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Popping and flaking characteristics of sorghum varieties and their inter correlations analysis

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ABSTRACT

A total number of 39 genotypes were evaluated for popping characters and 53 genotypes were evaluated for flaking traits which are released varieties, Hybrids and improved cultures. Observations on 500 grain weight, grain volume, density of the grains volume of the grain after imbibitions, diameter of the grains, 500 popped grain weight, number of unpopped grains, diameter of the popped grains, density of popped grains and volume of the flour per kilogram of grain were recorded for popping qualities and observations on 500 grain weight, grain volume, density of the grains diameter of the grain, 500 flaked grain weight, diameter of the flaked grain, volume of 500 flaked grains and density of the flaked grains were recorded for flaking traits. Based on the mean performance the entries TKSV 0802, TKSV 0808 and TKSV 0809 are promising for popping characters and TKSV 0801, TKSV 0804, TKSV 0809, TKSV 0816, TNS 607, TNS 618, Co (S) 28, K 4 TWC 100 and TWC 120 are promising for flaking traits. A strong positive correlation were noticed for all the popping traits with volume of flour for ½ kilogram of grains except 500 popped grain weight for which a non significant positive correlation were noticed. A significant positive correlation were noticed with density of the flaked grains and grain volume, density of grains, diameter of grains and volume of 500 flaked grains. The above results enable to screen and identify sorghum genotypes suitable for popping and flaking types from a large number of genotype cultivated in the country.

Key words: Jowar, physical quality, physiological, popping, flaking, inter correlations

Sorghum (*Sorghum bicolour* (L) Moench is the third most important cereal of India after rice and wheat. It provides food to millions, in habiting the semi-arid tropics of the world. Jowar is nutritionally superior to rice and comparable in many respects with wheat. It provides cheap staple food and is comparatively more nutrition's in terms of proteins, fat, carbohydrates, mineral etc., to millions of poor people, cattle and poultry (Rooney and Murthy 1981). Lysine is the first limiting amino acid as in rice and wheat but lysine is fairly adequate in jowar (House 1960). Chapati or roti prepared from a blend of sorghum – greengram and bengalgram can be dried and powdered to form an acceptable base for a weaning food. Popped sorghum and flakes had been well utilized for popcorn and mostly used during festival times.

Different varieties of jowar are available for popping and flaking purposes. However, varieties have not been differentiated for their specific applications. Therefore, it is necessary to identify a particular variety for a particular application for maximum utilization.The aim of the present study was to identify a particular variety for specific use such as popping and flaking by evaluating their physical, physiological popping and flaking characteristics. In this context, the nutritional value flavour, colour and texture of the popped and flaked produced are important to determine its acceptance and suitable as human niche foods.

The present study aimed to analyze inter correlations in sorghum varieties for the popping and flaking characters.

MATERIALS AND METHODS

During rabi 2010-11, thirty nine genotypes (34 varieties and 5 hybrids) namely TKSV 0801 to TKSV 0825, TKSV 0829, K 4, K 5, K 8, K-Tall, TWC 100, TWC 120, CSH 9, APK 1, CSH 14,

CSH 18 and CSH 23, CSV 17 and PSRV 1 were used as the experimental materials for popping characteristics the grains of the above genotypes were taken and observations on 500 grain weight (g), grain volume (cc), density of the grains (g/cc), volume of grains after imbibitions (cc), diameter of the grain (mm) 500 popped grain weight (g), number of popped grains (g), diameter of the popped grain (mm), density of popped grain (g/cc) and volume of the flour per ½ kg of grain (lt.) were recorded on each genotype with average of three replications. The methodologies followed for all characters were as per Khairwal et al (1997) in bajra. Data were subjected to analysis of variance, correlation co efficient (Johnson et al 1995) and regression analysis (Singh and Chaudhary 1977)

RESULTS AND DISCUSSION

Mean squares due to genotypes were significant for all characters except for the trait swelling index indicating that variations existed among the materials for the parameters studied and the data could be processed further. Based on mean performance (Table 1), the sorghum varieties, TKSV 0805 (16.15 g) TKSV 0808 (14.42 g) TKSV 0809 (15.22 g), TWC 100 (16.17 g) and TWC 120 (15.88 g) have recorded significantly higher 500 grain weight than the General Mean.

The sorghum cultures viz., TKSV 0804 (8.62 cc), TKSV 0829 (8.91 cc), K 8 (8.71 cc) and TWC 100 (8.90 cc) showed similar trend than General Mean in the volume of grain. In the traits 500 popped grain weight, the jowar cultures viz., TKSV 0805 (12.62 g), TKSV 0808 (13.22 g), TKSV 0809 (13.55g), TKSV 0822 (14.42g), K 4 (14.52g), K 8 (12.88g) TWC 100 (14.75g) and TWC 120 (13.78g) showed higher weight General Mean. Under the trait, no. of unpopped grains, the entries viz., TKSV 0808 (6.2 nos), TKSV 0809 (8.4 no.) and TKSV 0825 (8.02 no.) are the lowest unpopped grain numbers than the General Mean. These above traits are the desirable traits for popping characteristics in sorghum. Among the traits studied, volume of flour per ½ kilogram of grain is one of the important characters. People in general prefer higher out turn of flour from a genotype. Among genotypes studied, K 4 (0.730l) recorded highest volume of flour per ½ kilogram of grain followed by TKSV 0805 (0.710l) and TKSV 0809 (0.680l).

Fifty three genotypes were analysis for flaking characteristics during 2011 – 12. The mean squares due to genotypes were significant for all characters. Based on mean performance (Table 2), the jowar varieties, TKSV 0805 (15.52g), TKSV 0809 (14.42g), TKSV 0822 (14.44g), Co(s) 28 (14.22g), Co 30 (13.88g), K 4 (14.32g), K 8 (14.34g), TWC 100 (14.34g) and TWC 120 (15.18g) registered significantly higher 500 grain weight than the general mean. The jowar cultures viz., TKSV 0805 (8.44 cc), TKSV 0808 (8.75 cc), TKSV 0809 (9.25 cc), TKSV 0810 (8.82 cc), TKSV 0816 (9.22 cc), TKSV 0816 (9.27 cc), TKSV 0824 (8.67 cc), TNS – 607 (9.89 cc), TNS – 618 (8.71 cc), K 4 (9.05 cc) and TWC 100 (8.42cc) showed higher grain volume than general mean.

In the 500 flaked grain weight, the entries viz., TKSV 0804 (16.22g), TKSV 0805 (18.12g), TKSV 0808 (15.26g), TKSV 0809 (17.22g), TKSV 0822 (16.69g), TNS – 608 (15.32g), Co(s) 28 (17.16g), IS 2663 (10.23g),TNS – 618 (16.44g), TNS 623 (15.16g), K 4 (17.62g), K 8 (15.50g), TWC 100 (16.72g) and TWC 120 (17.33g) were recorded higher weight than the general mean. In the volume of 500 flaked grains, the entries viz., TKSV 0804 (37.75cc), TKSV (39.22cc), TKSV 0808 (37.77CC), TKSV 0809 (38.82cc), TKSV 0810 (33.32cc), TKSV 0812 (36.35cc), TKSV 0818 (35.52cc), TKSV 0822 (36.21cc), TKSV 0829 (37.68cc), TNS 608 (37.66cc) TNS 482 (34.32cc), TNS 486 (36.22cc), TNS 495 (37.50cc), TNS 599 (32.62cc), C43-81 (33.32cc), Co(S)28 (39.24cc), IS 1255 (34.23cc), TNS 623 (37.76cc), Co 30 (37.76cc). K 4 (38.22cc), K 8 (37.34cc), TWC 120 (38.12cc) were recorded higher volume for 500 flaked grains. From among the traits for both popping and flaking, the entries are suitable for popping and flaking purposes viz., TKSV 0809, K 4 and TWC 100.

Table 1. Mean performance of Advance sorghum genotypes for physical physiological and popping characteristics

Sl. No.	Entries	500grain weight (g)	Grain volume ( )	Density the grains ( )	Volume of grains after imbibitions	Diameter of the grain ( )	500 popped grain weight (g)	Number of Unpopped	Diameter of the popped ( )	Density of the popped ( )	Volume of flour per ½ kilo gram
1.	TKSV 0801	12.44	7.43	1.67	8.89	2.91	8.50	28.2	5.65	1.14	0.620*
2.	TKSV 0802	11.2	6.78	1.65	7.52	2.52	7.62	16.4*	4.92	1.12	0.380
3.	TKSV 0803	13.2	7.72	1.71	8.92	2.06	9.22	22.5	4.82	1.19	0.410
4.	TKSV 0804	14.02	8.62*	1.63	9.92*	2.78	10.17	18.3*	5.25	1.17	0.610*
5.	TKSV 0805	16.15*	7.22	2.24*	9.44	3.14*	12.62	24.2	6.32	1.75*	0.710*
6.	TKSV 0806	12.55	5.62	2.20*	7.66	2.66	11.21	20.4*	5.16	2.01*	0.520*
7.	TKSV 0807	11.21	5.35	2.09*	6.58	2.12	9.02	41.6	4.80	1.72*	0.380
8.	TKSV 0808	14.42*	8.22*	1.75	10.11*	3.06	13.22*	6.2*	6.22*	1.61	0.660*
9.	TKSV 0809	15.22*	8.85	1.72	11.52*	3.26*	13.55*	8.4*	6.42*	1.53	0.680*
10.	TKSV 0810	12.24	7.72	1.58	8.55	2.38	10.56	33.1	4.41	1.36	0.480
11.	TKSV 0811	11.32	6.95	1.62	7.56	2.41	9.92	38.4	3.82	1.43	0.330
12.	TKSV 0812	11.22	7.32	1.80	8.35	2.75	11.56	27.7	3.62	1.58	0.540*
13.	TKSV 0813	10.23	6.30	1.62	7.56	2.55	8.22	35.8	4.21	1.30	0.320
14.	TKSV 0814	9.88	7.11	1.38	8.12	1.16	7.88	37.5	3.02	1.10	0.280
15.	TKSV 0815	9.15	5.02	1.30	9.14	1.22	6.52	44.2	2.66	1.29	0.310
16.	TKSV 0816	10.31	8.19*	1.27	10.25*	3.02	9.12	28.4	5.88	1.12	0.420
17.	TKSV 0817	9.33	7.35	1.20	8.86	1.88	7.88	34.5	3.02	1.07	0.380
18.	TKSV 0818	13.92	8.12	1.71	9.57	3.07	10.55	30.3	6.36	1.29	0.525*
19.	TKSV 0819	10.21	6.22	1.64	7.57	2.21	8.26	32.2	4.27	1.32	0.520*
20.	TKSV 0820	8.35	5.92	1.41	6.32	1.34	7.12	37.4	3.03	1.20	0.410
21.	TKSV 0821	7.65	4.52	1.69	5.85	1.18	6.22	40.2	2.76	1.37	0.350
22.	TKSV 0822	17.22	8.56	2.08	9.92	2.62	14.42	11.3	5.42	1.74	0.722
23.	TKSV 0823	11.32	7.66	1.47	8.33	2.67	10.06	17.2	6.21	1.31	0.540
24.	TKSV 0824	12.21	7.50	1.61	9.06	2.71	10.25	19.1	4.42	1.35	0.570
25.	TKSV 0825	8.82	4.92	1.79	6.28	1.92	8.02	28.2	3.55	1.63	0.440
26.	TKSV 0829	14.22	8.91	1.59	10.32	2.65	12.26	18.3	4.22	1.37	0.610
27.	K 4	16.21	8.05	2.01	12.11	3.40	14.52	9.4	5.21	1.80	0.730
28.	K 5	12.32	5.70	2.16	8.30	2.32	10.82	3.4	6.22	1.90	0.520
29.	K 8	14.25	8.71	1.63	10.62	3.34	12.88	6.5	5.05	1.48	0.620
30.	K Tall	11.30	5.30	2.13	7.22	2.07	9.22	4.2	6.41	1.73	0.405
31.	TWC 100	16.17	8.90	1.81	9.82	1.95	14.75	8.4	5.82	1.60	0.630
32.	TWC 120	15.88	7.55	2.10	8.88	3.44	1378	16.3	6.24	1.82	0.620
33.	CSH 9	13.25	6.22	2.13	7.55	1.92	10.21	12.2	4.82	1.64	0.450
34.	APK – 1	11.21	5.31	2.11	6.63	1.82	9.85	15.1	4.66	1.85	0.470

35.	CSH 14	13.21	6.21	2.12	7.52	2.06	12.05	9.2	6.27	1.94	0.480
36.	CSH 18	12.5	6.31	1.98	8.46	2.17	11.20	10.4	5.82	1.77	0.410
37.	CSH 23	11.75	7.71	1.52	9.11	2.26	8.85	14.5	5.77	1.14	0.430
38.	CSV 17	13.36	6.22	2.15	8.34	1.92	10.75	20.6	4.82	1.72	0.510
39.	PSRV 1	14.12	5.62	2.51	8.12	2.27	12.21	4.2	5.05	2.17	0.610
	Mean	**12.45**	**6.96**	**1.79**	**8.59**	**2.39**	**10.39**	**21.05**	**4.94**	**1.50**	**0.50**
	CD	**1.88**	**1.23**	**0.24**	**1.01**	**0.68**	**2.06**	**0.51**	**0.61**	**0.22**	**0.11**

Table 2. Mean performance of Advance sorghum genotypes for physical physiological and flaking characteristics

S. No	Entries	500 grain Weight (g)	Grain Volume (cc)	Density of the grains (g/cc)	Diameter of the grain (mm)	500 flaked grain weight (g)	Diameter of the flaked grain (mm)	Volume of 500 flaked grains (cc)	Density of the flaked grain (g/cc)	Colour of the grain Before flaking	after Flaking
1.	TKSV 0801	11.44	7.24	1.58	2.82	13.23	4.82	24.82	0.53	Pearly white	White
2.	TKSV 0802	10.23	6.52	1.56	2.34	12.21	3.42	23.12	0.52	Pearly white	White
3.	TKSV 0803	12.20	7.53	1.62	1.98	14.42	2.82	25.12	0.57	Pearly white	White
4.	TKSV 0804	13.12	8.22	1.59	2.72	16.22	5.67	37.75	0.42	Pearl white	White
5.	TKSV 0805	15.52	8.44	1.83	3.12	18.12	6.26	39.22	0.46	Pearl white	White
6.	TKSV 0806	11.52	6.66	1.72	2.56	12.32	3.32	13.32	0.92	Pearl white	White
7.	TKSV 0807	10.21	6.75	1.51	2.06	14.41	2.75	16.67	0.86	Pearl white	White
8.	TKSV 0808	13.26	8.75	1.51	3.02	15.26	6.22	37.77	0.40	Pearl white	White
9.	TKSV 0809	14.42	9.25	1.55	3.12	17.22	6.14	38.82	0.44	Pearl white	White
10	TKSV 0810	11.08	8.82	1.25	2.34	12.12	2.78	33.32	0.36	Pearl white	Dull white
11	TKSV 0811	10.24	7.76	1.31	2.62	11.34	2.82	24.42	0.46	Pearl white	Dull white
12	TKSV 0812	12.24	7.88	1.55	2.72	13.32	2.92	36.35	0.36	Pearl white	Dull white
13	TKSV 0813	9.22	5.33	1.72	2.32	11.21	5.05	23.22	0.48	Pearl white	Dull white
14	TKSV 0814	7.56	7.33	1.03	1.12	9.88	2.35	20.55	0.48	Pearl white	Dull white
15	TKSV 0815	8.13	5.66	1.43	1.26	10.26	2.66	22.26	0.46	Pearl white	Dull white
16	TKSV 0816	9.22	9.22	1.00	3.15	10.73	4.28	21.62	0.49	Pearl white	Dull white
17	TKSV 0817	8.52	9.27	0.91	1.76	9.32	2.17	23.22	0.40	Pearl white	Dull white
18	TKSV 0818	11.52	8.33	1.38	3.12	13.27	4.82	35.52	0.37	Pearl white	Dull white
19	TKSV 0820	9.34	6.55	1.42	2.21	11.21	3.32	22.66	0.49	Pearl white	Dull white
20	TKSV 0821	7.50	5.56	1.34	1.32	8.82	2.95	20.71	0.25	Pearl white	Dull white
21	TKSV 0822	14.44	9.33	3.33	1.18	16.69	2.75	36.21	0.46	Pearl white	Dull white
22	TKSV 0824	8.82	8.67	1.01	2.54	10.12	3.38	24.42	0.41	Pearl white	Dull white
23	TKSV 0825	8.62	7.55	1.14	2.37	9.98	4.15	23.32	0.42	Pearl white	Dull white
24	TKSV 0829	12.26	7.22	1.69	2.62	14.42	5.15	37.68	0.38	Pearl white	Dull white
25	TNS 603	11.82	4.59	2.57	1.82	13.32	4.31	26.32	0.50	Pearl white	Dull white
26	TNS 607	10.52	9.89	1.06	2.62	11.52	4.62	23.26	0.49	Pearl white	Dull white
27	TNS 608	12.26	7.22	1.69	2.52	15.32	4.06	37.66	0.41	Pearl white	white
28	TNS 482	10.21	6.88	1.48	2.32	12.12	3.82	34.32	0.35	Pearl white	White
29	TNS 483	9.86	7.57	1.30	1.95	10.75	2.55	29.33	0.36	Pearl white	White
30	TNS 486	11.82	6.95	1.70	2.08	13.22	2.70	36.22	0.37	Pearl white	White

31	TNS 495	12.13	6.33	1.91	3.15	14.23	5.80	37.50	0.38	Pearl white	White
32	TNS 598	9.86	7.22	1.36	2.82	10.50	3.82	31.63	0.33	Pearl white	White
33	TNS 599	8.22	5.33	1.54	2.72	10.80	3.41	32.62	0.34	Pearl white	White
34	C 43 -81	9.66	6.53	1.47	2.65	11.23	3.22	33.32	0.35	Pearl white	White
35	Co (s) 28	14.22	8.33	1.70	3.21	17.16	6.21	39.24	0.44	Pearl white	White
36	IS 2660	7.62	6.22	1.22	2.11	9.22	4.15	27.22	0.32	Dull white	Dull white
37	IS 2663	8.14	5.85	1.39	2.32	10.23	3.92	28.26	0.36	Dull white	Dull white
38	IS 7034	10.26	6.44	1.59	2.31	9.28	3.42	27.25	0.34	Pearl white	Dull white
39	IS 3201	9.67	6.92	1.39	1.95	9.82	3.07	20.53	0.47	Dull white	Dull white
40	IS 9807	7.62	8.22	0.92	2.82	7.50	3.62	20.77	0.36	chalky white	Dull white
41	IS 1255	11.66	7.35	1.58	2.63	12.63	3.14	34.23	0.37	chalky white	Dull white
42	IS 1563	10.27	5.33	1.92	2.85	14.32	3.62	26.26	0.54	chalky white	Dull white
43	TNS 618	12.63	8.71	1.45	2.21	16.44	5.45	28.34	0.58	Dull white	Dull white
44	TNS 623	13.27	7.33	1.81	2.11	15.16	5.26	37.76	0.40	Dull white	Dull white
45	TNS 624	10.33	5.85	1.76	2.62	13.32	3.88	23.27	0.52	Dull white	Dull white
46	Co (s) 30	13.88	7.57	1.83	3.06	14.42	5.82	37.76	0.38	Dull white	Dull white
47	K 4	14.32	9.05	1.58	3.35	17.62	6.34	38.22	0.46	Pearl white	Dull white
48	K 5	10.88	6.54	1.66	2.32	12.76	4.23	29.36	0.43	Pearl white	Dull white
49	K 8	14.12	8.22	1.71	3.02	15.50	5.26	37.34	0.41	Pearl white	Dull white
50	K Tall	10.72	5.85	1.83	2.17	12.22	3.17	21.50	0.56	Pearl white	Dull white
51	TWC 100	14.34	8.42	1.70	2.55	16.72	5.89	30.17	0.82	Milk white	Dull white
52	TWC 120	15.18	7.55	2.01	2.32	17.33	6.12	38.12	0.82	Milk white	Dull white
53	DJ 6514	6.12	4.33	1.41	1.12	8.22	2.75	19.57	0.42	Milk white	Dull white
	Mean	**11.0**	**7.3**	**1.6**	**2.4**	**12.8**	**4.1**	**29.2**	**0.4**		
	CD 5%	**2.34**	**1.06**	**0.14**	**0.17**	**1.64**	**0.26**	**3.32**	**0.04**		

Phenotypic correlation coefficient between popping characteristics area presented in the Table 3**.** The trait viz., 500 grain weight recorded significantly positive correlation to all the traits except for 500 popped grain weight and number of unpopped grains for which non significant positive correlation for 500 popped grain weights and negative significant correlation for number of unpopped grains was recorded. The trait viz., volume of the flour pe ½ kilograms of grains recorded significantly positive correlation with all the traits except the trait viz., 500 popped grain weight similar observation was made by R. Sankarapandian (2000) in sorghum.

The phenotypic correlation coefficients between flaking characteristics are presented in the Table 4. The trait viz., 500 grain weight, showed significant positive correlation with grain volume and diameter of the flaked grain. It showed significant negative correlation with density of the flaked grains. The trait viz., grain volume showed significant and positive correlations for all traits. Finally the trait viz., density of the flaked grains showed significant positive correlation with grain volume, density of the grains, diameter of the grain and volume of 500 flaked grains whereas it showed significant negative correlation with 500 grain weight and non significant negative correlations with 500 flaked grain weight and Diameter of the flaked grain.

CONCLUSION

It may be concluded from all the analysis, that K 4, TWC 100 and TWC TKSV 0809 are suitable for both popping and flaking traits and traits associated are volume of the flour per ½ kilogram of grains for popping and density of flaked grains for flaking traits are important while selecting the genotypes.

Table: 3. Inter correlations among popping characteristics in sorghum

	Grain volume	Density of the grains	Volume of grains after imbibitions	Diameter of the grain	500 popped grain weight	Number of Unpopped grains	Diameter of the popped grains	Density of the popped grains	Volume of the flour per ½ kilogram of grains
500 grain weight	0.624**	0.507**	0.683**	0.651**	0.253	-0.656**	0.672**	0.443**	0.828**
Grain volume		-0.306*	0.832**	0.637**	0.081	-0.289*	0.376*	-0.319*	0.574**
Density of the grains			-0.145	0.153	0.171	-0.538**	0.450**	0.909**	0.388*
Volume of the grains after imbibitions				0.663**	0.041	-0.391*	0.413**	-0.089	0.651**
Diameter of the grains					0.290	-0.407**	0.635*	0.134	0.704**
500 popped grain weight						-0.077	0.195	0.1845	0.165
Number of unpopped grains							-0.704**	0.536**	0.595**
Diameter of the popped grains								0.368**	0.556**
Density of popped grains									0.382*
Volume of the flour per kilogram of grain									

Table: 4. Inter correlations among flaking characteristics in sorghum

	Grain volume	Density of the grains	Diameter of the grain	500 flaked grain weight	Diameter of flaked grain	Volume of 500 flaked grains	Density of the flaked grains
500 grain weight	0.280*	0.24	0.219	-0.034	0.357**	0.110	-0.343*
Grain volume		0.714**	0.353*	0.367**	0.471**	0.667**	0.587**
Density of the grains			0.677**	0.313*	0.211	0.648**	0.682**
Volume of the grains				0.937**	0.387**	0.579**	0.418**
500 flaked grain weight					0.468**	0.374**	-0.086
Diameter of the flaked grain						0.577**	-0.177
Volume of 500 flaked grains							0.482**
Density of the flaked grains							

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