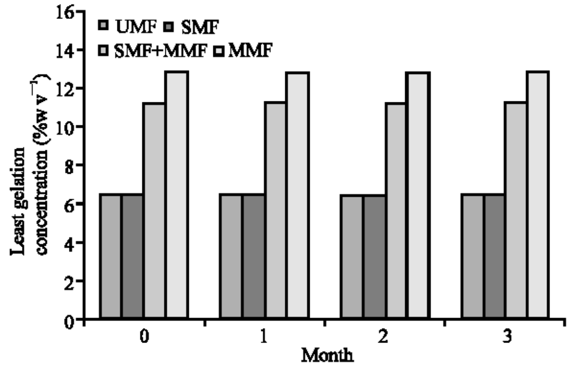

Fig. 3: Least gelation concentration of millet flours in storage, UMF = Untreated Millet Flour, SMF = Soaked Millet Flour, SMF+MMF= 50:50 blend of soaked millet flour and malted millet flour, MMF = Malted Millet Flour

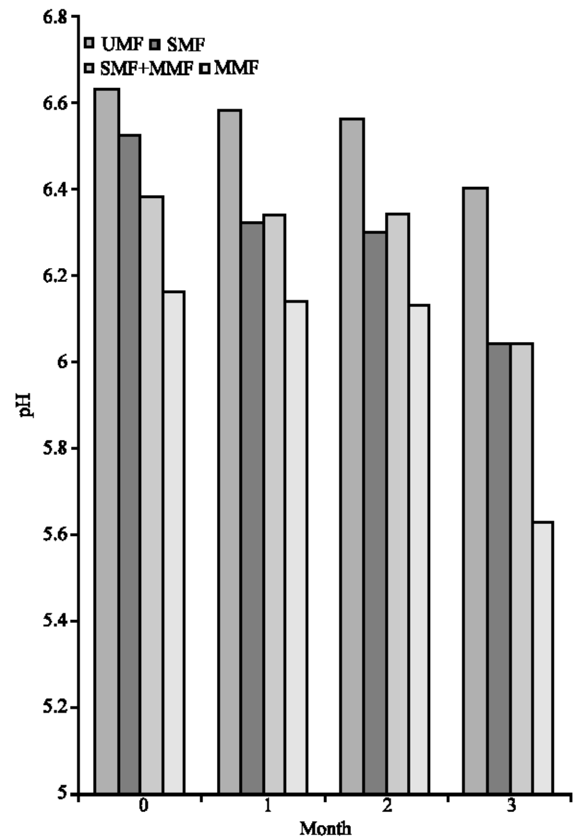

Fig. 4: pH of millet flours in storage, UMF = Untreated Millet Flour, SMF = Soaked Millet Flour, SMF+MMF= 50:50 blend of soaked millet flour and malted millet flour, MMF = Malted Millet Flour

increased significantly ($p<0.05$) after one month of storage. The TBA value of the malted millet flour

Table 1: Mean sensory scores of porridges prepared from fresh and stored millet flours

	0 month				One month				Two months				Three months			
Sample	C/A	Aroma	Taste	OA	C/A	Aroma	Taste	OA	C/A	Aroma	Taste	OA	C/A	Aroma	Taste	OA
UMF	7.08^{a}	7.15^{a}	7.08^{a}	7.15^{a}	7.67^{a}	7.47^{a}	6.40^{a}	7.20^{a}	7.67^{a}	7.33^{a}	6.20	7.13^{a}	7.33^{a}	7.47^{a}	6.07^{a}	6.80^{a}
SMF	7.08^{a}	6.85^{a}	6.92^{a}	7.08^{a}	6.53^{ab}	6.67^{abc}	6.27^{a}	6.73^{ab}	6.53^{abc}	6.53^{abc}	6.07	6.67^{ab}	6.27^{abc}	6.60^{ab}	6.00^{a}	6.33^{ab}
SMM+ MMF	6.61^{ab}	6.77^{a}	6.69^{a}	6.62^{a}	5.33^{c}	6.67^{abc}	6.40^{a}	6.33^{ab}	5.33^{c}	6.53^{abc}	6.20	6.27^{ab}	5.00^{c}	6.53^{ab}	5.93^{a}	6.00^{ab}
MMF	5.85^{b}	6.24^{a}	6.31^{a}	6.00^{a}	6.20^{abc}	6.60^{abc}	6.67^{a}	6.73^{ab}	6.13^{bc}	6.47^{abc}	6.47	6.67^{ab}	5.40^{bc}	6.47^{ab}	5.80^{a}	6.40^{ab}
LSD	1.14	-	-	-	1.84	1.13	-	1.26	1.48	1.09	-	1.26	1.35	1.18	-	1.22

Scores are based on a 9-point hedonic scale: 9 = Extremely liked and 1 = Extremely disliked. Means in the same column not followed by the same superscript are significantly different ($p<0.05$), UMF = Untreated Millet Flour, SMF = Soaked Millet Flour, SMF+MMF = 50-50 blend of soaked millet flour and malted millet flour, MMF = Malted Millet Flour, C/A= Colour/Appearance, OA= Overall Acceptability

witnessed a significant ($p<0.05$) increase only after the third month of storage. Since the TBA value of a food sample reflects the level of accumulation of free fatty acids (rancidity), it is often expected that, given the same conditions, the sample with the most fat content will have the highest TBA value. Since soaking and germination lead to the liberation of lipolytic enzymes and the degradation of fats (Briggs and Macdonald, 1983) the TBA values of the samples are in order. However, the relatively high TBA values exhibited by the soaked millet flour and the s ignificant ($p<0.05$) increase after just one month of storage may be due to increased hydrolytic rancidity as a result of higher moisture content.

The result of the least gelation concentration of the flours is shown on Fig. 3. All the samples exhibited constant least gelation concentration throughout the period of storage. Since starch plays the major role in the gelling properties of cereals, the constant least gelation concentration of the flours during the period of storage indicates little or no change in the carbohydrate content of the flours. Ooraikul and Moledina (1981) showed that starch could retrograde at low moisture content of about 7% in potato granules; this could affect the gelling properties. Hence, the stable least gelation concentration could mean that the starch was stable during the period of storage.

The result of the pH of the flours is shown in Fig. 4. The pH of all the samples decreased all through the period of storage, though insignificantly ($p>0.05$). The untreated millet flour had the highest value (lowest acidity): 6.40-6.63 while the malted millet flour had the lowest PH (highest acidity): 5.78-6.16. The successive decrease in the pH values of the samples indicates that they keep well since increasing acidity will not encourage the proliferation of micro-organisms.

The result of the sensory evaluation of the porridges (enyiokwolla) prepared from the stored millet flours is shown on Table 1. The sensory scores indicate that acceptability of the porridges decreased as storage time increased though they were still acceptable even after 3 months. However, panelists complained about the tastes which they said were slightly bitter after the third month of storage. This may be due to residual tannins and the rootlets that were not removed in the case of the malted millet flour. The colours of the porridges also turned darker in the malted samples. This may be due to the malting process. Overall, porridge from untreated millet flour was most acceptable followed by that from soaked millet flour, malted millet flour and 50-50 blend of soaked millet flour and malted millet flour, respectively.

CONCLUSION

Millet flours from untreated millet grains and soaked millet grains stored in high density polyethylene for up to three months yield acceptable porridge (enyiokwolla) while millet flour from malted millet grain yield acceptable porridge (enyiokwolla) after 2 months.

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