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Sensory and Nutritional properties of Millet based High Fiber Biscuit

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Abstract: ***Consumer interest in healthy eating is shifting towards the potential health benefits of specific foods and food ingredients. Unconventional ingredients combined with usual bakery flour yields better acceptable, healthy and nutritious bakery products.The present study aims to evaluate the sensory and nutritional properties of millet based high fiber biscuit. The high fiber biscuit was formulated using millets, whole grains, flax seed and spices after repeated trials and the recipe was standardized. When subjected to sensory evaluation, the newly formulated high fiber biscuit derived a score of 4.5 ± 0.51, out of a maximum score of 5, for its overall acceptability, indicating, the biscuit was well accepted. The results of the comparative analysis of nutritional quality and cost of the newly formulated high fiber biscuit with six high fiber biscuits available in the market indicate that, it contains the highest amount of fiber (19.21 g/100 g), lowest amount of calories (424.6 Kcal/100 g) and fat content (13.10 g/100 g). Hence, the study proved that the newly formulated millet based biscuit is well acceptable based on its sensory properties and fiber rich nutritional quality.***

Keywords: Healthy eating, formulation, bakery, functional food, comparative analysis

1. Introduction

Rapid urbanization involving changes in occupation patterns, life styles, family structures and value system reflected as changes in practices and in the level of physical activity. A large shift from consumption of coarse grains such as sorghum, barley, rye, maize and millet to more refined cereals, like polished rice and wheat is seen especially among the urban population and higher income groups (Vijayakumar et al., 2009).

"Millet" is a generic term for a heterogeneous group of forage grasses known for their small "coarse" grains (Weber 1998). It has been reported that millet proteins are good sources of essential amino acids except lysine and threonine but are relatively high in methionine. Millets are also rich sources of phytochemicals and micronutrients (Mal et al., 2010; Singh et al., 2012). The presence of all the required nutrients in millets makes them suitable for large-scale utilization in the manufacture of food products such as baby foods, snack foods and dietary supplements and, increasingly, more millet products have entered into the daily lives of people, including millet porridge, millet wine, millet biscuits and millet mixes (Subramanian et al., 2007; Liu et al., 2012). Millets must also be accepted as functional food and nutraceuticals because they provide dietary fibers, proteins, energy, minerals, vitamins and antioxidants required for human health (Truswell 2002).

There is ample scope to enhance the nutritional value of biscuits both quantitatively and qualitatively using nutritious food ingredients. In this regard, there are several food ingredients with exceptional nutritional qualities because of their nutraceutical and/or nutritional components, such as millets, oil seeds, condiments and other novel ingredients. Value addition to existing foods with such ingredients is a simple and feasible way of enhancing nutritional values of foods and in turn the health benefits. There is therefore a need to revive these important groups of health promoting foods to enhance nutritional quality of diets of consumers and thus help to prevent and manage the burden of non-communicable diseases (Ballolli 2010). Preparation of biscuit from millets and its fortification with other nutritious ingredients will result in increased utilization of millet and production of nutritious biscuits (Kumar et al., 2010). In view of this, the present work was undertaken to study the sensory and nutritional properties of newly formulated millet based high fiber biscuit.

2. Materials and Methods

2.1 Development and Standardization of millet based high fiber biscuit

Blends of dry roasted whole grains such as Barnyard millet (Echinochloa), Finger millet (Eleusinecoracana), little millet (Panicumsumatrense), Kodo millet (Paspalumscrobiculatum), Maize (Zea mays), Jowar (Sorghum) and Wheat (Triticum) in equal proportions were mixed along with oat bran (Avena sativa) and dry roasted, powdered flax seed (Linumusitatissimum). Spices such as red chilli (Capsicum annuum), garlic (Allium sativum) and cinnamon (Cinnamomumverum) and salt were added to the above mixture to add flavor to the biscuit. The above mixture was kneaded into dough by adding vegetable oil and water. The prepared dough was rolled to a thickness of 1cm and cut into equal sizes using a biscuit cutter and baked at 250ºC for 25 minutes. The newly formulated high fiber biscuit weighed 10 g each.The recipe was repeated in many trials, altering the quantities of ingredients in definite proportions, which produced similar results of the product. Thus, the recipe of the product was standardized.

2.2 Sensory Evaluation

The formulated biscuit was subjected to sensory evaluation to test the acceptability using a five point hedonic scale, where 1= dislike extremely, 2 = dislike moderately, 3 =

neither like nor dislike, 4 = like moderately and 5 = like extremely.

Criteria for selection of judges for sensory evaluation –

- Willingness to participate in the study
- With normal taste sensitivity – free from any oral problems that could affect taste
- Not allergic to the ingredients used in formulation of the biscuit.
- Free from illness

Based on the criteria for selection mentioned above, twenty adult men with normal taste sensitivity and who were not allergic to the ingredients used in the biscuit were chosen as judges for the sensory evaluation. The score card for the evaluation of the biscuit was provided along with instructions to each judge before evaluation. Each judge indicated the extent of his likes or dislikes in terms of appearance / colour, texture / doneness, odour, taste, flavour and overall acceptability of the biscuit. The sensory scores of the high fiber biscuit for each parameter were subjected to statistical analysis to calculate mean scores.

2.3 Nutritional properties

The proximate principles namely moisture, carbohydrates, fat, total ash, crude fiber, energy, crude protein, and total dietary fiber content of the biscuitwas analyzed following standard methods.

Comparison of nutritional properties and cost of the newly formulated high fiber biscuit with the high fiber biscuits available in the market

A market survey was carried out to collect the labels of a few high fiber biscuits available in the market. Information on the nutritional content and cost of the biscuits were collected from the labels of the biscuits. The nutritional quality and cost of the newly formulated high fiber biscuit were compared with the high fiber biscuits available in the market and subjected to analysis.

3. Results and Discussion

3.1 Formulation of millet based high fiber biscuit

Blends of dry roasted whole grains such as Barnyard millet (Echinochloa), Finger millet (Eleusinecoracana), little millet (Panicumsumatrense), Kodo millet (Paspalumscrobiculatum), Maize (Zea mays), Jowar (Sorghum) and Wheat (Triticum) in equal proportions were mixed along with oat bran (Avena sativa) and dry roasted, powdered flax seed (Linumusitatissimum). Spices such as red chilli (Capsicum annuum), garlic (Allium sativum) and cinnamon (Cinnamomumverum) and salt were added to the above mixture to add flavor to the biscuit. The above mixture was kneaded into dough by adding vegetable oil and water. The prepared dough was rolled to a thickness of 1cm and cut into equal sizes using a biscuit cutter and baked at 250ºC for 25 minutes. The newly formulated high fiber biscuit weighed 10 g each.

Blending of millet grains, or their milling fractions with other nutritive ingredients, is one of the most convenient techniques to produce food products with high nutritional and functional quality and to promote their utilization in a large range of food products. This is because conversion of millet grains in pure-millet bakery goods and some solid food products is not easy because of the deficiency of gluten in millet and some functional properties that are needed to make easy-to-handle, good texture, and ready-to-eat products compared with wheat and some other cereal grains (Ahmed et al., 2013).

3.2 Sensory properties of the millet based high fiber biscuit

The formulated biscuit was subjected to sensory evaluation to test the acceptability of the product using a five point hedonic scale, where 1= dislike extremely, 2 = dislike moderately, 3 = neither like nor dislike, 4 = like moderately and 5 = like extremely. Twenty adult men with normal taste sensitivity and who were not allergic to the ingredients used in the biscuit were chosen as judges for the sensory evaluation. Each judge indicated the extent of his likes or dislikes in terms of appearance / colour, texture / doneness, odour, taste, flavour and overall acceptability of the biscuit. The mean sensory scores of the millet based high fiber biscuit is presented in table 1 –

Table 1: Mean sensory scores of high fiber biscuit

Parameters	*Mean*	*Standard Deviation*
Appearance / Colour	4.5000	.68825
Texture / Doneness	4.5500	.51042
Odour	4.8000	.41039
Taste	4.5000	.68825
Flavour	4.8500	.36635
Overall Acceptability	4.5000	.51299

Sensory evaluation has been defined as a scientific method used to evoke, measure, analyze and interpret those responses to products as perceived through the senses of sight, smell, touch, taste, and hearing (ISO 1992). As defined by ISO Standard 5492 (1992), sensory analysis is the “examination of organoleptic attributes of a product by the sense organs (Clydesdale 1993).”

3.3 Appearance

Outcome of sensory evaluation of the biscuits on appearance indicated that the product obtained a mean score of 4.5 ± 0.69. The scores were between “like moderately” and “like extremely” categories. Appearance is an important attribute in food choice and acceptance. The eyes perceive the initial quality of food, receiving such information as color, size, shape, texture, consistency and opacity. Acceptability, sensory characteristics, safety, and aesthetics of food are all affected by color (Edelstein 2013).

3.4 Texture / Doneness

Outcome of sensory evaluation of the biscuits on texture / doneness indicated that the product obtained a mean score of 4.55 ± 0.51. The scores were between “like moderately” and “like extremely” categories. The sense of touch delivers impressions of a food’s texture through oral sensations or the skin. Texture is a very complex perception: the first

input is visual; second comes touch, either directly through the fingers or indirectly via eating utensils; the third is the feeling in the mouth (mouthfeel), as detected by the teeth and tactile nerve cells on the tongue and palate. According to ISO Standard 5492 (1992), texture is defined as, "All the mechanical, geometrical and surface attributes of a product perceptible by means of mechanical, tactile and, where appropriate, visual and auditory receptors(Stone et al., 1993)."

3.5 Odour

The High Fiber biscuits derived a mean score of 4.8 ± 0.41 for odour. The scores were between "Like moderately" and "like extremely" categories. Smell is an integral part of taste and general acceptance of the food before it is put in the mouth. It is therefore an important parameter when testing acceptability of formulated foods. Human subjects have varying sensitivities to odors, depending on hunger, satiety, mood, concentration, presence or absence of respiratory infections, and gender (e.g. women who are menstruating or are pregnant may perceive odors differently). Because different people perceive a given odorant differently, identifying a new odor from a food product requires as large a panel as possible to get valid results (Muhimbula et al., 2011).

3.6 Taste

The mean score obtained by the biscuits for its taste was 4.5 ± 0.69. The scores were between "Like moderately" and "like extremely" categories. Taste, or the perception of gustatory input, is the most influential factor in a person's selection of a particular food. Taste is perceived by the taste buds, which are primarily on the surface of the tongue, by the mucosa of the palate, and in areas of the throat. Taste is an important parameter when evaluating sensory attribute of food. The product might be appealing and having high energy density but without good taste, such a product is likely to be unacceptable (Awasthi et al., 2000).

3.7 Flavor

Of all the sensory properties, the biscuits obtained the highest mean score of 4.85 ± 0.37 for its flavor. While taste relies on the sensation produced through the stimulation of the taste buds, flavor is a broader concept. Flavor is the combined senses of taste, aroma, and mouthfeel. Mouthfeel encompasses textural and chemical sensations such as astringency, spice heat, cooling, and metallic flavor (Muhimbula et al., 2011).

3.8 Overall acceptability

The mean score of the overall acceptability of the biscuits was 4.5 ± 0.51, indicating that the scores obtained by the product for its overall acceptability were between "like moderately" and "like extremely" categories.

3.9 Nutritional properties of high fiber biscuit

Table 2: Nutritional properties of high fiber biscuit

Nutrients	Laboratory Test Method	Values	
		Laboratory Test Method	'Nutritive Value of Indian
Moisture (g)	AOAC 925.10	8.41	11.47
Carbohydrates (g)	By Difference (Ref. AOAC 986.25)	68.05	41.55
Fat (g)	AOAC 922.06	13.10	14.59
Crude Fibre (g)	AOAC 962.09	2.05	6.20
Total ash (g)	AOAC 923.03	1.82	1.82
Energy (Kcal)	Nutritive value of Indian foods (ICMR)	424.60	319.09
Crude Protein (g)	AOAC 920.87	8.62	7.36
Total Dietary Fibre (g)	IS 11062 :1984	19.21	23.90

As presented in table 2, the nutrient analysis of the high fiber biscuit based on laboratory test method and 'Nutritive value of Indian foods', NIN, indicated the Moisture content of the biscuit to be 8.41 g and 11.47 g respectively; Carbohydrate content of the biscuit to be 68.05 g and 41.55 g respectively; Fat content of the biscuit to be 13.10 g and 14.59 g respectively; Crude fiber content of the biscuit to be 2.05 g and 6.2 g; Total ash content to be 1.82 g; Energy content of the biscuit to be 424.6 Kcal and 319.09 Kcal respectively; Crude Protein of the subject to be 8.62 g and 7.36 g respectively; and total dietary fiber content of the biscuit to be 19.21 g and 23.9 g respectively. Differences in the nutrient values estimated by laboratory method and calculated using 'Nutritive value of Indian foods' were present because, certain ingredients of the biscuit such as oat bran and kodo millet were not included in the 'Nutritive value of Indian foods' book. As a result, the nutritive value of the biscuit was calculated only based on the ingredients present in the Nutritive value of Indian foods book. The laboratory analysis of nutrients has estimated the exact values of nutrients present in the biscuit using various techniques for the respective nutrients.

Comparison of nutritional properties and cost of the newly formulated high fiber biscuit with high fiber biscuits available in the market

Table 3: Comparison of nutritional properties and cost of the newly formulated high fiber biscuit with high fiber biscuits available in the market

S. No	Products	Energy (Kcal) / 100 g	Protein (g) / 100 g	Fat (g) / 100 g	Carbohydrates (g) / 100 g	Dietary Fiber (g) / 100 g	Cost (Rs.) / 100 g
1	Sample A	535.71	7.1	25	75	2.9	24
2	Sample B	475	9.0	19	67	9.5	43.33
3	Sample C	478	7.1	21.2	62.8	3.6	18
4	Sample D	439	8.3	10.1	78.8	6.4	10
5	Sample E	455	7.5	9.6	62	6	20
6	Sample F	441	8.0	10.7	78.1	4.3	9.09
	Newly formulated high fiber biscuit	**424.6**	**8.62**	**13.10**	**68.05**	**19.2**	**24.89**

As indicated in table 3, the newly formulated high fiber biscuit contained the highest amount of fiber, 19.2 g per 100 g of biscuits with the least amount of calories, 424.6 Kcal per 100 g of biscuits, when compared to the samples of high fiber biscuits available in the market, chosen for the study. The other proximate principles in the newly formulated high fiber biscuit, such as Protein, Fat and Carbohydrates were similar to that of the samples used for the study. Cost comparison of the newly formulated high fiber biscuit with the samples indicates that the cost of the high fiber biscuit was higher than most of the other samples except sample B. Inclusion of a few expensive fiber and antioxidant rich ingredients such as oat bran, flaxseed and garlic powder increased the cost of the high fiber biscuit. The results of this comparative analysis indicate that, though the cost of the newly formulated high fiber biscuit is higher than most of the samples, it contains the highest fiber, lowest calories and fat content of all the samples used for the study. The high fiber biscuit can be used as a dietary supplement for treating non-communicable diseases such as metabolic syndrome, diabetes and cardiovascular diseases because of its rich fiber content.

4. Conclusion

The study concludes that formulation of value added millet biscuits are not only acceptable well based on sensory properties, but also nutritionally dense with high fiber content. It is right time for potential minor millets to be included as part of the daily diet. The advantages of millet consumption include – nutritional properties like high fiber, protein and minerals which help treating many diseases; surplus availability; and cost-effectiveness. Future trends need increasing productivity and trade (regionally and internationally) and adding value to millet products by improving / increasing processing and utilization in industry. New research findings in this area indicate the potential value of millet based diets in prevention of diseases. Formulation and development of new cost-effective products rich in fiber and antioxidants will help to tackle such diseases by the different target specific underlying mechanisms.

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