Bamboo shoot fortified cookies as a healthy snack

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Abstract

Bamboo shoot is a less known traditional delicacy consumed in many Asian countries since ancient times. The juvenile shoots are gaining worldwide importance for its health benefits due to its nutritional value and presence of bioactive compounds and are emerging as a potential ingredient for modern functional foods and nutraceuticals. The fresh juvenile shoots have been used since ancient times as food and medicine and have now gained recognition for various functional merits as a dietary supplement, food antioxidant, cosmetic ingredient and as a nutraceutical component for preventing diseases. During the last decade, people have become very concerned about health and a busy lifestyle has made people depend more on functional or fortified foods as they provide health benefits beyond the basic nutritional functions. In the present work, young juvenile shoots were processed and used for preparing fortified cookies. Higher nutrient and mineral content was observed in oven dried bamboo shoot flour as compared to wheat flour. Minerals analysis by Wavelength Dispersive X-ray Fluorescence Spectroscopy showed that potassium content was very high (5050mg/100g) in oven dried bamboo shoot flour. The incorporation of bamboo shoots shows increase in the nutritional value in fortified cookies as compared to control cookies. Oven dried bamboo shoot flour cookies shows higher content of amino (0.20/100g), protein (0.97g/100g), carbohydrate (14.48g/100g), starch (64.60g/100g), moisture (0.38g/100g) and ash (1.04g/100g). Bamboo shoots that are rich in nutrients and bioactive compounds can be used for the enrichment of bakery products such as cookies to produce healthy snacks.

Keywords: Bamboo shoot, Fortification, Cookies, Nutrition.

Introduction

Bamboo is one of the most economically important plants in the world as every part of the plant - culm, rhizome, root, leaves and young shoots can be used for different purposes. It is mostly known for its industrial uses but less recognized as a source of food or medicine. The young emerging shoots are a delicacy in many Asian countries and it is considered as an ideal vegetable for healthy diet (RFRI 2008). Bamboo shoots are gaining worldwide importance for its health benefits due to its nutritional value and presence of bioactive compounds and are emerging as a potential ingredient for
modern functional foods and nutraceuticals. The fresh juvenile shoots have been used from ancient
times as food and medicine and have now gained recognition for various functional merits as a dietary
supplement, food antioxidant, cosmetic ingredient and as a nutraceutical component for preventing
diseases. The young shoots are not only delicious but are rich in nutrients, mainly proteins,
carbohydrates, minerals, vitamins, and fiber and are low in fat and sugar (Shi and Yang 1992; Nirmala
et al. 2011). However, the food potential of bamboo shoot remains as an underutilized seasonable
vegetable. In most of the countries, people are still using the old-age traditional technology for
processing and preserving the shoots and preparing traditional food items which are not liked by the
modern generation, due to which bamboo is losing its popularity amongst the younger generation.

Bamboo shoot has attracted significant research and commercial interest, and is gaining popularity as
food item due to its many health promoting bioactive compounds which include effectiveness in
decreasing blood pressure, cholesterol, increasing appetite, having anti-cancerous and anti-diabetic
properties (Park and Jhon 2009; Hong et al. 2010; Koide et al. 2011; Nirmala et al. 2011; Singhal et
al. 2013). It is also reported to be a good source of minerals such as K, P, Na, Mg, Ca, and Fe and it
also contains trace elements such as cadmium, cobalt, copper, nickel, manganese, selenium, and zinc
(Nirmala et al. 2011; Saini et al. 2017). Micronutrient deficiency is the source of hidden hunger in the
world today affecting over two billion people worldwide (Abeshu and Geleta 2016). A way to address
such deficiencies cheaply is through food fortification or supplementation and bamboo shoots which
is rich in minerals and vitamins is a potential source.

Cookies are very popular and an easily available food products in most of the places due to low cost,
satisfying taste, longer shelf life and more. Nowadays, consumers are not only concerned for energy
giving food items but have also interest for food providing health benefits. The development of novel
products fortified with bamboo shoots will enrich the quality of the food products and also open an
area to take maximum benefit of this highly nutritive and healthy vegetable. In order to utilize this
health food and to make it available throughout the year, there is a need for incorporation of the shoot
for making common food products that is easily available throughout the year to overcome the
malnutrition and food insecurity that is common particularly in rural areas.

Material and Methods

Material

Preparation of bamboo shoot sample

The juvenile shoots of *Dendrocalamus hamiltonii* Nees & Arn. ex Munro was procured from the local
vegetable market of Shillong, Meghalaya (India), during the peak season from June- September and
transported to Department of Botany, Panjab University, Chandigarh, India. The shoots were washed,
peeled and cut into small chunks. Shoots were spread over a tissue paper to remove excess water and
dried in an oven at 60°C for 24 hour. The samples were grounded to powder and put inside a glass
bottle, sealed tightly and stored in a freezer until further use. Wheat flour was procured from the local market Sector 14, Chandigarh, India.

Figure 1. **Dendrocalamus hamiltonii** Nees & Arn. ex Munro, (A) Young shoots, (B) Peeled shoots, (C) Chunks, (D) Oven dried bamboo shoot flour.

### Preparation of bamboo shoot cookies

Fortified cookies were prepared, with wheat flour and/ or oven dried bamboo shoot flour. One formulation was kept as control having only 100g wheat flour. In the other formulations 10% of wheat flour was replaced with oven dried bamboo shoot flour. The other ingredients used were as: ghee or clarified butter (30g), sugar (40g), milk (60ml) and baking powder (2g). All the ingredients were mixed for 5-10 min to make the dough. Uniform biscuits of thickness 3mm and a circular 2.5 diameter were prepared using a wooden rolling pin and baked at 200°C for 15-20 min. Biscuits were cooled at room temperature and placed in an airtight glass bottle for further analysis.
Methods

Nutritional analysis for wheat flour, oven dried bamboo shoot flour, control cookies and oven dried bamboo shoot flour fortified cookies was performed using the established methods. Carbohydrate content was estimated by using the method of Whistler (1971), starch content by the method of McCready et al. (1950), amino acids by the method of Lee and Takahashi (1966) and protein content by the method of Bradford (1976). Estimation of moisture content was done by weighing 1 g of sample and drying in an oven at 60°C for 24 hrs. The ash content in the sample was estimated by using the dry-ashing method of Harbers (1994). The estimation of crude fat was done by using the Soxhlet method given by AOAC (1990).

Mineral content was estimated using Wavelength Dispersive X-ray Fluorescence Spectroscopy (WDXRF, S8 TIGER, Bruker, Germany) controlled by software Quant Express. All measurements were carried out for about 20 min in an individual sample. For analysis, samples were homogenized to a fine powder with mortar pestle and were sieved to attain a particle size less than 50 μm.

Result and Discussion

Nutrient and mineral content of bamboo shoot and wheat flour

Wheat is a good source of nutrients but some of the minerals which are essential for normal diet are not found in significant amount. In order to improve its nutritional value, the flour is fortified to overcome the deficiency. Bamboo shoot is one such plant which is a delicious vegetable, rich in nutrients and has a number of health promoting bioactive compounds. The young shoots are reported to be a good source of minerals such as K, P, Na, Mg, Ca, and Fe along with trace elements such as cadmium, cobalt, copper, nickel, manganese, selenium, and zinc (Nirmala et al. 2011; Saini et al.)
In the present study, as compared to wheat flour, oven dried bamboo shoot flour shows higher content of amino acids (8.89g/100gm), protein (9.61g/100g), carbohydrates (9.80g/100g), moisture (3.50g/100g), ash (8.92g/100g) and fat (14.63g/100g) except starch (Table 1). Oven dried bamboo shoot flour also shows higher mineral content as compared to wheat flour (Table 2). Potassium, an essential macro-element is a heart-friendly mineral which helps to maintain normal blood pressure and in oven dried bamboo shoot flour its content (5050mg/100g) was very high as compared to wheat flour (160mg/100g). Iron content was estimated to be 2.4 mg/100g in wheat flour and 7.1 mg/100g in oven dried bamboo shoot flour. Iron deficiency is very prevalent in many parts of the world, particularly in developing countries like India (Kotecha 2011) and fortification of common and popular food items like biscuits with bamboo shoots can increase the iron content. Zinc is another micro mineral element and its deficiency may lead to retarded skeletal development and immunodeficiency disorders. In oven dried bamboo shoot flour, Zinc was found to be very much higher with 8.9 mg/100gm as compared to 1.2 mg/100gm in wheat flour. The content of copper was also higher (0.8 mg/100gm) in oven dried bamboo shoot flour compared to wheat flour (2.1 mg/100g). Bamboo is one of the richest sources of organic silicon and 190 mg/100g of silica was found in oven dried bamboo shoot flour whereas 28 mg/100gm in wheat flour. Dietary minerals are of great interest for health specialist and consumers, due to the number of biochemical processes they are involved in, and the benefits of their adequate and balanced intake have been highlighted.

Trace elements in bamboo shoots associated with antioxidant defense system are selenium, zinc, copper, iron, and manganese. These minerals are also indispensable for the activities of various antioxidant enzymes and their deficiencies have profound effects on metabolism and tissue structure. Hidden hunger due to micronutrient deficiency affecting billions of people worldwide can be minimize through food fortification or supplementation and bamboo shoots which is rich in minerals and vitamins is a potential ingredients.

Table 1. Nutrients (g/100g) comparison for wheat flour and oven dried D. hamiltonii shoot flour.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Wheat flour</th>
<th>Oven dried bamboo shoot flour</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amino acid</td>
<td>0.21±0.01</td>
<td>8.89±0.01</td>
</tr>
<tr>
<td>Proteins</td>
<td>9.00±0.20</td>
<td>9.61±0.03</td>
</tr>
<tr>
<td>Carbohydrates</td>
<td>0.65±0.01</td>
<td>9.80±0.62</td>
</tr>
<tr>
<td>Starch</td>
<td>76.51±1.59</td>
<td>12.25±0.35</td>
</tr>
<tr>
<td>Moisture</td>
<td>8.72±0.50</td>
<td>3.50±0.28</td>
</tr>
<tr>
<td>Ash</td>
<td>0.62±0.15</td>
<td>8.92±0.03</td>
</tr>
<tr>
<td>Fat</td>
<td>1.75±0.12</td>
<td>14.63±0.31</td>
</tr>
</tbody>
</table>

Values reported are measurement replication means ± standard deviation (n = 03 replicates).
Table 2. Minerals (mg/100g) comparison for wheat flour and oven dried *D. hamiltonii* shoot flour.

<table>
<thead>
<tr>
<th>Minerals</th>
<th>Wheat Flour</th>
<th>Oven dried bamboo shoot flour</th>
</tr>
</thead>
<tbody>
<tr>
<td>K</td>
<td>160</td>
<td>5050</td>
</tr>
<tr>
<td>P</td>
<td>150</td>
<td>590</td>
</tr>
<tr>
<td>S</td>
<td>130</td>
<td>290</td>
</tr>
<tr>
<td>Na</td>
<td>-</td>
<td>20</td>
</tr>
<tr>
<td>Cl</td>
<td>60</td>
<td>890</td>
</tr>
<tr>
<td>Mg</td>
<td>50</td>
<td>230</td>
</tr>
<tr>
<td>Ca</td>
<td>30</td>
<td>170</td>
</tr>
<tr>
<td>Si</td>
<td>28</td>
<td>190</td>
</tr>
<tr>
<td>Zn</td>
<td>1.2</td>
<td>8.9</td>
</tr>
<tr>
<td>Fe</td>
<td>2.4</td>
<td>7.1</td>
</tr>
<tr>
<td>Cu</td>
<td>0.8</td>
<td>2.1</td>
</tr>
<tr>
<td>Ni</td>
<td>0.5</td>
<td>0.7</td>
</tr>
</tbody>
</table>

Nutrient content of oven dried bamboo shoot cookies

The proximate composition (Table 3) shows that cookies fortified with oven dried bamboo shoot flour has higher content of amino acids (0.20g/100gm), proteins (0.97g/100g), carbohydrates (14.48g/100g), starch (64.60g/100g), moisture (0.38g/100g) and ash (1.04g/100g) as compared to the control cookies whereas the content was amino acids (0.06g/100gm), proteins (0.40g/100g), carbohydrates (9.16g/100g), starch (57.05g/100g), moisture (0.14g/100g) and ash (0.62g/100g). The fat content was higher in control cookies. The amino acid content was observed to increase by more than thrice in oven dried bamboo shoot flour fortified biscuits. The increase in protein content of cookies fortified with bamboo shoot flour was also reported by Mustafa et al. (2016) and Choudhury et al. (2015). Sood et al., (2013) also reported increased protein content in bamboo shoot fortified nuggets and crackers. The starch content increased around 13.23% in oven dried bamboo shoot flour fortified biscuits. Increase of starch content in oven dried bamboo shoot flour fortified biscuits may be due to hydrolysis of starch as a result of heat treatment (Rehman and Shah 2005). The ash content of fortified cookies increased up to 67.74%. The increase in ash content may be due to the high mineral content in the fortified cookies (Francischi et al. 1994). The fat content of control biscuits was 26.23 g/100g and 22.00 g/100g in oven dried bamboo shoot fortified biscuit which showed decreased of about 16.13%. This was probably due to low fat content of bamboo shoot (Shi and Yang 1992; Nirmala et al. 2011).
Bamboo shoots, with their high nutritive and therapeutic value hold great promise for utilization as a health food. Recipes such as chutney, pulao, halwa, curry, and bhaji have been standardized by Engineering Resource Group, Bangalore (NMBA 2009). Several other value-added products such as candies, nuggets, crackers, chutney, chips, cookies, chappaties, and buns have now been prepared from bamboo shoots. Farris and Piegiovanni (2008) prepared a popular Italian food namely, ‘Amaretti cookies’ using bamboo fiber as an ingredient. Incorporation of bamboo fiber imparted a characteristic flavor, texture and taste to the cookies. Bamboo shoots not only improved their shelf-life, sensory and nutritional qualities but also increased their physicochemical and nutraceutical properties.

Table 3. Comparison of nutrients (g/100g) in control and oven dried bamboo shoot flour fortified cookies.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Control Cookies</th>
<th>Oven dried bamboo shoot flour fortified cookies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amino acid</td>
<td>0.06±0.01</td>
<td>0.20±0.01</td>
</tr>
<tr>
<td>Proteins</td>
<td>0.40±0.07</td>
<td>0.97±0.04</td>
</tr>
<tr>
<td>Carbohydrates</td>
<td>9.16±0.43</td>
<td>14.48±0.27</td>
</tr>
<tr>
<td>Starch</td>
<td>57.05±0.63</td>
<td>64.60±0.18</td>
</tr>
<tr>
<td>Moisture</td>
<td>0.14±0.04</td>
<td>0.38±0.08</td>
</tr>
<tr>
<td>Ash</td>
<td>0.62±0.02</td>
<td>1.04±0.09</td>
</tr>
<tr>
<td>Fat</td>
<td>26.23±0.49</td>
<td>22.00±0.30</td>
</tr>
</tbody>
</table>

Values reported are measurement replication means ± standard deviation (n = 03 replicates).

Conclusion

Bamboo shoots are a rich source of nutrients and health promoting bioactive compounds such as phenols, phytosterols, and dietary fiber. A large number of studies in a variety of in vitro and in vivo system show that dietary fiber, phenols, and phytosterols have many biological effects that potentially might contribute to prevention of coronary heart diseases, cancer, diabetes and more. The present study revealed that, cookies fortified with oven-dried bamboo shoot flour had high amount of amino acid, protein, carbohydrate and starch content which holds a great promise for utilization in the development of novel bamboo shoot-based food products. The results indicate that oven-dried bamboo shoot flour being a rich source of nutrients, could also be utilized for the preparation of bakery products with improved nutraceutical qualities.

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Reference


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