Characterisation of Tanzanian Local Sorghum Varieties

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Abstract

Many local varieties of sorghum grown in Tanzania have not been characterised in terms of their end uses. This study was conducted to characterise 14 such varieties. Three improved varieties commonly grown in this country were included for comparison. Physical analyses that included 100-grain weight, percent dehulling loss and percent water absorption were done. Chemical analysis of the samples to determine protein, crude fibre, fat, ash, and carbohydrate contents was done. Results showed that the 100-kernel weight ranged between 1.48 and 3.18 g. Some of the local varieties had kernel sizes that were greater than those of the improved ones. Dehulling losses for the studied varieties ranged from 4.63 to 29.85%. These losses were generally low for the commonly used local varieties. Water absorption ranged between 6.10 and 28.85%. The flour making varieties showed low water absorption capacity. The protein contents of the studied varieties (8.27-13.52%) differed significantly (P<0.05). However, the crude fibre (1.23-2.30%), fat (3.00-4.30%), ash (1.96-4.25%), and carbohydrate contents (78.84-83.96%) of sorghum varieties did not differ significantly (P>0.05). Studies on endosperm texture revealed that most floury varieties had generally high dehulling losses and were therefore unsuitable for producing dehulled products. Corneous varieties wereconsidered suitable for producing dehulled products due to their low dehulling losses. The intermediate endosperm texture varieties, which also experienced intermediate dehulling losses, need more studies in order to be properly classified. Some of these,varieties such as Langalanga are already being used for flour making without prior dehulling. The study, therefore, calls for more screening of the local sorghum varieties not used in this study to identify their potential in relation to end uses for future exploitation and, where possible, to exploit the promising trait for incorporation in breeding programmes.

Key words: Sorghum varieties, physical and chemical characteristics, Tanzania

Introduction

In Tanzania, sorghum is an important crop for food and cash for people living in the semi-arid areas of the country, e.g., Dodoma, Singida, Mara and Shinyaga. Although local and improved sorghum varieties are cultivated in these areas, local varieties have received less attention from researchers than the improved varieties such as *Serena, Lulu, Tegemeo, Pato* and *Macia* that have been given less preference by farmers due to their inferior taste and more tolerance to pest attack. Attempts to characterise these sorghums have focussed mainly on the improved varieties, whose biggest advantage over the local varieties is their high yielding capacity.

An important factor among these varieties that has been overlooked in breeding programmes for sorghum in Tanzania is the role played by the traditional varieties, most of which are low-yielding genotypes. They have survived to date due to a number of potentials identified in the Collaborative Project to Investigate Consumer Preferences for Selected Sorghum and Millet Products in the SADC Region of Africa (Laswai *et al.*, 1999). These potentials have been documented by Participatory Rural Appraisal (PRA) studies in the villages and urban areas. The potentials are in the areas of production and consumption, which include relative hardness, resistance to post-harvest insect damage, and ability to keep viability that favour their use as

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seed for future crop. In addition, their dehulling ability, colour and palatability when compared to the introduced high-yielding varieties and their ability to withstand bird damage, as a result of their loose panicles are other advantages. The improved varieties have compact panicles, that make attack by birds very easy and thus birds can sit comfortably on them and cause high grain damage. Despite these potentials, some of the local varieties are prone to lodging and attack by insects and diseases (Laswai *et al.*, 1999).

Saadan and Mndolwa (1999a) have pointed out the need to categorize varieties by characteristics of importance to various end users. It has further been pointed out that areas of collaborative research include promotion of processing, marketing, storage and utilization (Saadan and Mndolwa, 1999b). This study was therefore conducted with the objective of characterising these local varieties in relation to different end uses.

Materials and methods

Materials

Sample collection and reagents used

Sorghum samples used in this study were obtained from several regions namely Dodoma (*Lugugu, Udo, Pato, Serena*); Singida (*Langalanga, Langalanga miwa and Langalanga mkojo wa ng'ombe*); Coast region (*Kibaha*-local); Bukoba (*Bukoba*-local); Mara (*Miningamhela*); Morogoro (*Mbangala, Mwingo wa nyumbu, Mngindo, Jebele, Songea, Tegemeo)*; Arusha (*Mtama mwekundu*) and Iringa (*Vwupemba)*. Reagents used in this analysis were of analytical grade from Sigma Chemicals.

Methods

Qualitative and quantitative grain evaluation

Physical characteristics investigated were colour, endosperm texture, hardness, percent water absorption, percent dehulling loss and 100-kernel weight. Colour of the grains was judged visually according to IBPGR and ICRISAT (1993) classification of kernel colour. Endosperm texture and hardness were obtained using the standard methods of analysing grain endosperm texture and hardness (Gomez *et al*, 1997). Quantitative grain quality evaluation included 100-kernel weight (in grams); percent water absorption and percent dehulling loss as detailed by Gomez *et al*. (1997). Dehulling losses were determined after using the Tangential Abrasive Dehulling Device (TADD) to dehull for 4 minutes. Four 20 g samples were dehulled for every sorghum variety. Each dehulling was done in duplicate and the loss during dehulling expressed as a percentage of the total weight of sample used.

Chemical analyses conducted included crude protein, crude fat, crude fibre, ash content in accordance with the AOAC methods (AOAC, 1990), and dry matter and moisture content determination (Gomez *et al*, 1997). Carbohydrate content was obtained by difference (AOAC, 1995).

Statistical analyses were carried out to compare the means of the different treatments as per Steel and Torrie (1990).

Results and discussion

The results of 100-kernel weight, dehulling losses and percent water absorption are summarised in Table 1.The local varieties had mean 100-kernel weight ranging between 1.48 and 3.18 g (Table 1). The size of the improved varieties was between 1.56 and 2.82 g. It was observed in this study that, *Jebelė* variety from Morogoro region was the most superior of all the varieties (local or improved) used in this study in terms of having large size that was mostly preferred. Although the yield records of these local varieties are scanty in literature, in comparison with improved varieties, this particular variety needs to be studied further. The focus should be to see if the big size trait could be incorporated in the national breeding programme, for the advantage of consumers and farmers. *Mbangala* is another local variety that may warrant investigation by breeders. According to Kent (1983), 1000-grain weight of sorghum lies between 10 and 38 g, with an extreme range of 7 to 61 g. Rooney and Serna-Saldivar (1991) have given a range of 0.3 to 8 g for 100-grain weight for this cereal. The results of 100-grain weight obtained

Table 1: The 100-kernel weight, dehulling losses and percent water absorption capacity of different sorghum varieties

Variety	100-kernel weight (g)	Dehulling loss (%)	Water absorption (%)
Local			
Miningamhela	1.48	12.65	28.85
Udo	1.84	17.53	17.05
Bukoba	1.86	25.00	23.30
Kibaha	2.02	5.75	13.70
Mngindo	2.12	4.63	8.55
Mtama mwekundu	2.33	48.25	25.50
Langalanga	2.36	9.58	9.50
Mwigo wa nyumbu	2.38	24.03	18.25
Lugugu	2.58	7.13	6.10
Langalanga miwa	2.45	7.23	14.30
Songea	2.47	17.63	18.05
Langalanga mkojo wa ng'ombe	2.49	9.40	15.00
Vwupemba	2.53	36.55	22.25
Mbangala	2.92	6.62	5.75
Jebele	3.18	22.85	18.50
Improved			
Serena	1.56	29.85	20.50
Tegemeo	2.57	9.70	11.45
Pato	2.82	10.10	9.60
Mean	2.33 ± 0.44	16.60 ± 11.83	15.61 ± 6.43
Range	1.48 - 3.18	4.63 - 29.85	6.10 - 28.85

*Data based on quadruplicate determinations and expressed as mean ± standard deviation

in this study compared well with values reported in literature for sorghum.

The percent dehulling losses (i.e., the proportion of the total grain weight that is lost after removing the dehulled grains, expressed as a percentage) for the local varieties ranged between 4.63 and 48.25 (Table 1). The improved varieties had dehulling losses ranging between 9.7 and 29.85%. Close scrutiny also revealed that the varieties commonly consumed in the dehulled state had generally low dehulling losses (e.g., *Mngindo*, 4.63; *Kibaha*-local, 5.75; *Mbangala*, 6.62; *Lugugu*, 7.13 and *Langalanga*, 7.23, 9.4 and 9.58). The remaining varieties were not so popular for making flour in the dehulled forms and those with high values of dehulling loss were commonly used for brewing and for making *togwa* (a non-alcoholic fermented beverage). With the exception of *Serena* variety, that had highest dehulling losses in the group of improved varieties, *Pato* and *Tegemeo* had close to 10 % dehulling loss. This value was higher than that encountered for the popular local sorghum varieties used for preparing stiff porridge. It seems logical to believe that, for any sorghum to be accepted and therefore used by a large majority of consumers for *ugali,* dehulling losses need to be below 10%, the value commonly encountered for the popular local sorghum varieties. This possibly explains the preference for the local varieties despite their low yielding potentials.

Results from the water absorption capacity determination experiments are shown in Table

1. On one hand, Sorghum varieties that need to be steeped or malted before making food products ought to have high water absorption capacity so that they can be steeped within a short time. On the other hand, varieties that do not take in water fast are good for wet dehulling. The second category varieties could also be good in minimisation of migration of tannins into the endosperm layers during traditional dehulling.

The process of re-wetting often involves sprinkling the grains with water prior to and during dehulling. This facilitates migration of this water into the inner layers of the grain. Such migration is disadvantageous because it favours complex formation between endosperm proteins and tannins, which lower the nutritional quality of the proteins.

Water absorption capacity results showed some relationship with the dehulling losses. Samples that had high dehulling losses also absorbed high quantities of water during steeping. This could imply that sorghum varieties with high water absorption capacities are unsuitable for dehulling as the dehulling losses will be high. However, such varieties may be good for making products that require steeping and/or malting as unit operations in the production of the products.

The proximate compositions of the samples used in this study are summarized in Table 2. With the exception of *Kibaha-local, Mtama*

Table 2: Proximate compositions of local and improved sorghum varieties

Variety	Protein (%)	Crude fibre (%)	Fat (%)	Ash (%)	Carbohydrates (%)
Local					
Miningamhela	13.52	1.69	3.08	2.22	79.49
Udo	11.43	1.76	3.00	2.34	81.47
Bukoba	11.58	1.90	3.21	1.96	81.43
Kibaha	8.59	2.22	3.38	2.18	83.63
Mngindo	11.99	1.74	3.20	2.15	80.92
Mtama mwekundu	8.27	2.20	3.40	2.17	83.96
Langalanga	12.93	1.75	3.40	2.28	79.64
Mwigo wa nyumbu	12.48	1.69	3.17	2.19	80.47
Lugugu	12.78	1.62	3.28	2.43	79.89
Langalanga miwa	11.04	2.06	3.26	2.23	81.41
Songea	11.42	1.89	3.23	2.18	81.28
Langalanga mkojo wa ng'ombe	9.20	2.16	3.31	2.08	83.25
Vwupemba	10.31	2.01	3.28	2.24	82.16
Mbangala	11.56	2.24	3.11	4.25	78.84
Jebele	11.03	2.09	3.24	2.27	81.37
Improved					
Serena	8.98	2.30	3.22	2.10	83.40
Tegemeo	11.38	1.23	4.30	2.22	80.87
Pato	11.35	1.89	3.23	2.45	81.08
Mean	11.05 ± 1.48	1.93 ± 0.27	3.29 ± 0.26	2.43 ± 0.62	81.36 ± 2.27
Range	8.27 - 13.52	1.23 - 2.30	3.00 - 4.30	1.96 - 4.25	78.84 - 83.96

*Data based on quadruplicate determinations and expressed as mean ± standard deviation *mwekundu, Langalanga mkojo wa ng'ombe* and *Serena*, all the remaining varieties had protein content above 10%. The variation in protein content between the samples (8.27-13.52%) differed significantly (P<0.05). Variation in crude fibre content between the varieties (1.23-2.30%) was not significant (P>0.05). The fat contents (range 3.00-4.3%) also did not differ significantly (P>0.05) among sorghum varieties. The differences in ash content between the samples (1.96-4.25%) and carbohydrate content between the samples (78.84-83.96%) were not significant (P>0.05).

Information arising from grouping of the studied varieties according to endosperm texture is shown in Table 3. The results showed, that the most floury varieties (i.e., *Mtama mwekundu, Serena, Bukoba-local, Vwupemba* and *Miningamhela*) are unsuitable for dehulling but could find important use in malting if they are proved to have high diastatic power. Coincidentally, all these varieties (Table 3) were also found to have high dehulling losses. The most corneous varieties (i.e., *Mbangala, Pato, Mngindo* and *Kibaha-local*) were suitable for dehulling to prepare flour for *ugali* or sorghum "rice" (*pilau* and *makande*) (Saadan and Mndolwa, 1999b). The low dehulling losses of these varieties observed in this study are in full support of this proposition. The endosperm texture of these varieties (i.e., all the *Langalanga* types, *Songea, Mwingo wa nyumbu, Udo, Lugugu* and *Tegemeo*) is intermediate between floury and corneous category. This observation agrees with the levels of dehulling losses of the samples classified as intermediate in the grouping based on endosperm texture. More studies are needed for the intermediate endosperm texture varieties in order to classify them properly. Some of the varieties in this category, like Langalanga are already being used for flour making without prior dehulling in Singida region.

Table 3: Grouping according to the endosperm texture

Grouping	Variety	Colour
Mostly floury	Mtama mwekundu	Red
	Serena	Brown
	Bukoba	Dull white
	Jebele	Dull white
	Vwupemba	Reddish brown
	Miningamhela	Dull white
Intermediate	Langalanga miwa	Cream
	Langalanga mkojo wa ng'ombe	Cream
	Songea	White
	Mwingo wa nyumbu	Dull white
	Udo	Brown
	Lugugu	White
	Tegemeo	Dull white
	Langalanga	Cream
Mostly corneous	Mbangala	Cream
	Pato	White
	Mngindo	White
	Kibaha	White

Conclusions and recommendations

Among the local varieties, there are sorghums that have grains bigger than those of improved varieties. This means that such varieties need to be identified and incorporated in the national breeding programme in those cases where grain size is used as one of the quality attributes in the breeding. The varieties used in this study did not show wide variation in chemical composition except for the protein content. The study revealed that most of the varieties commonly used for making dehulled products (*pilau, makande* and *ugali*) are generally those with corneous or intermediate endosperm texture, low water absorption capacity and which are white or cream in colour. *Mbangala* , *Mngindo* (local) and *Pato* (improved) varieties are excellent for making dehulled sorghum products. There is also a wide range of local (*Langalanga, Songea, Mwingo wa nyumbu, Lugugu*) and improved varieties (*Tegemeo*) that have future prospects for use in dehulled sorghum-based products due to their intermediate endosperm texture. Although *Udo* falls under this category, its high tannin content and brown colour make it unsuitable for making whole grain dehulled sorghum foods. The variety is, however, suitable for brewing as it has been shown to have high diastatic power. The remaining screened varieties are too soft to qualify as food in the dehulled form, due to either high dehulling losses or excessive pigmentation. More studies are needed to establish end uses of the intermediate texture sorghum varieties. Together with this, the long list of local Tanzanian sorghum that was not included in this study requires investigation to identify and exploit potentials that may be inherent in them.

Acknowledgements

We are grateful to the Sokoine University of Agriculture, Morogoro, Tanzania, for financing this study.

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