Development of Nutritionally Superior and Eggless Vegetarian Cookies by Using Chiaseed Flour

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Abstract

The influence of partial replacement of refined wheat flour (maida) by chia seed (Salvia hispanica L.) flour on nutritional and sensory qualities of cookies was analyzed. The ingredients used in the cookies were refined wheat flour, chia seed flour, chia gel, butter, sugar, milk, baking soda, cocoa powder and vanilla essence. The sensory analysis of cookies prepared with different proportions of chia flour and maida was done. The fat, crude fiber, protein and carbohydrate content of the developed cookies having 50% chia seed flour was determined. Chia flour is rich in protein and is complete with all eight essential amino acids. It is also rich in calcium, iron, vitamin C, omega-3-fatty acids, and antioxidants, rightly called as a food for healthy skin, hair and nail. Therefore, the developed cookies indicated the commercial scope of manufacturing good quality vegetarian cookies, which will be helpful for providing daily dietary requirement of protein, dietary fiber and other minerals.

Keywords: Cookies, Chia seed flour, Chia gel, Omega-3 fatty acids.

1. Introduction

The development of new products is a strategic area of the food industry. Consumers are demanding foods that show two main properties: the first-one deals with the traditional nutritional aspects of the food, whereas, as a second feature, additional health benefits are expected from its regular ingestion. These kinds of food products are often called functional foods. Functional foods have gained tremendous attention worldwide over the past few years due to the wave of healthy lifestyle changes. One of the reasons for the interest to shift to a healthier lifestyle is the increasing number of people suffering from cardiovascular diseases (CVDs), high blood pressure, obesity, diabetes, and other related diseases. These conditions are commonly due to inactive lifestyle and poor diet where the daily food consumed contains high amounts of saturated fatty acids (SFAs). The total dietary fiber (TDF) has become an important component in the daily diet because intake of TDF has health beneficial effects. Some of them include reduction of cholesterolemia, modification of the glycemic and insulinaemic responses, changes in intestinal function and antioxidant activity (Abdul-Hamid and Luan, 2000; Esposito et al., 2005). Recently, chia has regained its popularity by becoming one of the main oil sources that contains high levels of PUFA. Chia, which used to be the major food crop of the indigenous peoples of Mexico and Guatemala, is now widely cultivated and commercialized for its (omega) ω-3 α-linolenic acid (ALA) content and antioxidant properties.

Chia (Salvia hispanica L.), a biannually cultivated plant, is categorized under the mint family (Labiatae), superdivision of Spermatophyta, and kingdom of Plantae, prominently grown for its seeds. Chia seed is composed of protein (15-25%), fats (30-33%), carbohydrates (26-41%), high dietary fiber (18-30%), ash (4-5%), minerals, vitamins, and dry matter (90-93%). The seed also contains a high amount of antioxidants (Ixtaina et al., 2008). The seed contains 25 to 40% oil with 60% of it comprising (omega) ω-3 α-linolenic acid and 20% of (omega) ω-6 linoleic acid. Both essential fatty acids are required by the human body for good health, and they cannot be artificially synthesized (Mohd Ali et al., 2012). Furthermore, an omega-6/omega-3 ratio of 4:1 or less is recommended. A high ratio of omega-6/omega-3 is detrimental to health and may lead to the development of chronic diseases. Improving the dietary ratio by increasing the omega-3 fatty acids is essential for brain functioning and for the management of cardiovascular disease.
arthriti and cancer (Simopoulos and Cleland, 2003). Therefore, the incorporation of seeds such as chia in the diet, which contain high contents of these fatty acids, is particularly desirable. Chia flour is rich in protein and is complete with all eight essential amino acids. It is also rich in calcium, iron, vitamin C, omega-3-fatty acids, and antioxidants, so called as a food for healthy skin, hair and nail. However, a major challenge to the development of enriched food products is presented by the multiple acceptance criteria: product freshness, sensory characteristics, appearance, storage conditions, ease of preparation and safety standards, which must be achieved, despite the addition of an active ingredient (Drusch and Mannino, 2009) and nutritional benefits.

Cookies are widely accepted and consumed in developing countries. Traditionally cookies are made from wheat flour. Cookies prepared from Chia seed flour can be presented as specialized product by partial replacement of wheat flour which a valuable supplement vehicle for nutritional improvement; however, cookies have been suggested as a better use of composite flour than bread because of their ready-to-eat form, wide consumption and relatively long shelf-life (Lorens et al., 1979). In this study, we attempted to access the suitability of replacement of wheat flour by whole chia seed flour for improvement in quality and nutritive value of cookies and to strengthen the utilization of chia seed in India.

2. Materials and Methods

2.1 Raw Materials

Wheat flour, chia seeds and other ingredients such as sugar, hydrogenated fat, baking powder, and milk were procured from the local market of Anand, Gujarat. Whole chia flour was obtained by grinding whole chia seeds in a food processor grinder and then shifted through a 250 µm sieve, to obtain fine flour to be used as experimental material. Some part of ground chia flour was soaked in water for 5 hour to form a firm gel to be used as an egg replacer in the preparation of cookies (Borneo et al., 2010).

2.2 Blend Formulation

Blend of wheat flour and chia flours containing 0%, 30%, 50%, 70%, 100%, on a replacement basis were prepared. The choice of these levels based on initial experiment that the maximum level of wheat flour substitution that would produce an acceptable baked product. They were then packed in polyethylene bags, sealed, labeled and stored until required.

2.3 Preparation of Cookies

The cookies were prepared according to the procedure described by McWatters et al. (2003) with slight modifications. The basic ingredients used were 100g of flour blend, 30g of hydrogenated vegetable fat, 50g of sugar, 20g of hydrated chia gel, 10g cocoa powder, 1g salt, 0.5g sodium bicarbonate, 0.5g of ammonium bicarbonate and 0.5g of baking powder. The dry ingredients were weighed and mixed thoroughly in a bowl by an electronically operated beater for 3-5 minutes. At first creaming was done by beating, shortening and sugar for incorporation air until the mix become fluffy and smooth, then other ingredients with flour blend were kneaded. Care was taken for prevention of gluten network formation. The dough was rolled thinly on a sheeting board to a uniform thickness (8.0 mm) and cut out using a round scorn cutter to a diameter of 35.0 mm. The cut out dough pieces were baked on greased pans at 160°C for 15 min in a baking oven. The prepared cookies were cooled to room temperature (30 ± 2°C) and packed in high density polyethylene bags.

The details of the nomenclature of the prepared cookies were as follows:

- T1: Cookies sample prepared with 0:100 proportion of whole chia flour and wheat flour
- T2: Cookies sample prepared with 30:70 proportion of whole chia flour and wheat flour
- T3: Cookies sample prepared with 50:50 proportion of whole chia flour and wheat flour
- T4: Cookies sample prepared with 70:30 proportion of whole chia flour and wheat flour
- T5: Cookies sample prepared with 100:0 proportion of whole chia flour and wheat flour

2.4 Sensory Evaluation of the Cookies

All the fortified cookies and control cookies were evaluated for their sensory qualities by the panel of 12 judges from the faculties and students of College of Food Processing Technology and Bio-Energy, Anand Agricultural University, Anand. Nine point Hedonic scale rating was used for evaluation of the freshly baked cookies samples, where 9 represented liked extremely and 1 represented disliked extremely. The result of sensory characteristics of cookies was evaluated in terms of different attributes namely: colour, flavour, taste, texture and overall acceptability.

2.5 Statistical Analysis

The Minitab program was used for the analysis of variance (ANOVA) to obtain the sensory results of the cookies samples. The sample with more similar sensory characteristics as the control sample was
selected for determination of nutritional composition on the basis of the degree of significance (P<0.05).

2.6 Determination of Nutritional Composition

The cookie moisture content was determined in triplicate by AACC method 44-15.02 (AACC, 2010). Ash content, fat content, crude fiber and beta carotene in different biscuits samples were determined as per standard methods (AOAC, 2000). Total carbohydrates value was obtained by subtracting total of moisture, protein, fat, crude fiber and ash content from 100.

3. Results and Discussions

On evaluation of result, it was found that wheat flour can be fully replaced by whole chia flour in gluten free baking (Gruss, 2013), but major disadvantage is the colour of the flour, which is slightly blackish or brownish. From the evaluation of the replacement study of wheat flour by whole chia flour, it was found that the colour of the cookies became increasingly dark by using high proportion of chia flour. The colour of the developed cookies was masked by using 10% cocoa powder, which also enhanced the flavour of the cookies.

3.1 Sensory Evaluation of Cookies

Sensory attributes of all cookies samples packed in HDPE were evaluated in fresh condition at ambient temperature. Hedonic scale rating was used for evaluation of cookies samples. Different attributes selected were colour, flavour, taste, texture and overall acceptability. The sensory values were presented in Table 1. The rating for texture for 30%, 50%, and 70% chia cookies samples were not significantly different from the control sample, but by using 100% chia flour the texture of the cookies were not liked by most of the panelists. The colour of the 30% chia flour cookies sample was rated significantly higher than all other trial cookies samples. But the colour of cookies with 30% and 50% chia flour were not significantly different from the control samples (p<0.05). The colour of the cookies darkened by using more than 50% chia flour and was strongly rejected by the judges. The control cookies were liked significantly more than all the trial samples in terms of taste and there was no significant difference in preference for taste between the 30% and 50% cookies (p<0.05). The flavour of the 30% and 50% chia cookies sample was similar in flavour to the control and significant higher than the other trial cookies, which could mean the concentration of chia could have had an impact on the aroma of the cookies. Overall the 30% and 50% chia cookies was to be liked statistically as much as the control samples (p<0.05). The picture of the control as well as 50% chia flour cookies is presented in Fig 1 (a, b).

According to the statistical analysis of sensory attributes of cookies prepared with different proportions of the chia flour and wheat flour blend, it was found that panelists like the cookies with 30% chia flour as much as the control sample, but the cookies with 50% chia flour is also liked and the sensory results was not significantly different from the control cookies samples (p<0.05). Other cookies samples prepared from chia flour more than 50% were strongly rejected because of the low sensory scores, less than 7. The mean overall acceptability scores of more than 8 for cookies sample up to 50% chia flour indicated the commercial scope for manufacturing good quality vegetarian cookies with replacement of wheat flour.

3.2 Nutritional Composition of Optimized Cookies

Nutritional composition of the optimized cookies samples that are the cookies prepared with 30:70 and 50:50 chia flour and wheat flour samples were analyzed and compared with the nutritional value of the control cookies solely made with wheat flour. The data is presented in Table 2. The increased ash content of 7.33g/100g flour in T3 sample was due to high percentage of mineral content present in chia flour. The protein content of the cookies followed a clear linear trend with the control (0% chia) sample having the lowest percentage protein and the 50% containing sample having the highest level up to 14.86, even higher than the cookies with 30% chia flour. The increase in protein content in the sample cookies is due to the added chia. As the 0% chia control sample contained the lowest protein content, which indicated that chia can significantly increase the protein content in the cookies like product.

The dietary fiber (DF) content of the chia flour was found to be 43.09 g/100g which was higher than the range (35-40 g/100g) reported by Reyes-Caudillo et al. (2008). As expected, the control sample had the lowest DF content, with an increasing trend with the 30% and 50% addition of chia. Lipid content of the chia flour cookies was significantly higher compared to the control cookies, but 60% of the lipids present in chia flour are PUFA. The omega-6-fatty acid present in whole chia flour is in the range of 17.6-20.4% (Ayerza, 1998; Alvarez-Chavez et al., 2008). As defined by the guidelines of the Australian New Zealand Food Authority (1995) proposed nutrient claims, chia incorporated chips can be used as an excellent sources of omega-3 fatty acid.

4. Conclusions

The composition and nutritive value of T3 -
Table 1: Effect of replacement of whole chia flour on sensory characteristics of cookies

<table>
<thead>
<tr>
<th>Sample</th>
<th>Colour</th>
<th>Taste</th>
<th>Flavour</th>
<th>Texture</th>
<th>Overall acceptability</th>
</tr>
</thead>
<tbody>
<tr>
<td>T₁</td>
<td>8.854167&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>9&lt;sup&gt;a&lt;/sup&gt;</td>
<td>9&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>8.860833&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>9&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>T₂</td>
<td>8.541667&lt;sup&gt;a&lt;/sup&gt;</td>
<td>8.916667&lt;sup&gt;a&lt;/sup&gt;</td>
<td>8.9375&lt;sup&gt;a&lt;/sup&gt;</td>
<td>8.791667&lt;sup&gt;b&lt;/sup&gt;</td>
<td>8.770833&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>T₃</td>
<td>8.333333&lt;sup&gt;b&lt;/sup&gt;</td>
<td>8.145833&lt;sup&gt;a&lt;/sup&gt;</td>
<td>8.2291667&lt;sup&gt;b&lt;/sup&gt;</td>
<td>8.583333&lt;sup&gt;a&lt;/sup&gt;</td>
<td>8.125&lt;sup&gt;ab&lt;/sup&gt;</td>
</tr>
<tr>
<td>T₄</td>
<td>6.791667&lt;sup&gt;d&lt;/sup&gt;</td>
<td>7.083333&lt;sup&gt;b&lt;/sup&gt;</td>
<td>7.2083333&lt;sup&gt;bc&lt;/sup&gt;</td>
<td>8.041667&lt;sup&gt;de&lt;/sup&gt;</td>
<td>7.020833&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>T₅</td>
<td>6&lt;sup&gt;c&lt;/sup&gt;</td>
<td>5.9375&lt;sup&gt;c&lt;/sup&gt;</td>
<td>6&lt;sup&gt;c&lt;/sup&gt;</td>
<td>7.875&lt;sup&gt;c&lt;/sup&gt;</td>
<td>5.895833&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

Different superscripts within a column denote significant differences (P<0.05).

Table 2: Nutritional composition of optimized cookies sample as compared to the control sample

<table>
<thead>
<tr>
<th>Nutrition Aspects</th>
<th>Control (T₁)</th>
<th>T₂</th>
<th>T₃</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture (%)</td>
<td>3.08</td>
<td>3.103</td>
<td>3.12</td>
</tr>
<tr>
<td>Ash (%)</td>
<td>0.67</td>
<td>5.22</td>
<td>7.33</td>
</tr>
<tr>
<td>Protein (%)</td>
<td>8.52</td>
<td>12.728</td>
<td>14.86</td>
</tr>
<tr>
<td>Fat (%)</td>
<td>25.13</td>
<td>30.208</td>
<td>35.235</td>
</tr>
<tr>
<td>Crude fiber (%)</td>
<td>0.3</td>
<td>13.082</td>
<td>18.69</td>
</tr>
<tr>
<td>Carbohydrates (%)</td>
<td>62.3</td>
<td>48.74</td>
<td>25.455</td>
</tr>
<tr>
<td>Energy</td>
<td>509.45</td>
<td>487.712</td>
<td>478.375</td>
</tr>
</tbody>
</table>

cookies samples containing 50:50 ratios of whole chia flour and wheat flour represent balanced quantity of carbohydrate, protein, fat, crude fiber and samples were most acceptable in sensory evaluation as compared to other samples and was more similar to the control samples. The results have shown the possibility of utilizing whole chia seed flour to improve the nutritional and functional properties of cookies. By partial replacement of wheat flour by chia flour leads to partial gluten free baking. The greatest impact on the nutritional characteristics was observed in the incorporation of chia flour, which increases the fiber content of the cookies up to 18.69%. The incorporation of chia gel functions as egg replacer in the preparation of cookies. Therefore, the developed cookies indicated the commercial scope of manufacturing good quality vegetarian cookies which will be helpful for providing daily dietary requirement of protein, dietary fiber and other minerals.

5. Future Scope of Work

The future of incorporation of chia seed as whole, as grounded flour or as gel is still challenging. Based on the current research findings, chia seed is a good choice of healthy oil to maintain a balanced serum lipid profile. However, unlike vitamin E and coenzyme Q10, in vivo clinical bioactivity and safety evaluation of chia seeds are still limited. Furthermore, details on the mechanisms of chia seed’s hypolipidemic effects need to be studied and compared with those of the isolated omega 3 and omega 6 fatty acids. As chia
seed contain high amount of fat, there is need of future research for shelf life study of the cookies prepared with fully or partially replaced wheat flour by chia flour.

References
Heuer B, Yaniz Z and Ravina I (2002). Effect of late salinization of chia (Salvia hispanica), stock (Matthiola tricuspida) and evening primrose (Oenothera biennis) on their oil content and quality. Industrial Crops and Products, 15(2): 163-167.