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Effect of Processing on Some Functional Properties of Millet (*Eleusine coracana*) Flour

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Abstract: Raw, boiled, germination and toasted flours from millet (*Eleusine coracana*) seeds were analyzed for functional properties. The raw sample contained 8% least, gelation, 750% water absorption, 142% oil absorption, 10% foaming capacities, 14cm^3 oil emulsion and 5cm^3 foaming stabilities which collapsed after 15 min. Boiling improved water absorption, oil absorption, least gelation capacities and oil emulsion stability. Germination and toasting significantly reduced the functional properties. The raw and boiled samples may be useful in some food formulations.

Key words: Processing, functional properties, millet (*Eleusine coracana*), industrial application

INTRODUCTION

Millet (*Eleusine coracana*) is a cereal grain, which is exceptionally tolerant to a wide variety of conditions, particularly drought conditions. Unlike guinea corn, millet does not seen to be toxic at any stage and makes good meal and flour. The grain is used in production of alcoholic and non-alcoholic drinks, poultry and animal feed and eaten by man when cooked.

Millet grain appears to be higher in protein than most cereals. The composition is made up of protein 9-10%, fat 3-4%, fiber 2%, carbohydrate 75-85% ash 1-2% and energy 414 Kcal. It has a high percentage of indigestible fiber because the seeds are enclosed in hulls, which are not removed by ordinary processing methods. It is a good source of thiamine, vitamin B, calcium, phosphorus magnesium and iron[1]. In Nigeria, researchers have worked on its proximate, mineral, amino acid, vitamins and fatty acid compositions[1,2].

The industrial use of millet would depend on knowledge of its functional properties, which include water absorption, oil absorption, oil emulsion and least gelation capacities, protein solubility under pH and protein to solution ratio and salt concentration. There is dearth of information on the function properties of seeds. The aim of this study was to investigate the effect of different processing on the functional properties of the seeds with a view of ascertaining its use in food industry.

MATERIALS AND METHODS

The sample was obtained from a market in Akure Ondo State, Nigeria. The research was conducted in the Chemistry Laboratory, Federal College of Agriculture, Akure, Nigeria in June, 2003.

Preparation of sample

Raw sample: Raw sample was hand picked to separate stones and unhealthy seeds from good ones. The healthy seeds were washed in distilled water, drained using a sieve and sun dried for 6 h, milled in a Kenwood blender, sieved in a 40-mesh sieve and stored in an airtight plastic container prior to analyses.

Boiled sample: Raw seed (100 g) was boiled in distilled water for 30 min, cooled (25°C), sun dried for 6 h, milled in a Kenwood blender and ground to pass in a 40-mesh sieve and stored in an air-tight plastic container prior to analyses.

Toasted sample: Raw seed (100 g) was toasted (45 min) in a saucepan by heating on a gas burner. At intervals, spoon was used to turn the seeds, cooled (25°C), ground to pass in a 40-mesh sieve and stored in an air-tight plastic container prior to analyses.

Germinated sample: Raw seed (100 g) was placed in a beaker, moist with distilled water and left to stand for 7 days. The germination sample was sun dried for 6 h and ground to pass in 40-mesh sieve and stored in an airtight plastic container prior to analyses.

Functional properties

The least gelation capacity (LGC): The method of Coffmann and Garcia[3] was employed. Appropriate flour, suspense of 2, 4, 6, 8, 10, 14 and 16% (w/v) were prepared in 5 cm^3 distilled water. The test tubes containing suspension were heated for 1h in boiling water followed by rapid cooling under running tap water. The LGC was determined as the concentration in which the flour from the inverted test did not fall down or slip.

Water absorption capacity (WAC): The WAC was determined by using the method of Beuchat[3], 1 g flour was mixed with 10 cm^3 distilled water in a mixer, kept at room temperature (30°C) for 30 min, centrifuge at 3500 pm for 30 min and the supernatant meted in a 10 cm^3 graduated cylinder. The density of water assumed to be 1 g cm^{-3}. The excess water absorbed by the flour was expressed as the percentage water bound by 100 g samples.

Foaming capacity (FC) and foaming stability (FS): FC and FS were studied according to the method of Coffman and Garcia[4]. One-gram sample was whipped with 50 cm^3 of distilled water for 5 min in a Kenwood blender at speed settings fast and was poured into a 100 cm^3 graduated cylinder. Total volume at intervals between 25 min and 1500 were noted for the FS. To obtain the FC, volume increase (%) was calculated according to the following equation.

$$\text{Vol. Increase} = \frac{\text{Vol. after whipping-Vol. whipping}}{\text{Vol. before whipping}} \times 100$$

Oil absorption capacity (OAC): Sosulski's[3] test procedure was used, 0.5g of the sample was added to 3.0 cm^3 of vegetable oil in 10 cm^3 graduated centrifuge tubes. The mixture was stored with glass rod to disperse the flour in the oil. After holding for a period of 30 min, at speed setting fast and the volume of separation oil was noted. The excess oil absorbed was expressed as the percentage oil bound by 100 g samples. The density of the oil was determined by means of specific gravity bottles.

Oil emulsion stability (OES): An emulsion was prepared according to Beuchat's procedure[4]. One gram of sample was blended in a Kenwood blender with 50 cm^3 of distilled waster for 30 min at maximum speed. Vegetable oil was added in 5 cm^3 portions with continued blending. A drop in consistency or decrease in resistance to blend was considered the point at which to discontinue oil. The emulsion so prepared was then allowed to stand in a graduated cylinder and the volume of water separated at intervals between 1 to 24 h was noted in each case.

Analysis of data: All determinations were carried out in triplicate for each sample. Analyses carried out were standard error (SE), coefficient of variation (CV%) and analysis of variance[5].

RESULT AND DISCUSSION

Table 1 presents the functional properties of the processed samples. Germination effected the most pronounced loss in the entire processed sample, followed by toasting while boiling did not have any effect. The reason might be due to denaturation of the protein content of the sample. The WAC (650-750%)[6], cowpea flour (230-250%)[7], Cola nuts (201-210%)[8] and rice flour (225-250%)[9]. WAC is considered a critical function of protein in viscous food then this sample could be used for viscous food formulations.

Roasting and germination significantly ($p<0.05$) reduced OAC when compared with boiling. The effect of toasting, germination, boiling can therefore be seen not advantageous in that the protein was denatured. OAC is attributed to physical entrapment of oil[10]. The high OAC recorded for the raw and boiling samples suggests the lipophillic nature of its constituents[11]. The OAC (71-142.5%) were comparable to the OAC for pigeon pea (89.7%)[16] but lower that for cowpea sample (290-321%)[17] 201-215%[7]. OAC is important, as oil acts as a flavor retainer and improves the month feel of foods (Kinsella, 1976). The flour would be very good in this respect.

LGC was increase by boiling (12%). 10% was record for effect of toasting and germination on the samples. This implies that boiling might improve setting properties of millet flour. The values obtained here were comparable to the results recorded for cocoyam flour (8-10%)[6] and Adenopus beviflourus benth flour (10-14%)[12] but lower then those reported for African yam bean flour (16-20%)[13] Soyabean (18%)[14] and locust bean (16%)[15].

FC was also improved by boiling (10%) when

Table 1: Some functional properties of millet flour (% dry matter)

Parameter	Roasted	Germinated	Raw	Boiled
WAC	750	700	650	750
LGC	10	10	8	12
OAC	12	137	71	75
FC	4	4	4	10
Mean	226.5	212.8	183.3	211.8
Std error	354.8	330.6	312.7	360.1

WAC:Water Absorption Capacity, LGC:Least Gelation Capacity, OAC:Oil Absorption Capacity, FC:Foaming Capacity

Table 2: Foaming stability (cm^3, dry matter) of millet flour

Time (min)	Roasted	Germinated	Raw	Boiled
0	0.0	2.0	5.0	2.0
5	0.0	1.8	4.0	1.8
10	0.0	1.0	2.2	0.4
15	0.0	0.0	1.1	0.0
20	0.0	0.0	0.0	0.0
25	0.0	0.0	0.0	0.0
Mean	-	1.6	3.1	1.4
Std error	-	0.5	1.8	0.9
CV (%)	-	31.3	58.1	64.3

Table 3: Emulsion stability (cm^3, dry matter) of millet flour

Time (h)	Roasted	Germinated	Raw	Boiled
0	40.0	42.0	44.0	48.0
1	36.0	39.0	44.0	48.0
2	36.0	37.0	44.0	48.0
3	35.0	36.4	44.0	48.0
4	35.0	36.4	44.0	48.0
5	35.0	35.8	44.0	48.0
6	35.0	35.8	44.0	48.0
7	35.0	35.8	44.0	48.0
8	35.0	35.8	44.0	48.0
22	35.0	35.8	44.0	48.0
24	35.0	35.8	44.0	48.0
Mean	35.6	36.9	44.0	48.0
Std Error	1.5	2.0	0.0	0.0
CV (%)	4.2	5.4	0.0	0.0

compared to other processing methods. The value (4-10%) compared with those recorded for cocoyam [5]but lower than results of other literatures cited. The low value recorded for the samples may not enhance their functionality in the food industries where foaming is important where foaming is important.

FS results are presented in Table 2. The values recorded were low (2-5%). Boiling, germination and toasting significantly ($p<0.05$) reduced FS. No foam was recorded for the toasted sample. The low value recorded for raw sample disappeared within 15 min, this disappearance could be due to protein denaturation. The result was comparable to results obtained for soy protein concentrate (5%)[11]. Most commercial products are stable for more than 2 h; (consequently millet flour would not be attractive for products where foaming is important.

The results obtained for the OES is shown in Table 3. All the values were high but higher in boiled sample. Toasted and germinated samples produced lower results. The lower OES observes in toasted and germinated samples might be due to possibly to denaturation, which might have destroyed the hydrophobic domains. The decrease in emulsion stability as time increase might be due to increase contact leading to coalescence which thereby reduces stability, Raw and boiled samples have a stable emulsion for the period of 24 h. They would be useful in product that depends on the formulation of stable emulsions.

CONCLUSION

This report showed that raw millet flour has certain functional properties, which make it suitable for some food formulations. Boiling improved LGC, WAC, OAC and OES. Other processing methods (germination and toasting) showed significant negative effects on the industrial applications of the sample protein.

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