The Pharma Innovation Journal 2021; 10(12): 1528-1530

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2021; 10(12): 1528-1530

www.thepharmajournal.com
Received: 19-10-2021
Accepted: 30-11-2021

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Physico-chemical properties of sorghum and standardization of sorghum cookies

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Abstract
Sorghum is a gluten free cereal and forms the staple diet of a majority of populations living in the semi-arid tropics. Sorghum contains various phenol and antioxidant compounds that could have health benefits, which make the grain suitable for developing functional foods. The current study was undertaken to study the physico-chemical properties and standardization of cookies with different level (25, 50, 75 & 100%) of incorporation. The weight and volume of different sorghum varieties varied significantly among the varieties. M-35-1 sorghum variety was taken for the development of cookies. Result revealed that 25 per cent was on far with the control cookies and 50 per cent was selected with enriching the nutrient content of the sorghum. The sensory score decreases as increasing the sorghum incorporation level in refined wheat flour cookies.

Keywords: Physico-chemical, properties, sorghum, standardization, sorghum

Introduction
Sorghum [*Sorghum bicolor* (L.) Moench] belongs to the *Poacea* family, tribe of *Andropogoneae*, genus of *Sorghum* and species of *bicolor*. It is a diploid plant with 2n = 20 chromosomes. Sorghum is an important staple food for millions of people in the developing countries. It is also known as the great millet which has 5th rank in global production in cereals and is 4th after rice, wheat and maize in India. Sorghum is mainly grown in the *kharif* (rainy) and *rabi* (post rainy) seasons and sorghum grown in *rabi* season is characterized by excellent grain quality, exclusively used for human consumption. Sorghum grain contains high fiber and non starchy polysaccharides and starch with some unique characters. Protein quality and essential amino acid profile of sorghum is better than many of the cereals and millets. Sorghum in general is a rich source of fiber and B complex vitamin (Gopalan *et al*., 2010 and Patil *et al.*, 2010) [3, 4]. Grain is rich in fiber and minerals apart from having a sufficient quantity of carbohydrates (72%), protein (11.6%) and fat (1.9%). Starch is the major constituent of the grain. The two major bakery industries namely bread and biscuits account for almost 82 per cent of the total bakery products. Cookie" originates from a Dutch word *koekje*, which means "little cake;" the sound of a cracker being eaten most likely led to the use of that name (Zydenbos *et al*., 2004) [6]. Cookies hold an important position in snack foods due to varieties in taste, crispiness and digestibility

Material and Methods
The present study was conducted in the year 2016-17.The sorghum varieties AKJ-1 (*Atharga kempu jola*), SMJ-1(*Sakkari mukkari jola*), KMJ-1 (*Kagi moti jola*) or pop sorghum and M-35-1 (*Bilijola*) grown in farmers fields around Vijayapur and Regional Agricultural Research station, Vijayapur, University of Agricultural Sciences, Dharwad during *rabi* season were selected for investigation other raw materials were procured from local market Dharwad to prepare sorghum cookies and refined wheat flour cookies. The physico-chemical properties of sorghum flour were studied.
Cookies were prepared by replacing refined wheat flour in different level of incorporation of sorghum (M-35-1) flour in 100:0, 75:25, 50:50 and 25:75 (Refined wheat flour: sorghum flour) proportion. Refined wheat flour cookie (100:0) was taken as control. Cookies were manually prepared by following traditional creamy method and baked in a commercial baking oven with top temperature of 180 °C and bottom temperature of 150 °C for 25 minutes.

Experimental results
The grain weight of sorghum varieties showed that M-35-1 (11.33g) had more weight and

AKJ-1 (5.8g) had less weight. The grain volume was found high in M-35-1 (3.4 ml) and the lowest value was recorded in AKJ-1 *and* SMJ-1 (1.9 ml). The M-35-1, KMJ-1 and SMJ-1 varieties had similar bulk density (3.2w/v). There was significant differences were noticed for weight and volume and insignificant difference was noticed for bulk density. Visual observation of grains revealed that M-35-1, KMJ-1 and SMJ-1 were white in colour while AKJ-1 was having red colour. The weight and volume of different sorghum varieties varied significantly among the varieties (table1), similar observations were made by Adeyeye, (2016) [1] and Subramanian and Jambunath (1980) [5] noticed significant difference between varieties for weight and volume of grains

Visual observation showed that M-35-1, KMJ-1 and SMJ-1 had white colour, whereas AKJ-1 had red colour. The dough consistency of M-35-1 and AKJ-1 varieties was rough and non stretchable whereas KMJ-1 and SMJ-1 was slight smooth KMJ-1 had highest water absorption index (2.76g) followed by AKJ-1 *(*2.45g) and low water absorption was found in SMJ-1 *(*2.04g). There was no significant difference between the selected sorghum varieties for water absorption index.

The flour nutrient composition of different types of sorghum varieties are depicts the moisture content of sorghum varieties was ranging from 9.83 to 10.93%, AKJ-1 (9.8%) had lower moisture while KMJ-1 (10.93%) had higher moisture content. The ash content of different sorghum varieties flour varied significantly, between 1.37 to 1.91%, higher content was found in SMJ-1 (1.91%) and lower in M-35-1 (1.37%) variety (table 2).

The protein content ranged between 11.90 to 16.73g among the varieties, higher content was noticed in KMJ-1 (16.73g) and lower in AKJ-1 (11.90g). Significant differences were noticed among the varieties for protein content.

The fat content was found high in M-35-1 (4.73%) and low in (KMJ-1) pop sorghum (3.21%), and significant differences were observed between the all sorghum varieties.

For optimization study preparation of butter cookies studied, for preparation commercial available sorghum flour was taken cookies were developed by substituting sorghum flour for refined wheat flour in the ratio of 100:0, 75:25, 50:50, 25:75 and 0:100 (Refined wheat flour: sorghum flour). The mean organoleptic scores (table-3) revealed that, the refined wheat flour cookies scored high (score>8) for all the sensory attributes followed by the 75:25 (score - 7.5), 50:50 (score - 7.3), 25:75 (score-6.3) 0:100 (Score- 6.1) and all were found acceptable. The result revealed that as the sorghum flour incorporation increased, there was decrease in mean overall acceptability of sensory attributes from 8.20 to 6.10. Similar results were noticed by Adeyeye (2016) [1] where they observed decrease in all sensory parameters with increase in sorghum flour incorporation.

Cookies prepared exclusively from 100 per cent sorghum flour found acceptable (score- 6.10). Cookies prepared with 25 per cent sorghum flour were on par with control (Refined wheat flour) cookies for all sensory attributes. All cookies prepared from different levels of incorporation were found acceptable (score >6). However there was significant difference noticed between 100 per cent sorghum flour cookies and refined wheat flour cookies (Table 3).

Higher acceptability index was noticed in 100% refined wheat flour (90.9) incorporated cookies followed by 75:25, 50:50 and 25:75 (RWF: sorghum) (85.3, 80.07 and 74 respectively). Cookies with 100% sorghum incorporation had lower acceptability index of 72.50. However cookies were acceptable. Acceptability index revealed that 50:50 was found more acceptable for all sensory parameters, with evenly baked attractive appearance, pleasant baked aroma and slight coarser mouth feel.

Table 1: Physical characteristics of sorghum varieties

Characteristics	Varieties				S.Em.±	C. D. @ 5%
	M-35-1	KMJ-1	SMJ-1	AKJ-1		
Colour	White	White	White	Red	_	_
Weight (100 grains)	11.33 ± 0.05	8.4 ± 0.10	6.4 ± 0.00	5.80 ± 0.00	0.0331	0.1081*
Volume (100 grains/ml)	3.4 ± 0.57	2.56 ± 0.57	1.96 ± 0.57	1.93 ± 0.57	0.0331	0.1081*
Bulk density	0.32 ± 0.04	0.32 ± 0.04	0.32 ± 0.09a	0.30 ± 0.08	0.0129	0.04210 NS

*Significant at 5% level
NS- Non Significant

Table 2: Nutrient composition of different sorghum variety flours (g%)

Sorghum varieties	Moisture	Ash	Protein	Fat	Crude fiber	CHO	Energy (kcal)
RWF	11.67 ± 0.0	0.48 ± 0.0	7.86 ± 0.0	0.38 ± 0.0	0.24 ± 0.01	79.29 ± 0.0	352 ± 0.01
M-35-1 (White sorghum)	10.87 ± 0.01	1.37 ± 0.0	14.11 ± 0.39	4.73 ± 0.0	1.55 ± 0.01	67.37 ± 0.43	368 ± 0.06
KMJ -1 (Pop sorghum)	10.93 ± 0.01	1.58 ± 0.05	16.73 ± 0.20	3.21 ± 0.05	1.31 ± 0.02	66.23 ± 0.19	360 ± 0.13
SMJ -1*(Hurda)*	10.05 ± 0.03	1.91 ± 0.01	15.04 ± 0.0	3.89 ± 0.0	1.83 ± 0.0	67.28 ± 0.03	364 ± 0.10
AKJ-1 (Red sorghum)	9.83 ± 0.07	1.55 ± 0.03	11.90 ± 0.0	3.24 ± 0.01	1.49 ± 0.0	72.01 ± 0.04	364 ± 0.25
S.Em. ±	0.0216	0.0173	0.1160	0.0152	0.0057	0.1232	0.0836
C. D. @ 5%	0.0680*	0.0545*	0.3656*	0.0481*	0.0181*	0.3884*	0.2636*

RWF- Refined wheat flour * Significant at 5% level

Table 3: Organoleptic evaluation of sorghum cookies at different incorporation level

Level of incorporation	Appearance	Colour	Taste	Aroma	Texture	Overall acceptability	AI
100:0 (RWF: Sorghum)	8.10 ± 1.10	8.10 ± 1.10	8.30 ± 1.05	8.30 ± 0.67	8.10 ± 1.28	8.20 ± 1.03	90.9
75:25 (RWF: Sorghum)	8.0 ± 0.94	7.90 ± 0.99	7.80 ± 0.78	7.60 ± 0.84	7.30 ± 1.41	7.50 ± 1.26	85.3
50:50 (RWF: Sorghum)	7.80 ± 1.03	7.60 ± 0.96	7.22 ± 0.97	7.40 ± 0.84	7.00 ± 1.49	7.30 ± 1.15	80.7
25:75 (RWF: Sorghum)	7.50 ± 0.96	7.0 ± 1.01	6.40 ± 0.51	6.60 ± 0.55	6.30 ± 0.42	6.30 ± 1.02	74.0
100% (Sorghum)	7.20 ± 1.13	7.10 ± 1.19	6.10 ± 1.59	6.40 ± 1.71	6.20 ± 1.43	6.10 ± 0.56	72.5
S.Em. ±	0.6153	0.6189	0.6643	0.6373	0.8060	0.7728	--
C. D. @ 5%	0.8763*	0.8814*	0.9467*	0.9048*	1.1480*	1.1007*	-

RWF: Refined wheat flour
*significant at 5% level

Conclusion

The weight and volume of different sorghum varieties varied significantly among the varieties. Cookies with 50:50 (refined wheat flour: sorghum flour) incorporation level was found best with all sensory parameters to enrich the nutrient content without affecting the quality. Sorghum incorporation could be done up to the 50% level in refined wheat flour to enrich the nutrient content of the cookies.

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