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Formulation and sensory evaluation of biscuits prepared from supplementation of whole wheat flour with chia seed flour

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Abstract
The objective of this study was to evaluate the optimum level of chia seed flour to be incorporated in biscuits and analysis of sensory attributes of biscuits. Seven different formulations were made replacing whole wheat flour by: 5% chia flour (T1), 10% chia flour (T2), 15% chia flour (T3), 20% chia flour (T4), 25% chia flour (T5), 30% chia flour (T6) and 35% chia flour (T7). The result of sensory evaluation showed that up to 30 per cent chia seed flour can be successfully incorporated to whole wheat flour to develop biscuits without adversely affecting their sensory attributes.

Keywords: Chia seed flour, sensory evaluation, biscuits, whole wheat flour, formulation

Introduction
Modern diet is loaded with calories and trans-fats, leading the consumers towards cardiovascular and other chronic diseases. The research for wholesome food sources has given prominence to chia seeds. Chia (*Salvia hispanica*) belongs to Lamiaceae family. The seeds are tiny, oval shaped and black or white in colour. It is native to Mexico and Guatemala (Patel, 2015) [17]. The major cultivating countries are Argentina, Peru, Bolivia, Colombia, Ecuador, Guatemala, Mexico and Australia (Jamboonsri *et al*. 2012) [14]. They contain about 40% lipids (almost 60% as omega-3) (Coelho and Salas-Mellado, 2014) [6], besides proteins of high biological value (about 19% of the total weight) (Olivos-Lugo *et al*., 2010; Ixtaina *et al*., 2008) [16, 13]. In addition, they contain minerals, vitamins, and antioxidants such as tocopherols (238–427 mg kg−1) and polyphenols (Coelho and Salas-Mellado, 2014) [6]. Chia seeds contain high fiber contents (34.6%) as reported by Ixtaina *et al*. (2011) [12], which is about 9% higher than those found in other cereals and can increase satiety and decrease energy consumption (Olivos-Lugo *et al*., 2010) [16]. They are highly hygroscopic and form a gel on imbibing water (Patel, 2015) [17]. The gum present in chia seed has the ability to hold water and oil as well as having emulsifier and stabilizer potential (Segura-Campos *et al*., 2014) [21].
The consumption of chia has been increasing over the years, given its health benefits related to chronic diseases such as obesity, cardiovascular diseases, diabetes, and cancer (Ixtaina *et al*., 2008; Poudyal *et al*., 2013; Vazquez-Ovando *et al*., 2010) [13, 19, 25]. These benefits result mainly from the high concentrations of essential fatty acids, dietary fibers, proteins, antioxidants, vitamins, carotenoids, and minerals in chia seeds (Ayerza and Coates, 2011; Reyes-Caudillo *et al*., 2008) [2, 20]. Today, chia seed is consumed whole or in the form of flour, alone (in natura), added to other foods, such as yogurts, salads, and fruits (Cahill, 2004; Vuksan *et al*., 2007) [5, 26], in preparations such as breads, cakes, granola bars, beverages, and others.
In general, the incorporation of chia in foods improves their physicochemical and sensory characteristics, especially their nutritional properties (Grancieri *et al*., 2019) [10]. The chia seeds in bakery products increase their concentrations of proteins, unsaturated fatty acids, antioxidants and dietary fiber (Iglesias-Puig and Haros, 2013; Segura-Campos *et al*., 2013) [11, 22].
In recent years, there is a much research on biscuit ingredients and proportion which could be modified to make biscuits nutritious and healthy (Yamsaengsung *et al*., 2012) [28]. This approach not only promotes the development of diversified and nutrient rich bakery products, but also reduces over exploitation and excessive use of wheat for making bakery products. Composite flour bakery products have manifold advantages, apart from extending the availability of wheat flour, these are looked upon as carrier of useful functional food components and nutrients (Divyashree *et al*., 2016) [7].

Baked cereal products are generally chosen as ideal material over others owing to their wide consumer acceptance. However, developing a marketable product with potential health benefits requires thorough investigation of multiple product parameters (Goyat *et al*., 2018) [9]. The purpose of the present study was to determine the optimum level of chia seed flour which can be incorporated in biscuits by replacing whole wheat flour and evaluation of the sensory parameters of formulated biscuits.

Materials and Methods

Procurement of raw materials

The present study was conducted in the Department of Foods & Nutrition, College of Home Science, G.B. Pant University of Agriculture and Technology, Pantnagar, Udham Singh Nagar, Uttarakhand. For the study, chia seeds and other ingredients *viz*. whole wheat flour, sugar, vegetable oil, baking powder, sodium bicarbonate, ammonium bicarbonate, custard powder and vanilla essence required for biscuit preparation were purchased from local market of Pantnagar (Udham Singh Nagar), Uttarakhand, India. Soya lecithin (emulsifier) was purchased online from Amazon.

Preparation of chia flour

Chia seeds were cleaned by removing dust, impurities and other foreign materials. Thereafter, seeds were milled in electric grinder. The chia seed flour thus obtained was kept in air tight container for further use.

Preparation of blends from whole wheat flour and chia seed flour

The whole wheat flour and chia seed flour were mixed in different ratios as shown in Table 1. The control sample contained 100% whole wheat flour.

Table 1: Blend ratio of whole wheat flour and chia seed flour

Sample Code	Whole wheat flour	Chia seed flour
Control	100	0
T1	95	5
T2	90	10
T3	85	15
T4	80	20
T5	75	25
T6	70	30
T7	65	35

Preparation of biscuits

Biscuits were prepared according to the recipe given by Whitley (1970) with certain modifications. The ingredients used for biscuit making have been listed in Table 2.

Table 2: Ingredients for biscuit

Ingredients	Amount
Whole wheat flour/blend	100g
Sugar	30g
Fat	20g
Custard powder	10g
Soy lecithin	0.5g
Ammonium bicarbonate	1g
Salt	0.6g
Baking powder	0.4g
Sodium bicarbonate	0.3g
Vanilla essence	0.5ml
Water	As required for proper consistency

The traditional creaming method was used for the preparation of biscuits. All the dry ingredients i.e. baking powder, custard powder, soy lecithin, ammonium bicarbonate, sodium bicarbonate and salt were mixed with composite flour and sieved 3-4 times. Fat and sugar were mixed in a mixer until the mixture became light fluffy. Into the mixture, composite flour containing dry ingredients were added and mixed thoroughly. Water was added to the flour mixture and it was kneaded lightly to make soft dough. The dough was rolled out into sheets using a rolling pin and cut into the circular shape of 6 mm thickness using a biscuit cutter. The cut mass was transferred to a greased baking tray and baking was carried out at 180 °C for 15-20 min in a preheated oven. After cooling, biscuits were packed in high density polyethylene pouches, labeled and stored at ambient temperature for various determinations.

Sensory Evaluation of Biscuits

Sensory evaluation of the biscuit samples was carried out for consumer acceptability and preference by fifteen semi-trained panelists from the Department of Foods and Nutrition, College of Home Science, G.B. Pant University of Agriculture and Technology. The biscuit samples were evaluated for various sensory parameters using score card method (Amerine *et al*., 1965) [1].

Statistical analysis

Microsoft excel programme was used for data entry and analysis. Simple statistical tools such as mean, standard deviation (SD) and percentages were calculated for all the parameters. The experimental data were statistically analyzed for analysis of variance using Web Agri Stat Package 2.0 (WASP).

Results and Discussions

Sensory evaluation of control and chia seed flour incorporated biscuits

In addition to the search for healthy foods with high nutritional value, consumers have searched for foods with good sensory characteristics (Dutra, 2014) [8]. The optimization of some parameters, such as shape, color, appearance, aroma, flavor, texture, consistency, and the interaction between different components aimed at good quality and good acceptance is important in the development of a new product (Barbosa *et al*., 2003) [3]. The maintenance of sensory quality of a food can favor consumer's loyalty to a specific product in an increasingly demanding market (Teixeira, 2009) [24]. The scores for the sensory parameters of the biscuit samples are presented in Table 3. The biscuit samples varied significantly ($p< 0.05$) in terms of color, flavor, taste, texture and overall acceptability scores.

Color is an important attribute because it can arouse individual's appetite. It is one of the parameters used for process control during baking and roasting, because brown pigments appear as browning and caramelization reactions progress (Pereira *et al*., 2013) [18]. The highest colour score was obtained for the biscuits made from whole wheat flour (8.25) followed by biscuits prepared by substitution of 5 per cent (8.00) and 10 per cent (7.75) chia seed flour respectively. The score for colour was lowest for 35 per cent chia seed flour supplemented biscuits (6.75). The study revealed that colour scores decreased with increasing incorporation of chia seed flour to whole wheat flour. The biscuits with higher

proportion of chia seed flour were significantly darker. The chia seeds are black in color, which affect the color of biscuits (Divyashree *et al*., 2016) [7].

Table 3: Sensory evaluation of whole wheat flour biscuits (control) and chia seed flour incorporated biscuits

	Colour	Flavour	Taste	Texture	Overall acceptability
Control	8.25 ± 0.58^{a}	8.75 ± 0.42^{a}	8.50 ± 0.57^{a}	8.20 ± 0.65^{a}	8.65 ±0.53^{a}
T1	8.00 ±0.53^{ab}	8.40 ± 0.28^{ab}	8.25 ± 0.36^{ab}	7.85 ± 0.50^{ab}	8.13 ± 0.24^{ab}
T2	7.75 ± 0.26^{abc}	8.00 ± 0.50^{bc}	7.89 ± 0.54^{abc}	7.75 ± 0.23^{ab}	7.86 ± 0.36^{bc}
T3	7.50 ± 0.45^{bc}	7.85± 0.25^{bc}	7.70 ± 0.30^{bcd}	7.73 ± 0.29^{ab}	7.69 ± 0.42^{bc}
T4	7.38 ± 0.34^{bcd}	7.62 ± 0.48^{c}	7.55 ± 0.25^{bcd}	7.60 ± 0.56^{abc}	7.53 ± 0.25^{bc}
T5	7.25 ± 0.31^{cd}	7.40 ± 0.30^{c}	7.39 ± 0.60^{cd}	7.38 ± 0.35^{bc}	7.36 ± 0.31^{cd}
T6	7.20± 0.37^{cd}	7.35 ± 0.54^{c}	7.25 ± 0.42^{cd}	7.05 ± 0.42^{bc}	7.29 ± 0.44^{cd}
T7	6.75 ± 0.40^{d}	6.50± 0.34^{d}	7.00 ± 0.38^{d}	6.80 ± 0.58^{ab}	6.76 ± 0.34^{d}
CD at 5%	0.723	0.696	0.769	0.812	0.645

Values are represented as Mean±SD for fifteen values. Different alphabets in superscript in each column shows significant difference between values at 5% level of significance ($p< 0.05$)

Flavor is sensory phenomenon which is used to denote the sensations of odor, taste and mouth feel. Flavoring substances are aromatic compounds which are conceived by the combination of taste and odor and perceived by the mouth and nose (Sharif *et al*., 2017) [23]. In this study highest flavor scores were observed for whole wheat flour (control) biscuits (8.75) followed by 5 per cent chia seed flour incorporated biscuits (8.40) whereas, lowest was for 35 per cent chia flour biscuits (6.50).

Taste is an important attribute in acceptance of food product. Results of the study revealed that whole wheat flour biscuits scored higher for taste in comparison to chia seed flour incorporated biscuits. Further, it was observed that the replacement of whole wheat flour by chia seed flour up to 30 per cent in the biscuits resulted in better taste and the scores decreased with further increase in the level of chia seed flour.

Texture analysis is primarily concerned with measurement of the mechanical properties of a product, often a food product, as they relate to its sensory properties detected by human via applying controlled forces to the product and recording its response in the form of force, deformation and time. Texture measurements can be very valuable for the quality control and process optimization as well as for the development of new products with desirable properties and characteristics (Bourne, 1978) [4]. The mean score for texture was highest for whole wheat flour biscuit (8.20) followed by that made by adding 5 per cent chia seed flour (7.85). From the study it was revealed that hardness of biscuits increased as the chia seed incorporation increased, it was acceptable up to 30 per cent incorporation. These results agreed with Divyashree *et al*., (2016) [7] who reported that the texture of biscuits containing composite flours is harder and hardness increased as the level of substitution increased.

In terms of sensory analysis, the overall acceptability of a food is influenced by the intrinsic properties it possesses, that is, the appearance, aroma, flavor, texture, aftertaste, and auditory attributes of the food (Murray and Baxter, 2003). The overall acceptability scores were highest for whole wheat flour biscuits (8.65) whereas low score (6.76) was obtained by 35 per cent chia seed flour incorporated biscuits. Further it was found that in biscuits up to 30 per cent chia seed incorporation to wheat flour was acceptable. Beyond this level the overall acceptability scores declines. This may be because the biscuits containing high levels of chia seed flour may lack in the sensory characteristic associated with biscuits. Similar result was obtained by Divyashree *et al*., (2016) [7] where with the increase in the level of composite flour, the Overall acceptability of biscuits decreased. There was no significant decrease in sensory score up to 30% of buckwheat and 15% of chia seed flour addition. But a further increase in the addition of composite flour, significantly decreased all parameters of sensory analysis.

Conclusion

From the present study, sensory data revealed that chia seed flour incorporated biscuit have a good acceptability up to 30 per cent level beyond which it declined. Therefore, it can be concluded that 30 per cent chia seed flour can be successfully incorporated to whole wheat flour to develop biscuits without adversely affecting their sensory attributes. Also, chia seed flour can be used to enrich the nutritional qualities of other food products.

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