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Research Article

PREPARATION OF BREAD AND COOKIES FROM SORGHUM FLOUR

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ABSTRACT

The present investigation was undertaken to study the effects of incorporation of sorghum flour on organoleptic and nutritional properties of bread and nankatai. The experiment was laid in factorial completely randomized design with six treatments (0, 10, 20, 30, 40 and 50% sorghum flour incorporation with wheat maida) and with five replications. The observations on organoleptic and nutritional properties were recorded and presented in this manuscript. The content of nutrients like crude protein, ash, crude fiber, soluble protein and total sugar of maida, sorghum flour, bread and nankatai were determined. Sorghum protein is superior to wheat protein in biological value and digestibility. Sorghum is totally free from gluten contains, more fibre and micronutrients.

Bakery products namely bread and nankatai were prepared by using flour blends of wheat maida and sorghum flour. Excellent quality bread and nankatai were produced by substituting 20 and 30 per cent sorghum flour to wheat maida, respectively. It was observed that the organoleptic properties of bread and nankatai decresed with increase in proportion of sorghum flour. But nutritional properties of bread and nankatai were increased in respect of ash, crude fiber and total sugar with increase in proportion of sorghum flour.

Addition of sorghum flour more than 20% in bread and more than 30% in nankatai preparation indicated that the sensory properties such as colour and appearance, flavour, texture, taste and overall acceptability decreased drastically.

The overall results indicated that the positive response of sorghum flour substitution to wheat maida up to 20 and 30 per cent level in preparation for bread and nankatai respectively.

INTRODUCTION

Bakery industry in India is considered as one of the major industries in food processing. Baking products are gaining popularity as processed foods because of their availability, ready to eat convenience and reasonably good shelf life. Wheat based baked products like bread, cookies, and cakes are popular among the baked 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). Cookies hold an important position in snack foods due to varieties in taste, crispiness and digestibility. At present cookies and biscuits are prepared from white flour which is inferior in quality and low in fiber content. For this reason interest in research has arisen in increasing fiber content in diet. Baked products have proved to be acceptable carriers of fiber from various sources (Brockmole and Zabik, 1976).

Bread is one of the most widely consumed food product in the world and bread making technology is probably one of the oldest technology known (Selomulyo and Zhou, 2007). It is an important staple food for many countries. The product is basically made of hard wheat flour, yeast, fat, sugar, salt and water (Badifu *et al*., 2005).

Millets, sorghum, and pulses are traditionally the staple grains for household consumption (Dayakar Rao *et al.,* 2007). In rural areas of central Maharashtra, per capita annual consumption of sorghum is around 60 kg, accounting for almost half (48%) of per capita consumption of all cereals (Parthasarathy Rao *et al.,* 2010).

About 700 million people are nourished by sorghum, since it constitutes a source of calories, protein and minerals. Progress has been made in developing high yielding varieties and hybrids with improved agronomic traits that resulted in excess production. Nutritional importance of sorghum is 349 Kcal

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energy, 9.6 % protein, 3.8 % fat, 73.2 % carbohydrates, 2.4 % ash and 11 % moisture content (Chavan and Salunkhe, 1984). Sorghum (*Sorghum bicolor* L. Moench) and maize (*Zea mays*) are closely related members of the subfamily Panicoideae in the family Gramineae. Sorghum originated in Central Africa with various hypotheses placing the domestication of sorghum. Sometime between 4500 and 1000 BC, after which it spread to Asia and India (Kimber, 2000). Sorghum is a major cereal in the semi-arid regions of the world where it is an important food and feed crop. Sorghum species (*Sorghum vulgare and Sorghum bicolor*) are members of the grass family.

It is usually referred to as milo or milo-maize in North America. The USA is a major producer of sorghum, but the grain is not consumed as human food except for a very small fraction, but as animal feed and fodder, while in the semi-arid tropics of Africa and India the grain forms the staple diet for large populations, where nearly all the produce is used directly as human food. Sorghum, like other cereals, is an excellent source of starch and protein.

It is a gluten-free cereal, which bears significance in the present day scenario where the occurrence of Celiac Disease (CD), an immunological response to gluten intolerance is on the rise. Grain sorghum contains phenolic compounds like flavonoids (Shahidi and Naczk, 1995). The starches and sugars in sorghum are released more slowly than in other cereals (Klopfenstein and Hoseney, 1995) and hence it could be beneficial to diabetics (Toomey, 1988). Sorghum is consumed in various forms around the world like baked bread, porridge, tortillas, couscous, gruel, steam-cooked products, alcoholic and non-alcoholic beverages and so on.

Sorghum (*Sorghum bicolor* L. Moench), a member of grass family, is the fifth leading cereal crop used throughout the world after wheat, rice, maize and barley (Suhendro *et al.,* 1998). It is also referred to as ‘‘coarse grain” or ‘‘poor people crop” as it can sustain the lives of the poorest rural people (www.fao.org). It is grown in the arid and semi-arid regions of the world (Murty and Kumar, 1995) and is an important cereal due to its extensive drought resistance and requirement of relatively lower inputs (Watson, 1970) and hence called ‘Life Saver’ (www.fao.org). More than 500 million people in the developing countries depend on sorghum as the main staple food (Mutisya *et al.*, 2009). So relevant scientific information generated for this crop can certainly play a key role in agricultural development in these countries of the world (Palmer, 1992).

Sorghum flour is becoming increasingly common in gluten-free baked goods, mostly because it has similar nutritional properties to wheat, is light in colour and bland in flavour (Lovis, 2003). Olatunji *et al*. (1992) developed a cake recipe for cake using sorghum or maize and cassava starch (70:30).

In addition to composite breads, several researchers have reported on the production of gluten-free bread from sorghum and much of this work is reviewed by Taylor and Dewar (2001). India is the largest producer of sorghum in the world with 7.15 million tons during 2007 and almost entire production of sorghum (95 %) in the country from above regions (GOI, 2007). As India produces 7.24 X 10^6 metric tons of sorghum per annum and stands as the third largest producer in the world (www.fao.org) so there is enough potential in this crop to be utilized as a raw material for bakery products and other food industries. Hence, the present research project “Preparation of bakery products using sorghum flour”, was undertaken.

MATERIALS AND METHODS

Material: Sorghum grains

Sorghum grains of Phule Vasudha (variety) and SPH-1620 (hybrid) were obtained from the Sorghum Improvement Project MPKV, Rahuri as and when required. Maida, vanaspati ghee, sugar, milk, yeast and other ingredients were purchased from the local market.

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. Whole sorghum flour was used for preparation of bakery products.

Composite flour

Maida was replaced with 0, 10, 20, 30, 40 and 50% by Phule Vasudha whole sorghum flour. The same was repeated with SPH-1620 whole sorghum flour. This composite flour was utilized in the preparation of *bread* and cookies. All other ingredients were kept constant in all composite flours.

Preparation of bread and nankatai

Composite flour of wheat and sorghum used for preparation of cookies according to the standard method of A.A.C.C. (1975) and the methods of Kent (1984) were followed in the *bread* making procedures.

Ingredients for bread

Blended flour 600g, fat 30g, sugar 90g, salt 9g, yeast 12g, milk 120 ml and water 360 ml as per requirement.

Ingredients for nankatai

Blended flour 1000g, fat 500g, sugar 500g, salt 10g, sodium bicarbonate 4g, ammonium bicarbonate 4g, and water 64 ml as per requirement.

Proximate composition of different types of breads and nankatai

The *bread* and *nankatai* were dried and then ground by using laboratory grinder to 60 mesh and then analyzed for crude protein, crude fiber, total sugars, soluble protein and ash contents using standard procedure of A.O.A.C., (1990).

Sensory evaluation of bread and nankatai

These products were evaluated by semi-trained judges for different sensory attributes such as colour and appearance, texture, flavour and taste using 1 to 9 point hedonic scale (Amerine *et al*., 1965). The mean for five judges was considered for evaluating the quality

Statistical design and analysis

All chemical constituents and organoleptic parameters were analyzed by using three and five replications, respectively. The data obtained in the present investigation was statistically analyzed by using Factorial Completely Randomized Design given by Panse and Sukhatme (1967).

RESULTS AND DISCUSSION

Proximate composition of maida and sorghum flour

The proximate composition of wheat (maida), Phule Vasudha (sorghum variety) and SPH-1620 (sorghum hybrid) is estimated. It is clear from the result that ash content and crude fiber content of maida was lower than sorghum. This might be due to use of superfine maida. The composition of wheat flour varies with the extraction rate (Kent-Jones and Amos, 1967; Baljeet *et al.,* 2010; Butt *et al*., 2001 and Vetrimani *et al*., 2005). Crude protein (11.80%) and soluble protein (1.01%) content were at higher level in wheat maida while ash, total soluble sugars and crude fiber content were higher in Phule Vasudha and SPH-1620 genotypes than wheat maida (Table 1). Except crude protein all other nutrients content in SPH-1620 were comparable with that of Phule Vasudha. The chemical composition of sorghum grain is more variable than that of many other cereal crops due to large variation in their genotypes (Rooney, 1973; Yousif and Magboul, 1972; Eggum *et al.,* 1983; Serna-Saldivar and Rooney, 1995 and El Sharif, 1993).

Table 1. Proximate composition of maida and sorghum flour*

Particulars	Wheat	Phule Vasudha	SPH-1620
Crude protein (%)	11.80	11.39	9.35
Ash (%)	0.76	4.85	4.14
Total sugar (%)	1.5	2.73	2.43
Soluble protein (%)	1.01	0.99	0.78
Crude fiber (%)	0.64	3.28	2.92

*Results are mean of five replications.

Effect of different levels of sorghum flour on nutritional quality of bread

The results with respect to effect of addition of different levels of sorghum flour on nutritional quality parameters of the *bread* are presented in Table 2. From the results it was observed that the incorporation of sorghum flour with wheat maida improves the nutritional quality of composite *bread* especially in terms of crude fiber, total sugars and ash content. From the results it was observed that Phule Vasudhas′ flour addition to wheat maida for preparation of *bread* showed better results in case of all treatments than SPH-1620s′ flour addition to wheat maida. From the results it was observed that statistical observations showed significant results for all nutritional quality parameters except soluble protein in case of varieties as well as treatment combinations (Table 2).

Crude protein

The control sample was found to contain highest crude protein (10.37%) whereas lowest results were observed for treatment T5 (10.21%) in case of P.Vasudha and for treatment T5 (8.90%) in case of SPH-1620. Decrease in crude protein content with increase in sorghum flour was due to lower protein content in sorghum flour as compared to maida. Similar effect has been reported by Eddy *et al.* (2007) for wheat/cassava composite *bread*. This finding was also agreed with Mongi *et al.* (2011) who reported that the substitution of wheat flour with cocoyam flour decreased crude protein content of bread.

Table 2 Effect of different levels of sorghum flour on nutritional quality of *bread*

Particulars	Crude protein (%)	Ash (%)	Crude fiber (%)	Total sugar (%)	Soluble protein (%)
V1	10.29	2.38	1.39	5.32	0.98
V2	9.63	2.15	1.26	5.10	0.94
SE (m) +	0.013	0.021	0.014	0.013	0.017
CD at 5%	0.038	0.060	0.040	0.038	NS
		Proportion/Treatment			
T0	10.37	0.90	0.51	4.80	1.06
T1	10.21	1.45	0.83	4.96	1.02
T2	10.04	2.01	1.16	5.13	0.98
T3	9.88	2.54	1.48	5.29	0.94
T4	9.72	3.08	1.84	5.45	0.90
T5	9.56	3.61	2.14	5.62	0.86
SE (m) +	0.023	0.036	0.024	0.022	0.030
CD at 5%	0.066	0.104	0.069	0.065	0.087
		Interaction			
V1T0	10.37	0.90	0.51	4.80	1.06
V1T1	10.34	1.50	0.85	5.00	1.03
V1T2	10.30	2.10	1.20	5.21	1.00
V1T3	10.27	2.68	1.54	5.41	0.97
V1T4	10.24	3.25	1.97	5.63	0.94
V1T5	10.21	3.82	2.24	5.84	0.90
V2T0	10.37	0.90	0.51	4.80	1.06
V2T1	10.07	1.40	0.80	4.92	1.01
V2T2	9.77	1.91	1.12	5.04	0.96
V2T3	9.48	2.40	1.41	5.16	0.91
V2T4	9.20	2.91	1.71	5.27	0.86
V2T5	8.90	3.40	2.03	5.39	0.81
SE (m) +	0.032	0.050	0.033	0.032	0.042
CD at 5%	0.094	0.147	0.098	0.092	NS
CV	0.56	3.86	4.38	1.05	7.64

Whereas, V1=P.Vasudha, V2=SPH-1620; T0=100% wheat maida+0% sorghum flour; T1=90% wheat maida+10% sorghum flour; T2=80% wheat maida+20% sorghum flour; T3=70% wheat maida+30% sorghum flour; T4=60% wheat maida+40% sorghum flour; T5=50% wheat maida+50% sorghum flour, Results are mean of three replications.

Ash

The control sample was found to contain lowest ash content (0.90%) whereas highest results were observed for treatment T5 (3.82%) in case of P.Vasudha and for treatment T5 (3.40%) in case of SPH-1620. Increase in ash content with increase in sorghum flour was due to higher ash content in sorghum flour as compared to maida. This finding was agreed with Christine *et al.* (2012) who reported that the substitution of wheat flour with beniseed flour increased ash content of bread. Similar effect has been reported by Mahedy *et al.* (2012) for wheat/mushroom composite *bread***.**

Total sugar

The control sample was found to contain lowest total sugar content (4.80%) whereas highest readings were observed for treatment T5 (5.84%) in case of P.Vasudha and for treatment T5 (5.39%) in case of SPH-1620. Increase in total sugar content with increase in sorghum flour addition for the preparation of composite bread was due to higher total sugar content in sorghum flour as compared to maida. This finding was agreed with Islam *et al.* (2011) who reported that the substitution of wheat flour with brown rice and maize flour increased total sugar content of bread.

Crude fiber

The control sample was found to contain lowest crude fiber content (0.51%) whereas highest readings were observed for treatment T5 (2.24%) in case of P.Vasudha and for treatment T5 (2.03%) in case of SPH-1620. Increase in crude fiber content with increase in sorghum flour was due to higher crude fiber content in sorghum flour as compared to maida. Similar effect has been reported by Yusnita *et al.* (2011) for wheat/corn cob composite *bread***.** This finding was also agreed with Okafor *et al.* (2012) who reported that the substitution of wheat flour with mushroom powder increased crude fiber content of bread.

Soluble protein

The control sample was found to contain highest soluble protein (1.06%) whereas lowest readings were observed for treatment T5 (0.90%) in case of P.Vasudha and for treatment T5 (0.81%) in case of SPH-1620. Decrease in soluble protein content with increase in sorghum flour for preparation of composite bread was due to lower soluble protein in sorghum flour as compared to maida.

Effect of different levels of sorghum flour on sensory quality of bread

The results on effect of different levels of sorghum flour addition into wheat maida for bread preparation on their sensory quality parameters are presented in Table 3. The *breads* were prepared using sorghum flour at different levels ranging from 0 to 50% with wheat maida. The *breads* were evaluated with respect to colour and appearance, flavour, taste, crumb and crust texture and overall acceptability.

Table 3 Effect of different levels of sorghum flour on sensory quality of *bread*

Particulars	Colour	Flavour	Taste	Crust & crumb Texture	Overall acceptability
V1	5.70	5.50	6.33	5.87	5.94
V2	5.10	5.13	5.67	5.60	5.48
SE (m) +	0.09	0.08	0.12	0.09	0.06
CD at 5%	0.25	0.22	0.33	0.26	0.16
		Proportion/treatment			
T0	8.60	8.80	8.40	8.60	8.63
T1	8.00	7.60	8.30	8.40	8.13
T2	7.30	7.20	8.10	8.00	7.85
T3	3.70	3.90	4.60	3.90	4.30
T4	2.70	2.40	3.70	3.50	3.08
T5	2.10	2.00	2.90	2.00	2.30
SE (m) +	0.15	0.13	0.20	0.16	0.10
CD at 5%	0.43	0.38	0.57	0.45	0.29
		Interaction			
V1T0	9.00	8.80	8.40	8.80	8.70
V1T1	8.40	8.00	8.40	8.60	8.40
V1T2	8.00	7.40	8.20	8.40	8.05
V1T3	3.80	4.40	5.40	4.20	4.90
V1T4	2.80	2.40	4.20	3.20	3.15
V1T5	2.20	2.00	3.40	2.00	2.45
V2T0	9.00	8.80	8.40	8.80	8.70
V2T1	7.60	7.20	8.20	8.20	7.85
V2T2	6.60	7.00	8.00	7.60	7.65
V2T3	3.60	3.40	3.80	3.60	3.70
V2T4	2.60	2.40	3.20	3.80	3.00
V2T5	2.00	2.00	2.40	2.00	2.15
SE (m) +	0.22	0.19	0.28	0.22	0.14
CD at 5%	0.61	0.53	0.80	0.64	0.40
CV	8.95	7.87	10.54	8.72	5.55

*Foot notes as per Table no 2.

From sensory evaluation of composite *bread* it was observed that addition of Phule Vasudha flour for preparation of composite *bread* showed higher sensory score values for colour, flavour, taste, crumb and crust texture and overall acceptability than addition of SPH-1620 flour in the wheat maida for *bread* preparation. From this it can be conclude that addition of Phule Vasudhas′ flour for preparation of composite *bread* is better than SPH-1620s′ flour. It can be revealed from the results obtained on sensory quality of composite *bread* that there was decrease in sensory score with the increase in addition of sorghum flour of either cultivator or hybrid. Results showed statistically significant difference among the genotypes as well as treatments.

Colour and appearance

Colour is very important parameter in judging the properly baked *bread* that not only reflects the suitable raw material used for the preparation but also provides information about the formulation and quality of the product.

Bread prepared with 10 and 20% sorghum flour was not significantly different in colour and appearance from the control. In the present study, assignment of lower score by the panelists to the crust and crumb colour of *breads* may be attributed to the darker colour of sorghum flour imparted to resultant *breads* than wheat maida. Summer and Nielsen (1976) concluded that the incorporation of 20% sorghum flour in *bread* formulation darkened the internal and external loaf colour of the bread. The darker crust colour may be because of the greater amount of the maillard reaction between reducing sugars and proteins (Raidi and Klein, 1983). Non-wheat flour in *bread* formulation has been shown to increase colour darkness in baked products (Banks *et al.,* 1997). The results obtained are in general agreement with those results from the literature.

Flavour

Flavour is main criteria that make the product to be liked or disliked. The perception of flavour is a combination of taste, smell, impression and texture. *Breads* prepared with 10% and 20% sorghum flour addition with maida were not significantly different in flavour from the control. *Breads* prepared from 30% to 50% sorghum flour addition showed low score to flavour. A similar decrease in the flavour of *breads* with increase in the supplementation levels of fenugreek flour was noticed by Sharma and Chauhan (2000). This finding was also agreed with Joel *et al.* (2011) who reported that the substitution of wheat flour with soy flour decreased flavour of bread.

Taste

Taste is sensation perceived by the taste buds and influenced by the texture, flavour, taste and composition of the product. It is one of the essential parameter related to acceptability of the product. *Breads* prepared with 10 and 20% sorghum flour addition with maida were not significantly different in taste from the control. *Breads* prepared from 30 to 50% sorghum flour addition showed low score for taste. Results of present research are in accordance with the findings of Perten (1977) who reported that high levels of wheat substitution in composite flour bread were detrimental to bread characteristics and loaf volume. Abdelghafor *et al.* (2010) reported similar

results for taste of *bread* from composite flour of sorghum and hard white winter wheat.

Texture (crumb and crust)

Texture is combined sensation of all the rheological and structural parameters of the product during chewing and biting. *Breads* prepared with 10 and 20% sorghum flour were not significantly different in texture from the control. *Breads* prepared from 30 to 50% sorghum flour showed low score to texture. Sorghum flour tends to give a drier and gritty (sandy) texture to sorghum and wheat composite *breads* (Munck, 1995). It was generally accepted that, it was the corneous endosperm of sorghum which adversely affects the *breads* crumb and crust texture (Munck, 1995). It was reported that since wheat flours contain gluten protein which by suitable development gives the *bread* it's unique and much desired texture; the inclusion of sorghum flours dilutes wheat gluten, and consequently weakens its strength. The presence of starch in baking affects crumb characteristics (Taha, 2000). Alpaslan and Hayta (2006) reported that ground flaxseed, soy and corn flours had a significant effect on the textural parameters of *bread*.

Overall acceptability

Overall acceptability is the total reflection of the scores obtained for colour, texture, flavour, and taste of the *bread*. There was decrease in all these parameters with the addition of sorghum flour in the composite *bread*. The overall acceptability parameter also scored minimum at highest level of addition of sorghum flour in the composite *bread*.

Table 4 Effect of different levels of sorghum flour on nutritional quality of *nankatai*

Particulars	Crude protein (%)	Ash (%)	Crude fiber (%)	Total sugar (%)	Soluble protein (%)
V1	5.49	1.63	1.08	22.60	0.62
V2	4.84	1.43	0.94	22.35	0.59
SE (m) +	0.017	0.014	0.011	0.010	0.005
CD at 5%	0.049	0.042	0.032	0.028	0.016
Proportion/Treatments					
T0	5.59	0.40	0.19	22.09	0.71
T1	5.43	0.85	0.52	22.25	0.67
T2	5.26	1.30	0.85	22.40	0.62
T3	5.08	1.75	1.17	22.56	0.58
T4	4.91	2.21	1.51	22.70	0.54
T5	4.75	2.67	1.82	22.87	0.52
SE (m) +	0.029	0.025	0.019	0.017	0.010
CD at 5%	0.085	0.073	0.055	0.049	0.028
Interaction					
V1T0	5.59	0.40	0.19	22.09	0.71
V1T1	5.56	0.90	0.55	22.30	0.67
V1T2	5.52	1.35	0.91	22.50	0.64
V1T3	5.47	1.85	1.25	22.71	0.60
V1T4	5.43	2.38	1.62	22.90	0.57
V1T5	5.39	2.89	1.96	23.12	0.54
V2T0	5.59	0.40	0.19	22.09	0.71
V2T1	5.30	0.80	0.49	22.19	0.66
V2T2	5.00	1.25	0.79	22.30	0.60
V2T3	4.68	1.65	1.08	22.40	0.56
V2T4	4.39	2.04	1.39	22.50	0.50
V2T5	4.10	2.45	1.68	22.62	0.50
SE (m) +	0.041	0.035	0.027	0.024	0.013
CD at 5%	0.120	0.103	0.078	0.070	NS
CV	1.38	4.00	4.60	0.18	3.86

*Foot notes as per Table no 2.

Breads baked with 10 and 20% sorghum flour were not significantly different in overall acceptability from the control. Bankar *et al.* (1986), based on their results, suggested that *bread* containing up to 20% sorghum flour could be baked with acceptable sensory quality. Composite *bread* produced from composite flours at the ratios 90:10, 80:20 and 70:30 wheat: sorghum was found to yield acceptable *bread* quality (Taha, 2000). Koca and Anil (2007), based on their results, suggested that *bread* containing up to 20% flaxseed flour could be baked with acceptable sensory quality.

Effect of different levels of sorghum flour on nutritional quality of nankatai

The results of the proximate composition of the *nankatai* containing different levels of sorghum flour are presented in Table 4. From results it was observed that flour of Phule Vasudha addition to maida for preparation of *nankatai* showed better results in case of all treatments than flour of SPH-1620 addition to maida. It may be due to Phule Vasudha have superior nutritional quality than SPH-1620.

Crude protein

The control sample was found to contain highest crude protein (5.59%) whereas lowest readings were observed for treatment T5 (5.39%) in case of P.Vasudha and for treatment T5 (4.10%) in case of SPH-1620. Decrease in crude protein content with increase in sorghum flour was due to lower protein content in sorghum flour as compared to maida (Gupta *et al*., 2011 and Adebowale *et al*., 2012).

Ash

The control sample was found to contain lowest ash content (0.40%) whereas highest readings were observed for treatment T5 (2.89%) in case of P.Vasudha and for treatment T5 (2.45%) in case of SPH-1620. Increase in ash content with increase in sorghum flour was due to higher ash content in sorghum flour as compared to maida (Javaid *et al*., 1995 and Shoukat *et al.,* 2006).

Total sugar

The control sample was found to contain lowest total sugar content (22.09%) whereas highest readings were observed for treatment T5 (23.12%) in case of P.Vasudha and for treatment T5 (22.62%) in case of SPH-1620. Increase in total sugar content with increase in sorghum flour was due to higher total sugar content in sorghum flour as compared to maida (Adebowale *et al*., 2012).

Crude fiber

The control sample was found to contain lowest crude fiber content (0.19%) whereas highest readings were observed for treatment T5 (1.96%) in case of P.Vasudha and for treatment T5 (1.68%) in case of SPH-1620. Increase in crude fiber content with increase in sorghum flour was due to higher crude fiber content in sorghum flour as compared to maida (Tyagi *et al*., 2007 and Vitali *et al.,* 2009).

Soluble protein

The control sample was found to contain highest soluble protein (0.71%) whereas lowest readings were observed for treatment T5 (0.54%) in case of P.Vasudha and for treatment

T5 (0.50%) in case of SPH-1620. Decrease in soluble protein content with increase in sorghum flour was due to lower soluble protein in sorghum flour as compared to maida.

Effect of different levels of sorghum flour on sensory quality of nankatai

It can be revealed from the results obtained in present study that there were statistically significant results observed for all sensory quality parameters. *Nankatai* prepared with sorghum and wheat composite flour were subjected to sensory evaluation by a semi-trained panel judges as described by Amerine *et al.* (1965). Evaluation was carried out by the panelists for parameters of colour and appearance, flavour, taste, texture and overall acceptability (Table 5).

Table 5 Effect of different levels of sorghum flour on sensory quality of *nankatai*

Particulars	Colour	Flavour	Taste	Texture	Overall acceptability
V1	6.70	6.83	6.90	6.70	6.78
V2	6.33	6.40	6.43	6.10	6.32
SE (m) +	0.08	0.10	0.09	0.09	0.06
CD at 5%	0.23	0.28	0.25	0.26	0.17
Proportion/Treatment					
T0	8.80	8.80	8.80	8.60	8.75
T1	8.20	8.10	8.50	8.20	8.25
T2	8.10	7.80	8.10	7.80	7.95
T3	6.90	7.50	7.60	7.40	7.35
T4	4.00	4.30	4.10	3.60	4.00
T5	3.10	3.20	2.90	2.80	3.00
SE (m) +	0.14	0.17	0.15	0.16	0.10
CD at 5%	0.39	0.48	0.43	0.44	0.30
Interaction					
V1T0	9.00	9.00	8.80	8.60	8.85
V1T1	8.40	8.20	8.60	8.40	8.40
V1T2	8.00	7.80	8.20	8.00	8.00
V1T3	7.00	7.40	8.20	7.60	7.55
V1T4	4.60	4.80	4.20	4.20	4.45
V1T5	3.20	3.80	3.40	3.40	3.45
V2T0	9.00	9.00	8.80	8.60	8.85
V2T1	8.00	8.00	8.40	8.00	8.10
V2T2	8.20	7.80	8.00	7.60	7.90
V2T3	6.80	7.60	7.00	7.20	7.15
V2T4	3.40	3.80	4.00	3.00	3.55
V2T5	3.00	2.60	2.40	2.20	2.55
SE (m) +	0.20	0.24	0.21	0.22	0.15
CD at 5%	0.56	0.68	0.60	0.63	0.42
CV	6.72	8.04	7.12	7.68	5.03

*Foot notes as per Table no 2.

Colour and appearance

Colour is an important sensory attribute of any food because of its influence on acceptability. Colour is an important parameter in judging properly baked cookies as brown colour resulting from Maillard reaction is always associated with baked goods. *Nankatai* prepared with 10, 20 and 30% sorghum flour were not significantly different in colour and appearance from the control (Sharma *et al*., 1999 and Elkhalifa and El-Tinay, 2002).

Flavour

Statistical results for flavour of *nankatai* prepared from different levels of sorghum flours presented in Table 5. The results indicated that the sorghum supplementation level significantly affected the flavour of *nankatai*.

Nankatai prepared with 10, 20 and 30% sorghum flour were not significantly different in flavour from the control. Similar effect has been reported by Oyidi (1976) who found that cake and biscuits made from wheat flour were larger, and the sorghum flour did not hold moisture, dried and crumbled easily and had an off-flavour.

Taste

Statistical results for taste of *nankatai* prepared from different levels of sorghum flours presented in Table 5. The results indicated that sorghum supplementation level significantly affected the taste of *nankatai*. *Nankatai* prepared with 10, 20 and 30% sorghum flour were not significantly different in taste from the control (Ullah, 1990 and Gambus *et al.,* 2003).

Texture

Nankatai prepared with 10, 20 and 30% sorghum flour were not significantly different in texture from the control. *Nankatai* prepared from 40 and 50% sorghum flour showed low score for texture. Glover *et al*. (1986) studied systematically why sorghum addition to wheat in the production of high ratio cakes reduced volume, and caused brittle crumb structure and inferior crust appearance. Using fractionation-reconstitution techniques, they identified lipids and starch of sorghum as responsible components for the texture development.

The use of non-glutinous composite flours in cookie preparation reduces the textural strength of cookies where such strength is dependent upon approximate levels of gluten development. This is because in contrast to bread, the gluten network in cookies is to be only slightly cohesive without being too elastic (Schober *et al*. 2003; Mridula *et al.,* 2007 and Maha *et al.,* 2012).

Overall acceptability

The results indicated that sorghum supplementation level significantly affected the overall acceptability of *nankatai*. *Nankatai* prepared with 10, 20 and 30% sorghum flour were not significantly different in overall acceptability from the control. *Nankatai* prepared from 40 and 50% sorghum flour showed low score for overall acceptability. Sanaa *et al*. (2006) reported that the substitution of wheat flour with 30% of barley, rye, millet or sorghum whole grain meal had no significant effects on the quality (i.e. cookie height and diameter) of cookie products. Gupta *et al*. (2011) reported that the cookies containing 30% barley seed flour was found to be most acceptable by the panelists. The results obtained are in general agreement with those results from the literature.

CONCLUSION

Sorghum flour addition into *bread* formulation had considerable effects on physicochemical and sensory properties of *bread*. It may be concluded from the present study that sorghum flour can be successfully incorporated in refined wheat flour *bread* up to a level of 20% to yield *bread* of enhanced nutritional quality with acceptable sensory attributes. But in case of *nankatai* it was found that *nankatai* of good nutritional and sensory qualities could be produced using 30% level of sorghum flour substitution in maida without affecting the *nankatai* quality adversely and at the same time reduce the economic and domestic load on wheat usage.

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