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Nutritional Composition and Sensory Quality of Cookies Incorporated with Little Millet (*Panicum Milliarae*)

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Abstract

Present study was carried out to formulate and evaluate the little millet based cookies for their nutritional and sensory acceptability to increase the utilization of millet in the preparation of healthy snacks. Two types of cookies were developed *viz* sugar cookies and salt cookies by replacing one part of refined wheat flour with little millet flour by repeated trials. Proximate composition, iron and calcium content were estimated and sensory analysis was done for all the samples to find out the effect of incorporation of millet. Cookies were packed in zip lock covers and stored at room temperature and refrigerator and sensory analysis was carried out till 30 days at the intervals of 10 days. Results showed that cookies were good sources of fat, protein and iron, especially salt cookies were high in protein and iron. There was no significant difference in sensory profile of the cookies prepared by incorporating millet flour in comparison with control products. The storage temperature and duration did not alter the sensory attributes as judged by statistical analysis.

Keywords*:* Nutritional Composition; Sensory Analysis; Storage Studies; Low Temperature Storage.

Introduction

Millets, alternatively called as coarse cereals, are small grains grown in low rain fall areas (Sambavi et al., 2015), they are staple food sources not only providing major nutrients like protein, carbohydrates, fat etc, but also provide fair amounts of minor nutrients (Singh, 2016), *Ragi* (finger millet), *Navane* (Foxtail millet), *Samai* (Little millet), *Haraka* (Kodo millet), *Banti* (Barnyard millet) are commonly used millets, largely cultivated in the Asian and African countries (Jayabhaye et al., 2014). Millets are called as low glycemic foods, as they release sugars slowly into the blood stream. Hence, they are good for diabetic people and also they are poor source of gluten, hence good for people with celiac disease (Karuppaswamy et al., 2013).

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In many developing countries malnutrition and other communicable diseases are increasing because of life style and consumption of diets high in calories, fat and low in protein (Singh, 2016). On account of this, there is an increasing level of awareness regarding health benefits of millets, hence consumers are attracted more towards traditional foods and want to know more about their nutritional benefits and role in prevention of certain non-communicable diseases.

Little millet (*Panicum milliarae)* is a small seeded cereal included among the minor millet. It is a nutritious but neglected crop. Little millet has a good storage stability and is of superior nutritional value; a good source of energy, protein, B complex vitamins, fiber and minerals. It is specifically a rich source of iron with 9.30 mg/100g (Gopalan et al., 2009).

Beneficial effect of consumption of little millet among humans are indicated by many investigators. Hypoglycemic action, hypolipidemic effect and faecal bulking effects of little millet have been determined and reported. It also contains phytochemicals such as phenolic acids, flavonoids, tannins and phytates (Krishnakumari and Thayumanavan, 1997).

Snacks food market, is one of the largest market in the world, continuous innovations in the new flavors and new products are expected to score huge gains in the upcoming years. Among the snacks food market,

baking industry occupies wide area and demand is increasing for bakery products at the rate of 10.07% annually, so bakery products are the best vehicle to incorporate the small millets to enhance the nutritive value and for better health (Kamaljit et al., 2010). Refined wheat flour is the major ingredient in the bakery sector, however, it has low level of important micronutrients, which are removed during the process of refining. Studies indicate that refined wheat flour has lower levels of protein, fat, minerals, vitamins and dietary fiber in comparison to whole wheat flour (Oghbaei and Prakash, 2013, Oghbaei and Prakash, 2016). Comparatively refined wheat flour also contains less nutrients than millets (Gopalan et al., 2009).

Cookies are a group of foods which has long shelf life, generally accepted by all age groups and are available almost everywhere (Turner et al., 2010, Popov-Raljic et al., 2013). The main ingredients in cookies preparation are refined wheat flour, fat and sugar (Paret and Delcour, 2008). The objective of present study was to prepare cookies by partial replacement of wheat flour with little millet and analyze its nutritional and sensory quality.

Materials and Methods

Dehusked little millet (*Panicum milliarae*) was obtained from the local organic shop. Low trans fat margarine was procured from an organic source and all the other ingredients used for the formulation of products such as refined wheat flour, icing sugar, and other spices were brought from local market. All the chemicals and solvents used for the study were of analytical grade and were procured from E-Merck, Mumbai, SD Fine, Qualingens Fine Chemicals, Mumbai, and Nice chemical laboratories (Kolkata). Glass double distilled water was used for all the analysis.

Method

Dehusked little millet (*Panicum milliarae*) was cleaned and extraneous materials were removed. This cleaned millet was milled into fine flour in milling machinery and whole millet flour was used in the study to retain the fiber content.

Two types of cookies were prepared *viz.*, sugar cookies and salt cookies.

Sugar Cookies

Refined wheat flour (40 g) was sifted along with baking powder (1/2 tsp.) and kept aside. Margarine (25 g) and icing sugar (35 g) was creamed together and folded well with flour and cardamom powder (2 no.). Cookies were rolled and baked in a preheated oven at 200°C for 10 minutes. In the experimental product, 20% of refined wheat flour was replaced with little millet flour.

Salt Cookies

Refined wheat flour (80 g), margarine (25 g) and other herbs and spices (green chili - 2 no., omum seeds -1/2 tsp, curry leaves - 5 g, coriander leaves - 6 g and salt (to taste) were mixed together. Curd (25 ml) was added to this mixture and kneaded well to make stiff dough. The dough was rolled and cookies were baked in preheated oven at 170°C for about 15 - 20 minutes. In experimental cookies, 40% of refined wheat flour was replaced with little millet flour.

Analysis of Nutrients

Cookies were analyzed for nutritional composition by standard techniques. Moisture was estimated by oven drying and repeated weighing of samples till a constant dry weight was obtained and moisture calculated by difference in weight (AOAC, 2005). Fat was extracted by Soxhlet distillation method using suitable organic solvent, and extracted fat was weighed after removing the solvent (Raghuramulu et al., 2003). Protein was determined by the Kjeldahl procedure which measures the nitrogen content of a sample. The digested sample was made alkaline with NaOH and the nitrogen is distilled off as ammonia. This is "trapped" in a boric acid solution and quantified by titration with a standard HCl solution. A conversion factor of 6.25 was used to convert the percent nitrogen to crude protein (AOAC, 2000). Total ash was estimated by incinerating the food sample in a muffle furnace at 600°C for 3 - 5 hours. It was weighed and the total ash obtained was converted to solution for measuring iron and calcium (Raghuramulu et al., 2003). Iron was estimated colorimetrically by method of Wong using potassium thiocyanate for color development. A standard curve was prepared by using ferrous ammonium sulphate. The iron content of sample was then read from the standard curve (Raghuramulu et al., 2003). Calcium was precipitated as calcium oxalate, the precipitate dissolved in hot dilute H_2SO_4 and titrated against standard potassium permanganate (Oser, 1965).

Sensory Analysis

Cookies were randomly coded and subjected to

sensory analysis for appearance, color, texture, aroma, taste and overall quality by using the score card having 1-10 grading scale by semi-trained panel members (n = 30). The products were evaluated by the panel members in mid-morning and water was allowed in between the samples. Effect of incorporation of millet on sensory attribute was analyzed and the results were tabulated. To determine the alteration in the sensory quality during the storage, all samples were packed in the Zip lock cover, one set of samples were stored in the refrigerator (low temperature) and another set of samples were stored at room temperature. Sensory evaluation was done for the samples stored at both the temperature till the end of 30th day at the intervals of 10 day and results were recorded.

Statistical Analysis

The data were analyzed statistically using suitable tests. Standard deviation and t-test was used for the compositional analysis data and also post test carried out to see any significant differences between the samples. The sensory analysis data was subjected to t-test to determine the statistically significant differences among the products which were developed.

Results and Discussion

Analysis of Nutritional Composition

Nutritional composition of cookies was analyzed and the results are presented in Table 1. Moisture content of the refined wheat flour (RWF) cookies and litte millet (LM) sugar cookies was found to be 3.17±0.08 and 3.64±0.02 respectively as there was no added water in the cookies during preparation, the moisture content was not high.

But in salt cookies curd was used to prepare the dough, hence, moisture content was in higher range (12.29±0.32 in RWF and 13.08±0.07 LM) as curd has 89% moisture (Gopalan et al., 2009). Fat content of sugar cookies was high in both RWF and LM flour cookies because of added fat, i.e margarine, and slightly lower fat content was found in salt cookies as lesser fat was used than sugar cookies. Addition of millet did not change the protein content significantly in salt and sugar cookies, though between the products, salt cookies had more protein than sugar cookies. Kumar et al., (2015) and Hemalatha et al., (2006) reported that addition of millet flour resulted in an increase in protein and fiber content in millet incorporated biscuits.

Table 1: Nutritional composition of cookies (per 100g)

Nutrients	RWF Sugar Cookies	LM Sugar Cookies	RWF Salted Cookies	LM Salted Cookies
Moisture (g)	3.17±0.08	3.64±0.02	12.29±0.32	13.08±0.07
Fat (g)	25.31±0.12	25.68±0.10	18.84±0.02	18.36±0.00
Protein (g)	5.40±0.11	5.30±0.00	9.96±0.21	10.06±0.11
Ash (g)	0.92±0.02	1.13±0.01	3.10±0.00	4.20±0.03
Calcium (mg)	15.43±0.03	33.89±1.56	54.69±0.78	70.10±0.77
Iron (mg)	2.07±0.06	2.28±0.12	3.95±0.46	6.65±0.30

RWF- Refined wheat flour, LM- Little millet.

Ash content of LM cookies was higher than RWF cookies as little millet is richer in mineral content. Increased iron content was seen in both sugar (2.28 mg/100g) and salt cookies (6.65 mg/100g). LM salt cookies has highest iron content due to the addition of greens, as green leafy vegetables are rich in iron (Gopalan et al., 2009).

Millet incorporated cookies has higher calcium content than RWF cookies and more calcium content was found in LM salt cookies. This enhancement could be due to addition of curd, which has a higher calcium content (Gopalan et al., 2009). Hemalatha et al., (2006) also reported a content of 3.30 mg of iron and 23 mg of calcium/100g in the 20% little millet incorporated cookies. Shiny et al., (2012) also reported an improved nutrient profile in the millet incorporated biscuits.

Effect of Incorporation of Millet on Sensory Attributes of Cookies

Sensory characteristics of cookies are presented in the Table 2. Scores for all sensory attributes of cookies ranges from 9.0-9.1± 0.8. Sensory evaluation of cookies for appearance, color , texture and flavor shows no significant difference between the RWF cookies and LM cookies. It ranged between 9.0- 9.1± 0.7. Shiney and John (2012) also found that millet added biscuits were well accepted by panel members.

Table 2: Effect of incorporation of millet on sensory attributes (Mean ± Standard deviation) of Cookies

Sensory attributes	Sugar Cookies		Salt Cookies	
	Refined wheat flour	Little millet	Refined wheat flour	Little millet
Appearance	9.0 ± 0.6	9.1 ± 0.7	9.1 ±0.7	9.3 ±0.7
p-value	-	0.350 ns	-	0.845 ns
Color	9.1±0.6	9.2±0.6	9.2 ±0.7	9.2 ±0.7
p-value	-	0.571 ns	-	0.550 ns
Texture	9.1 ±0.7	9.1 ±0.7	9.1 ±0.8	9.3 ±0.6
p-value	-	0.461 ns	-	0.855 ns
Flavor	9.1 ±0.8	9.1 ±0.7	9.1 ±0.7	9.3 ±0.7
p-value	-	0.377 ns	-	1.000 ns
Overall quality	9.1 ±0.7	9.2 ±0.7	9.1 ±0.7	9.1 ±0.7
p-value	-	0.566 ns	-	1.000 ns

P value indicates statistical significance between refined wheat flour and millet Cookies on application of Student's 'T' test., ns- not significant

Effect of Storage on Sensory Quality of Cookies

Effect of storage on sensory value of sugar cookies and salt cookies are presented in the Table 3 and Table 4. Comparison was done between the duration of storage with 0 day samples using Students T test and the P value are indicated in tables. It was also done between the samples stored at room and low temperature and appropriate statistical notations are indicated along with the attribute scores in tables. On the 10th day of storage period, products stored at the refrigerator and room temperature were given almost similar scores for all the attributes and no significant difference was observed in any of the attributes.

Table 3: Effect of storage on sensory quality of Sugar cookies: comparison between samples stored at different temperature and with 0 day sample (P value)

Sensory attributes	Refined Wheat Flour cookies		Little Millet cookies	
	R.T.	R.F.	R.T.	R.F.
10th day				
Appearance	9.0 ± 0.8	9.0 ±0.8 ns	9.0 ± 0.6	9.0 ±0.5 ns
p-value	0.711 ns	0.729 ns	0.854 ns	1.000 ns
Color	9.1±0.8	9.1 ±0.7 ns	9.1±0.7	9.2 ±0.8 ns
p-value	0.855 ns	0.698 ns	0.695 ns	1.000 ns
Texture	9.1 ±0.7	9.1 ±0.8 ns	9.1 ±0.7	9.1 ±0.7 ns
p-value	1.000 ns	0.863 ns	1.000 ns	0.593 ns
Flavor	9.1 ±0.8	9.1 ±0.8 ns	9.2 ±0.7	9.1 ±0.8 ns
p-value	0.867 ns	0.867 ns	0.576 ns	1.000 ns
Overall quality	9.1 ±0.7	9.2 ±0.5 ns	9.2 ±0.7	9.2 ±0.7 ns
p-value	0.854 ns	1.000 ns	0.597 ns	0.730 ns
20th day				
Appearance	9.0 ± 0.8	9.0 ±0.7 ns	9.0 ± 0.7	9.0 ±0.6 ns
p-value	0.678 ns	0.583 ns	0.711 ns	0.436 ns
Color	9.1±0.8	9.1 ±0.7 ns	9.1±0.7	9.2 ±0.8 ns
p-value	0.855 ns	0.701 ns	0.695 ns	1.000 ns
Texture	9.1 ±0.8	9.1 ±0.7 ns	9.0 ±0.7	9.2 ±0.6 ns
p-value	1.000 ns	1.000 ns	1.000 ns	1.000 ns
Flavor	9.1 ±0.7	9.2 ±0.7 ns	9.1 ±0.7	9.1 ±0.7 ns
p-value	0.867 ns	0.728 ns	0.576 ns	0.848 ns
Overall quality	9.1 ±0.7	9.2 ±0.7 ns	9.2 ±0.5	9.2 ±0.7 ns
p-value	1.000 ns	0.520 ns	0.597 ns	0.713 ns
30th day				
Appearance	9.1 ± 0.7	9.1 ±0.6 ns	9.0 ± 0.7	9.0 ±0.7 ns
p-value	0.243 ns	0.673 ns	0.056 ns	0.169 ns
Color	9.1±0.7	9.1 ±0.7 ns	9.0±0.7	9.2 ±0.8 ns
p-value	0.333 ns	1.000 ns	0.706 ns	0.469 ns
Texture	9.1 ±0.8	9.1 ±0.7 ns	9.1 ±0.7	9.1 ±0.7 ns
p-value	0.854 ns	0.855 ns	0.860 ns	0.593 ns
Flavor	9.1 ±0.8	9.1 ±0.6 ns	9.1 ±0.7	9.1 ±0.7 ns
p-value	0.736 ns	0.725 ns	0.844 ns	1.000 ns
Overall quality	9.0 ±0.7	9.2 ±0.8 ns	8.0 ±0.7	9.0 ±0.7 ns
p-value	0.698 ns	0.132 ns	0.730 ns	0.371 ns

R.T.- Room temperature, R.F.- Refrigerator, P value indicates statistical significance on application of Student's 'T' test between 0 day and stored samples. Notations with attributes indicate difference between sample stored at different temperatures, ns: not significant.

Table 4: Effect of storage on sensory quality of Salt cookies: comparison between samples stored at different temperature and with 0 day sample (P value)

Sensory attributes	Refined Wheat Flour cookies		Little Millet cookies	
	R.T.	R.F.	R.T.	R.F.
10th day				
Appearance	9.0 ± 0.6	9.3 ±0.6 ns	9.0 ± 0.7	9.2 ±0.7 ns
p-value	0.560 ns	0.442 ns	0.687 ns	0.709 ns
Colour	9.1±0.6	9. 2±0 ns	9.2±0.7	9.2 ±0.6 ns
p-value	0.698 ns	1.000 ns	0.709 ns	0.698 ns
Texture	9.1 ±0.7	9.1 ±0.7 ns	9.0 ±0.7	9.1 ±0.7 ns
p-value	0.710 ns	1.000 ns	0.711 ns	1.000 ns
Flavour	9.1 ±0.8	9.0 ±0.7 ns	9.2 ±0.8	9.3 ± 0.7 ns
p-value	1.000 ns	0.377 ns	0.714 ns	0.205 ns
Overall quality	9.1 ±0.7	9.2 ±0.7 ns	9.2 ±0.7	9.2 ±0.7 ns
p-value	1.000 ns	0.852 ns	0.571 ns	0.698 ns
20th day				
Appearance	9.1 ± 0.7	9.1±0.6 ns	9.1 ± 0.8	9.1 ±0.7 ns
p-value	1.000 ns	0.727 ns	0.426 ns	0.461 ns
Colour	9.1 ± 0.7	9.2 ±0.7 ns	9.2 ± 0.8	9.2 ±0.6 ns
p-value	1.000 ns	1.000 ns	1.000 ns	0.727 ns
Texture	9.1 ±0.8	9.0 ±0.7 ns	9.1 ±0.7	9.1 ±0.7 ns
p-value	0.860 ns	0.867 ns	0.711 ns	0.593 ns
Flavour	9.1 ±0.7	9.2 ±0.7 ns	9.1 ±0.8	9.2 ±0.7 ns
p-value	0.867 ns	0.867 ns	0.714 ns	0.704 ns
Overall quality	9.3±0.7	9.2 ±0.7 ns	9.1 ±0.8	9.2 ±0.7 ns
p-value	0.470 ns	1.000 ns	1.000 ns	1.000 ns
30th day				
Appearance	9.0 ± 0.7	9.1 ±0.7 ns	8.9 ± 0.7	9.1 ±0.8 ns
p-value	0.720 ns	0.281 ns	0.461 ns	0.490 ns
Colour	8.9±0.8	9.0 ±0.8 ns	9.0±0.8	9.1 ±0.7 ns
p-value	1.000 ns	1.000 ns	0.252 ns	0.461 ns
Texture	9.1 ±0.8	9.0 ±0.8 ns	9.1 ±0.8	9.0 ±0.8 ns
p-value	0.860 ns	0.311 ns	0.868 ns	0.609 ns
Flavour	9.2 ±0.7	9.3 ±0.8 ns	9.1 ±0.7	9.1 ±0.7 ns
p-value	0.662 ns	0.205 ns	1.000ns	0.604 ns
Overall quality	8.9±0.7	9.0 ±0.8 ns	9.2 ±0.7	9.1 ±0.7 ns
p-value	0.264 ns	0.556 ns	0.367 ns	0.255 ns

samples stored at different temperature and with 0 day sample (P value)

R.T.- Room temperature, R.F.- Refrigerator, P value indicates statistical significance on application of Student's 'T' test between 0 day and stored samples. Notations with attributes indicate difference between sample stored at different temperatures, ns: not significant.

On the 20th and 30th day of storage period, sensory scores slightly decreased from 9.3 to 8.0 for the products stored at room temperature in comparison with samples stored under refrigeration, however, the differences were not significant. Little millet contains phenolic compounds, which function as powerful anti-oxidants and increase the shelf life cookies by preventing them from rancidity (Krishnakumari and Thayumanavan, 1997).

Conclusion

Cookies prepared by incorporating little millet flour exhibited better nutritional composition. Addition of green leafy vegetables and curds to the salt cookies was highly beneficial in the enhancement of iron and calcium content. The sensory quality of cookies was also good, with no significant differences found in the acceptability of millet incorporated and standard cookies. There was no off flavor or off odor developed during the storage period at both the storage conditions. Hence in conclusion, it can be stated that addition of little millet in the preparation of cookies is a healthy option to utilize millet and provide essential nutrients without any alteration in the taste profile of the products with good shelf life.

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