Assessment and Effectiveness of Fennel Powder Extract Based Cookies in Hyperglycemic Subjects

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Abstract

Background: In the current world, almost half of the total world’s population is experiencing lifestyle complications that have deleterious effects on the human wellbeing. These life endangering endeavors are multiplying in magnitude of their adversity because of poor dietary habits. At present, there is a strong need to introduce the benefits of consuming functional foods for the treatment and prevention of disease related complications. The plants of Umbelliferae Apiaceae family are a rich treasure of bioactive polyphenols, imparting hypoglycemic, hypocholesterolemic, and anti-inflammatory, anti-cancer, anti-microbial, carminative and anti-allergic properties.

Objective: The present study was aimed to assess the effectiveness of fennel extract based cookies on hyperglycemic human subjects.

Keywords: Fennel; Phytochemicals; Polyphenols; Antioxidants; Proximate analysis; Sensory evaluation; Hyperglycemia

Introduction

Since the last few decades, people are increasingly centered on altering their nutritional approaches to struggle with the lifestyle linked chronic health problems. Vegetables and fruits are highly rich sources of phytochemicals that are renowned for their health benefits [1]. These phytochemicals provide protection against various health issues such as different tumors [2], heart problems [3], elevated blood glucose levels [4], hypertension [5], inflammatory disorders [1], bacterial infections [6], viral infections [7] and other microbial infections [8], psychiatric illnesses [9], peptic ulcers [10], joints and bone related disorders such as osteoporosis [11]. Fennel plant, biologically known as Foeniculum Vulgare, is a familiar culinary spice that is also used as a therapeutic plant. It belongs to the family Apiaceae [12]. It is used in a wide range against gastrointestinal [13], endocrinal [14], reproduction [15], respiratory problems [16] and as a lactation improving agent [17]. Fennel is also employed in make-up [18] and medicinal products [13]. Fennel also imparts flavor to the edibles such as breads, pastries, pickles and cheese. The current study has proved that the nutritional syndromes can be corrected by healthful intakes. The functional and nutraceuticals foods are effective in the management of human health, on basis of their compositional profiling [19]. A review on detailed evaluation of Foeniculum vulgare concluded that it constitutes 9.5% protein, 6.3% of moisture, 13.4% minerals, 10% fats, 42.3% carbohydrates and 18.5% fiber. The vitamins and minerals composition of F. vulgare includes potassium, calcium, iron, sodium, riboflavin, phosphorus, thiamine, vitamin C and niacin. The phenolic contents include 4-O-cafeoylquinic acid, 3-O-cafeoylquinic acid, 1,3-O-di-cafeoylquinic acid, 5-O-cafeoylquinic acid, 1,5-O-di-cafeoylquinic acid and 1,4-O-di-cafeoylquinic acid [20]. Increased oxidative stress results in excessive production of Reactive Oxygen Species (ROS). It leads to the initiation of pathological conditions [21]. Elevated blood glucose levels, known as hyperglycemia, is a condition in which an excessive amount of glucose circulates in the blood plasma (American Diabetes Association). It occurs due to impaired insulin sensitivity of cells or insufficient insulin production. Persons with increased circulatory blood sugar concentrations are at risk of developing different complications endangering health and survival [22,23]. An experiment to assess the antimicrobial and antioxidant capacities of fennel vital oil using methanolic and ethanolic extracts indicated the presence of twenty three polyphenols with trans-anethole (69.87%) being the major one followed by fenchone (10.23%), estragole to be 5.45% and limonene (5.10%) [24]. A human trial to investigate the outcomes of Fennel in the management of hyperglycemic cases concluded that the mean values of blood sugar levels of individuals after two hours of fennel administration were lowered from 313.5 mg/dL ± 108.69 mg/dL to 262 mg/dL ± 88.69 mg/dL and from 279.33 mg/dL ± 96.24 mg/dL to 246.5 mg/dL ± 91.93 mg/dL for patients having 100 mg/kg body weight and 50 mg/kg body weight respectively [25].

Methodology Study Design

Quasi experimental study design

Settings: The study was conducted at following settings: Food Science and Technology Lab (Lab. No. 101) of University Institute of Diet and Nutritional Sciences (UIDNS), University of Lahore, Diabetic Center Services Hospital, Lahore.
**Sample size:** 53 hyperglycemic subjects.

This was a human-based trial to study the effectiveness of fennel extract-based cookies on the physiology (fasting blood glucose level at beginning (0 day) and at end (60th day), respectively)

**Sampling technique:** Purposive sampling technique

**Sampling selection:** The samples were selected according to the inclusion and exclusion criteria.

**Inclusion criteria:** Male and female hyperglycemic patients attending the Services Hospital, Lahore were included in the study.

**Exclusion criteria:** Diabetic patients with other complications (diabetic neuropathy, diabetic nephropathy) and non-cooperative/unwilling hyperglycemic subjects were not included in the study.

**Equipments:** Weighing Balance, Kjeldal Apparatus, Mixer, Oven, Rotary Evaporator, Orbital shaker, Baking Oven, Glucometer, 53 glucose meter strips for each interval, sterilized needles.

**Collection and Preparation of Material**
Ripe Fennel seeds sample were purchased from a local market of Lahore. The seeds of Fennel were subjected to shadow drying for 3 to 6 hours to remove adhering moisture followed by oven drying at 70°C and grinding to pass through 100 Mesh Screen Filter. Fennel seeds powder was packed in an air tight jar for further analysis.

**Proximate analysis**
The analysis for moisture content, ash content, crude protein, crude fat and crude fiber of fennel seeds powder was performed according to the methods of AOAC [26]. All the tests were executed in triplicates.

**Preparation of fennel powder extract**
The process of fennel seeds powder sample extraction was performed by using ethanol as solvent. Ethanol extracts of the fennel seeds (20% w/v) was prepared by shaking using orbital shaker for 24 hours at 30 rpm. The resultant supernatant was subjected to centrifuge at 9000 rpm for fifteen minutes. The coarse particles were filtered through proper filtration media for extract separation and then subjected to rotary evaporator for the recovery of solvents at 300 rpm [27,28].

**Antioxidant indices**
The powdered extract was evaluated for their antioxidant capacity through different tests including TPC (Total Phenolic Contents) and DPPH (1, 1-diphenyl-2-picrylhydrazyl) assay as discussed below:

**Determination of Total Phenolic Content (TPC)**
The Total Phenolic Content (TPC) in fennel powder extract was assessed using Folin-Ciocalteu method [29]. The mechanism is based on the phosphoric acid reduction to phosphorylated protein, and as the number of aromatic phenolic group upturns, the results of absorbance increases. For this purpose, fennel powder extracts (50 μl) was discretely added to nine tubes each having 250 μl Folin-Ciocalteu reagent and 750 μl (20%) sodium carbonate solution, and the final volume was filled with distilled water to 5 ml. After two hours, the absorbance was measured at 765 nm using a UV/Visible Spectrophotometer (CECIL CE7200) against the control and blood analysis for circulatory glucose levels were determined at mid-meal 1 dose daily for period of two months.

**Feeding trial**
To explore the therapeutic potential of our developed functional fennel seeds powder extract based cookies against the lifestyle linked problem with special reference to hyperglycemia, 53 hyperglycemic patients were selected randomly from the Diabetic Center of Services Hospital, Lahore. Cookies were provided to the study volunteers for regular intake (4 cookies at mid meals in one dose daily). The patients' current medications were followed as prescribed. Anthropometry and blood analysis for circulatory glucose levels were determined at beginning (0 day) and at end (60th day), respectively.

**Data Collection Tool**

**Fasting Blood Sugar Level Test**

**Physical parameters feed intake:** The selected hyperglycemic were advised to take 4 fennel seeds powder extract based cookies at mid-meal 1 dose daily for period of two months.

**Determining circulatory glucose levels:** Circulatory blood glucose concentration was measured using a Glucometer (Optimum, Optimum...
Medisence). For taking the sample, the area of the skin to be used as a site of puncture was inspected wearing a pair of latex-free gloves and the puncture site was cleaned using alcohol swab. After calibration of Glucometer, the reagent strip was removed from the container and placed in the Glucometer with the test pad facing up. Then the skin puncture was performed using a sterilized needle. The blood drop was transferred to the reagent strips. Then, the timer on the Glucometer was immediately pressed to take reading. And final reading was noted down.

Data analysis: Data was entered and analyzed using SPSS version 25. Numerical data like age, blood glucose level etc. was presented in the form of Mean ± S.D. Categorical data like gender, diabetes status was presented in the form of F (%) After fulfilling the parametric assumptions, paired sample T-test and one sample T-test were used to compare BSL (Blood Sugar Level) value before and after intervention among hyperglycemic subjects.

Results

The present research was divided into four sections. Firstly, the proximate analysis of fennel seeds was performed; secondly, fennel extract was evaluated for its antioxidant potential. At third step, fennel extract based cookies were prepared for feeding trial of hyperglycemic patients. Finally, the effect of fennel extract based cookies on hyperglycemic subjects’ blood sugar level was assessed with human trials.

Proximate analysis

The proximate analysis is performed to evaluate the compositional profiling of the product being selected for clinical experiments. The mean values of proximate analysis of fennel seeds powder; value of results of extraction yield of fennel powder using ethanol as solvent are tabulated in (Table 1 and 2). The proximate composition of fennel seeds powder in the graphical form is given in (Figure 1).

Blood glucose levels

The results tabulated have shown significant lowering of the circulatory fasting blood glucose concentrations of the hyperglycemic subjects in a period of two months with fennel extract based cookies (Figure 2) (Table 1-3).

Statistical interpretations on the blood glucose levels of hyperglycemic subjects

The mean ± Standard Deviation (S.D) values for initial fasting blood glucose levels (when fennel containing cookies as mid meal snack were not given) and final fasting blood glucose levels (after the treatment with fennel containing cookies as mid meal snack) of 53 hyperglycemic patients for a duration of two months i.e. 8 weeks feeding trial was subjected to evaluation using SPPSS version 25. The data was analyzed by using the statistical one sample and paired sampled T- test (Table 4-6).

Discussion

The use of Fennel as a therapeutic agent is quite evident. The investigation led by Syed et al. [13], concluded that the fennel seeds contain 8.8 g moisture, 15.8 g crude proteins, 9.91 g crude fats, 52.59

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**Table 1:** Proximate composition of Fennel Seeds Powder (%).

<table>
<thead>
<tr>
<th>Proximate Composition</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture</td>
<td>8.44 (0.51)</td>
</tr>
<tr>
<td>Ash</td>
<td>9.93 (0.55)</td>
</tr>
<tr>
<td>Protein</td>
<td>8.51 (0.42)</td>
</tr>
<tr>
<td>Fat</td>
<td>9.87 (0.15)</td>
</tr>
<tr>
<td>Crude Fiber</td>
<td>13.09 (1.31)</td>
</tr>
<tr>
<td>Nitrogen Free Extract</td>
<td>49.08 (3.04)</td>
</tr>
</tbody>
</table>

**Table 2:** Extraction yield of fennel seeds powder.

<table>
<thead>
<tr>
<th>Solvents</th>
<th>Extraction Yield (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethanol</td>
<td>4.7 ± 0.18</td>
</tr>
</tbody>
</table>

**Table 3:** Results for antioxidant indices of fennel seeds powder ethanolic extract determined by TPC and DPPH assay.

<table>
<thead>
<tr>
<th>Solvents used</th>
<th>TPC (mg GAE/g)</th>
<th>DPPH Assay (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethanol</td>
<td>104.1 ± 1.7</td>
<td>143.6 ± 4.3</td>
</tr>
</tbody>
</table>

**Table 4:** Descriptive statistics on mean blood glucose values of hyperglycemic subjects.

<table>
<thead>
<tr>
<th>Pair</th>
<th>Mean</th>
<th>N</th>
<th>Std. Deviation</th>
<th>Std. Error Mean</th>
<th>95% Confidence Interval of the Difference Lower</th>
<th>Upper</th>
<th>f</th>
<th>Sig. (2-tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Blood Glucose</td>
<td>132.17</td>
<td>53</td>
<td>13.591</td>
<td>1.867</td>
<td>-7.294</td>
<td>-3.385</td>
<td>-5.483</td>
<td>2</td>
</tr>
<tr>
<td>Final Blood Glucose</td>
<td>126.83</td>
<td>53</td>
<td>13.315</td>
<td>1.830</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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**Figure 1:** Graphical representation of the mean values of proximate analysis of fennel seeds powder.

**Figure 2:** Graphical representation according levels of BSL.

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g nitrogen free extracts per 100 g seeds sample respectively. Another study by Bukhari et al. [28], outlined the compositional profile of *Foeniculum vulgare* as containing 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.

The determination of total phenolic content of fennel by Faudale et al. [29], explored the values of total phenolic content using ethanol to be 104.0 mg ± 3.8 mg GAE/g. Also in the same study, the DPPH values of fennel using ethanolic and n- hexane solvents extracts included 116.8% ± 4.3% and 92.7% ± 2.1% respectively. Hyperglycemia is a recognized risk factor for diabetes. Many herbs such as *Foeniculum vulgare* mill usually distinguished as fennel seeds due to its anti-diabetic activities have therapeutic properties to subdue the elevated blood glucose level. In a study by Sania Zulfiqar in 2019 study, the hyperglycemic patients were distributed into three groups (G0, G1, and G2) that were prescribed to use a calculated quantity of fennel seeds at doses once daily on empty stomach in varying proportions. There was a significant decline in the blood glucose levels in diabetic patients after two hours of fennel administration. Before fennel administration, the mean values exhibited as 313.5 mg/dL ± 108.69 mg/dL and 279.33 mg/dL ± 4.3% and 92.7% ± 2.1% respectively. Hyperglycemia is a recognized risk factor for diabetes. Many herbs such as *Foeniculum vulgare* are highly beneficial in imparting therapeutic effects to subordinate the elevated blood glucose level. *F. vulgare* extracts (100 mg/kg).

The results showed that action with *F. vulgare* and diabetic animals were cured by *F. vulgare* which anti hyperglycemic effects of *Foeniculum vulgare* Mill. (fennel) on menopausal symptoms in postmenopausal women: a randomized, triple-blind, placebo-controlled trial. Menopause. 2017;24(9):1017-21.

*References*


