NUTRITIONAL AND ROCESSING QUALITY OF SORGHUM

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12 Processing and Cooking Quality Characters in Sorghum

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1. INTRODUCTION

The processing and food quality characters of the cultivar are of great importance to the farmers who grow sorghum for their own consumption (Pushpamma and Vogel, 1982). The acceptability and extension of high-yielding cultivars of sorghum are affected by their consumer quality characters (Rooney and Murty, 1982). Over the past few years, a systematic evaluation of genetic variability for processing and food quality characters of sorghum has been attempted at ICRISAT and some of these studies are reported in this chapter. Results from these investigations would be useful in formulating selection criteria for breeders and could be applied in the development of laboratory techniques necessary to rapidly screen large number of breeding stocks.

2. PROCESSING OF SORGHUM

2.1 **Traditional Dehulling**

In several countries of Africa and some regions of South India sorghum is consumed after removing the pericarp of the grain by traditional methods with a mortar and pestle (Vogel and

Graham, 1979). Moist grain is placed in a mortar and pounded with a pestle until the pericarp is separated from the endosperm. In this process, variable quantities of germ are removed from the grain. The pounded material is winnowed and the bran is separated. The endosperm recovered is either pounded again to obtain flour or is cleaned in water and cooked depending upon the food product. Although mechanical methods of dehulling have been designed and some pilot plants are in operation (Riechert, 1982), currently most of the dehulling of sorghum in the rural areas is done by traditional methods. Preliminary reports from Upper Volta and Mali indicated that sorghum grain from local cultivars of West Africa was relatively easier to dehull by traditional methods (Murty and House, 1980), than introduced cultivars from USA and India. These reports have prompted the undertaking of controlled evaluations of sorghum samples from diverse origin for their traditional dehulling quality.

2.2 **Dehulling Quality of Sorghum Cultivars**

Fifty-five sorghum cultivars representing different taxonomic groups of the world collection, improved cultivars of recent origin and diverse breeding stocks were included in the dehulling studies. These cultivars exhibited variation for size, shape, weight, breaking strength, presence of testa, endosperm texture and pericarp thickness of the grain. The samples were grown during the rabi seasons of 1978, 1979 and 1980 at the ICRISAT Centre. A standard quantity of 400 g of grain was used for each dehulling quality observation. A stone mortar and a wooden pestle with a steel ring at the end were used as dehulling equipment. Each sample was placed in the mortar and adequate quantity of water was added. A skilled woman pounded the grain samples with the pestle and the number of pounded strokes necessary to satisfactorily dehull the grain were recorded. Three grain samples of each cultivar were dehulled by three different women and the three observations were averaged. The dehulled material was dried at 70°C for half an hour and winnowed to separate the bran. The endosperm was washed and dried again at 70°C until the moisture per cent decreased to 10. The weight of dehulled endosperm and broken

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grain were recorded after sifting the endosperm with a US standard sieve of mesh 1.70 mm. The dehulled endosperm was visually scored for the extent of pericarp removal on a scale 1 to 5.

The physical properties of the grain samples with respect to grain size, grain shape, weight per 100 grains and breaking strength of the grain exhibited a broad range (Table 12.1). Pericarp thickness of the cultivars varied from thin to very thick while the endosperm texture varied from floury to completely corneous. Among the 30 cultivars studied, the number of pounding strokes necessary to dehull 400 g grain varied from 336 to 644 with a mean of 473 (Table 12.1). The extent of pericarp removal ranged from complete to very poor removal. Further pounding of samples which had poor initial pericarp removal resulted in more broken endosperm. The per cent endosperm recovery ranged from 69 to 88 with a mean of 80 (Table 12.1). Per cent brokens ranged from 1 to 30. In general, grains with a highly corneous endosperm produced the least number of brokens and yielded more endosperm while floury endosperm lead to the highest per cent brokens. These results are in agreement with those obtained by Maxon et al., (1971) who, using a Scott barley pearler studied the pearling quality of sorghum grains having different endosperm textural properties. However, grains with a thin pericarp and highly corneous endosperm (Bulk 2, IS 3813) resulted in a relatively poor pericarp removal compared to grains with a very thick pericarp and highly corneous endosperm (IS 5758). Pericarp removal of the turtle beaked caudatum type of grains (E 15-5, SPV 35, Bulk 3, EC 64734) was slower and incomplete. The pericarp around the hylar region of caudatum grain types was particularly difficult to remove.

Another set of 25 cultivars were evaluated from grain samples grown in two consecutive years, 1980 and 1981 for their traditional dehulling quality (Table 12.2). In general, the results confirmed the observations made on the 30 cultivars in 1979. The average endosperm recovery of the 25 cultivars in the year 1980 was 80.2 per cent while in 1981 it was 73.4 per cent. The per cent of brokens were also relatively higher in 1981. Cultivars S 29 and Market 1 (originating from West Africa) with a thick pericarp and highly vitreous endosperm

Table 12.1. Traditional Dehulling Quality of Thirty Sorghum Cultivars—1979

Genotypes	100 grain volume cc	100 grain weight g	Grain shape[a]	Breaking strength kg[b]	Pericarp thickness[c]	Endo-sperm texture[d]	Pounding strokes No.	Pericarp removal[e]	%Endo-sperm recovery	%Brokens (<10 mesh)
1	2	3	4	5	6	7	8	9	10	11
IS 5758	1.87	2.27	3	7.1	5	1	518	1.0	79.0	1.2
Kenya standard	2.48	2.89	3	7.5	5	3	590	4 0	69 5	16.8
IS 5497	2.45	2.94	3	7.2	3	4	414	2.0	80 7	4.3
IS 5452	2.53	2.99	3	7.3	2	4	430	2.3	79.3	10.5
Langi langa	2.02	2.47	1	7.7	2	2	488	2.3	81.4	7.5
Bulk 2	2.18	2.77	1	9.3	2	2	483	2.0	85.7	4.4
SB 411	2.33	2.86	1	8.2	2	3	549	3.3	88.6	3.1
SB 412	2.45	2.90	1	6.7	2	3	542	4.0	68.8	9.0
IS 6414	2.33	2.88	1	7.2	1	3	474	2.0	81.1	20.3
E 15-5	3.13	3.67	5	15.0	3	1	568	2.0	83.0	0.5
SPV 35	2.90	3.37	5	9.0	3	1	487	3.0	81.8	6.6

Contd.

Table 12.1 (*Contd*)

1	2	3	4	5	6	7	8	9	10	11
Bulk 3	2.75	3.38	5	14.6	3	1	499	1.6	84.2	3.0
EC 64734	2.48	3.11	5	8.9	3	2	499	3.0	85.7	6.5
IS 4505	2.88	3.27	3	7.4	2	3	380	3.0	82.7	22.7
IS 5473	3.02	3.63	3	8.2	3	3	470	2.3	79.6	21.6
IS 5108	2.70	3.18	3	7.0	3	4	463	2.0	78.6	1.0
341	3.17	3.69	3	8.7	2	3	541	3.6	85.1	5.3
IS 5879	3.18	3.77	3	7.1	2	3	336	3 0	75.2	18.8
IS 2203	3.48	4.31	3	6.6	2	3	373	3.0	85.6	30.8
Kalgonda	2.83	3.31	3	8.0	1	3	444	3.6	81.3	8 5
IS 2176	3.42	4.09	3	7.9	1	3	484	2.6	82.1	8.0
IS 3813	3.40	4.40	3	8.4	1	3	373	3.0	85.6	1.6
SPV 8	3.22	3.95	1	7.9	2	3	545	3.0	81.8	3.0
BG 12	3.42	4.12	3	7.2	3	3	383	4.0	71.0	15.9
IS 3812	3.53	4.33	3	8.1	2	3	413	2.0	83.7	5.2
IS 4242	3.80	4.51	3	8.7	3	3	407	3.0	82.7	5.0
E 125	4.05	4.83	1	7.4	3	4	475	3.0	78.7	5.4
IS 14897	5.63	6.80	1	10.4	3	3	644	3.0	75.3	9.2
IS 7799	3.95	4.73	1	9.4	2	3	441	2.3	83.2	6.6
IS 7788	3.95	4.78	1	9.4	1	3	492	3.3	81.3	11.5

[a]Grain shape was scored on a 1 to 5 scale where 1=round and 5=flat;
[b]Breaking strength of individual grains was measured with a Kiya hardness tester;
[c]Pericarp thickness was scored on a scale of 1 to 5 where 1=thin and 5=very thick;
[d]Endosperm texture was scored on a scale of 1 to 5 where 1=81 to 100 per cent corneous, 2=61 to 80 per cent corneous, 3=41 to 60 per cent corneous, 4=21 to 40 per cent corneous and 5=0 to 20 per cent corneous;
[e]Pericarp removal was scored on a scale of 1 to 5 where 1=complete removal and 5=very poor removal.

Table 12.2. Traditional Dehulling Quality of 25 Sorghum Cultivars—1980 and 1981

Genotypes	100 Grain volume cc		Grain weight g/100		Breaking[a] strength kg		Shape[b]		Pericarp[c] thickness		Endosperm texture[d]		No. of strokes		Pericarp % removal[e]		Endosperm % recovery		% Brokens (<10 mesh)	
	1980	1981	1980	1981	1980	1981	1980	1981	1980	1981	1980	1981	1980	1981	1980	1981	1980	1981	1980	1981
M 35-1	3.25	3.12	4.08	3.96	7.4	6.9	1	2	1	1	3	3	398	332	1.8	1.7	77.7	81.1	15.30	9.0
CSH 5	2.37	2.10	3.13	2.50	7.5	7.1	2	2	2	2	2	2	513	435	2.3	1.8	85.3	76.9	5.3	18.5
M 50009	2.37	2.21	2.92	2.16	8.0	7.8	2	2	2	2	2	2	501	432	2.3	1.5	87.3	78.9	5.6	13.3
M 50013	2.32	2.08	2.88	2.56	8.9	7.5	2	2	3	2	2	2	505	476	2.0	1.8	86.0	77.6	4.7	15.8
M 35052	2.22	2.26	2.79	2.70	7.1	7.2	2	3	2	3	2	2	496	525	1.8	2.0	83.7	72.8	6.5	27.2
M 50297	2.63	2.35	3.40	2.94	9.8	8.8	3	3	3	3	2	1	446	487	2.5	2.7	81.5	76.8	9.4	15.9
P 721	2.25	2.12	2.46	1.96	6.8	4.6	5	5	5	5	5	5	463	264	4.6	5.0	70.6	52.0	26.1	34.1
CO 4	2.35	2.43	2.99	3.01	6.2	6.1	3	2	3	2	3	3	452	418	2.7	2.2	80.1	73.2	9.8	23.6
P. Jonna	2.83	2.57	3.48	3.16	7.6	6.5	3	3	2	3	4	3	412	448	2.6	2.2	82.0	70.2	9.8	27.8
Mothi	2.68	2.39	3.40	2.93	9.5	9.7	2	2	2	2	2	2	526	565	2.2	1.5	82.2	76.6	6.4	12.1
E 35-1	2.95	2.82	3.69	3.52	14.0	14.0	5	4	3	4	1	1	487	594	2.2	2.2	82.6	76.1	4.1	10.9
IS 158	2.40	2.20	2.89	2.49	6.4	5.9	3	2	5	4	2	3	440	426	2.3	2.5	75.9	81.0	20.2	13.1
WS 1297	3.57	3.14	4.13	3.54	6.2	5.2	2	3	5	4	4	4	377	358	5.0	4.3	85.8	61.4	23.1	35.2
Swarna	3.22	2.90	4.10	3.63	8.6	7.8	2	3	4	2	2	2	345	325	2.7	2.2	79.3	80.9	10.1	8.0
S 29	2.22	1.96	2.78	2.35	8.7	7.8	2	2	5	5	1	1	403	388	1.0	1.0	87.1	82.6	2.6	6.1
S 13	1.93	1.85	2.46	2.29	9.9	9.2	2	2	4	4	1	1	446	492	1.2	1.5	82.3	76.6	7.6	14.3
IS 2317	3.12	3.00	3.70	3.51	9.6	7.0	4	3	5	5	4	4	500	477	4.0	4.0	75.0	67.5	16.4	34.8
IS 7035	2.63	2.16	3.25	2.48	6.6	5.3	3	2	5	4	4	3	437	483	4.5	4.2	77.3	72.4	15.4	24.6
IS 7055	2.75	2.25	3.14	2.49	7.3	5.1	5	3.5	5	5	4	4	476	551	5.0	4.7	68.0	62.0	40.5	50.7
IS 9985	5.40	5.15	6.90	5.98	10.6	8.6	1	2	2	1	3	3	409	389	2.7	3.5	73.7	69.0	12.8	27.5
IS 8743	2.40	2.11	3.02	2.52	7.3	6.3	3	2	4	4	3	3	431	547	3.7	3.2	80.9	71.2	9.0	20.0
Dobbs	2.33	1.90	2.62	2.05	10.5	6.9	5	5	5	5	4	3	537	552	5.0	5.0	67.2	63.4	16.1	21.8
CS 3541	2.28	2.44	2.93	2.86	8.5	7.8	2	2	2	2	2	2	517	588	1.8	2.2	79.9	74.4	10.0	15.6
Segaolane	2.30	2.00	2.78	2.51	7.2	6.5	2	1.5	2	2	3	2	392	416	2.2	2.0	83.7	79.8	6.2	8.8
Market 1	2.33	2.10	2.92	2.53	8.9	7.5	3	2	5	5	1	1	315	453	1.3	1.2	89.6	81.7	1.2	2.8
Mean	2.68	2.46	3.31	2.90	8.36	7.32	2.84	2.6	3.36	3.24	2.64	2.48	448.96	456.96	2.77	2.64	80.18	73.44	11.76	19.6
Sem ±	0.134	0.131	0.173	0.162	0.348	0.370	0.237	0.185	0.253	0.266	0.221	0.212	11.375	16.83	0.241	0.240	1.155	1.480	1.703	2.91
Min.	1.93	1.85	2.46	1.96	6.2	4.6	1.0	1.5	1.0	1.0	1.0	1.0	315	264	1.0	1.0	67.2	52.0	1.2	2.8
Max.	5.40	5.15	6.90	5.98	14.0	14.0	5.0	5.0	5.0	5.0	5.0	5.0	537	594	5.0	5.0	89.6	82.6	40.5	50.7

[a]Breaking strength was measured with a Kiya hardness tester;

[b]Grain shape was scored on a 1 to 5 scale where 1 = round and 5 = flat;

[c]Pericarp thickness was scored on a scale of 1 to 5 where 1 = thin and 5 = very thick;

[d]Endosperm texture was scored on a scale of 1 to 5 where 1 = 81 to 100 per cent corneous, 2 = 16 to 80 per cent corneous, 3 = 41 to 60 per cent corneous, 4 = 21 to 40 per cent corneous and 5 = 0 to 20 per cent corneous;

[e]Pericarp removal was scored on a scale of 1 to 5 where 1 = complete removal and 5 = very poor removal.

•Values averaged over three replications.

yielded the cleanest endosperm and produced the least brokens. However, corneous grains like CSH 5 and S 13 also showed good dehulling quality. Grain with a subcoat (IS 2317, WS 1297 and IS 7035) and grain with a brown pericarp (Dobbs and IS 7055) exhibited very poor dehulling quality. Grain with pigmentation and pink coloured spotting on the pericarp generally yielded endosperm with a similar coloured spotting, although to a lesser extent than brown grains. Pericarp removal of the red and yellow pericarp types from South India (CO 4 and Patche Jonna) was satisfactory. However, their less corneous endosperm contributed to more brokens and consequently poor endosperm recovery. Significant differences were observed between 1980 and 1981 for the number of pounding strokes, per cent endosperm recovery and per cent brokens for thin pericarp types (CSH 5) and soft endosperm types (WS 1297 and P 721). Probably initial poor pericarp removal led the women to continue pounding which made a negative contribution to per cent endosperm recovery and brokens. Highly corneous endosperm types with a very thick pericarp possessed the most desirable traditional dehulling qualities, as evidenced by a complete pericarp removal, less broken endosperm and less manual effort. Thick pericarp is governed by single recessive gene (Ayyangar et al., 1934) and can be visually selected.

3. COOKING QUALITY

In several regions of the Indian semi-arid tropics, sorghum is consumed in the form of boiled rice-like products after removing the pericarp (Subramanian and Jambunathan, 1980). Cooking time, volume and texture of the cooked product are important quality criteria for rice-like products. In order to assess the variability for these cooking quality characters, small grain samples (20 g) from 112 diverse sorghum cultivars (including the 25 from dehulling experiments) were evaluated under controlled laboratory conditions. Whole/pearled grain samples were used for cooking quality evaluation. Grain samples were boiled in excess of water on an electric hot plate. The time taken for satisfactory cooking of the grain (judged by examination of 2 or 3 kernels after cutting them longitudinally with a scalpel) and the final volume and weight of the cooked

product obtained by filtering the cooking water were recorded. The texture of the cooked grain was subjectively scored. Variability observed for cooking quality characteristics of the 112 cultivars is summarised in Table 12.3. Water absorption of

Table 12.3. Variability for Boiled Grain Attributes Among 112 Cultivars of Sorghum[a]

Attribute	Mean	±s.e.	Range	
			Minimum	Maximum
Corneousness	2.73	0.10	1.00	5.00
Grain weight (g/100)	3.31	0.09	0.76	6.80
Water absorption capacity of grain (%)[b]	24.97	0.49	15.71	40.23
Breaking strength (kg)	7.58	0.22	1.80	15.03
Grain density	1.28	0.10	1.00	1.43
Cooking time (min)	81.1	1.02	54.00	114.0
Weight of cooked grain (g)	48.9	0.30	41.5	57.2
Volume of cooked grain (cc)	44.0	0.31	36.0	52.5
Per cent increase in weight	143.5	1.52	107.4	186.2
Per cent increase in volume	182.9	2.71	100.0	273.5
Cooked grain texture[c]	3.2	0.07	1.1	4.7

[a]Whole grain samples were used.
[b]% water absorption of the grain was determined by soaking 100 whole grains in water for 5 hours at room temperature and observing the increase of weight.
[c]Cooked grain texture was rated by pressing individual grains by the thumb and fore finger on a scale of 1 to 5 where 1 = very soft and 5 = hard.

whole grain varied from 15.7 to 40.2 per cent while cooking time varied from 54 to 114 minutes. Increase in the weight and volume of the grains as a result of cooking varied from 107 to 186 per cent and 100 to 273 per cent respectively.

The cooking quality of whole grain and pearled grain samples were studied comparatively for only the 25 cultivars of the dehulling experiments (Table 12.4). As a result of dehulling, the cooking time was reduced by half and the volume and

Table 12.4. **Variability for Some Cooking Quality Attributes of Whole Grain and Dehulled Grain from 25 Sorghum Cultivars**[a]

Attribute	Mean	± s.e.	Range Minimum	Range Maximum
% water absorption of grain	37.95	0.93	30.62	48.52
	(24.704)	(0.99)	(17.4)	(40.23)
Cooking time (min)	45.24	2.167	33.00	79 00
	(86.32)	(1.56)	(71.0)	(111.0)
Weight of cooked grain (g)	74.80	1.24	62.50	88.15
	(50.26)	(0.60)	(44.04)	(52.5)
Volume of cooked grain (cc)	70.18	1.285	57.50	82.00
	(45.92)	(0.60)	(40.0)	(52.5)
Per cent increase in weight	273.60	6.167	212.00	340.00
	(151.2)	(2.82)	(130.5)	(181.5)
Per cent increase in volume	362.40	8.786	283 00	465.50
	(197.0)	(4.94)	(142.5)	(273 5)
Cooked grain texture	2.33	0.11	1.00	3.57
	(2.55)	(0.12)	(1.12)	(3.75)

[a]Values within parentheses indicate observations on whole grain samples and values without parentheses indicate observations on dehulled grains.

weight of the cooked product increased by about 80 per cent. Correlation coefficients (r values) between various grain and cooking quality characteristics (Table 12.5) indicated that grain density was positively correlated with per cent increase in the volume of the cooked product.

Table 12.5. **Correlations between Various Physical and Cooking Quality Parameters of Whole Grain**[a]

Correlations	r values
Corneousness vs % water absorption of grain	−0.529
vs Breaking strength	0.557
vs % Increase in cooked volume	0.543
% Water absorption of grain vs. grain density	−0.521
vs % Increase in cooked volume	−0 379
Breaking strength (kg) vs Grain density	−0.422
vs Cooking time	0.367
vs % Increase in volume	0.389
Grain density vs % Increase in volume	0 662

[a]Based on observations on 112 cultivars. The sign and magnitude of the correlations were in general the same in cooked product from whole grain and pearled grain.

r value at 1 per cent level for 110 d.f.=0.25.

4. *SORU* QUALITY EVALUATION

Soru, a South Indian food, is a boiled rice-like product prepared by using pearled sorghum grain. In order to evaluate the *soru* quality characters of sorghum, taste panel studies were conducted at Bhavanisagar (South India). Pearled grain samples from the 25 cultivar set were used. Samples of 125 g were cooked in approximately 800 to 900 ml of water on an electric stove. The freshly prepared samples of *soru* were evaluated independently for taste, texture and colour by a taste panel of six farm women. Duplicate *soru* samples of each test entry were prepared for the taste panel evaluation. The product was submerged in water and stored overnight, as per the local custom, and the keeping quality was evaluated in the morning.

A white *soru* similar to boiled rice in appearance and texture was preferred by the panelists (Table 12.6). In general, white grains with a corneous endosperm produced an acceptable product. The keeping quality of *soru* from the cultivar CO 4 was

Table 12.6. *Soru* Quality Scores of 25 Sorghum Cultivars[a]

Genotype	Colour	Taste	Texture	Keeping quality
M 35-1	1.7	1.2	1.1	1.6
CSH 5	1.5	1.4	1.6	1.3
M 50009	1.5	1.5	1.8	1.7
M 50013	1.3	1.5	2.0	2.1
M 35052	1.2	1.7	1.5	1.7
M 50297	1.6	1.8	2.0	1.3
P 721	2.6	2.7	2.7	3.0
Co 4	1.9	1.6	1.6	1.1
Patcha Jonna	2.4	2.3	2.4	2.3
Mothi	1.2	1.5	1.7	1.6
1.31	1.3	1.7	1.7	1.8
IS 158	2.0	2.0	3.0	2.7
WS 1297	3.0	2.1	1.8	2.4
Swarna	1.9	1.9	1.9	1.7
S 29	1.1	1.2	1.1	1.2
S 13	1.0	1.0	1.3	1.7
IS 2317	2.6	1.2	1.0	1.2
IS 7035	3.0	2.6	2.8	1.6
IS 7055	3.0	1.8	1.1	2.0
IS 9985	2.0	2.1	2.2	1.3
IS 8743	2.0	2.0	2.0	2.0
Dobbs	3.0	3.0	3.0	3.0
CS 3541	1.1	1.7	1.8	1.9
Segaolane	1.7	1.6	1.6	1.3
Market 1	1.5	2.0	2.0	1.8
Mean	1.9	1.8	1.9	1.8
Sem ±	0.08	0.09	0.10	0.10
Range	1.0-3.0	1.0-3.0	1.0-3.0	1.2-3.0

[a]Mean of two independent observations of six taste panelists from Bhavanisagar.

All characters were rated on a scale of 1-3 (1 = good).

found to be the best. In fact, the texture of *soru* from white grain with testa (IS 2317) was rated better due to its soft and fluffy nature and better keeping quality. Therefore, white grain types with intermediate and soft endosperm might combine good cooking and product quality.

5. CONCLUSIONS

Grain samples of 55 sorghum cultivars were studied for various physical characters and traditional dehulling properties. Kernels with a highly corneous endosperm and a very thick pericarp were easier to dehull by hand pounding than those with a thin pericarp and those with a soft endosperm. Corneous grains yielded more pearled endosperm and less broken grains. The dehulling quality of floury grain and those with a testa was poor. Turtle-beaked or *caudatum* types of grain posed problems in pericarp removal at the hylar region. Round or oval grain with a hard endosperm and a very thick white pericarp would be ideal for traditional dehulling.

Studies on the cooking quality of 112 cultivars of sorghum indicated a broad range for variation for cooking time, cooked grain texture and volume and weight of the cooked product. Cooking time of the dehulled grains was reduced by half while the increase in volume and weight of the cooked product was about 80 per cent. Taste panel studies on the *soru* (boiled rice-like product) quality of 25 sorghum cultivars indicated that kernels with a white thick pericarp and intermediate endosperm texture formed a better combination for traditional dehulling and cooking quality. *Soru* from soft endosperm types exhibited the most desirable texture.

REFERENCES

Ayyangar, G.N.R., C. Vijayaraghavan, and V.P. Rao, 1934, Inheritance of characters in sorghum—the great millet, VI. Pearly and chalky grains, Indian J. Agric. Sci. 4: 96.

Maxon, E.D., W.B. Fryar, L.W. Rooney, and M.N. Krishnaprasad, 1971, Milling properties of sorghum grain with different proportions of corneous to floury endosperm, Cereal Chem. 48: 478-490.

Murty, D.S., and L.R. House, 1980, Sorghum food quality: Its assessment and improvement, Report submitted to the 5th Joint Meeting of the

UNDP-CIMMYT-ICRISAT Policy Advisory Committee, ICRISAT, Hyderabad, India, October 14-18, p. 28.

Pushpamma, P., and S.M. Vogel, 1982, Consumer acceptance of sorghum and sorghum food products, In Proc. of an Int. Symp. on Sorghum Grain Quality, ICRISAT, October 28-31, 1981, ICRISAT Centre, Patancheru 502324, India.

Riechert, R., 1982, Sorghum dry milling. In *Sorghum in the Eighties*, Proc. of an Int. Symp., Nov. 1-7, 1981, ICRISAT Centre, Patancheru 502324, India.

Rooney, L.W., and D.S. Murty, 1982, Evaluation of sorghum food quality, In *Sorghum in the Eighties*, Proc. of an Int. Symp. Nov. 1-7, 1981, ICRISAT Centre, Patancheru 502324, India.

Subramanian, V., and R. Jambunathan, 1980, Traditional methods of processing of sorghum (*Sorghum biocolor L. Moench*) and pearl millet (*Pennisetum americanum*) grains in India, Reports of the International Association of Cereal Chemist. 10: 115-118.

Vogel, S., and M. Graham, 1979, Sorghum and millets—Food production and use, Published by International Development Research Centre, Publication IDRC 123, E Box 8500, Ottawa, Canada, p. 64.

13 Processing and Culinary Properties of Grain Sorghum

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1. INTRODUCTION

Sorghum is one of the most important crops that is used by man as a staple food. However, perhaps because of the stigma attached to it as a "poor" man's food, very little work on processing and grain quality seems to have been done on this grain. However, for some time work has been done on the processing and technological and culinary properties of sorghum at the Central Food Technological Research Institute, Mysore. A short account of the results is presented here.

2. PROCESSING OF SORGHUM

2.1 Primary Processing

Some of the bran from sorghum can be removed after grinding followed by sieving. Conditioning the grain with about 3-5 per cent extra moisture for 5-10 minutes prior to grinding enables the moistened bran to be ground coarse relative to the endosperm and it can therefore be easily removed by sieving (Table 13.1). The endosperm is recovered as coarse semolina, fine semolina and as flour. Varietal differences exist in respect of the yield of semolina and the completeness of bran removed. Softer sorghums can be refined in this way but some of the