Compositional profiling of fennel seed

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ABSTRACT

Foeniculum vulgare is a medicinal herb that is used all around the word as spice. The mandate of current study was to explore the nutritional worth of fennel seed because of its easily availability and mostly use. The raw materials were analyzed for the proximate like moisture, fat, protein, fiber, ash & NFE and mineral profile. The composition profiling of Foeniculum vulgar indicated moisture, protein, fat, fiber, ash and nitrogen free extract as 6.24±0.24, 9.38±0.39, 9.76±0.34, 18.21±0.73, 12.97±0.51 and 43.44±1.82%, respectively. Moreover, Foeniculum vulgar contained appreciable amount of minerals especially potassium 852.45±33.25 mg/100 g followed by calcium 580.6±24.39 mg/100 g, manganese 211.35±7.40 mg/100 g, sodium 16.21±0.65 mg/100 g and iron 9.72±0.38 mg/100 g whereas zinc was found only in minute quantities.

Key words: Foeniculum vulgar, proximate composition, minerals.

INTRODUCTION

Nutraceutical is the coordinated sequence of 2 words “nutrition and pharmaceutical” that is defined as the food product that helps to promote health status along with medicinal benefits, including the treatment of diseases with prevention. Different types of products that come under the class of nutraceuticals are dietary supplements and functional foods (Chaturvedi et al., 2011). According to IFIC (International Food Information Council), functional foods are defined as dietary components in which health benefits are provided beyond the basic nutrition. Different foods like breads, baby foods, bars, enriched cereals, fortified snack foods, prepared meals and many others are included in functional foods (Keservani et al., 2010). In nutraceuticals we mainly concern with phytochemicals and antioxidants. It has been proved by research that foods with phytochemicals may help to provide protective shield from diseases such as diabetes, heart disease and hypertension e.g. carrots contain carotenoids which act as an antioxidant and is beneficial for health in preventing chronic diseases by avoiding oxidative damage in our body (Chaturvedi et al., 2011).

Foeniculum vulgare is a popular and recognized aromatic, herbaceous, annual, biennial and perennial plant and belongs to the family of Apiaceae. Depending upon the variety it grows in mild climatic areas in good soil (Gori et al., 2012). This plant was native to Mediterranean and Southern Europe regions but now widely distributed in the temperate and tropical regions of the world, hence widely cultivated. In China it is also a very economic and popular medicinal plant. Foeniculum vulgare as a herb has a number of culinary and traditional medicinal uses. Capillaceum and Piperitum are two important subspecies of this plant that contain essential oil, fatty acids and phenolic compounds etc as main constituents (He and Huang, 2011).

The monitored contents of fennel seed (vitamin and mineral profile) are: dietary fibre 5.75 to 7.59 g/kg, Ca 56 to 363 mg/kg, K 4,241 to 5,851 mg/kg, Mg 82 to 389
mg/kg, Na 77 to 512 mg/kg, dry matter 61 to 75.8 g/kg, weight of pseudobulb 199 to 383 g, nitrates 650 to 3,767 mg/kg, vitamin C 87 to 347 mg/kg (Koudela and Petříková, 2008). According to the proximate analysis fennel seeds contain carbohydrate, crude protein, fiber, ash, fat, moisture as 56.35, 23.19, 17.51, 10.50, 9.96 and 7.27% respectively. Total phenolic compounds in fennel seeds are about 7.55 mg GAE/g. The percentage of fennel seeds essential oil is 1.1%. Dominant fennel essential oil compound is trans-anethole (92.2%), followed by cineole (4.09%), fenchone (1.2%), α-pinene (0.26%), anisaldehyde (0.95%) and limonene (0.085%) (Faten et al., 2011).

MATERIALS AND METHODS

Research experiments were conducted in the “Functional and Nutraceutical Food Research Section” National Institute of Food Science and Technology, University of Agriculture, Faisalabad. Locally cultivated fennel seed was used to determine compositional profiling of fennel seed.

Procurement of materials

Fennel seeds were procured from Oil Seed Research Institute, Ayub Agriculture Research Institute, Faisalabad. Reagents (analytical and HPLC grade) and standards were purchased from Merck (Merck KGaA, Darmstadt, Germany) and Sigma-Aldrich (Sigma-Aldrich Tokyo, Japan). For efficacy trials male Sprague Dawley rats were acquired from National Institute of Health (NIH) Islamabad. Diagnostic Kits used were from Sigma-Aldrich, Bioassay (Bioassays Chemical Co. Germany) and Cayman Chemicals (Cayman Europe, Estonia).

Sample preparation

Unwanted substances like dust, stones and straws were removed in order to clean fennel seed. Fennel seeds were ground (Renker, Model: GMO 1 grinder) and contained in an air tight jar, placed in lab cabinet at ambient temperature and analyzed for their quality attributes as antioxidant capacity and polyphenols.

Proximate analysis of samples

Analysis of ground fennel seeds for moisture, ash content, crude protein, crude fat, crude fiber and nitrogen free extract (NFE) were carried out according to their respective methods (AOAC 2006). All the tests were executed in triplicates.

Moisture content of samples

Fennel seed moisture content was estimated by drying the 5 g sample in forced air draft oven (Model: DO-1-30/02, PCSIR, Pakistan) at 105±5°C for the duration until weight was constant according to AOAC (2006) Method No. 934-01.

Crude protein of samples

Protein content in fennel seed sample was estimated by using Kjeltech Apparatus (Model: D-40599, Behr Labor Technik, Gmbh-Germany) as per procedure mentioned in AOAC (2006) Method No. 984-13. According to this procedure, ground fennel seeds were digested with conc. H₂SO₄ by using digestion mixture (K₂SO₄:FeSO₄:CuSO₄ as 100:5:10) until the color was transparent greenish. The digested material was then diluted up to 250 mL in volumetric flask. 10 mL of 40% NaOH with 10 mL of digested sample were taken in distillation apparatus whereas liberated ammonia was collected in a separate beaker containing 4% boric acid solution, using methyl red as an indicator. Ammonium borate was formed that was used for nitrogen determination in sample. Thus percentage of nitrogen in the sample was assessed by titrating the distillate against 0.1N H₂SO₄ solution till light golden coloration. Crude protein content was estimated by multiplying nitrogen percent (N%) with factor (6.25).

\[ N(\%) = \frac{\text{Vol. of } 0.1N \text{ H}_2\text{SO}_4 \times 0.0014 \times \text{Vol. of dilution (250mL)} \times 100}{\text{Vol. of distillate taken} \times \text{Weight of sample}} \]

Crude protein (%) = Nitrogen (%) x 6.25

Crude fat

Crude fat content in fennel seed was determined by using hexane as solvent in Soxtec System (Model: H-2 1045 Extraction Unit, Hoganas, Sweden) by following the protocol of AOAC (2006) Method No. 920-39.
Crude fiber of samples
Crude fiber in fat free samples of fennel seed was determined by digesting firstly with 1.25% H$_2$SO$_4$ for 30 min and then with 1.25% NaOH solution through Labconco Fibertech (Labconco Corporation Kansas, USA) as described in AOAC (2006) Method No. 978-10. After that sample was filtered and washed with distilled water. Residue was weighed and placed in muffle furnace at temperature of 550-650°C till grey or white ash was obtained. The crude fiber percentage was calculated according to formula below

\[
\text{Weight loss on ignition (g) \times 100} / \text{Weight of sample (g)}
\]

Ash content of samples
Ash in each dry fennel seed sample of 5 g was estimated by direct incineration in a Muffle Furnace (MF-1/02, PCSIR, Pakistan) at 550-600°C after charring, till grayish white residue (AOAC, 2006; Method No. 942-05).

Mineral contents of samples
Powdered sample of fennel seed was subjected to mineral estimation according to the protocol of AOAC (2006). Fennel seed sample (0.5 g) was heat digested along with HNO$_3$ and perchloric acid (7:3) on hot plate until 1-2 mL colorless solution remained. Digested sample was diluted up to 100 mL and subjected to mineral analysis. Sodium, potassium and calcium were estimated through Flame Photometer-410 (Sherwood Scientific Ltd., Cambridge) whereas Atomic Absorption Spectrophotometer (Varian AA240, Australia) was used for the measurement of zinc, iron and manganese and other minerals in the sample.

RESULTS & DISCUSSION
Proximate and mineral analysis
Proximate and mineral analysis is quantitative determination of a mixture to find the percentage of components. These analyses have an important role in chemical screening of compounds. Proximate composition in Table 1 showed that fennel seed contains moisture, crude protein, crude fat, crude fiber, ash and NFE as 6.24±0.24, 9.38±0.39, 9.76±0.34, 18.21±0.73, 12.97±0.51 and 43.44±1.82%, respectively. Likewise mineral profiling in Table 2 showed high potassium 852.45±33.25 mg/100 g followed by calcium 580.6±24.39 mg/100 g, manganese 211.35±7.40 mg/100 g, sodium 16.21±0.65 mg/100 g and iron 9.72±0.38 mg/100 g whereas zinc was found only in minute quantities.

Proximate composition analysis is a measurement to estimate the relative amounts of moisture, protein, lipid, fiber, ash and carbohydrate. Protein, lipid and carbohydrate each contribute to the total energy content while water and ash only contribute mass. Recent experimental studies are in harmony with investigations of Saeed et al. (2009). They showed that percentage of moisture, protein, fat and fiber in fennel was 8.05±1.35, 1.21±0.06, 0.18±0.12 and 2.97±0.4%, respectively. Furthermore, Kaur and Arora, (2010) performed the experiment and suggested that fennel seed contains moisture 8.39%, ash 9.8%, fiber 14.80% and protein 15.68% on dry basis.

Additionally, Faten et al. (2011) found the chemical composition of fennel and observed that fennel contains 23.19% crude protein, 17.51% fiber, 10.50% ash, 9.96% fat and 7.27% moisture, correspondingly. The data regarding proximate composition in current studies is in accordance with previous findings of Anubhuti et al. (2011); Rather et al. (2012) and Chittora & Veer (2013) who worked separately and concluded that moisture; protein, fat, ash, fiber and NFE contents of fennel are 6.3, 9.5, 10, 13.4, 18.5 and 42.3%, respectively on dry basis.

Minerals are crucial and inevitable part of diet as they constitute only 4-6% of human body. Mineral analysis related results of fennel seeds were verified by findings of Ozcan et al. (2008) who worked on mineral contents of some medicinal plants which are mostly used as traditional condiments. Level of K of fennel seed in this work was found to be very higher than those of others. Mineral content of fennel

Seed was 2019.2, 1030.1, 11.6, 4.52, 3.81 and 1.54 mg/100 g for potassium, calcium, iron, sodium, manganese and zinc. Significance of these elements
cannot be overemphasized because different enzymes require them as a cofactor. Koudela and Petříková (2008) suggested the monitored parameters of

**Table 1: Proximate composition of fennel seed**

<table>
<thead>
<tr>
<th>Proximate Composition</th>
<th>Quantity (%)</th>
</tr>
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<tbody>
<tr>
<td>Moisture</td>
<td>6.24±0.24</td>
</tr>
<tr>
<td>Crude protein</td>
<td>9.38±0.39</td>
</tr>
<tr>
<td>Crude fat</td>
<td>9.76±0.34</td>
</tr>
<tr>
<td>Crude fiber</td>
<td>18.21±0.73</td>
</tr>
<tr>
<td>Ash</td>
<td>12.97±0.51</td>
</tr>
<tr>
<td>NFE</td>
<td>43.44±1.82</td>
</tr>
</tbody>
</table>

**Table 2: Mineral composition of fennel seed**

<table>
<thead>
<tr>
<th>Minerals</th>
<th>Concentration (mg/100 g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potassium</td>
<td>852.45±33.25</td>
</tr>
<tr>
<td>Calcium</td>
<td>580.6±24.39</td>
</tr>
<tr>
<td>Manganese</td>
<td>211.35±7.40</td>
</tr>
<tr>
<td>Sodium</td>
<td>16.21±0.65</td>
</tr>
<tr>
<td>Iron</td>
<td>9.72±0.38</td>
</tr>
</tbody>
</table>

potassium, sodium, manganese and calcium in fennel as 504.6, 29.45, 23.55 and 20.95 mg/100 g and trace amount of iron and zinc, correspondingly. Sodium, potassium and calcium are the major micronutrients present in plants as an essential cations. These minerals are required for human body in large amounts. However, their deficiency results in arthritis bone and tooth related disorders. Manganese is an important element for proper and normal growth of human bone structure. It is a very significant mineral in aiding to increase mineral density of spinal bone. Fe is required for production of red blood cells in a process known as the haemopoiesis, but it is also part of hemoglobin (pigment of RBC) that binds to oxygen to facilitate its transport from the lungs via the arteries to all cells throughout the body. Zinc is required for working of insulin, fertility as well as for mental and body growth.

**References:**

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