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Nutritional Quality of Hybrid Sorghum Genotypes

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Sorghum grains are mostly used for the *roti* preparation. The M 35-1 (*Maldhandi*) a sorghum cultivar is known for its good quality of *roti* due to having pearly white grain colour, its flour having higher water holding capacity, and good organoleptic taste. However, this cultivar is low yielding. To evolve sorghum high yielding hybrid genotype coupled with good *roti* qualities, systematic breeding program was planned and executed to overcome this problem. Fifteen newly developed genotypes of hybrid sorghum along with check DSV 6 were studied for various nutritional quality parameters, with special reference to the *roti* quality. Considering nutritional quality and organoleptic evaluation parameters studied for *roti* quality, none of the newly developed hybrid genotype was found superior than the check DSV 6. However, CSH 16, SHD 36, CSH 15 and SHD 6 were found to be promising for protein, sugar, water absorption, and soluble protein content as well as for *roti* quality parameters. Therefore, they can be used for further improvement in nutritional quality of hybrid sorghum genotypes through breeding program.

Introduction

Sorghum (*Sorghum bicolor* L. Moench) is the king of cereals and is one of the important food crops in dry lands of tropical Africa, India and China (Shobha *et al.*, 2008). India ranks second in the world for sorghum production and first with respect to many regionally important crops like millets and pseudo-cereals. Sorghum is the principal staple food of Maharashtra, and is also an important food of Karnataka, Madhya Pradesh, Tamil Nadu and Andhra Pradesh (Anonymous, 2006a, b). Sorghum can be milled to produce starch or grits (semolina) from which many ethnic and traditional dishes can be made. The most common products are leavened and unleavened breads,

porridges, boiled grains and steam cooked products such as couscous. Sorghum flour also makes an excellent fry coating for fish, chicken and beef. Sorghum is also used in the preparation of several snacks and for popping, chewing, and malting (Rao and Murty, 1981). There is a considerable variation in sorghum for levels of proteins, lysine, lipids, carbohydrates, fiber, calcium, phosphorus, iron, thiamine, and niacin (Chavan *et al.*, 2009). Sorghum has chemical composition similar to or better than rice and wheat in some respects. The grains contain high fiber and non-starchy polysaccharides and starch with some unique characteristics. Protein quality and essential amino acid profile of sorghum is better than many of the cereals.

Sorghum in general is rich source of B-complex vitamins.

Sorghum *roti* is very popular in villages and small towns as an accompaniment to gravy meat and vegetable curries and is one of the traditional recipes of India. It is round, flat, unleavened bread often used in the cuisine of western and central India, especially in the states of Gujarat, Sorghum *roti* is known by various names in the different languages of India: *chapati* (Hindi), *bhakri* (Marathi), *rotla* (Gujarati), *rotte* (Telugu), etc. (Subramanian and Jambunathan, 1981). Because sorghum flour is gluten-free flour, it is very tough to spread the dough without breaking the shape and one really needs hands-on experience and many failed attempts to get the skill. No leavening agents, oil/ghee are added. Just fresh sorghum flour, warm water and touch of fire - pure grain power in its glory. Arabinoxylans have been isolated from different cereals and responsible to play important role in maintaining water balance and rheological properties of dough (Michniewicz *et al.*, 1991; Vietor *et al.*, 1992; Nandini *et al.*, 2001). Typically *bhakri* is accompanied by various curries, chutney (*thecha* – a thick paste of really hot green or red chilies) and raw onion (Murty and Subramanian, 1981; Subramanian and Jambunathan, 1981, 1982). *Bhakri* has its own advantages from dietary point of view. Being made from cereals, it is high in dietary fiber but at the same time very easy to digest. Developing hybrid genotypes with high yield potential coupled with nutritionally superior quality grains is the prime objective of the breeding programme. This paper deals with the details of nutritional quality of hybrid grain sorghum genotypes developed through a systematic breeding programme and compared with the local check.

Materials and Methods

Sorghum grains

Hybrid sorghum grain samples were obtained

from all India Co-ordinated Sorghum Improvement Project, Dharwad, Karnataka, India during *Kharif*-2015 season from advanced varietal and special trials.

Cleaning sorghum grains

The sorghum grains were cleaned to remove all extraneous material.

Milling of sorghum grains

Cleaned sorghum grains were subjected to milling in laboratory grinding mill. Whole sorghum flour was used for nutritional quality parameters testing and preparation of *roti* product.

Nutritional quality of sorghum grain

The sorghum grain flour was then analyzed for crude protein, total sugars, soluble protein, and free amino acids and phenolics contents using standard procedure of AOAC, (1990).

Preparation of sorghum roti

The flour was made from milling grains and fine flour was made in to dough with water. The 100 g sorghum flour was taken for preparation of *roti*. The dough was well kneaded, divided into small balls, flattened on a hard wooden or metal surface sprinkled with a small quantity of flour and was baked on both sides on a hot pan (Shobha *et al.*, 2008). The prepared *rotis* were then kept in bamboo basket covered with cloth piece and stored at room temperature for studying the extension of shelf life.

Sensory evaluation of sorghum roti

The sensory evaluation for different quality parameters like colour and appearance, flavour, texture, taste and overall acceptability was carried out after every 4, 8, 12 and 24 h by semi trained panel of 10 judges on a 9 point hedonic scale (Amerine *et al.*, 1980).

Statistical analysis

All results obtained in the present study were analysed using standard methods of Panse and Sukatme, (1967).

Results and Discussion

Nutritional quality: Fifteen hybrids sorghum genotypes were studied for flour, dough, *roti* and nutritional quality and their results are presented in tables 1 and 2.

Hectoliter weight: The hectoliter weight gives the soundness of the grain as well as higher recovery of the flour. It is a unit weight of the grain in a specific volume. The hectoliter weight of hybrid sorghum genotypes ranged from 71.75 to 77.91 kg/hl. The DSV 6 genotype gave higher hectoliter weight than rest of the hybrid genotypes studied.

Water absorption capacity: The water absorption capacity is positively correlated to the *roti* quality. The higher the water absorption capacity the superior was the quality of the *roti*. The water absorption capacity of flour ranged from 100 to 110%. The hybrid genotype SPH 1737 gave higher water absorption percentage than other genotypes.

Crude protein: The crude protein content ranged from 7.82% (SPH 1724) to 10.70% (CSH 16) in the sorghum genotypes studied (Table 1). Similar results reported by Chavan *et al.*, (2010) and Chavan and Patil (2010).

Soluble protein: The soluble protein content in the flour mostly responsible for the holding more water and developing smoothness to the *roti*. The soluble protein content in the hybrid sorghum flour ranged from 1.03% (SHD 6) to 1.35% (SPH 1737).

All hybrid sorghum genotypes were statistically significant different in their soluble content. Similar reports are available from Glover *et al.*, (1986), Hulse *et al.*, (1980) and Kolpfenstein and Hosney (1995).

Total soluble sugars: The total soluble sugars in the hybrid sorghum genotype ranged from 1.17% (CSH 15) to 1.83% (SPH 1736). All the genotypes studied were significantly different. The higher sugar percentage in sorghum flour representing good amylolytic activity while preparation of *roti*. Total soluble sugars are mostly responsible for good taste of the *roti* (Table 1). Similar results are reported by Chavan and Salunkhe (1984) and Chavan *et al.*, (1989).

Starch: The starch content of the hybrid sorghum genotypes ranged from 52.04% (CSH 23) to 58.61% (CSH 30). Higher starch content gives good colour and amylopectin activity during *roti* preparation.

Free amino acids: The free amino acids in the hybrid sorghum genotypes ranged from 63.86 mg/100g flour (CSH 30) to 81.19 mg/100g flour (DSV 6). The hybrid sorghum genotypes were statistically significantly different in the free amino acid content. This component mostly responsible for aroma development while roasting combines with moisture, soluble proteins and sugars.

Phenolics: The phenolics content in the studied genotypes ranged from 1.38% (CSH 30) to 2.92% (SHD 6).

The phenolics mostly responsible for astringent taste to the product but now-a-days it acts as antioxidants which prevent cancer development in human body (Salunkhe *et al.*, 1984, Awika and Rooney, 2004).

Table.1 Nutritional constituents responsible for roti quality prepared from different genotypes of Kharif hybrid sorghum

Genotype	Colour of the grain	Appearance/ Shape of the grain	Hectoliter weight (Kg/hl)	Water absorption (ml/100g)	Crude Protein (%)	Soluble proteins (%)	Total sugars (%)	Starch (%)	Free amino acids (mg/100g)	Phenolics (%)
SPH 1736	DB	RO	72.39	100	9.67	1.26	1.83	54.87	73.40	1.40
SPH 1748	DB	RO	77.70	100	9.14	1.19	1.37	56.99	75.23	1.62
SPH 1724	DB	RO	76.17	100	7.82	1.22	1.18	53.25	72.26	1.40
CSH 30	DB	RO	76.53	105	8.58	1.06	1.27	54.28	70.16	1.38
SPH 1737	DB	RO	75.19	110	8.66	1.35	1.38	52.56	72.07	2.10
CSH 16	DB	RO	76.11	100	9.32	1.34	1.40	52.50	74.02	1.95
CSH 25	DB	RO	75.15	100	9.80	1.06	1.46	52.20	74.63	2.00
CSH 23	DB	RO	74.62	100	9.36	1.31	1.26	52.04	71.71	2.44
CSH 14	DB	RO	73.39	110	9.25	1.12	1.25	54.47	66.30	2.41
CSH 15	DB	RO	71.75	110	9.10	1.17	1.17	56.67	70.21	2.57
CSH 16	DB	RO	73.59	100	10.70	1.27	1.67	57.27	75.94	2.51
CSH 30	DB	RO	74.35	100	8.75	1.19	1.17	58.61	63.86	2.10
SHD 6	DB	RO	72.90	100	10.48	1.03	1.57	55.26	75.97	2.92
SHD 36	DB	RO	73.41	100	10.36	1.07	1.58	57.16	69.84	2.64
DSV 6	DW	RO	77.91	100	9.70	1.14	1.52	53.73	81.19	1.52
Range	-	-	71.75-77.91	100-110	7.82-10.70	1.03-1.35	1.17-1.83	52.04-58.61	63.86-81.19	1.38-2.92
Mean	-	-	74.74	102	9.38	1.18	1.40	54.79	72.45	2.06
S.E. \pm	-	-	1.81	4.02	0.74	0.10	0.19	2.05	4.05	0.49
C.D. at 5 %	-	-	5.44	12.10	2.25	0.31	0.58	6.16	12.15	1.48

Replications: 3; Grain colour: Creamy = C, Creamy White = CW, Dull White = DW, White = W, Brown = B, and Dull Black = DB.

Grain Shape: Round = R, Oval/Oblong = O and Wrinkle = W.

Table.2 Organoleptic quality of roti prepared from different genotypes of Kharif hybrid sorghum

Genotype	Water required for dough (ml)	Kneading quality	Spreading quality	Organoleptic quality parameters					Rank by DMRT	Loss in weight during storage (%)		
				Colour and appearance	Flavour	Texture	Taste	Overall acceptability		4 hrs	8 hrs	24 hrs
SPH 1736	80	1	1	5.17	4.83	5.33	5.17	5.13	7	2.44	4.30	10.98
SPH 1748	90	1	1	5.00	5.83	5.50	6.33	5.67	5	2.70	4.73	11.08
SPH 1724	90	1	1	5.83	5.50	5.33	5.14	5.45	6	2.75	4.83	10.71
CSH 30	95	1	1	5.17	5.17	5.33	4.83	5.13	7	2.54	4.33	10.45
SPH 1737	80	1	1	4.17	4.83	4.50	4.17	4.42	9	3.15	4.38	10.82
CSH 16	90	1	1	5.17	5.33	4.83	4.67	5.00	8	2.48	4.74	11.91
CSH 25	90	1	1	5.17	4.67	5.33	4.83	5.00	8	2.45	4.63	11.55
CSH 23	90	1	1	4.17	4.83	4.50	4.17	4.42	9	2.56	4.67	10.89
CSH 14	90	1	1	4.83	4.17	4.50	4.17	4.42	9	2.45	4.42	10.86
CSH 15	100	1	1	6.50	6.50	6.50	5.67	6.29	3	2.45	4.32	10.15
CSH 16	90	1	1	6.83	6.33	7.33	6.50	6.75	2	2.76	4.78	11.12
CSH 30	90	1	1	6.17	5.83	5.67	6.33	6.00	4	2.63	4.76	10.31
SHD 6	95	1	1	6.50	5.67	6.50	6.50	6.29	3	2.66	4.53	9.98
SHD 36	90	1	1	6.83	6.50	7.33	6.33	6.75	2	2.55	4.38	10.82
DSV 6	90	1	1	7.33	6.67	7.00	6.83	6.96	1	2.78	4.74	10.91
Range	80-100	-	-	4.17-7.33	4.17-6.67	4.50-7.33	4.17-6.83	4.42-6.96	-	2.44-3.15	4.30-4.83	9.98-11.91
Mean	90	-	-	5.66	5.51	5.70	5.44	5.58	-	2.62	4.57	10.84
S.E. \pm	4.83	-	-	0.95	0.74	0.96	0.92	0.85	-	0.18	0.18	0.48
C.D. at 5 %	14.49	-	-	2.87	2.22	2.89	2.79	2.57	-	0.55	0.57	1.44

Kneading quality of dough, score: Good = 1, Fair = 2, Poor = 3. **Spreading quality of roti, score:** Easy spreading without crack = 1, Slightly difficult to spread with minute cracks = 2, Difficult to spread with cracks = 3.

Sensory score: Like extremely (Excellent) - 9, Like very much (Very good) - 8, Like moderately - 7, Like slightly-6, Neither like nor dislike - 5, Dislikes lightly - 4, Dislike moderately - 3, Dislike very much - 2, Dislike extremely-1.

Roti quality

After sorghum grain yield, the organoleptic quality of sorghum *roti* is very important for consumer point of view. Therefore, hybrid genotypes of sorghum grown at Dharwad AICRP project during *kharif*-2015 season were used for the *roti* preparation and organoleptic evaluation (colour and appearance, texture, flavour/aroma, taste and overall acceptability using 1 to 9 hedonic scale rating). On the basis of these parameters and overall acceptability Duncan Multiple Range Test was used to give the numbering for ranking the genotypes. For smoothness of the *roti* storage study was also conducted and water loss was measured at 4, 8 and 24hrs.

Considering nutritional quality and organoleptic evaluation parameters studied for *roti* quality, none of the newly developed hybrid genotype was found superior than the check DSV 6. However, CSH 16, SHD 36, CSH 15 and SHD 6 were found to be promising for protein, sugar, water absorption, and soluble protein content as well as for *roti* quality parameters (Table 2).

Similar results were reported by Bankar *et al.*, (1986), Chavan *et al.*, (1988, 2009, 2015).

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