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Shruti Puri
Department of Food Science, MCM DAV College for Women, Chandigarh, India

Loveleen Kaur Sarao
Department of Microbiology, Punjab Agricultural University, Ludhiana, Punjab, India

Jahanavi Trehan
Department of Food Science, MCM DAV College for Women, Chandigarh, India

Ramanpreet Kaur
Department of Food Science, MCM DAV College for Women, Chandigarh, India

Corresponding Author:
Shruti Puri
Department of Food Science, MCM DAV College for Women, Chandigarh, India

Evaluation of the nutritional value of snacks prepared by fortification of gram flour with chia seeds

Shruti Puri, Loveleen Kaur Sarao, Jahanavi Trehan and Ramanpreet Kaur

Abstract
Functional foods, majorly snacks, have gained tremendous attention worldwide over the past few years due to the trend of healthy lifestyle. Snacks are one of the most popular conveniences, ready-to-eat, easy-to-carry, easy-to-store products consumed by all age groups. Snacks can be considered as a better vehicle for fortification and enrichment with chia seeds. In the present study, gram flour and chia seed flour were used to prepare composite wheat flour in order to improve the protein, crude fibre, fat content, and mineral content in snacks. Snacks were prepared from the gram flour and chia seed flour blends in the ratios of 50:0, 35:15, 25:25 and 15:35 respectively. Sensory quality and the acceptability scores were decreased with the increase in the level of chia seed flour. Snacks containing 50:0 (gram: chia) was acceptable in relation to the overall acceptability. There was a considerable increase in the fibre and mineral content in the snacks by adding chia flour. Therefore, the developed snacks indicated the commercial scope of manufacturing good quality snacks, which will be helpful for providing daily dietary requirement of protein, dietary fibre and other minerals.

Keywords: Chia seed flour, gram flour, composite flour, snacks

Introduction
Chia is the common name for some species of *Salvia*, among which *Salvia columbariae*, *Salvia hispanica*, and *Salvia polystachya* are the most important. Chia is native to Mexico. Chia is prominently grown for its seeds & has widely been used as a whole seed, seed flour, seed mucilage, and seed oil. Chia seeds is composed of protein (15-25%), fat (30-33%), carbohydrates (26-41%), high dietary fiber (18-30%), ash (4-5%), minerals, vitamins and dry matter (90-93%). The seed also consists of high amount of antioxidants (Ixtaina *et. al*., 2008). The seed contains 25 to 40% oil with 60% of it comprising (omega) ω-3 α-linoleic acid and 20% of (omega) ω-6 linoleic acid. Both of these essential fatty acids are required by human body for good health. In 2000, the US Dietary Guidelines recommended that the use of chia seed can be done as a primary food not exceeding 48g/day.

Chia can be considered as a "functional food" because apart from contributing to human nutrition, it helps to prevent Cardio vascular diseases (CVDs), inflammatory and nervous system disorders, diabetes etc. Due to its functional components, chia seed is used for the industries of health, food, animal feed, pharmaceuticals, and nutraceuticals (Munoz *et al*., 2013) [5]. Functional foods have gained tremendous attention worldwide over the past few years due to the way of healthy lifestyle. Various countries of the world including the Unites States, Canada, Chile, Australia, New Zealand, and Mexico has widely used chia seed or its oil for different applications such as breakfast cereals, bars, cookie snacks, fruit juices, cake and yoghurt (Norlaily *et al*., 2012) [6]. But in India, any of its application or use in making product was still not found. So, our study focused on making such a product which is healthy and can be consumed on a daily basis.

Snacks, majorly "matthi" is widely accepted and consumed in developing countries. Traditionally, matthi is made from wheat flour. Matthi is a Rajasthani snack. Matthi is a kind of flaky biscuit from north-west region of India. Mathri is served with mango, chilli or lemon pickle with tea. It is also served at marriages and Pooja. Masala Mathri is a variety of mathri with spices added which makes it more-crispier. It is one of the most popular snacks in North India, and is part of most marriage cooking or religious occasions like Karva chauth and even as tea-time snack.

This study attempted to access the suitability of replacement of wheat flour by whole chia seed flour in samples in different amounts (0g, 15g, 25g, 35g respectively) for improvement in quality and nutritive quality of snack and to strengthen the utilization of chia seed in India. The creation of this snack was influenced by the need to have a preserved food that remains edible for days and the finished products are often stored in big jars at room temperature. The present work was planned with the objectives ; Snacks (matthi samples) were elaborated with the addition of chia seeds 0g, 15g, 25g and 35g respectively; to analyze the influence of chia seed flour on the organoleptic quality of snack (matthi); Comparative study of proximate analysis of all samples and Sensory evaluation of the samples.

Materials and Methods

Sample Procurement

Plain flour, wheat flour, gram flour, semolina, refined oil were obtained from Local market of Chandigarh. Other ingredients (carom seeds, coriander seeds, cumin seeds, fennel seeds, black pepper, cloves, salt, asafetida, kasuri methi) were obtained from a local market in Kharar, Punjab.

Production of chia seed flour

The chia seeds were grinded in a clean grinder. The chia seed powder was sieved using a sieve of 500µm mesh size, to obtain a fine powder.

Product Development

Snack sample were prepared using the method given below. The ingredients used in preparation of snacks were composite flour (plain flour 250g, wheat flour 75g, gram flour 50g), semolina 50g, refined oil 1.5 cup, cumin seeds 0.5 tbsp., carom seeds 0.5 tbsp., coriander seeds 1 tsp., fennel seeds 1 tsp., black pepper 0.5 tsp., cloves 4, asafoetida 1 pinch, kasuri methi 2 tbsp. and salt according to taste. Snacks were prepared from different blends of gram flour and chia seed flour in the respective ratios of 50:0, 35:15, 25:25 and 15:35. Snack (50:0) was considered as control. Snack dough was prepared manually and rolled into a thin sheet and cut into desired shape using mould. The cut pieces were then deep fried in refined oil for 4-5 minutes. These snacks were then cooled and stored in air tight jars.

Compositional Studies

Moisture

The moisture content in the snack samples was determined by the Hot Air Oven Single Stage Method (AOAC 2000).

Fat

For the estimation of crude fat content, Soxhlet method (AOAC 2000) was used.

Ash

Sample (5 g) was taken in a previously weighed crucible. Crucibles were then placed in a muffle furnace at 550°C for 4 hours or until light grey ash resulted (AOAC 2000).

Crude Fiber

Crude fiber is defined as loss on ignition of dried residue remaining after digestion of sample with 1.25% sulphuric acid and 1.25% sodium hydroxide solution under specific conditions (AOAC 2000).

Protein

Protein content was estimated by using Micro-Kjeldahl method (AOAC 2000).

Carbohydrate

The values of moisture content, protein, fat, crude fiber and ash were added and subtracted from 100 (AOAC 2000).

Sensory Analysis

A team of 26 semi-trained panelists conducted a sensory evaluation of snacks after the deep frying. The analysis was performed at MCM DAV College for Women, in Chandigarh, India, in a stable temperature and light. Samples were scored using a nine-point hedonic scale, where 1 is dislike extremely, 2 is dislike very much, 3 is dislike like moderately, 4 is dislike slightly, 5 is neither dislike nor like, 6 is like slightly, 7 is like moderately, 8 is like very much and 9 is like extremely according to the appearance/colour, body/texture, mouth feel, flavor and overall desirability.

Results and Discussions

Proximate analysis

Moisture Content (%): Moisture content of all samples after preparation and after storage of 1 month was evaluated. Samples (A, B, C, D) showed moisture content of 4.83%, 8.54%, 9.89% and 10.94% respectively (Table 1). This showed that on increasing the amount of chia seed concentration, moisture content also increased. After one month storage, moisture content of samples A, B, C and D were 6.14%, 8.78%, 10.72% and 12.73% respectively. This showed that on storage, moisture was gained by the product. This may be due to high water binding and high hydration power of chia seeds. A study on fortification of biscuits with chia seeds reported that chia seeds have high water binding capacity reported by Tyagi *et al.* (2007) [9]. Similarly, Kibui *et al.*, (2018) [4] studied during manufacturing of chia enriched chips that the moisture content of chia seeds increases because of the high hydration power of chia mucilage as 100 mg of mucilage has ability to absorb 2.7g of water.

Table 1: Moisture content of Native samples and After 1 month storage samples

Sample	Native Sample	After 1 month storage
A	4.83	6.14
B	8.54	8.78
C	9.89	10.72
D	10.94	12.73

Crude Fibre Content: The crude fibre content of all samples after preparation and after storage of 1 month was evaluated. Samples (A, B, C, D) showed crude fibre content of 0.077%, 0.143%, 0.3% and 0.36% respectively (Table 2). This showed that on increasing the amount of chia seed concentration, crude fibre content also increased. After one month storage, crude fibre content of samples A, B, C and D were 0.119%, 0.42%, 1.07% and 1.32% respectively. This showed that on storage, the crude fibre content of the product increases. This may be due to increase in lipid content present in chia flour as PUFA and due to the gum like property of chia. A study reported by Ayerza 1995 [2]; Heuer *et al.*, (2002) showed that the crude fibre content of cookies fortified with chia seed flour showed an increasing trend with addition of chia. This was due to the increase in lipid content present in chia flour as PUFA. Also, Alfredo *et al.*, (2009) [1] studied that Chia has high fibre content due to the gum-like property of chia. Their

fiber-rich fraction had 56.4 g/100 g dietary fiber, where 53.45 g/100 g is insoluble dietary fiber and the remainder is soluble.

Table 2: Crude fibre content of Native samples and After 1 month storage samples.

Sample	Native Sample	After 1 month storage
A	0.077	0.119
B	0.143	0.42
C	0.3	1.07
D	0.36	1.32

Ash Content: The ash content of all samples after preparation and after storage of 1 month was evaluated. Samples (A, B, C, D) showed ash content of 2.6%, 3.12%, 3.19% and 3.89% respectively (Fig 1). This showed that on increasing the amount of chia seed concentration, ash content also increased. After one month storage, ash content of samples A, B, C and D were 2.68%, 3.21%, 3.41% and 3.8% respectively. This showed that on storage, ash content of the product increased except for Sample D. This may be due to high mineral content of chia flour. In a study done on fortification of cookies with chia seed flour, it was reported that the ash content increases with the increase in mineral content (Kibui AN and Owaga E, 2018) [4]. Also, Gayatri Mishra (2015) studied that the increase in ash content of chia fortified cookies was due to high percentage of mineral content present in chia flour.

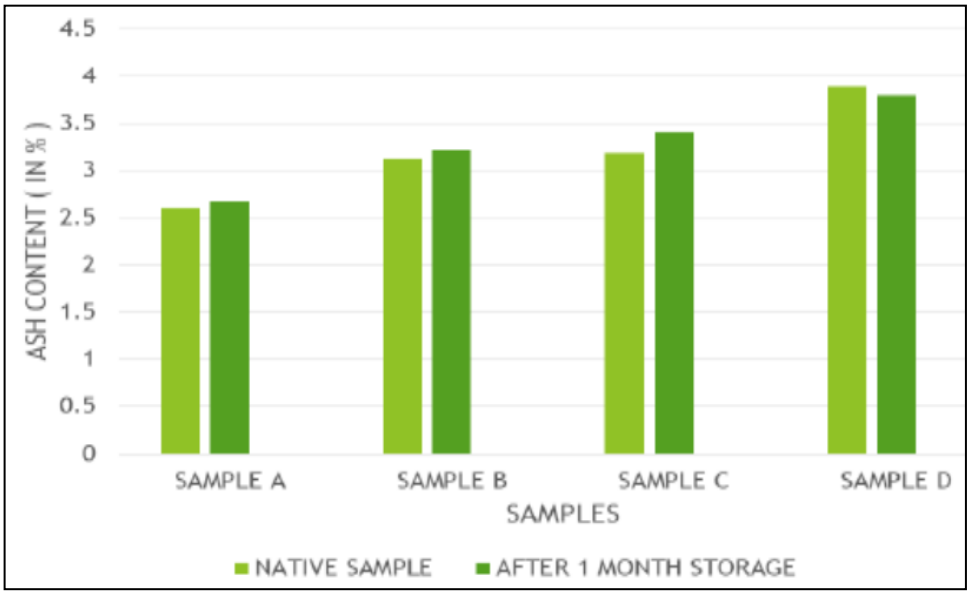

Fig 1: Ash content analysis of Native and stored samples

Fat Content: The fat content of all samples after preparation and after storage of 1 month was evaluated. Samples (A, B, C, D) showed fat content of 35.36%, 31.5%, 27.79% and 33.62% respectively (Fig 2). This showed that on increasing the amount of chia seed concentration, the fat content decreased except for Sample D. After one month storage, the fat content of samples A, B, C and D were 36.99%, 32.22%, 29.8% and 33.54% respectively. This showed that on storage, fat content of the product decreased. This may be due to an increase in the free fatty acid content and might be due to the high retention ability of chia seed flour. Singh *et al.*, (1993) [8] reported that the increase in fat content might be due to an increase in the free fatty acid content as studied during fortification of biscuits with chia seeds. In a study done on fortification of cookies with chia seed flour, Rufeng *et al.*, (1995) [7] reported that the increase in fat content might be due to the high retention ability of chia seed flour.

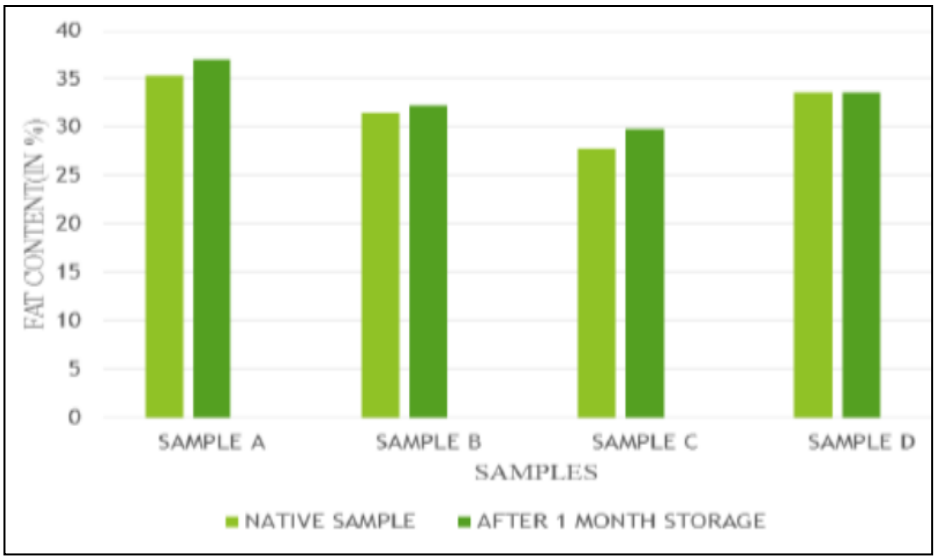

Fig 2: Fat content analysis of Native and stored samples

Protein Content: Protein content of all samples after preparation and after storage of 1 month was evaluated. The native samples (A, B, C, D) showed protein content of 19.95%, 23.1%, 25.53% and 34.14% respectively (Table 3). This showed that on increasing the amount of chia seed concentration, protein content also increased. After one month storage, protein content of samples A, B, C and D were 17.2%, 21.5%, 23.14% and 31.8% respectively. This showed that on storage, protein content of the product decreases. This may be due to the presence of chia seeds as it contains approximately 16.5% proteins.

Table 3: Protein content of Native samples and After 1 month storage samples.

Sample	Native Sample	After 1 Month
A	19.95	17.2
B	23.1	21.5
C	25.53	23.14
D	34.14	31.8

Carbohydrate Content: The carbohydrate content of all samples after preparation and after storage of 1 month was evaluated. Samples (A, B, C, D) showed carbohydrate content of 37.18%, 32.56%, 31.9% and 16.03% respectively. This showed that on increasing the amount of chia seed concentration, carbohydrate content decreased. After one month storage, carbohydrate content of samples A, B, C and D were 36.87%, 34.63%, 32.3% and 19.19% respectively. This showed that on storage, the carbohydrate content of the product decreased.

Sensory evaluation (on the basis of overall acceptability [average])

The sensory evaluation of all the samples after preparation was done (Fig 3). Samples (A, B, C, D) showed an overall acceptability of 7.92, 6.84, 6.89 and 6.71 respectively out of 10 (Table 5). This showed that on increasing the amount of chia seed concentration, the overall acceptability of the samples decreased. As observed, the native sample was the most accepted and in the fortified samples, the sample fortified with 50g chia seed was satisfactory.

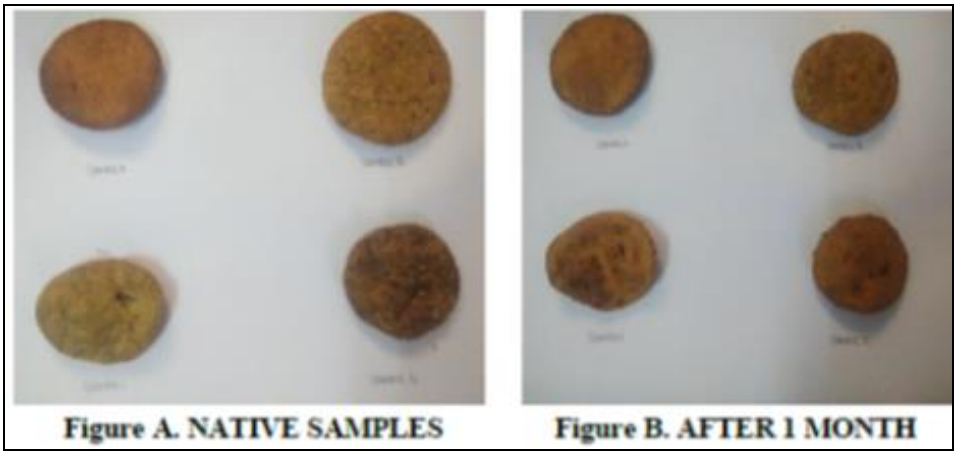

Fig 3: Storage of samples

Table 4: Carbohydrate content of Native samples and After 1 month storage samples.

Sample	Native Sample	After 1 month
A	37.18	36.87
B	32.56	34.63
C	31.9	32.3
D	16.03	19.19

Table 5: Sensory Evaluation of Native Samples.

Sample	Appearance / Colour	Body / Texture	Mouthfeel	Flavour
A	7.98	8	7.94	7.65
B	7.19	6.63	6.73	6.83
C	7.09	6.86	6.65	6.98
D	6.98	6.79	6.33	6.77

Conclusion

Composite flour prepared from chia seed flour considerably affected the physicochemical, sensory and nutritional properties of snacks. The present study was conducted to compare the effect of fortification on the chemical and sensory attributes of snacks. They were made by four different formulations by varying the percentage of chia added in the ratios of gram: chia as 50:0, 35:15, 25:25 and 15:35 respectively. Moisture, ash, fat, fibre, protein and carbohydrate were analyzed for both fortified and non-fortified samples. The sensory analysis was also done. The moisture content of the cookies increased with increase of the chia seed content and the ash content of all the snack samples which were fortified was more than that of the normal snack. A general trend of increase in the fat content was observed except in the case of sample containing 35g of chia seed flour. The protein content came out to be maximum for the snacks containing 35g of chia seed content, and least was that of the control. All in all the results came were in accordance to the fortification done.

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