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## Evaluation of initial advance hybrid sorghum genotypes for *roti* and nutritional quality

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### Abstract

In India sorghum is traditionally consumed in the form of unleavened pan cake/Roti/Bhakari. Because of sorghum is a staple food in many parts of the country. Though sorghum grains are nutritious, the consumption of this cereal is decreasing due to non-availability of easy cooking raw materials from the sorghum. The other major reasons are; dying traditional food habits, requirement of special skill for preparing sorghum *rotis*. For many years sorghum eating population particularly in *rabi* growing areas, the *roti* made from Maldandi (M 35-1) is preferred for taste and softness, over other genotypes. But now days some new genotypes of *rabi* sorghum are developed which gives better nutritional as well as organoleptic quality of the *roti* than the M 35-1. A study was done on the flour, *dough*, *roti* and nutritional quality of initial advance hybrid trials during *Rabi*-2017-18 at Rahuri and Dharwad research centers to identify superior genotypes.

Considering the flour, *dough*, *roti* and nutritional quality parameters among the new sorghum genotypes from initial advance varietal trials from Rahuri center SPH 1863, SPH 1898 and CSH 15R and from Dharwad center SPH 1896, SPH 1863 and SPH 1898 were found promising for flour, *dough*, *roti* as well as nutritional quality. Therefore, these genotypes should be considered for further research programme and development of new sorghum genotypes.

**Keywords:** *Roti*, sorghum, *Bhakri*, nutritional and organoleptic properties, initial advance hybrid trials

### 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) [23]. 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. 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) [22]. 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) [11]. 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 (Chavan *et al.*, 1988; 2010; 2015, 2017a-d) [14, 13, 4, 12, 10].

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) [18]. 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

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properties of dough (Michniewicz *et al.*, 1991; Vietor *et al.*, 1992; Nandini *et al.*, 2001) [17, 26, 19]. 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) [18]. *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 (Chavan *et al.*, 1989, 2010; Nirmal *et al.*, 2017 and Chavan and Salunkhe, 1984) [6, 7, 20, 5]. However it was necessary to study the effect different locations on the nutritional and roti quality therefore, present study was under taken to identify superior genotype for future development.

## Material and Methods

### Material: Sorghum grains

Sorghum grains were obtained from two locations Rahuri and Dharwad for nutritional and *roti* quality testing. These sorghum grain samples were collected during *Rabi*-2017-18 season.

### Methods: 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 using 60 mesh sieve. 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 A.O.A.C., (1990) [2].

### Preparation of sorghum roti

The flour was made from milling grains, sieved 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) [23]. The prepared *rotis* were then kept in bamboo basket 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) [1].

### Statistical analysis

All results obtained in the present study were analysed using standard methods of Panse and Sukatme, (1967) [21].

## Results and discussion

### a. Nutritional quality

**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 ranged from 73.93 to 77.82 kg/hl for Rahuri center and 76.64 to 80.32 for Dharwad center trials respectively. The Rabi

Rahuri center entry CSH 15R gave higher hectoliter weight than rest of the genotypes studied and from Dharwad center CSH 15R also gave highest hectoliter weight than other genotypes (Tables 1 and 3).

**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 65 to 82% for Rahuri center and 72 to 85% for Dharwad center trials. The genotype CSV 29R from Rahuri and SPH 1897 from Dharwad center gave higher water absorption percentage than other genotypes.

**Crude protein:** The crude protein content ranged from 8.35% (CSV 22) to 10.68% (SPH 1863) at Rahuri center in the initial advanced hybrid genotypes studied with their checks. From Dharwad center the protein content ranged from 8.20% (CSV 29R) to 10.56% (SPH 1898) (Tables 1 and 3).

**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 flour ranged from 0.77% [CSV 29R] to 1.55% [SPH 1896] at Rahuri center trials. At Dharwad center soluble protein ranged from 1.26 (SPH 1898) to 1.84% (SPH 1896). All the genotypes were significantly different in their soluble content (Tables 1 and 3).

**Total soluble sugars:** From Rahuri center trials the total soluble sugars ranged from 1.47% (SPH 1897) to 2.10% (M 35-1). From Dharwad center the total soluble sugar content ranged from 1.38% (CSV 29R) to 2.09% (Phule Vasudha). 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* (Tables 1 and 3).

**Starch:** The starch content of the initial advanced hybrid trials from Rahuri center ranged from 49.17% (CSH 13) to 61.54% (SPH 1864). From Dharwad center the starch content ranged from 47.03% (SPH 1898) to 60.47% (SPH 1864). Higher starch content gives good colour and amylopectin activity during *roti* preparation.

**Free amino acids:** The free amino acids in the initial advanced hybrid trials studied genotypes from Rahuri center ranged from 62.85 mg/100g flour (SPH 1896) to 81.92 mg/100g flour (Phule Vasudha). From Dharwad center trials free amino acids ranged from 69.61 mg/100g flour (SPH 1896) to 87.18 mg/100g flour (SPH 1863). The advanced sorghum genotypes were 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 initial advanced hybrid trials studied genotypes from Rahuri center ranged from 1.52% (CSV 29R) to 2.58% (SPH 1898). From Dharwad center trials phenolics content ranged from 1.44% (SPH 1897) to 2.59% (SPH 1896). The phenolics mostly responsible for astringent taste to the product but nowadays it acts as antioxidants which prevent cancer development in human body.

**b: Roti quality**

All grain samples of initial advanced hybrid trials of *Rabi-2017-18* season grown at Rahuri center and Dharwad centers were used for the *roti* preparation and then used for organoleptic evaluation (colour and appearance, texture, flavour/aroma, taste and overall acceptability using 1 to 9 hedonic scale rating (Tables 2 and 4). On the basis of these parameters and overall acceptability Duncan Multiple Range Taste 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 (Table 2 and 4).

**Conclusions**

During *Rabi-2017-18* total 12 sorghum initial advanced hybrid genotypes grown at Rahuri and Dharwad center were evaluated for flour, dough, *roti* and nutritional quality parameters using above parameters. On the basis of these characters among the new sorghum genotypes from Rahuri center SPH 1863, SPH 1898 and CSH 15R and from Dharwad center SPH 1896, SPH 1863 and SPH 1898 were found promising for flour, dough, *roti* and nutritional quality (Tables 1 to 4). Therefore, these genotypes should be considered for further research programme and development of new sorghum genotypes.

**Table 1:** Nutritional constituents responsible for *roti* quality prepared from different *Rabi-2017-2018* (IAHT) cultivars of sorghum (Rahuri Center)

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 (%)
CSH 15R	CW	O	77.82	80	10.24	1.00	1.89	50.30	77.95	2.27
SPH 1897	CW	O	75.94	65	8.46	1.11	1.47	55.73	71.35	1.58
SPH 1899	CW	O	75.43	65	9.09	1.18	1.64	54.49	68.11	1.65
SPH 1896	CW	O	75.30	68	8.41	1.55	1.48	58.00	62.85	2.04
M 35-1	CW	O	73.93	75	8.91	1.39	2.10	59.33	67.83	1.75
CSV 22	CW	O	76.76	70	8.35	1.02	1.55	54.32	71.01	1.84
SPH 1863	CW	O	77.78	72	10.68	1.01	1.90	50.80	77.36	2.26
SPH 1898	CW	O	76.28	68	10.53	1.28	2.00	54.31	66.44	2.58
CSV 29R	CW	O	76.84	82	8.38	0.77	1.50	52.23	81.53	1.52
CSH 13	CW	O	76.31	74	10.49	1.04	1.60	49.17	68.59	1.94
SPH 1864	CW-	O	76.73	74	9.35	1.40	2.00	61.54	67.30	2.10
Phule Vasudha	CW	O	77.55	70	9.39	0.88	1.62	55.30	81.92	1.59
Range	-	-	73.93-77.82	65-82	8.35-10.68	0.77-1.55	1.47-2.10	49.17-61.54	62.85-81.92	1.52-2.58
Mean	-	-	76.39	71.92	9.36	1.14	1.73	54.63	71.85	1.93
S.E. ±	-	-	1.08	5.15	0.87	0.22	0.22	3.55	6.02	0.31
C.D. at 5 %	-	-	3.26	15.47	2.62	0.66	0.67	10.68	18.07	0.95

Replications: 3; - = No sufficient seed.

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 hybrid/varieties of *Rabi-2016-2017* (IAHT) cultivars of sorghum (Rahuri Center).

Genotype	Water required for dough (ml)	Kneading quality	Spreading quality	Organoleptic quality parameters					Rank by DMRT	Loss in weight during storage (%)		
				Colour & appearance	Texture	Flavour	Taste	Overall acceptability		4 hrs	8 hrs	24 hrs
CSH 15R	60	1	1	7.83	6.50	7.33	7.17	7.21	3	2.21	4.81	13.24
SPH 1897	70	1	1	6.17	6.33	6.67	6.33	6.38	10	2.62	4.42	12.60
SPH 1899	65	1	1	6.83	6.67	6.50	6.33	6.58	7	2.36	4.15	12.65
SPH 1896	80	1	1	6.17	6.33	6.67	6.33	6.38	10	2.21	4.15	12.15
M 35-1	80	1	1	6.67	6.67	6.33	6.50	6.54	8	2.32	4.10	12.23
CSV 22	70	1	1	6.17	6.33	6.83	6.67	6.50	9	2.95	4.78	12.33
SPH 1863	70	1	1	7.17	7.17	7.50	7.83	7.42	1	2.83	4.42	12.65
SPH 1898	60	1	1	7.00	7.33	7.33	7.83	7.37	2	2.18	6.73	12.57
CSV 29R	65	1	1	6.17	6.67	5.67	6.67	6.30	11	2.23	4.83	12.42
CSH 13	65	1	1	7.33	6.67	6.83	7.00	6.96	4	4.15	6.38	10.82
SPH 1864	70	1	1	6.83	6.50	6.33	7.33	6.75	5	2.78	6.74	11.91
Phule Vasudha	70	1	1	6.83	6.50	6.67	6.83	6.71	6	2.43	4.62	11.55
Range	60-80	-	-	6.17-7.83	6.33-7.33	5.67-7.50	6.33-7.83	6.30-7.42	-	2.18-4.15	4.10-6.74	11.55-13.24
Mean	69.17	-	-	6.76	6.64	6.72	6.90	6.76	-	2.61	5.01	12.26
S.E. ±	6.06	-	-	0.51	0.30	0.49	0.52	0.37	-	0.53	0.96	0.59
C.D. at 5 %	18.20	-	-	1.53	0.91	1.46	1.56	1.13	-	1.60	2.89	1.78

Replications: 5 minimum; - = No sufficient seed.

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.

**Table 3:** Nutritional constituents responsible for *roti* quality prepared from different *Rabi*-2017-2018(IAHT) cultivars of sorghum (Dharwad Center)

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 (%)
CSH 15R	CW	O	80.32	82	9.12	1.31	1.88	47.98	73.20	1.76
SPH 1897	CW	O	79.40	85	8.49	1.41	1.68	52.33	70.91	1.44
SPH 1899	CW	O	78.43	72	9.60	1.27	1.80	51.48	70.62	1.61
SPH 1896	CW	O	78.65	80	10.43	1.84	2.00	51.00	69.61	2.59
M 35-1	CW	O	78.42	84	9.06	1.64	1.85	55.67	69.67	1.98
CSV 22	CW	O	76.64	75	8.21	1.54	1.57	57.29	73.63	1.78
SPH 1863	CW	O	78.90	80	10.34	1.28	2.08	49.10	87.18	2.19
SPH 1898	CW	O	79.57	82	10.56	1.26	1.90	47.03	76.46	2.55
CSV 29R	CW	O	77.06	84	8.20	1.27	1.38	52.21	73.60	1.68
CSH 13	CW	O	78.64	80	9.70	1.37	1.92	51.09	69.73	1.64
SPH 1864	CW-	O	77.73	80	8.27	1.71	2.06	60.47	75.38	2.15
Phule Vasudha	CW	O	77.29	74	9.82	1.80	2.09	54.28	77.63	2.46
Range	-	-	76.64-80.32	72-85	8.20-10.56	1.26-1.84	1.38-2.09	47.03-60.47	69.61-87.18	1.44-2.59
Mean	-	-	78.42	79.83	9.32	1.48	1.85	52.49	73.97	1.99
S.E. $\pm$	-	-	1.04	4.33	0.84	0.21	0.20	3.79	4.76	0.37
C.D. at 5 %	-	-	3.12	12.99	2.55	0.63	0.62	11.19	14.31	1.14

Replications: 3; - = No sufficient seed.

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 4:** Organoleptic quality of *roti* prepared from different hybrid/varieties of *Rabi*-2017-2018 (IAHT) cultivars of sorghum (Dharwad Center).

Genotype	Water required for dough (ml)	Kneading quality	Spreading quality	Organoleptic quality parameters					Rank by DMRT	Loss in weight during storage (%)		
				Colour & appearance	Texture	Flavour	Taste	Overall acceptability		4 hrs	8 hrs	24 hrs
CSH 15R	75	1	1	7.40	7.60	7.80	7.60	7.60	7	2.95	4.78	10.33
SPH 1897	75	1	1	7.20	6.80	7.00	7.20	7.05	9	2.83	4.42	12.65
SPH 1899	70	1	1	8.80	7.20	7.80	7.60	7.85	6	2.18	4.73	11.57
SPH 1896	70	1	1	8.20	8.40	8.60	8.00	8.30	2	2.98	4.67	10.23
M 35-1	80	1	1	7.60	7.00	7.40	6.80	7.20	8	2.23	4.18	12.15
CSV 22	70	1	1	5.60	7.00	7.00	7.20	6.70	11	2.34	4.32	10.43
SPH 1863	75	1	1	8.40	7.80	8.20	8.00	8.10	3	2.13	4.33	10.54
SPH 1898	80	1	1	8.40	8.20	8.60	8.40	8.40	1	2.35	4.23	10.78
CSV 29R	80	1	1	5.60	6.50	7.00	7.20	6.65	12	2.38	4.10	10.35
CSH 13	70	1	1	8.40	7.60	8.20	8.00	8.00	5	2.62	4.42	10.60
SPH 1864	75	1	1	6.40	6.60	7.00	7.60	6.90	10	2.36	4.15	10.65
Phule Vasudha	70	1	1	8.40	7.60	8.20	8.00	8.05	4	2.21	4.15	11.15
Range	70-80	-	-	5.60-8.80	6.50-8.40	7.00-8.60	6.80-8.40	6.65-8.40	-	2.13-2.98	4.10-4.78	10.23-12.65
Mean	74.17	-	-	7.53	7.36	7.73	7.63	7.57	-	2.46	4.37	10.95
S.E. $\pm$	3.99	-	-	1.07	0.58	0.60	0.44	0.60	-	0.29	0.22	0.74
C.D. at 5 %	11.99	-	-	3.23	1.75	1.82	1.34	1.83	-	0.87	0.68	2.24

Replications: 5 minimum; - = No sufficient seed.

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.

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