Malting characteristics of Tanzania finger Millet variaties

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Abstract

Five millet varieties were collected from five different regions in Tanzania and the malting characteristics and the malt quality assessed. The malting losses, germinative energy, free amino nitrogen and diastatic power ranged between 9.4 –27.7% and 87.7 – 95.7%, 96 – 102 mg/100 and 34.7 – 45.1 SDU/g, respectively. Muhone variety from Dodoma region (MD) was the best for brewing purposes because of the high diastatic power while Bambare variety from Dodoma was worst. Significant differences ($P < 0.05$) between varieties were observed in germinative energy, free amino nitrogen (FAN) and diastatic power (DP). In millet grains, starch constituted more than three fourth of the grain weight followed by protein, crude fibre, ether extract and ash. Malting caused slight decrease in protein, ash and starch contents while it increased the ether extract, crude fibre and calcium.

Key Words: diastatic power, free amino nitrogen, finger millet, malting

Introduction

Millet is an annual grass that is extensively used in tropical and sub-tropical areas of the world. It is the fifth most important cereal in the world after wheat, maize, rice and barley. Among all millet, pearl millet *(Pennisetum typhoides)* accounts for 40% of the total world production *(Kent, 1983)*. The other common millet are finger millet *(Eleusince coracana)*, barnyard millet *(Echnochloa frumentacea)* proso millet *(Panicum miliaceum)*, foxtail millet *(Setaria italica)* and teff *(Eragrostis tef)*.

In the regions where millet is grown, it is used to prepare several types of food products, some of which are fermented. In East African countries, among other uses, millet is malted and used to brew various traditional beers (Ekundayo, 1969). Some of the popular traditional beers are known by their local names, e.g, mbege, ntulu, burra, irusu, and kindi. Malting is simply a biochemical modification of the grain to produce malt that has improved nutritional quality than normal grain. During malting the grain develops amylolytic enzymes, which hydrolyse starch to fermentable sugars. Traditional malting techniques include 24 hours steeping by continuous immersion of the grain followed by 2-3 days germination in 5-10 cm thick layers under damp burlap bags. The green malt is subjected to solar dehydration for one to two days (25-30°C). The other major uses of malted millet in Tanzania are preparation of non-alcoholic beverages and weaning foods. Some advantages brought about by malting include the improvement of grain nutritional quality by reducing the antinutritional factors responsible for poor digestibility and increasing palatability of the grains. Use of millet to replace expensive imported barley malt in beer brewing has been tried (Skinner, 1976, Nout and Davies, 1982). Sorghum has substituted barley malt in the production of lager beer in Nigeria (Koleoso and Olatunji, 1988). No such attempt has been made in Tanzania finger millet varieties. Finger millet has proved excellent in production of traditional beer such as mbege (Shayo et al, 1997). It is from this information that its potential in brewing lager beer is anticipated. The aim of this paper is, therefore, to analyse the malting characteristics of Tanzania finger millet varieties with the view to determine their suitability in brewing of lager beer.

Materials and Methods

Materials

Five millet varieties were collected from five regions in Tanzania. The names of the samples and the regions of origin are indicated in Table 1.

Table 1. Names of millet varieties and their regions of origin

Local names[a]	Abbreviation[a]	Source
Muhone	MD	Dodoma
Bambare	BA	Arusha
Ukusi	US	Singida
Mbeke	MK	Kilimanjaro
Ulyo	UR	Rukwa

[a]Local names from the growing areas

[b]The first letter represents the local name of the millet variety while the second is the first letter of the region of origin.

Methods

Micro-malting

The grains were cleaned by a combination of hand picking and water floatation. Broken and holed grains, stones, and other debris were rejected. After hand

Table 2 Chemical composition (% dry basis) of millets before and after malting

Variety	Protein		Ether extract		Crude fibre		Ash		Starch		Calcium		Phosphorus	
	BM[b]	AM[c]	BM	AM	BM	AM	BM	AM	BM	AM	BM	AM	BM	AM
Mk	8.91	8.28	3.12	3.40	3.26	3.44	2.9	2.42	82.7	81.4	0.33	0.41	0.24	0.21
BA	12.5	11.8	3.20	3.30	2.05	2.59	2.73	2.44	80.1	79.3	0.01	0.09	0.35	0.27
MD	10.7	10.4	3.05	3.00	2.14	2.42	3.12	2.90	81.4	80.7	0.17	0.19	0.45	0.37
US	10.9	10.5	3.31	3.39	2.50	2.84	2.61	2.41	81.1	80.4	0.34	0.42	0.12	0.09
SR	10.8	10.5	3.17	3.34	2.14	2.32	2.91	2.65	81.5	80.6	0.03	0.05	0.35	0.32
Mean	10.7	10.3	3.17	3.31	2.42	2.67	2.86	2.56	80.9	80.6	0.176	0.232	0.301	0.254
SD	1.27	1.26	0.09	0.12	0.50	0.45	0.20	0.19	0.89	0.84	0.158	0.915	0.126	0.108
Range	3.5	3.52	70.2	0.30	0.45	0.45	0.51	0.49	2.48	2.14	0.33	0.37	0.33	0.28

[a] Means and SD of four independent determinations.

[b] Before malting.

[b] After malting.

picking, the grains were poured into a vessel containing water and the floater were removed and discarded. Samples (0.5 kg) of the dried clean grains were put in aluminium pot and steeped with excess tap water for 48 hours. The grains were then germinated at room temperature for 2 days. The germinating grains were turned and moistened twice a day. At the end of 48 hours of germination, the wet grains were dried by spreading them in an oven at 40°C for 24 hours as described by Dewar et al. (1995).

Chemical Analyses

Five samples of millet and malt obtained from these samples were analysed for proximate composition. Protein, fat and ash were determined using the AACC methods (1983). Crude fibre content was determined as described by Osborne and Voogt (1978). Starch content was calculated by difference. Calcium and phosphorous were determined using the AOAC (1995) methods number 944.03 and 948.08, respectively. Malting losses were determined as described by Novellie (1962). Germinative energy (GE), diastatic power (DP) and free amino nitrogen (FAN) were determined as described by Dewar et al. 1995.

Results and Discussion

The chemical compositions of millet before and after malting are summarised in Table 2. As a general observation, starch content appeared high in millet grains compared to the other nutrients. According to Dendy (1995), starch is the most abundant chemical component, where it forms one half to three fourth of the whole grain. The decrease in starch content in the malt was due to hydrolysis by native enzymes (a – and b-amylases) during germination resulting in increase in reducing sugars (Dewar et al. 1995).

Malting also caused significant reduction ($P < 0.05$) in protein and ash contents. The decrease in protein as a result of malting was due to hydrolysis of native proteins to low molecular weight proteins or peptides and increase in enzyme activity (Hussian et al. 1966).

Ether extract and fibre slightly increased during malting. The increase in calcium content after germination is supported by Perrisse et al. (1966) who observed similar trend during malting of sorghum. The decrease in phosphorus content is a result of it being used up in the metabolic processes during germination. The results on malting losses are summarised in Table 3. The data obtained agree with those previously reported by Morral et al. (1986) that the malt losses of millet range from 2.5 – 17%. MD and UR varieties had higher values than the reported ones. This was due to the differences in the amount of saccharifying enzymes in the growing embryo, which induced growth of roots and shoots and hydrolysed starch (Novellie, 1962).

Table 3 Quality attributes of millet malt[a]

Variety	Malting losses %	Germinative energy %	FAN mg/100g	DP SDU/g
MK	15.2	87.7	108.0	40.9
BA	9.4	94.0	96.4	34.7
MD	27.4	93.3	102.2	45.1
US	12.6	92.0	102.3	41.6
UR	19.9	95.7	106.7	43.3

[a] Values are means of two independent determinations.

The germinative energy values for the grains are reported in Table 3. There was significant difference ($P < 0.05$) in germinative energy between varieties. The results conform with those of Dewar et al. (1995) who reported that after 72 hours from the start of the

germination, at least 90% of the millet grain should have germinated for it to be accepted for malting purposes. Based on this criterion, it is apparent from the results that all varieties except MK qualify for use as malting material. Other factors being favourable, BA and US varieties would be economically more favoured for malting because of the relatively lower malting losses. All the varieties did not attain 100% germination under the conditions of study and the UR variety exhibited the highest (95.7%) germinative energy. The variety with the lowest germinative energy was MK (87.7%). Low germinative energy is sometimes associated with chemical treatment in silos during storage due to age (Dendy, 1995) and poor moisture uptake during steeping (Hofmeyr), 1970, Daiber, 1975).

There was significant difference($P < 0.05$) in free amino nitrogen between the five-malted millet varieties. Morral et al. (1986), found that the value for FAN in millet malt was 87 – 155 mg/100g. The obtained results (Table 3) ranged from 96 – 108 mg/100g, thus conforming to the reported values. MK variety had highest FAN. The FAN content of the malt is the product of both the catabolic processes, which degrade the storage proteins into peptides and amino acids, as well as the anabolic processes that synthesise them into new proteins in roots and shoots. Adequate FAN content is necessary to support yeast growth during fermentation.

There are simple activities resulting from simultaneous action of α- and β- amylases. They are responsible for generation of extract and fermentable extract during the conversion of starch to alcohol. There is no universally accepted 'specification for sorghum and millet malts. However, a minimum specification of DP of 28 SDU/g for malt for industrial sorghum or millet beer brewing appears to be widely used (Dewar et al, 1995). The DP obtained in all samples (Table 3) was enough to make them suitable for malting purposes. The Analysis of variance (ANOVA) test showed that there is a significant difference ($P<0.05$) DP between the millet varieties. This is due to the fact that each variety had its own ability to produce giberrelins, the hormones which during malting, are produced in the germ of the grain and diffuse into the endosperm and the aleurone layer. In the endosperm they induce the synthesis of α- amylase (Dendy, 1995). MD variety showed a stronger enzyme activity than the other varieties as it had greater DP. DP is widely affected by germination time, temperature and moisture.

Conclusions and Recommendations

The results show that all the varieties studied have most of the important chemical constituents in substantial amounts. Malting caused decrease in starch and protein as a result of transformation of starch to sugars and FAN from proteins hydrolysis. These products are essential for beer making. Therefore, malt produced from these millet varieties is of high nutritional quality for brewing and food use. All the varieties used in this study displayed a high potential for malting. This is because they both produce the acceptable germinative energy of more than 90% except MK variety. The MD and UR seem to be better choices for malting and brewing as they produce malts of high diastatic power. The results obtained could be used as a base for further studies on various uses of millet varieties as malt.

Since there are so many millet varieties in this country and that most of them have not been studied in the context of brewing and food, there is urgent need for their screening. This will enable promotion of those with promising potential for the end uses.

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