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FUNCTIONAL CHARACTERISTICS OF MALTED FLOUR OF FOXTAIL, BARNYARD AND LITTLE MILLETS

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Abstract
Millets are significant as food crops in their respective agro-ecosystem. They play an important role and provide food security in times of drought and other natural challenges. Functional properties are important criteria while people developing new proteinicious products. Millets are now gaining popularity as neutraceuticals. A study was undertaken to determine functional properties of malted and unmalted flour prepared from foxtail, barnyard and little millets. The maximum moisture and germination percent was observed in sanwan millet followed by kutki and kangni. While the finally selected steeping times were 18 hours for kutki and sanwan and 12 h hours for kangni. The percent yield of the malt flour from millet grain after germination, kilining, drying, dehusking and sieving operations were maximum for sanwan millet followed by kutki and kangni. The bulk density of unmalted foxtail (kangni) millet flour was 0.70 gcc^{-3}, it was less than that observed for unmalted barnyard (sanwan) millet flour 0.80 gcc^{-3}. Highest bulk density was found for unmalted little millet (kangni) flour 0.82 gcc^{-3}. The bulk density in malted kutki flour showed highest reduction 30% when compared to malted flour of sanwan and kangni 29% and 20% respectively. The results showed significantly significant ($P<0.05$) reduction after malting of all three millets in water absorption capacity. Whereas the malted flour showed increase in fat absorption capacity from 110 to 180 ml/100g was found to be statistically significant as compare to unmalted flour of all three millets.

Keywords: functional properties, bulk density, water absorption capacity, kangni, sanwan, kutki, millet flour

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1. INTRODUCTION

The rural and tribal population in developing countries depends heavily on cereals and millets for their protein requirements. Millet is a name applied to a number of cereals characterized by their small seed. These are known as "pettit mais" or tropical crops. India is the largest producer of many kinds of millets which are often referred to as coarse cereals. These millets are categorized into major millets (Jowar and Bajra) and minor / small millets which includes several food crops namely finger millet (ragi, Eleusine coracana), little millet (kutki, Panicum milliare), Foxtail millet (kangni,Setaria italica) Barnyard millet (sanwan, Echinochloa frumentacea) kodo (Paspalum scrobiculatum L.) and proso millet. During the very early ages millets are thought to have been one of the staple foods in Central and Eastern Asia (mainly in China, India and Russia), Eurpoe and some parts of Africa (Hulse, 1980).

Foxtail millet or Italian millet (Setaria italica L.) also known as Kakun, Kangni, Tenai and Navane, is generally grown as a rainfed crop in India. Seeds are small in length and are generally light cream in colour. Barnyard millet or sanwan millet (Echinochloa frumentacea L.) is a short plant, frequently grown in the oriental countries and India. The grain is eaten just like rice by the poor clauses, but sometimes it is brewed for beer and also used as feed for cage birds. Little millet (Panicum miliare) is commonly known in India as kutki, samai and mutaki plants. Presently a large quantity of malt foods, malt extract preparations and considerable amount of malt required for brewing purposes is also being imported in the country. Since malt foods have been found to be highly valuable in the feeding of mal-nourished people and invalids, the malt industry is of a great national importance and has to be developed in the country M.P. produces large quantities of millets like kutki, kangni and sanwan which can be used for preparation of high quality malt and malt products. Therefore, these millets were undertaken for the present study.

Functional properties of protein govern the behavior of protein during processing, storage and when incorporated for various product formations as they affect food quality and acceptance (Kinsella, 1981). These functional properties play important role in the development of high protein textural new products, and in the spinning as well as extrusion of products into various shapes. These are also important in imparting the pleasing texture and eating quality to the products (Kulkarni et al. 1994). The information on functional properties of millet flour is meager, whereas lot of literature is available on the functional properties of different legumes and oilseeds. Germination improves the functional properties of legume and cereal seeds (Sosulski et al. 1976) and also increased the water and fat absorption capacities of mungbean (Del Rosario and Flores, 1981). Pathirana et al. (1983) revealed the malting conditions of sorghum using a local variety. They studied the effect of steeping and germination on physical and functional properties during malting. Pawar and Ingle (1988) found increase in oil and water absorption capacity of flour after 3 days germination of moth beans. Hansen et al. (1989), reported that during germination of grains alpha amylase degrades the starch granules, thereby reduces their water binding capacity and consequently lowering the viscosity of the gruel.

Akpapunam et al. (1996), reported that 2 days sprouting showed the highest level of water absorption capacities in soybean and bambara groundnut flour. Akubor and Obiegbuna (1999) stated that bulk density and water absorption capacity of millet (Pennisteum typhoidium) flour decreased significantly with increased length of germination time. However, it increased oil absorption capacity which would be advantageous in the preparation of supplementary foods. To investigate the influence of malting on the functional and physical characteristics of malted flour. To standardize the conditions for processing the malt from little, foxtail and barnyard millets with respect to steeping and germination to obtain high percentage of malt yield.

2. MATERIAL AND METHODS

The raw material Little millet (kutki) variety (RLM-11), Foxtail millet (Kangni) variety (RFM-11) and barnyard millet (Sanwan) variety (RBM-11) was procured from the regional minor millets research station Rewa, college of Agriculture, Jawaharlal Nehu Krishi Vishwa Vidyalaya, Jabalpur (M.P.). Functional and physical characteristics of malted flour: Bulk density by Okaka and Potter (1977), Water absorption capacity, Fat absorption capacity by Sosulski (1976).

Preparation of dehusked unmalted millet flour

The clean and graded grains were dehusked by hand operated pestle and mortar and mud mill (Kunaita) separately. Dehusked millets were ground in a hand operated mill and flour was sifted in 80 mesh sieves. The flour samples obtained were kept in air tight containers for use.

Preparation of malted flour

The millet seeds were cleaned, washed and steeped in water for 18h with intermittent change of water after each 4h interval, then drained and allowed to germinate under a wet cloth for 48h at room temperature 25 ± 2^0C. The seeds were dries in hot air oven at 65^0 for 20h. Devegetation was done by hand rubbing and separated by winnowing off. The sprouted grains after drying and devegetation were called green malt. The green malt was kilned on a frying pan at 55 ^{0}C temperature. After milling dehusked grains were obtained, which were made in fine powdered by hand operated mill, and sieved through a 80 mesh sieve. The flour thus obtained was the malt from millets.

Statistical analysis

All the experiments were conducted in triplicate. The data were statistically analysed for variance to test the significance of difference between various groups and critical difference was calculated as per the method of Panse and Shukhatame (1967). All the values reported are the average of three determinations.

3. RESULTS AND DISCUSSION

Malting

The malt yield of the grains depends directly on the steeping time and germination percentage of the seeds. Hence, in this context, the steeping time, germination percentage, sprout length and malt yield of all grains were studied and are given in the table 1 & 2.

Steeping time (Hydration capacity) of millets

The picked and cleaned millets grains were soaked in triple the volume of water at 25^0C + 2^0C for 6, 12, 18, 24 and 30 hours. The water absorbed was noted at the end of each period. It can be seen from table 1 that the moisture uptake increased gradually till 18 hours and there after it became static. Hence it is clearly depicted that the rate of moisture absorption was directly proportional to the steeping time upto 18 hours in case of kutki and sanwan. However, it was 12 h in the case of foxtail millets. The maximum moisture gain was observed at 30 hours in all the cases. Hence, a time of 18 hours was selected as steeping period for kutki and sanwan millets. Maximum percent moisture uptake was observed in the case of sanwan millet after 30 hours intervals. While in kutki millets it was absorbed only 8.33% from 6 hrs to 30 hrs whereas it was 12% and 8.28% increased moisture content in sanwan and kangni millet, respectively. This shows that kangni millets has less water absorption than others. The values recorded in this study were similar to the values obtained by Malleshi and Desikachar (1985) and Daudo (1986), through it was slightly higher than the previous findings of Lukow and Bushuk (1984) and Pawar and Pawar (1997), whereas, lower steeping time was observed in comparison to Pathirana *et al.* (1983). Deshpande (1987), showed that over soaking leads to water sensitivity and less effective germination. Hsu *et al.* (1983) noticed that with the increase in temperature, leads to increased moisture uptake. Therefore 18 hours steeping time was selected as an optimum steeping period for all millets in this study.

Table 1 Effect of steeping time on moisture absorbed (%) of different millets grain

Steeping time (h.)	Initial wt.of seeds (gm)	kutki		Kangni		Sanwan	
		Final weight (gm)	Moisture absorbed (%)	Final weight (gm)	Moisture absorbed (%)	Final weight (gm)	Moisture absorbed (%)
6	5 .00	6.52	30.33	6.20	24.13	6.73	34.67
12	5 .00	6.82	36.41	6.58	31.60	6.92	38.40
18	5 .00	6.89	38.40	6.59	31.80	7.26	45.13
24	5 .00	6.93	38.60	6.60	32.00	7.36	46.73
30	5 .00	6.93	38.60	6.62	32.40	7.36	46.73

Table 2 Effect of germination time on germination percentage, sprout length and malt yield (%) of different millets grain

Germination time (h.)	Germination percentage			Sprout length (mm)			Malt yield (%)		
	Kutki	Kangni	Sanwan	Kutki	Kangni	Sanwan	Kutki	Kangni	Sanwan
24	60	50	68	6	8	4	55	51	57
48	95	90	98	12	13	10	70	67	75
72	98	96	99	20	18	15	65	62	68

Germination percentage

The steeped seeds were germinated at 25^0C + 2^0C and RH 90% at different time intervals i.e., 24 h, 48 h and 72 h. The malting capacity of the grains depends directly on the germination percentage of the seeds. Hence, in this context, the germination percentages of millets were investigated. Sanwan and kutki millets recorded the highest viability, whereas, in Kangni it was comparatively low. It is further apparent from the table that there was maximum germination at 72 hours. These results were similar to the previous findings by various workers (Malleshi and Desikachar, 1979 & 1985, Kumari and Srivastava, 2000). Whereas, Suhasini *et al.* (2004) recorded 90% germination in wheat which is less than the present observations.

Sprout length

As germination progressed there was an increase in percent germination and sprout length in all the tested millets. There was a tremendous increase in both sprout length and percent germination at 72 hours of germination. However, rootlets and coleoptile or acrospore were also developed at this stage. Further germination lead to the development of plant itself. Rootlets and coleoptile or acrospire were produced at the expense of material from original seeds which lead to further loss in the yield of malt as reported by various workers such as Singh and Bains (1979) and Naut and Davies (1982) during germination of maize, sorghum and Indian barley. Similar observations were reported by Pawar and Pawar (1997), Nirmala *et al.* (2000) and Suhasini *et al.* (2004). Thus, in the present study germination was terminated at 48 h which was found suitable to take optimum yield of malt.

Malt yield

The percent yield of the malt flour obtained from the grains of different millet after germination, dehusking and sieving operations. The yield of malt for kutki, kangni and sanwan were 55, 70 & 65 at 24hrs, 51, 67 & 62 at 48hrs and 57, 75 & 68 at 72 hrs percent respectively. However, maximum yield was malt received at 48 h of germination in all the three millets. The yield being fairly comparable to that reported by Malleshi and Desikachar, (1979) Shukla *et al.* (1986), Pawar and Pawar (1997) and Malleshi and Klopfenstein (1998).

Physical and Functional Properties

Physical and functional properties denote certain physicochemical characteristics of materials which may have a bearing on the behaviour in food systems (Kinsella, 1976). Water absorption capacity, fat absorption capacity and bulk density were determined for unmalted and malted millet flours to evaluate the effect of various processing treatments and are given in the table 3.

Bulk density

The bulk density of the unmalted dehusked kangni millet grains was 0.70 g/cc^3 which was lesser as compared to sanwan and kutki grains i.e. 0.80 gcc^{-3} and 0.82 gcc^{-3} respectively. After germination, devegitation and drying process, malted grains of each millets showed reduction in the bulk density.

Table 3 Effect of malting on physical and functional properties of millets flour

Properties	Bulk density (g/cc^3)		Water absorption capacity (ml/100g)		Fat absorption capacity(ml/100g)	
	Unmalted	Malted	Unmalted	Malted	Unmalted	Malted
utki	0.82	0.60	135	90	110	160
Kangni	0.70	0.50	210	160	135	180
Sanwan	0.80	0.62	180	150	122	170
SEm$\pm$	0.015		3.66		3.05	
CD at 5%	0.046		11.29		9.38	

Malted kutki showed 30% highest reduction in bulk density whereas in case of sanwan it was 29% and lowest in kangni 20%. Similar results were reported by Akubor and Obiegbuna (1999) whereas, Onimawo and Asugo (2004), found increased bulk density by 8.7% after germination of melon seeds.

Water absorption capacity

Studies on water absorption capacity of proteinaceous material over a range of conditions are useful in assessing potential food applications of new proteins. The water absorption capacity of different proteins may be determined to facilitate adjustments in food formulations in interchanging protein sources. The water absorption capacity was found to be minimum in unmalted dehusked kutki (135 ml/100 g of flour) followed by sanwan millet flour (180ml/100g of flour) whereas, the kangni flour was found to have highest value of 210ml/100 g of flour. The data conspicuously revealed that water absorption capacity of kangni flours and its malted flour are remarkably higher than the other flours and their malted flours. The results obtained in the present investigation could not, however, be compared in want of previous scientific reports. The results found in the present study are similar to that reported by Akubor and Obiegbuna (1999), but contrast to other reports Onimawo and Asugo (2004) found significantly improved water absorption capacity in pigeon pea flour on germination.

Fat absorption capacity

Germination increased the capacity of millet flour to bind oil but decreased its water absorption capacity. The solubilization and dissociation of the millet proteins into sub units by germination may have occurred. This may have unmasked the non-polar residues from the interior of protein molecule which may lead to increased oil absorption capacity. The ability of proteins to bind fat is important for such attributions as meat replacers and extenders, principally because it enhanced flavours retention and improves mouth feel. In order to know whether a protein is suitable or not as a complete or partial substitute in foods, it is desirable to determine its fat absorption capacity. The table clearly indicates that malted kangni millet flour recorded a high fat absorption capacity value (180 ml/100g of flour) over other flours. The fat absorption capacity of unmalted flour of sanwan, kangni and kutki millet were found to be 122, 135 and 110 ml/100g of flour respectively. After germination, drying and seiving of millets, the fat absorption capacity of this malted millets flour were increased from 110 to 180 ml / 100g of flour. The results could be supported by various workers for different foods other than millets. Del Rosario and Flores (1981), Naryan and Narasinga Rao (1982) for mung bean and winged bean, respectively. EKe (2002) also found increase in FAC after malting.

4. CONCLUSIONS

In this study maximum moisture and germination percent was observed in sanwan millet followed by kutki and kangni. Finally selected steeping times were 18 hrs for kutki and sanwan and 12 hrs for kangni. The percent yield of the malt flour from millet grain after germination, kilining, drying, dehusking and sieving operations was maximum for sanwan millet followed by kutki and kangni. In malted flours, relative to that of unmalted, water absorption capacity decreased whereas fat absorption capacity found increased in all the three millets.

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