

RESEARCH PAPER

Physico-chemical and Sensory Evaluation of Sorghum-Finger Millet Papad

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ABSTRACT

The study was conducted to determine physico-chemical characteristics and sensory qualities of sorghum-finger millet papad. Papads were prepared from different sorghum varieties by incorporating finger millet flour and analyzed for physical, chemical and sensory qualities. Parbhani Moti sorghum variety was selected among five sorghum varieties based on sensory evaluation of papads. Finger millet flour was added to Parbhani Moti sorghum variety based papad as 10%, 20%, 30%, 40%, and 50% with other ingredients. The results revealed that Sorghum-finger millet papad prepared with 40% finger millet flour had moisture range of 9 to 9.25%, proteins 8.39 to 12.64%, fat 0.88 to 1.05 %, ash 0.54 to 1.27% and total carbohydrates 76.77 to 80.21% respectively.

Keywords: Sorghum-finger millet papad, Physico-chemical and Sensory characteristics

Sorghum [*Sorghum bicolor* (L.) Moench] popularly called as jowar, is the "king of millets" and is the fifth in importance among the world's cereals after wheat, rice, maize and barley (Awika and Rooney, 2004). Sorghum provides a good basis for gluten-free products and is recommended as safe for celiac patients. Therefore, the future promise of sorghum in the developed world is for wheat substitution for people with celiac disease or allergies to gluten (Bogue and Sorenson, 2008). Finger millet (*Eleusine coracana*) is also known as African millet, koracan, ragi, wimbi, bulo and telebun and it can be stored for long periods without insect damage and thus, is considered important during famine (FAO, 1995). The nutritive value of finger millet is 13.1, 7.1, 1.3, 76.3, and 2.2% of moisture, protein, fat, carbohydrates,

and mineral matters, respectively (Shakuntala and Shadaksharaswamy, 2001).

Papad is an indigenous traditional thin water like snack product prepared from a variety of ingredients. But, are generally made from blend of pulse flour, cereal flour and edible starches with other ingredients. Apart from value addition by processing to traditional products from these grains, development of newer products offers variety, convenience, quality, cost-efficiency and scope for increasing the nutritional value and is consumed as roasted or fried product or as an adjunct with vegetable soups and curries. A variety of papads are available in India, which are produced from a great diversity of ingredients (Veena *et al.*, 2012). Generally, cereal papads are prepared from gelatinized flour

prepared from soaked grains. The present study focused on physico-chemical and sensory quality of papads prepared from Sorghum-finger millet flour.

MATERIALS AND METHODS

Raw materials

Sorghum [*Sorghum bicolor* (L.) Moench] varieties like Parbhani Moti, Parbhani Jyoti, Akola Kranti, Phule Revati and Phule Vasuda were procured from Sorghum Research Station Parbhani, Maharashtra. Finger millet (*Eleusine coracana*), refined vegetable oil, papad khar and spice mix were procured from local market for preparation of sorghum millet papad. Chemicals used were analytical grade. Equipments and machineries like domestic mixer (for grinding of sorghum and finger millet grains), texturometer (Stable Micro System TAXT2 plus), colour measuring instrument – Colorflex EZ, cabinet drier, microwave oven were available in College of Food Technology, Vasantrao Naik Marathwada Krushi Vidyapeeth, Parbhani.

Preparation of papad

The detail procedure used for preparation of “Plane Sorghum papad” and “Sorghum-finger millet papad” are presented in figure 1 and figure 2 respectively.

Physico-chemical analysis

Physical Characteristics of Sorghum varieties and Finger millet like geometric mean diameter (GMD) (Gürsoy and Güzel, 2010), 1000 kernel weight of sorghum grains (W_{1000}), bulk density (BD) (AOAC, International 1990), true density (ρ_t), porosity (ϵ) were determined with the help of different formulae for respective parameter.

Physical quality attributes like total yield, number of sorghum-finger millet papad, unit weight of raw and fried sorghum-finger millet papad, diameter of raw and fried sorghum-finger millet papad, expansion percentage of fried sorghum-finger millet papad (Vidyavati *et al.*, 2004) were determined. Major chemical characteristics of sorghum varieties, finger millet and papad such as moisture (AOAC,

International 1990), ash (AOAC, International 1990), fat (AOAC, International 1990), protein (AOAC, International 1990) and total carbohydrate (Pearson, 1976) were determined along with minerals like calcium and iron (Raghuramulu *et al.*, 2003).

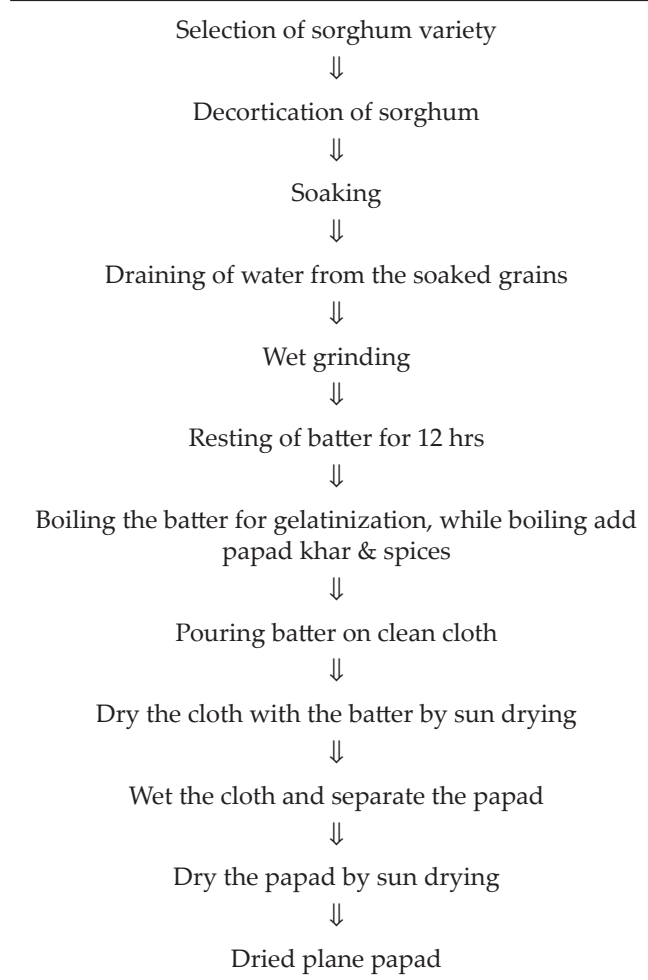


Fig. 1: Preparation of plane Sorghum papad

Sensory analysis

Freshly prepared Sorghum papad and Sorghum-finger millet papads were evaluated for sensory characteristics and judgments were made through rating products on a 9 point Hedonic scale (Joshi, 2006).

Statistical analysis

The data were analyzed for difference of significance by ANOVA used CRD and CD values are presented.

RESULTS AND DISCUSSION

Physical characteristics and nutritive values of sorghum and finger millet grains

Samples were compared for visual colour with Munsell colour chart and represented for the values of hue, value and chroma (Table 1). Colour of Parbhani Moti, Parbhani Jyoti, Phule Vasuda, Akola Kranti, Phule Revati and finger millet were pearly white (5Y 8/2) with very bold, creamy white (5Y 7/2) with bold, dull white (10YR 8/2) with round, pale yellow(10YR 7/2) with bold, pearly white (10YR 6/2) with round and brick red (8 R 6/2) with round respectively. In sorghum and finger millet, phenolic compounds, particularly anthocyanins and condensed tannins are major contributors of colour of the grains (Awika *et al.*, 2004; Jambamma *et al.*, 2011).

Table 1: Visual physical parameters of sorghum cultivars and finger millet grains

Cultivars	Visual parameters of grain		
	Colour	Muncell notation for colour	Shape
Parbhani Moti	Pearly white	5Y 8/2	Very bold
Parbhani Jyoti	Creamy white	5Y 7/2	Bold
Phule Vasuda	Dull white	10YR 8/2	Round
Akola Kranti	Pale yellow	10YR 7/2	Bold
Phule Revati	Pearly white	10YR 6/2	Round
Finger millet	Brick red	8 R 6/2	Round

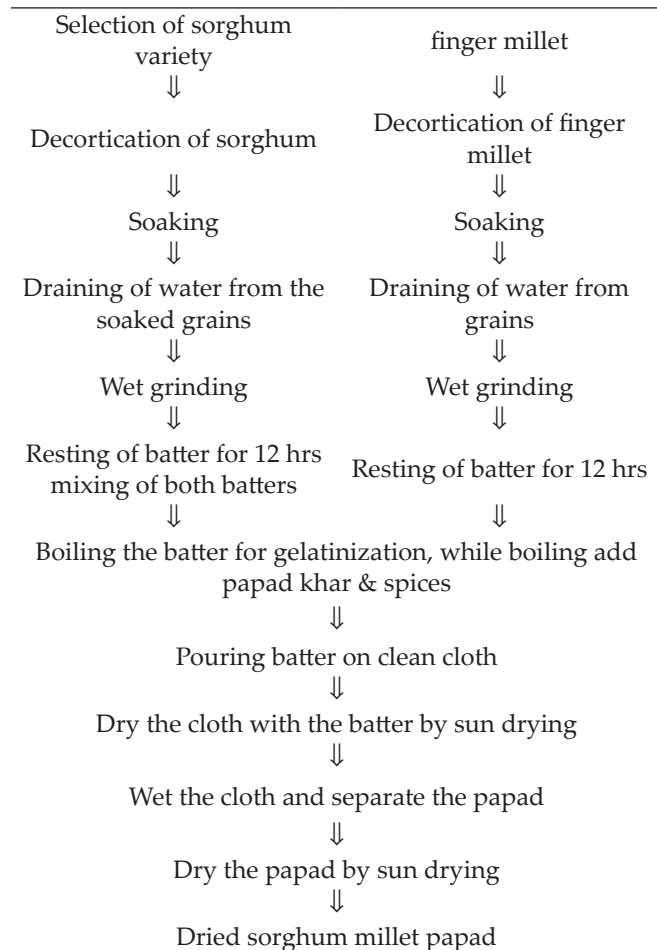


Fig. 2: Preparation of sorghum-finger millet papad

These results for weight are presented in Table 2. The highest thousand kernel weight (34.30g) and thousand kernel volume (28.5 ml) was observed for Parbhani Moti. Whereas the lowest thousand kernel weight (2.6g) and thousand kernel volume (1.7 ml) was observed in finger millet (Liman *et al.*, 2012). True density is an index of floury and corneous endosperm ratio inside the kernels. Higher the density indicates hardness of the grain. The true density of Akola Kranti (as 1.8 g/ml) was found to be highest while Parbhani Moti reported lowest (1.2 g/ml).

Table 2: Physical properties of sorghum cultivars and finger millet grains

Grains	Physical properties of grains					
	1	2	3	4	5	6
Parbhani Moti	34.3	3.81	28.5	1.2	0.6	32° 42'
Parbhani Jyoti	33.1	4.08	23	1.4	0.7	32° 11'
Phule Vasuda	34.1	3.91	26	1.3	0.65	30° 15'
Akola Kranti	34.2	4.02	18.5	1.8	0.9	31° 12'
Phule Revati	34.2	3.73	24	1.3	0.65	30° 12'
Finger millet	2.6	1.5	1.7	1.5	0.7	29° 11'
SE ±	0.1105	0.0270	0.129	0.0577	0.0624	—
CD at 5 %	0.3331	0.08161	0.3890	0.1739	0.1882	—

Note: Each value is a mean of three determinations
1. Thousand Kernels Weight (g), **2.** Kernel Size G.M.D (mm), **3.** Thousand Kernel volume (ml), **4.** True Density (g/ml), **5.** Bulk Density (g/ml), **6.** Angle of Repose (Degrees)

Akola Kranti had recorded highest bulk density (0.9 g/ml) while Parbhani Moti reported lowest one (0.6 g/ml). No significant difference in the value of angle of repose was observed among the cultivars (Vannalli *et al.*, 2008).

Moisture content ranged from 12 to 13.9%, fat (1.4 to 4.71%), protein (7.9 to 15.08%), carbohydrate (65.8 to 74.5%) and ash content ranged from 1.89 to 2.3% (Table 3). The variation in chemical composition might be due to variation in varieties used in our study (Chavan *et al.*, 2009; Jambamma *et al.*, 2011).

Table 3: Nutritional composition of sorghum varieties and finger millet grains

Particulars	Moisture (%)	Fat (%)	Protein (%)	Carbohydrate (%)	Ash (%)
Parbhani Moti	12	4.04	15.08	66.77	2.06
Parbhani Jyoti	13.5	3.9	14.7	65.8	2
Phule Vasuda	13.9	4.71	9.95	69.54	1.9
Akola Kranti	13.03	3.8	13.9	67.33	1.94
Phule Revati	13.9	3.89	9.8	70.52	1.89
Finger millet	13.9	1.4	7.9	74.5	2.3
SE ±	0.3631	0.0410	0.0472	0.0411	0.2396
CD at 5 %	1.0943	0.1236	0.1424	0.1241	0.7222

Note: Each value is a mean of three determinations

Table 4: Physical characteristics of raw papad prepared from different sorghum varieties soaked for different durations

Sorghum Variety	Total yield of papad (g)				Number of papad				Unit weight (g)				Diameter (cm)			
	Duration of soaking (days)															
	1	3	5	M	1	3	5	M	1	3	5	M	1	3	5	M
Parbhani Moti	79	79.5	72.5	77	18.5	17.4	16.6	17.5	4.01	4.45	5	4.4	8.05	8.18	8.35	8.1
Parbhani Jyoti	78.9	79.4	72.4	76.9	18	17.1	16.3	17.1	4.1	4.5	4.9	4.5	8.1	8.2	8.3	8.2
Phule Vasuda	79.8	80.2	75.5	78.5	18.6	17.5	16.1	17.4	3.92	4.2	4.7	4.2	8.02	8.12	8.3	8.1
Akola Kranti	79	79.5	74.3	77.6	17.4	16.9	16.1	16.8	4.8	4.9	5.3	5	8.04	8.14	8.35	8.1
Phule Revati	80	80.5	75	78.5	16.9	16.1	15.8	16.2	4.85	4.99	5.5	5.1	8	8.1	8.29	8.13
Mean	79.3	79.8	73.9	77.7	17.8	17	16.1	17	4.3	4.6	5	4.6	8	8.1	8.3	8.1
SE ±	0.36	0.057	0.26	—	0.26	0.057	0.057	—	0.036	0.04	0.26	—	0.25	0.03	0.036	
CD at 5%	1.13	0.17	0.82	—	0.81			—	0.11	0.13	0.81	-	0.79	0.11	0.11	

Note: Each value is a mean of three determinations M: Mean of three readings

Table 5: Physical characteristics of fried papad prepared from different sorghum varieties soaked for different durations

Sorghum Variety	Unit weight (g)				Diameter (cm)				Expansion per cent (%)			
	Duration of soaking of grains (days)											
	1	3	5	M	1	3	5	M	1	3	5	M
Parbhani Moti	4.82	5.51	6.17	5.5	9.52	10.42	10.51	10.15	18.26	27.38	25.86	23.83
Parbhani Jyoti	5.35	5.58	6.04	5.65	9.48	10.29	10.4	10.06	17.03	25.48	25.3	22.6
Phule Vasuda	4.74	5.2	5.8	5.24	9.34	10.05	10.25	9.88	16.45	23.76	23.49	21.23
Akola Kranti	5.82	6.07	6.54	6.14	9.37	10.15	10.28	9.93	16.54	24.69	23.11	21.45
Phule Revati	5.93	6.18	6.78	6.29	9.32	10.1	10.2	9.87	16.5	24.69	23.03	23.86
Mean	5.18	5.71	6.27	5.76	9.41	10.2	10.33	9.98	17.07	25.2	24.16	22.94
SE ±	0.01	0.02	0.03	—	.005	0.02	0.05	—	0.02	.005	0.02	—
CD at 5 %	0.03	0.08	0.12	—	0.01	0.08	0.17	—	0.08	0.01	0.08	—

Note: Each value is a mean of three determinations M: Mean of three readings

Physical quality attributes of raw and fried sorghum papad

The results of raw and fried papads are shown in the table 4 and 5. It is evident that the highest yield of papad was observed for Phule Revati soaked for 3 days (80.5 g) and lowest for Parbhani Jyoti papad soaked for 5 days (72.4 g). The number of papad obtained was highest in one day soaked grains (17.8) followed by three days (17) and five days soaked grains (16.1). The highest unit weight (5.5 g) was observed in Phule Revati papad prepared by five days soaked grains and lowest (3.92 g) was in Phule Vasuda papad prepared from one day soaked grains.

The diameter of raw papad ranged from 8.1 to 8.2 cm with a mean of 8.1 cm. The diameter of the Parbhani Jyoti papad was significantly highest (8.2 cm) followed by Phule Revati (8.13 cm). Similar increase in the diameter of papad prepared from cereals soaked for five days may be due to the increased water uptake by the ruptured granules of starch during steaming (Srilakshmi, 2006). The wide variation in the total yield, number of papads, unit weight and diameter of raw papad among the sorghum varieties may be attributed to the variation in chemical composition, nature of starch, their characteristic shape, size and cooking behavior of the starch present in them, depending upon the plant from which they are

derived (Srilakshmi, 2006).

The weight of fried papad ranged from 5.24 to 6.29 g with mean value of 5.76 g. Among the sorghum varieties, significantly highest weight of fried papad was observed in Phule Revati (6.29 g) and lowest was in Phule Vasuda papad (5.24 g). The highest diameter of fried papad was observed in Parbhani Moti papad soaked for five days (10.51 cm) and lowest was in Phule Revati papad soaked for one day (9.32 cm). A definite pattern of total amylose and hot water insoluble amylose contents may be related to better expansion of cereals and millets after frying. The highest expansion per cent was observed in Parbhani Moti soaked for three days (27.38) and lowest was in Phule Revati papad soaked for one day (16.5) only and the expansion per cent increase in papad during frying may be due to the replacement of moisture by oil due to the higher content of water insoluble amylase (Chinnaswamy and Bhattacharya, 1986).

Nutritional composition of raw sorghum papads

The data pertaining to the chemical composition of sorghum papad prepared samples from different sorghum varieties presented in Table 6, moisture content was range from 9 to 9.6%, fat (0.9 to 1.12%), protein (7.97 to 12.64%), carbohydrate (76.77 to 81.5%) and ash (0.54 to 0.59%).

Table 6: Nutritional composition of raw sorghum papad

Papad prepared from sorghum variety	Moisture (%)	Fat (%)	Protein (%)	Carbohydrate (%)	Ash (%)
Parbhani Moti	9	1.05	12.64	76.77	0.54
Parbhani Jyoti	9.6	0.93	11.93	76.95	0.59
Phule Vasuda	9.3	1.12	8.09	80.93	0.56
Akola Kranti	9.5	0.9	11.3	77.73	0.57
Phule Revati	9.05	0.92	7.97	81.5	0.56
Mean	9.29	0.98	10.38	78.77	0.56
SE ±	0.051	0.026	0.026	0.062	.005
CD at 5 %	0.15	0.081	0.083	0.193	.017

Note: Each value is a mean of three determinations

Table 7: Mean sensory score values for the sorghum papad prepared from three days soaked grains

Sorghum Variety	Appearance	Colour	Flavour	Taste	Texture	Overall acceptability
Parbhani Moti	8.3	9	8.3	8.4	8.1	8.3
Parbhani Jyoti	8.1	8.6	7.8	8.1	7.8	7.3
Phule Vasuda	8.2	7.9	7.1	7.2	7.1	7.5
Akola Kranti	7.6	7.8	7.5	7.2	7.2	7.5
Phule Revati	7.8	6.3	7.2	7.5	6.8	7.2
Mean	8	7.92	7.58	7.68	7.4	7.56
SE ±	0.057	0.26	0.057	0.057	0.071	0.057
CD at 5 %	0.17	0.81	0.18	0.17	0.22	0.17

Note: Each value is a mean of three determinations

Table 8: Standardization of formula (ingredients in g/100g) for preparation of sorghum-finger millet papad

Particulars	FormulaNo.1	Formula No. 2	Formula No. 3	Formula No. 4	Formula No. 5	Formula No. 6
Parbhani Moti	100	90	80	70	60	50
Finger millet	0	10	20	30	40	50
Papad khar	2	2	2	2	2	2
Black pepper	0.1	0.1	0.1	0.1	0.1	0.1
Sesame seeds	2	2	2	2	2	2
Asafoetida	0.05	0.05	0.05	0.05	0.05	0.05

Sensory valuation of sorghum papads

Parbhani Moti papad scored the highest for all the parameters (Table 7) like, appearance (8.3), colour (9), flavour (8.3), taste (8.4), texture (8.1) and overall acceptability (8.3) followed by Parbhani Jyoti papad stand second for colour (8.6), flavour (7.8), taste (8.1) and texture (7.8) (Nazni and Pradheepa, 2010).

Standardized of preparation of sorghum-finger millet papad

Standardization of formula (ingredients in g/100g) for preparation of sorghum-finger millet papad

(Table 8) was formulated by viriating the Parbhani Moti, finger millet compositions and compositions of other ingredients (Papad khar, black pepper, sesame seeds and asafetida) were kept constant.

Nutritional composition of raw sorghum-finger millet papad (Table 9) prepared from selected variety (Parbhani Moti) incorporated with different proportions of finger millet as moisture content was range from 9 to 9.25%, fat (0.88 to 1.05%), protein (8.39 to 12.64%), carbohydrate (76.77 to 80.21%), ash (0.54 to 1.27%), Calcium (3.35±0.57 to 144.81±0.57mg) and Iron (3.20±0.51 to 3.54±0.54mg).

Table 9: Nutritional composition of raw sorghum-finger millet papad

#	Moisture (%)	Fat (%)	Protein (%)	Carbohydrate (%)	Ash (%)	Calcium (mg)	Iron (mg)
S ₀ (100:00)	9	1.05	12.64	76.77	0.54	3.35± 0.57	3.20± 0.51
S ₁ (90:10)	9.01	1.01	11.78	77.52	0.68	21.31± 0.57	3.27± 0.45
S ₂ (80:20)	9.14	0.98	10.93	78.12	0.83	45.25± 0.57	3.32± 0.56
S ₃ (70:30)	9.21	0.94	10.08	78.8	0.97	78.44± 0.57	3.41± 0.42
S ₄ (60:40)	9.22	0.91	9.22	79.53	1.12	111.62± 0.57	3.47± 0.47
S ₅ (50:50)	9.25	0.88	8.39	80.21	1.27	144.81± 0.57	3.54± 0.54
Mean	9.1	0.9	10.5	78.4	0.9	67.46	3.36
SE ±	0.25	0.0073	0.0064	0.026	0.0064	0.13	0.026
CD at 5 %	0.77	0.022	0.019	0.079	0.19	0.40	0.079

Note: Each value is a mean of three determinations #: sorghum-finger millet papads (Parbhani Moti: Finger millet)

Table 10: Mean sensory score values for the sorghum-finger millet papad prepared from three days soaked grains

Sample	Appearance	Colour	Flavour	Taste	Texture	Overall Acceptability
S0 (100:00)	8.3	9	8.3	8.4	8.1	8.3
S1 (90:10)	7.1	7.6	7.7	8.1	7.9	8.1
S2 (80:20)	7.5	7.4	7.5	7.8	8.2	8.1
S3 (70:30)	7.3	7.1	7.1	7.9	8.1	8.2
S4 (60:40)	7.4	6.9	7.6	7.6	8.3	8.4
S5 (50:50)	7.5	6.9	7.6	7.9	8.1	8.2
Mean	7.36	7.18	7.5	7.86	8.12	8.2
SE ±	0.073	0.27	0.36	0.28	0.16	0.11
CD at 5 %	0.22	0.83	1.090	0.86	0.50	0.35

Note: Each value is a mean of three determinations #: Sorghum-finger millet papads (Parbhani Moti: Finger millet)

Table 11: Changes in sensory attributes of fried sorghum papads prepared from different sorghum varieties

Papad from sorghum variety	Sensory attributes		
	Duration of soaking (days)		
	1	3	5
Parbhani Moti	White, heavy and hard to break	White, light and crunchy	Creamish white, light, crispy and dissolving and very light off flavor
Parbhani Jyoti	Yellowish white, heavy and hard to Break	Yellowish white, light and crunchy and very light off flavour	Creamish white, light, crispy and dissolving and very mild off flavor
Phule Vasuda	White, heavy and hard to break	white and crunchy	white, light and crunchy and very mild off flavor
Akola Kranti	Pale yellow, heavy and hard to break	Pale white and crunchy	white, light and crunchy and very mild off flavor
Phule Revati	White, heavy and hard to break	white and crunchy	white, light and crunchy and very mild off flavor

Sensory evaluation of sorghum-finger millet papads

Sorghum papads incorporated with different proportions of finger millet were organoleptically evaluated and the best one (sample S₄) was selected based on the results reported in the Table 10. As the duration of soaking of grains increased, there was development of off flavour in the fried papad (Table 11). Papad prepared from five days soaked grains developed very mild off flavour. The textural changes in papad were attributed to the increased surface area by carbon dioxide liberated from Papad Khar during frying (Chowdhury *et al.*, 2009).

CONCLUSION

Out of five cultivars of sorghum on the basis of physical parameters, sensory characteristics and yield of papad the cultivar Parbhani Moti found the most suitable for papad preparation by conventional method. The incorporation of level of 40% by finger millet in sorghum flour was acceptable without any change in sensory, textural and quality parameters which shown significant increase in mineral content of sorghum-finger millet papad. It can be concluded from above discussion that three days soaking period for sorghum grains is suitable for papad making.

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