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MALTING CHARACTERISTICS OF SOME NEWER SORGHUM (Sorghum Bicolor) CULTIVARS

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ABSTRACT

Five sorghum varieties namely M35-1, CSH-1, SPV475, TAM 2566 and IS14384 obtained from International Crop Research Institute for Semi-Arid Tropics, India were assessed for their malting characteristics. Sorghum variety SK 5912 was used as control. M35-1, CHS-1 and SPV 475 were white, while others were highly pigmented. TAM 2566, IS 14384 and M35-1 varieties were found to be very floury, while CSH-1 and SPV 475 were steely. M35-1 and CHS-1 had the largest corn size and weight.

It was also found that TAM 2566 and IS 14384 had high germinative capacity and energy of 95-98 % compared to M 35-1 and SPV475 of very low germinative capacity and energy of 89%. The temperature of gelatinisation ranged from 72°C to 75°C for all the varieties considered.

TAM 2566 exhibited best malting characteristics with diastatic activity of about 39-degree Litner (°L), total soluble protein of 0.779% and total Nitrogen level of 1.70% all on dry weight basis. These values are close to those obtained for Sorghum variety SK 5912. Mashing and wort analysis of TAM 2566 confirm the suitability of this sorghum variety to compete favourably against Sorghum variety SK 5912 as possible replacer of barley for malting and brewing 100% Larger beer.

INTRODUCTION

The malting process that generates the fermentable mono and disaccharides is dependent upon the activity of a and b amylases that develop in the cereal seeds during germination[1]. Bureng and Worgan[2], reported that activity of amylases increased appreciably during malting.

Barley which is the conventional material used for malting is not cultivated in some countries especially Nigeria. As at 1992, the breweries in Nigeria annually spent about N495 million to import barley malt[3]. There is need to encourage substitution of some of the imported malted barley with sorghum to conserve foreign exchange and also ensure industrial utilization of sorghum. Sorghum (sorghum bicolor) is the world's fifth most important cereal in terms of both production and area planted[4]. Sorghum is produced in large quantities in Nigeria, between 1969 and 1991, 4,082'000 tonnes of sorghum were produced with harvested area of 5271'thousand ha harvested area and yield of 303kgha-[4,5,6,7,8].

The Federal Institute of Industrial Research Oshodi, Nigeria has reported research work on systematic scanning of Local varieties of cereal grains (mainly sorghum, millet and maize) to evaluate their malting characteristics[9]. The possibility of brewing larger beer using 100% sorghum from the SK5912 variety of sorghum grains has been reported and there was a claim that there are other varieties of sorghum that can be better than SK 5912[10].

Again, earlier studies have reported malting of sorghum[11]; corn[12] and brewing of beer with sorghum[3]. This paper therefore presents a study of the malting characteristics of selected newly developed sorghum varieties which can be adopted to the Nigerian arid region and which compete favourably against sorghum variety SK 5912 as possible replacer of barley for malting and brewing purposes.

MATERIALS AND METHODS

Collection of Samples.

Five different varieties of sorghum namely TAM 2566, M35-1, CSH-1, SPV475 and IS14384 were obtained from International Crop Research Institute for Semi- Arid Tropics (ICRISAT), India, and used for this work. Sorghum variety SK5912 was used as control. Each experiment was carried out in triplicate and average value determined.

Analytical Procedures

a. **Internal Assessment of Grain Samples:**

About 100 grains of each variety were counted and dissected longitudinally with a very sharp razor and cut surface examined for the presence of steely and mealy or floury portions of the endosperm, as described by A.O.A.C[13]. Also Colour of the samples were examined by spreading suitable portion of the sample evenly and observed against white background accordinly to A.O.A.C method [13]

b. **GERMINATIVE TESTS**

Germinative Capacity Test was carried out to measure the percentage of viable corns in a given variety of sorghum, according to procedure described by Institute of brewing[14], so also germinative energy.

c. **TEMPERATURE OF GELATINIZATION**

The gelatinisation temperature was evaluated using the method described by Institute of Brewing[14] . Twenty five gram slurry of milled sample (grit to liquor ratio 1.2)was made in a test tube. This was placed in a regulated water bath at 80°C. The slurry was stirred constantly until it just gelatinised. The temperature at which the slurry just gelatinised was the temperature of geletinisation for each sample, 3 values were obtained and average was determined.

d. **THOUSAND CORN WEIGHT (TWC)**

This was evaluated by weighing 10g of each variety, counting the number of grains present in the weighed sample and determining the weight of one thousand (1,000) corns, by simple proportion[13].

e. **MOISTURE CONTENT"**

Moisture content was determined according to the Methods of Analysis of Institute of Brewing[14].

f. **MALTING**

Twenty gram (20g) sample of each variety was weighed and washed thoroughly with tap water and steeped for 24hrs with vigorous aeration using wire tubes through out the steeping period. The water was drained followed by air-resting. The seeds were germinated for 5 days at a temperature ranging between 26°C and 28°C. During germination, humidification by wetting with water as well as regular turning of the grains were done. The green malt was later kilned for 10hrs at 65°C, 7hrs at 75°C and 6hrs at 85°C. This was followed by the removal of rootlets and shoots. The moisture of the kilned malt varied from 4 to 5%.

g. **MALT ANAYSIS**

The malt was analyzed for moisture according to the Methods of Analysis of Institute of Brewing[14] and the total soluble protein was determined by the method of Lowry. Total nitrogen content of the malt was determined according to Pearson's Chemical Analysis of foods[15]. The diastatic activity and extract yeild were carried out according to the procedure of the Institute of brewing[14].

BREWING TRIAL

The variety TAM 2566 was selected for brewing trial because of its high diastatic power and extract values compared to the other malted varieties. Saccharification test and wort analyses were carried out using the recommended methods of analysis of the Institute of Brewing[14].

RESULTS AND DISCUSSION

External and Internal Assessment of grains

The results of external and Internal assessment of the grain samples are presented in tables 1 and 2.

Table 1 Physical Appearance of The Grains

Varieties	Visual Colour	Mealiness/Flouriness	Steeliness
M.35-1	White	50% mealy	50% steely
CSH-1	White	Less mealy 30%	More steely
SPV 475	White	Less floury 30%	More steely
TAM 2566	Brown (highly pigmented)	Very Floury 90%	10% steely
IS 14384	Wine (highly pigmented)	Floury 60%	Less steely
SK5912	Brownish Yellow	Floury 80%	Less steely

Results are means of three experiments

Table 2 : Preliminary Analysis of the Raw Grains.

Varieties	% Moisture	Thousand Corn Weight	% Germinative Germinative Energy	% Germinative Capacity	Temperature of Gelatinisation
M.35-1	11.2	37g	98	98	72°C
CSH-1	11.5	35g	89	89	74°C
SPV 475	9.0	29g	95	95	72°C
TAM 2566	12.3	21g	98	98	72°C
IS. 14384	9.4	19g	96	96	75°C
SK5910	7.0	28.40g	97	97	75°C

Results are means of three experiments

M 35-1 and CSH-1 had the largest corn size and weighed 37g / 1000 corns and 35g/1000 corns respectively while the SPV 475 was medium sized corn weighing 29g/1000 corns, TAM, 2566 and IS4348 had very small sizes and weighed 21g/1000 and 19g/ 1000 corn respectively while the control SK5912 weighed 28.4g / 1000 corns. TAM 2566 was the most floury variety followed by IS 14384 and M35-1. CSH- 1 and SPV 475 were steely. The control SK5912 was floury. Mealy or floury kernels in which less than ¼ of the endosperm is glassy. The implication of the above is that mealy or floury varieties TAM 2566, IS 14384 and M35-1 would have better malting ability than the

steely varieties[16]. The average grain size of 25g /1000 corns of local varieties of sorghum was also reported by Olaniyi[16], which is similar to medium sized corn variety SPV 475.
TAM 2566 and IS 14384 were highly pigmented that is brownish also SK 5912 was brownish yellow while, others were white and creamy. This could be due to the presence of high tannin contents in them because tannins have been shown to contribute to pigmentation in grains[17].

Germinative Test

All the varieties displayed high germinative energy and germinative capacity of between 95% and 98% (table 2) with the exception of CSH-1 which showed slightly lower than minimum value of 90% expected of good and viable grains[18]. The germinative energy and capacity of sorghum variety SK5912 was 97%.

Temperature of Gelatinisation

IS 14384 has the highest temperature of gelatinisation (table2) of 75°C followed by CSH-1 with temperature of gelatinisation of 74°C. The other 3 varieties TAM 2566 SPV 475 and M35-1 had 72°C as their gelatinisation temperature. The control, SK5912 has 75°C as its temperature of gelatinisation.. The temperature of gelatinisation of sorghum starch has been found to range between 72°C and 75°C[19], and this varies with the type and size of the starch granules. Again, Olaniyi[16] has reported that the temperature of gelatinisation of malted sorghum starch was from 68°C –76°C.

Proximate Analysis

The result of the proximate analysis of the sorghum variaties (table 3) show that all the varieties including the control SK5912 had remarkably high Nitrogen Free Extract (NFE) content of 76.5% to 80.98% on dry matter basis. The protein content on dmb ranged from 9% to 11.5% while the fat content ranged from 2.62% to 3.52%. These values were comparable with chemical composition of raw sorghum as reported by Serna-Saloivar[20].

Table 3 : Promimate Analysis of Raw Grains (on Dry Matter Basis)

Varieties	% Protein	% Fibre	% Fat	% Ash	Nitrogen Free extracts %	Moisture Content %
M.35-1	10.2	21.5	262	1.20	77.5	3.2
CSH-1	9.7	1.68	3.52	1.51	76.5	6.8
SPV .475	9.3	1.41	2.77	1.55	78.05	5.4
TAM 2566	11.5	1.52	2.96	1.69	80.98	6.6
IS. 14384	9.0	2.53	3.0	1.69	77.94	6.6
SK5912	10.50	2.21	3.07	1.53	80.07	6.8

Results are means of three experiments

Malt Analysis

The result of the malt analyses shown in Table 4 indicate that malt produced from TAM 2566 had the highest diastatic power of 39 degrees litner (°L), total soluble nitrogen of 0.779%, total soluble protein of 4.87% and total nitrogen of 1.70%. Similar values for total soluble Nitrogen and total Nitrogen content had been reported by Koleosho and Olatunji[3], for barley malt. High protein content does not necessarily lead to poor shelf life of beer according to Olaniyi[16], the figures obtained for TAM2566 variety are very close to those obtained for the variety SK5912.

The diastatic power of the other four varieties was found to be lower,ranging from 20 to 24°L. Their total nitrogen, total soluble nitrogen, and total soluble protein ranged from 1.38-1.6%; 0.06-0.774% and 3.75-4.84% respectively.
The Kolbach index figures obtained for all the varieties were remarkably high (40.9-47.9). A value, 35 is the minimum value expected of well-modified malt[16].

During brewing Saccharification test shows that complete Saccharification occurred after one hour at 65°C during the last stage of mashing when the mash was completely negative to iodine (Table 5).

Table 4 : Chemical Indices of Malted sorghum varieties

Varieties	Diastatic Power (°Litner)	% Total Nitrogen Protein	% Total Soluble Nitrogen	% Total Soluble	Kobalch Index	Extract Yield g/100g.
M.35-1	23.7	1.54	4.48	0.774	49.9	6.67
CSH-1	20.3	1.46	3.75	0.60	40.9	4.528
SPV .475	20.4	1.60	4.19	0.670	41.7	9.310
TAM 2566	38.5	1.70	4.87	0.779	45.8	10.002
IS. 14384	23.6	1.38	4.26	0.681	49.0	8.531
SK5912	38.34	1.68	4.85	0.775	46.7	10.008

"Varieties are new varieties from International Crop Research Institute for Semi-Arid Tropics, India.
The results are means of three experiments.

Table 5 : Sugar Production (%Brix) During Saccharification with Malted Sorghum TAM2566

Temperature	Time	Brix (% sugar)	Iodine Reaction
50oC	0 minutes	4.0	(blue-black)
	15 minutes	6.0	(blue-black)
65oC	0 minute	8.0	(blue)
	15 minutes	10.0	(blue)
	30 minutes	11.0	(deep purple)
After boiling	30 minutes	15.2	(purple)
After cooling & Addition of Supernatant at 55oC	0 minute	16.2	(light purple)
At 65oC	0 minute	16.4	"
	15 minutes	16.5	"
	30 minutes	17.5	(very light purple)
	45 minutes	18.0	(purple trace)
	60 minutes	19.0	(purple trace)

Results are means of three experiments.

Table 6: A Wort Analysis During the Brewing of Sorghum beer with Malted Sorghum TAM 2566.

Parameter	Value
pH	5.3
Specific gravity	1.0424
Bitterness (FBC units)	30
Original gravity Op	113
Colour	23
Wort turn out	260mls
Brix	11.0
Apparent degree of attention (expressed as % fermentability)	91%
Real degree of attention (expressed as % fermentability	75%

To obtain these results 3 samples were analysed.

Wort analysis results (Table6) revealed that the pH of 5.3 and original gravity of 11.3°p obtained fell within the expected range for quality brewing. This is consistent with findings reported by Koleoso and Olatunji[3] on SK5912 variety.

The colour and the bitterness values were high at 23 and 30 EBC units respectively. These two parameters are likely to decrease to normal level after few days of fermentation.

The values of real degree of fermentation and apparent degree of fermentation were 74.5% and 91% respectively. These values are consistent with those reported by Koleosho and Olaniyi[3] (74.5 and 91% respectively for) sorghum beer from variety SK5912.

CONCLUSION

From the study, the selected newer sorghum varieties M35-1, CHS-1, SPV475 TAM 2566 and IS 14384 have good malting characteristics. However, TAM 2566 variety produced malt with the best quality and would be most suitable to compete favourably with variety SK5912 for brewing 100% malted sorghum larger beer.

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