Journal of Food Technology, 6 (5): 185-188, 2008
ISSN: 1684-8462

Effects of Soaking and Germination on Some Physicochemical Properties of Millet Flour for Porridge Production

O.B. Ocheme and C.E. Chinma
Department of Food Science and Nutrition, Federal University of Technology, Minna, Nigeria

Abstract: The effects of soaking and germination on some physicochemical properties of millet flour and the sensory properties of porridges produced from the flour were studied. Millet flours were prepared from untreated, soaked, germinated and soaked-germinated grains. There were significant (p#0.05) increase in protein, ash, dry matter, water absorption capacity, hygroscopicity and swelling power of flour as a result of soaking and germination. Fat, phytic acid, least gelation capacity and viscosity of flour samples decreased significantly (p#0.05) as a result of soaking and germination. Porridge prepared from ungerminated millet flour had higher sensory score, though all the porridges were accepted.

Key words: Germination, physicochemical, sensory properties, porridge, phytic acid

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. These intermediate products are used to prepare staple foods like cooked whole grains, thin and thick porridges, steam-cooked products like couscous and Kunun Zaki and preparation of tuwo and fura (Nkama and Ikwelle, 1997). Millet contains some anti-nutrients and toxic substance which hinder the efficient utilization of its nutrients. They include phytates and tannins (antinutrients) as well as silicon and molybdenum (toxic substances) from the soil (Mukuru, 1992). Phytate represents a complex class of naturally occurring phosphorus compounds. Phytic acid (myo-inositol, 1, 2, 3, 4, 5,-hexakis dihydrogen phosphate), is the main phosphorus store in mature seeds. It complexes with multivalent cations thus rendering many minerals biologically unavailable to animals and humans. Tannins, on the other hand adversely affect digestibility of proteins and carbohydrates and reduces growth, metabolizable energy and bioavailability of amino acids (Rostango, 1972). However, available evidence indicates that these antinutritional factors and toxic substances can be removed or reduced by such processing methods like steeping, malting and roasting (Nkama and Gbenyi, 2001).

Porridges produced from cereals are eaten in many parts of the world particularly in developing countries where they are part of the basic diet. Some examples include Ogi in Nigeria; Uji in Kenya and Kenkey in Ghana.

Enyiokwolla, a porridge produced from millet is a popular diet among the idomas and Tivs in Benue State, Central Nigeria. It is usually taken as a breakfast diet with Okpa or Akpukpa, a steamed pudding produced from bambara groundnut. Enyiokwolla production involves the cleaning of whole millet grains followed by 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. It may be futher heated if the thickness is not satisfactory.

The traditional method of processing millet into enyiokwolla does not take into account the anti-nutritive factors inherent in the grains. It is hope that by modifying the processing method by soaking and germinating the grains before milling into flour, the nutritional quality of the porridge (enyiokwolla) will be improved.

The objectives of this study were to determine the effect of soaking and germination on some physicochemical properties of millet flour determine the sensory properties of porridge produced from such flour sample.

Corresponding Author: O.B. Ocheme, Department of Food Science and Nutrition, Federal University of Technology, Minna, Nigeria

MATERIALS AND METHODS

Source of raw materials: Pearl millet (Pennisetum glaucum), ex-Borno variety was obtained from Benue Agricultural and Rural Development Agency, Makurdi, Benue, Nigeria.

Preparation of millet flour: Millet flour samples were produced from pearl millet using four different methods.

In the first method, 500 g of millet grains were thoroughly cleaned by removing unviable seeds. The grains were then washed with cold tap water and thoroughly rinsed with distilled water, followed by drying in a cabinet solar drier at a temperature range of 52-59°C for $8^1/_2$ h. The dried grains were milled using a bench-top attrition mill (Christy Hunt Agriculture Ltd, South Humberside, England). The resultant flour was sieved into a particle size of 100 µm. The flour was then packaged in a low density polyethylene bag and stored using plastic containers with lids in a refrigerator at 8°C from where samples were taken for use. This served as control.

In the second method, 750 g of millet grains were cleaned, then soaked in $1^1/_2$ L of distilled water for 12 h with the soak water being changed at 4 h interval. At the end of soaking period, the water was drained and the grains were solar dried, milled, packaged and stored as described above.

In the third method, the same procedure was followed as in the second method except that after soaking, the grains were evenly spread on jute bags and covered with the same material, in a secluded area in the laboratory and allowed to germinate at a temperature of 32±2°C for 48 h.

The grains were wetted with water at regular interval of 12 h. At the end of germination, the grains were dried, milled, packaged and stored as described above.

The 4th flour sample was prepared by mixing 250 g of the soaked millet grains and 250 g of the germinated millet grains after drying. This was then milled, packaged and stored as described above.

Physicochemical analysis: The loose and packed bulk densities were determined using the method of Akpapunam and Markakis (1981). The hygroscopicity, water absorption capacity, least gelation concentration, swelling power and viscosity where determined using the methods of Bhatty (1986), Lin *et al*. (1974), Coffman and Garcia (1977), Ooraikul and Moledina (1981) and Regenstein and Regenstein (1984), respectively.

Chemical analysis: pH was determined as described by Vasconcelos *et al*. (1990). The total titratable acidity, total and reducing sugars were determined as described by Kirk and Ronald (1991). The phytic acid content of flour samples were determined as described by Davies and Reid (1975). The moisture, crude protein, ether extract crude fibre and ash were determined using AOAC method (1984). The carbohydrate contents were calculated by difference. The energy value was calculated using Atwater factor method {(9×fat)+4×carbohydrate+4× protein)} as described by Osborne and Voogt (1978).

Preparation of porridge: Porridges were prepared from each flour sample. Twenty grams of flour was mixed with 100 mL of cold tap water (20% w/v) in a clean white plastic cup to form a slurry. This was cooked by placing the cups in a boiling water and stirred continuously for 10 min. Five grams of sugar was added to the porridge.

Sensory evaluation: The cooked porridge samples were evaluated for colour, aroma, taste and overall acceptability by a panel of 15 judges made up of students of the Department of Food Science and Technology, University of Agriculture, Makurdi, Benue, Nigeria using a nine point Hedonic scale (where 1 = disliked extremely and 9 = liked extremely).

Statistical analysis: All determinations were done in triplicates. The means were calculate land data obtained were subjected to analysis of variance. Means where compared using Least Significant Difference (LSD) as described by Ihekoronye and Ngoddy (1985).

RESULTS AND DISCUSSION

The result of the effect of soaking and germination on some physicochemical properties of millet flour is shown in Table 1. Germination significantly (p#0.05) increased the water absorption capacity, hygroscopicity, swelling power, least gelation concentration and viscosity of millet flour while the loose and packed densities of the flours decreased. The decrease in loose and packed densities of the flour sample as a result of soaking and germination could be attributed to enzymatic activities. The higher water absorption capacity and hygroscopicity of flour derived from germinated millet grains, 50-50 blend of soaked and germinated grains and soaked millet grains may be due to high protein content and the presence of more hydrophilic carbohydrates in these flour samples. The observed higher swelling power of the flour obtained from germinated millet grains as compared to the flour from untreated millet grains may be due to the reduced fat content of the flour. Zobel (1984) reported that fats may complex with starch and limit swelling. This is in line with

Table 1: Effect of soaking and germination on some physico-chemical properties of millet flour

Sample	Bulk density (g mL^{-1}) Loose	Bulk density (g mL^{-1}) Packed	Water absorption capacity (g g^{-1})	Hygroscopicity (%)	Swelling power (ml g^{-1})	Least gelation conentration (% w/v)	Viscosity (cp) spindle speed 12	Viscosity (cp) spindle speed 30	Viscosity (cp) spindle speed 60
UMF	0.51±0.01^{a}	0.63±0.01^{a}	1.31±0.01^{a}	65.46±1.27^{a}	4.06±0.07^{a}	8.00±0.00^{a}	6560^{a}	4420^{a}	3520^{a}
SMF	0.50±0.01^{a}	0.62±0.01^{a}	1.30±0.01^{a}	64.42±1.39^{b}	3.86±0.06^{b}	8.00±0.00^{a}	4060^{b}	2820^{b}	2440^{b}
SGMF	0.48±0.01^{a}	0.60±0.01^{a}	1.35±0.01^{b}	66.62±1.39^{c}	4.15±0.14^{c}	14.00±0.00^{b}	480^{c}	380^{c}	310^{c}
GMF	0.46±0.01^{a}	0.57±0.01^{a}	1.38±0.02^{c}	68.28±1.41^{d}	4.66±0.14^{d}	16.00±0.00^{b}	270^{d}	140^{d}	90^{d}
LSD	-	-	0.03	0.28	0.48	5.91	34.15	32.12	31.20

Values are on dry weight basis, Values are means±Standard deviation of triplicate determinations. LSD = Least significant Difference, - = No LSD value, Means in the same column followed by the same superscript are not significant different ($p \le 0.05$), UMF = Untreated millet flour, SMF = Soaked millet flour, SGMF = 50-50 blend of soaked and germinated millet flour, GMF = Germinated millet flour

Table 2: Effect soaking and germination on some chemical properties of millet flour

Sample	pH	TTA (% lactic acid)	Total sugar (g/100 g)	Reducing sugar (g/100 g)	Phytic acid (g/100 g)
UMF	6.66±0.01^{a}	0.52±0.01^{a}	1.71±0.00^{a}	0.54±0.00^{a}	0.58±0.004^{a}
SMF	6.53±0.08^{b}	0.52±0.00^{a}	1.82±0.00^{a}	0.86±0.00^{a}	0.49±0.004^{b}
SGMF	6.36±0.14^{c}	0.61±0.05^{b}	2.02± 0.00^{a}	1.17±0.00^{a}	0.33±0.004^{c}
GMF	6.13±0.21^{d}	0.74±0.10^{c}	2.23±0.00^{a}	1.27±0.00^{a}	0.31±0.004^{d}
LSD	0.01	0.02	-	-	0.02

Values are on dry weight basis, Values are means±Standard deviation of triplicate determinations. LSD = Least Significant Difference, - = No LSD value, Means in the same column followed by the same superscript are not significant different ($p \le 0.05$), UMF = Untreated millet flour, SMF = Soaked millet flour, SGMF = 50-50 blend of soaked millet and germinated millet flour, GMF = Germinated millet flour

the result obtained in this study since the swelling power increased as the fat content decreased. The increase in the least gelation concentration of the germinated grain flour may be due to the altered carbohydrate composition of the grain. The decrease in the viscosities of the flour prepared from the soaked and germinated millet grain flour may be due to the activities of enzymes. The activities of enzymes during germination may alter the composition of the grains (Sathe *et al*., 1983). The resultant materials: starch, sugars, alcohol, protein fraction and salts are non-newtonian and this affects the apparent viscosity.

The effect of soaking and germination on some chemical properties of millet flour is shown in Table 2. Germination significantly ($p \le 0.05$) reduced the phytic acid content of millet grains flour while the pH and Total Titratable Acidity (TTA) significantly reduced. There was no significant ($p \ge 0.05$) increase in the total and reducing sugars. However, the decrease in pH of flour samples may be due to higher acidity yield and total titratable acidity. The increased total and reducing sugars may be perhaps due to enhanced enzymic action which results in the degradation of starch into simpler compounds (simple sugars, oligosacchrides). Reduction in phytic acid content may be attributed to increased synthesis of phytase in germinated grain that lead to an increase in phytic acid degradation, thus, the reduction in the phytic acid content of flour from soaked-germinated grains.

The effect of soaking and germination on the proximate composition of millet flour is shown in Table 3. Germination significantly ($p \le 0.05$) increased the protein, dry matter and ash content while fat content and energy values of the flour samples showed a decrease. The increase in protein content could be due alterations of other components (starch, lipids, ash, crude fibre) which might have altered the proportion of the protein on dry weight basis during soaking and germination. Also, the fact that the vegetative part were not removed must have enhanced this development. The increase in dry matter content was probably as a result of the enzymic activities that took place during germination resulting in lower densities and hence faster drying rates (lower moisture content). The decreased value of fat in flour samples as a result of soaking and germination may be due to the action of lipolytic enzymes which utilized the fats present. The increase in crude fibre may be due to starch breakdown during germination. The variations in carbohydrate content may be attributed to increase and decreases that occurred in other food componets (fat, protein ash, crude fibre) as a result of soaking and germination.

Table 4 shows the effect of soaking and germination on the sensory quality of millet flour porridge. There was significant difference ($p \le 0.05$) in colour/appearance between porridge prepared from germinated and untreated millet flours. The colour of the porridge made from untreated and soaked millet grain flours were preferred to those made from the 50-50 blend of soaked and germinated millet flour as well as germinated millet grain flour. This may be due to the lighter colours of the former which made them more acceptable as consumers are used to this colour in the food. There was no significant difference in ($p \ge 0.05$) in aroma, taste and overall acceptability of porridge samples. This implies that porridge prepared from untreated millet flour sample and treated samples compares favourably.

Table 3: Effect of soaking and germination on proximate composition of millet (enyiokwolla) flour (% dry weight)

Sample	Dry matter	Fat	Protein	Ash	Crude fibre	Carbohydrate	Energy value (Kcal100 gG[1])
UMF	93.50±0.01[a]	4.62±0.13[a]	12.87±0.04[a]	1.65±0.04[a]	2.29±0.04[a]	78.57±0.41[a]	407.34±0.21[a]
SMF	93.38±0.05[a]	4.19±0.10[b]	12.88±0.06[a]	1.66±0.04[a]	2.34±0.07[a]	78.93±0.11[a]	404.95±0.32[b]
SGMF	93.95±0.12[ab]	3.68±0.09[a]	13.60±0.10[b]	1.84±0.03[ab]	2.35±0.04[a]	78.53±0.23[a]	401.64±0.14[c]
MMF	94.36±0.01[b]	2.99±0.09[d]	15.80±0.13[c]	1.95±0.07[b]	2.42±0.04[a]	77.56±0.12[a]	400.35±0.11[d]
LSD	0.57	0.10	0.24	0.20	-	-	1.23

Values are on dry weight basis, Values are means±Standard deviation of triplicate determinations. LSD = Least significant Difference, - = No LSD value, Means in the same column followed by the same superscript are not significant different (p#0.05), UMF = Untreated millet flour, SMF = Soaked millet flour, SGMF = 50-50 blend of soaked millet and germinated millet flour, GMF = Germinated millet flour

Table 4: Effect of soaking and germination on the sensory qualities of enyiokwolla

Sample	Colour/appearance	Aroma	Taste	Overall acceptability
UMF	7.08[a]	7.15[a]	7.08[a]	7.15[a]
SMF	7.08[a]	6.85[a]	6.92[a]	7.08[a]
SGMF	6.61[ab]	6.77[a]	6.69[a]	6.62[a]
GMF	5.85[b]	6.24[a]	6.31[a]	6.00[a]
LSD	1.14	-	-	-

Values are on dry weight basis, Values are means±Standard deviation of triplicate determinations. LSD = Least significant Difference, - = No LSD value, Means in the same column followed by the same superscript are not significant different (p#0.05), UMF = Untreated millet flour, SMF = Soaked millet flour, SGMF = 50-50 blend of soaked millet and germinated millet flour, GMF = Germinated millet flour

CONCLUSION

This study has shown that soaking and germination improves the nutritional quality of millet grain flour and the porridges prepared from these flours are acceptable.

REFERENCES

Akpapunam, M.A. and P. Markakis, 1981. Physicochemical and nutritional aspects of cowpea flour. J. Food Sci., 46: 1143-1151.

AOAC, 1984. Official Methods of Analysis 14th Edn. Association of Analytical Chemists. Washington DC, pp: 806-842.

Bhaty, R.S., 1986. Physicochemical and functional (Breadmaking) properties of hull-less barkery fractions. Cereal Chem., 63 (1): 31-35.

Coffman, A.W. and V.V. Garcia, 1977. Functional Properties and amino acid contact of protein isolate from mung bean flour. J. Food Sci., 48: 1654-1662.

Davies, N.T. and H. Reid, 1975. An evaluation of the phytate, Zinc, copper, iron and manganese content of and zinc availability from soyabased texture-vegetable protein meal substitute. Br. Mutr., 41: 579-584.

FAO, 1995. Sorghum and Millet in human nutrition-FAO Food and Nutrition Series. Trends and Outlook. Patencheru 502324. Andtr Pradesh, India.

Ihekoronye, A.I. and P.O. Ngoddy, 1985. Intergrated Food Science and Technology for the Tropics. Macmilliam Publisher, London, pp: 257-264.

Kirk, R.S. and S. Ronald, 1991. Pearson's Composition and Analysis of Food. 9th Edn. Longman Scientific an Technical London, pp: 645-681.

Lin, M.J.Y., E.S. Humbert and F.W. Sosulka, 1974. Certain functional Properties of Sunflower meal products. J. Food Sci., 39: 368-375.

Mukuru, S.Z., 1992. Traditional Technologies in small grain processing. J. Food Sci., 58: 47-56.

Nkama, I. and D.I. Gbenyi, 2001. Effect of malting of millet and sorghum on the residual phytates and polyphenols in dakuwa-a Jnigerian cereal legume ssnack food. Nig. J. Trop. Agric., 3: 270-273.

Nkama, I. and M.C. Ikwelle, 1997. Assessment of food quality of millet grain. In: Pear Millet in Nigerian Agricultural Production, Utilization and Research Priorities. Proceedings of the pre-season National Co-ordinated Research Programme on Pearl Millet, Maiduguri, Nigeria.

Ooraikul, B. and K.H. Moledina, 1981. Physico-chemical change in potato granules during storage. J. Food Sci., 46:110-112.

Osborne, D.R. and P. Voogt, 1978. The Analysis of Nutrients in Foods. Academic Press London, pp: 128.

Regentein, J.M. and C.E. Regestein, 1984. Food protein Chemistry. In: introduction to food Scientists. Academic Press, Orlando, pp: 286-287.

Rostango, H.S., 1972. Nutritive evaluation of sorghum in chicks. Doctorate Thesis, Purdue University, West Lafayette, Indiana, USA.

Sathe, S.K., S.S. Deshpande, N.R., D.E. Goll and D.K. Salunkhe, 1983. Effects of germination on protein, raffinose, oligosaccharides and antinutritional; factors in the great northern beans (*Phaseolus vulgris* L.) J. Food Sci., 48: 1796-1798.

Vasconcelos, A.T., D.R. Twiddy, A. Westby and P.J.A. Reilly, 1990. Detoxification to food cassava during garri preparation. Int. J. Food Sci. Tech., 25: 198-203.

Zobel, H.F., 1984. In: Effect of Malting Time on Chemical Composition and Functional Properties of Soyabean and Bambara Groundnut Flours. Akapunam, M.A., S.O. Igbedioh and I. Aremo. (Eds.). Int. J. Food Sci. Nutr., 47: 27-33.