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RESEARCH NOTE

Effect of malt milling energy, sedimentation rates and diastatic power measurement in sorghum selection

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Sedimentation rates, diastatic power measurements and electrical energy required to mill samples of sorghum malts were determined in ten sorghum cultivars. Samples with low milling energy ranked highly in sedimentation and diastatic power measurements. Significant negative correlations (r = 0·60 and 0·62, respectively) were obtained between milling energy and sedimentation rate and between milling energy and diastatic power measurement.

INTRODUCTION

An objective basis for barley breeding evaluation is the ability to distinguish between varieties (Henry, 1985). Selection of good-quality sorghum malt also requires prediction of milling properties. Chenost (1966) developed a rapid test for nutritional value of grass by measuring electrical energy required to mill materials that varied in fibrousness. Allison *et al.* (1976) adapted this method and differentiated between barleys that varied in malting quality. Low milling energy values were associated with higher malting potential.

This study assesses whether a malt milling test combined with diastatic power measurements and a sedimentation test may be of value in selecting sorghum.

MATERIALS AND METHODS

Samples of sorghum varieties FD1, SK, L1412, SSV7, SSV3, L1202, KSV8, FFBL, MORI and MDW were from the International Crops Research Institute for Semi-Arid Tropics (ICRISAT), Kano, Nigeria. The samples were stored at 5°C for three months to equilibrate to a moisture of 12·5 ± 0·1%. Only undamaged samples (visual observation of kernels cut in half) were used. The samples were size-graded (Wills & Ali, 1983) and 100 g kernels with a size range of 4·00–4·70 mm were used.

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Malt production

One hundred kernels were steeped in water (10 ± 2°C) with a six-hourly steep liquor change schedule as described by Lasekan (1991). They were spread in a controlled germination chamber at room temperature (28 ± 2°C), 95% RH, on a glass sheet lined with moist blotting paper and allowed to germinate for 6 days. During germination, kernels were turned and wetted twice daily with 20 ml of steep liquor per 100-g sample of sorghum kernels. Germinated seedlings were kilned in hot air at 55°C until the moisture content was 5·8%. Temperature was next raised to 65°C until the moisture content was 4%. The malt was polished by manually rubbing samples with a dry muslin cloth.

Milling energy

Milling energy was assessed on 10 g of each cultivar using the method of Allison *et al.* (1976); the total energy required to mill the samples was estimated by cutting out the trace from the recorder chart, and the curve area was expressed as weight. The experiment was repeated five times for each cultivar sampled and the mean value was recorded.

Diastatic power

The method of the Institute of Brewing (1977) as modified by Henry (1984) was used to estimate the diastatic power of 0·25 g of each cultivar.

Sedimentation

Ten grams of each malt were milled in a microhammer mill (Glen Creston Co. Ltd, London, UK) to a flour fine enough to pass through a 1-mm sieve (Lasekan, 1991). Four determinations of each sorghum flour with sedimentation rate in ethanol were measured according to the method of Palmer (1975) and the optical density values read on an Eel Unigalvo connected to a nephelometer head.

Statistics

Kendall's (1970) rank correlation was used to test statistical association between the milling energy, sedimentation rates and diastatic power.

RESULTS AND DISCUSSION

The milling energies necessary to mill samples of sorghum, their sedimentation rates and malt diastatic powers are shown in Table 1. The electrical energy required to mill samples varied from 266·3 ± 3·1 mg to 411·6 ± 9·2 mg, respectively. The cultivar FD1 which had the lowest milling energy of 266·3 ± 3·1 mg also ranked highly in both sedimentation test and malt diastatic power measurements. A similar trend was noted in other cultivars such as SK, L1412, SSV7, SSV3, L1202, MORI and MDW, in which the cultivars' milling energies and the other grading tests (sedimentation and malt diastatic power values) produced linear relationships. In contrast, cultivar KSV8 sedimented faster and also recorded a higher malt diastatic power than cultivars of equivalent milling energy.

Since it has been difficult to predict malting quality in sorghum from the milling energy of unmalted grain (Swanston *et al.*, 1991), it is best to adapt the experience with barley (Allison *et al.*, 1976) to the malted sorghum. Subsequently, it is possible to infer that the top ranked samples with low milling energy values would probably have correspondingly high malting potentials.

Correlation between milling energy and sedimentation rate

Correlation between the electrical energy required to mill samples and their sedimentation rates was calculated using Kendall's (1970) coefficient of rank correlation tau (τ).

$$\tau = \frac{P - Q}{\frac{1}{2}n(n-1)} \qquad (1)$$

where n = pairs of ranks. P and Q are the positive and negative contributions, respectively, of that score to test statistic S.

Significance of τ was further tested by introducing a correction for continuity, thus:

$$\frac{18(P - Q - 1)}{[\frac{1}{2}n(n-1)(2n+5)]} \qquad (2)$$

A significant negative correlation (−0·60) was obtained between the milling energy and sedimentation rates of the sorghum cultivars (Table 1). This does not necessarily imply the existence of a causative connection. The combination of these two methods (milling energy and sedimentation rates) in providing a screening system for malting quality has earlier been suggested by Allison *et al.* (1976).

Correlation between milling energy and diastatic power

A similar significant negative correlation (–0·62) between a cultivar's malt milling energy and diastatic power was also obtained (Table 1). This observation is consistent with those of Swanston *et al.* (1991). The significant negative correlation between milling energy and diastatic power may indicate a contribution of starch granule modification to the decrease in milling energy during malting (Swanston *et al.*, 1991).

Table 1. The milling energy, sedimentation and malt diastatic power measurements of sorghum cultivars

Cultivars	Milling energy[a] (mg)	Sedimentation[b] (nephelometer reading)	Malt diastatic power (mmole/s/kg)
FD1	266·3 ± 3·1 (1)	74·0 ± 1·8 (9)	8·10 (10)
SK	283·4 ± 6·3 (2)	70·3 ± 1·7 (6)	6·03 (6)
L1412	316·4 ± 7·0 (3)	71·4 ± 1·4 (7)	6·80 (8)
SSV7	336·5 ± 1·7 (4)	72·4 ± 1·2 (8)	6·22 (7)
SSV3	340·4 ± 1·8 (5)	68·6 ± 0·6 (5)	5·92 (5)
L1202	347·6 ± 7·1 (6)	62·7 ± 1·0 (4)	5·91 (4)
KSV8	355·7 ± 2·5 (7)	74·7 ± 1·6 (10)	7·03 (9)
FFBL	386·4 ± 3·5 (8)	51·4 ± 0·7 (3)	5·90 (3)
MORI	391·6 ± 4·0 (9)	47·2 ± 2·1 (2)	5·82 (2)
MDW	441·6 ± 9·2 (10)	16·3 ± 1·4 (1)	5·10 (1)
[c] Milling energy and sedimentation values		−0·60*	
[c] Milling energy and malt diastatic power		−0·62*	

[a] Mean ± S.E. (n = 5).
[b] Mean ± S.E. (n = 4).
[c] Coefficient of rank correlation (tau).
* $0·05 > P > 0·01$.
( ) Values in parentheses are the ranked order of parameters.

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