GLUCOSE LOWERING EFFECTS OF PRE-COOKED INSTANT PREPARATIONS CONTAINING MUSHROOM IN NON-INSULIN DEPENDENT DIABETIC AND HEALTHY SUBJECTS

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ABSTRACT

Mushrooms have been used as food and medicine in many parts of the world since time immemorial. They are potent exemplary sources of natural medicines with anti-diabetic activity. The high protein, fiber and low fat/energy contents of edible mushrooms make them excellent food for diabetics. Many investigators have endeavored to study the hypoglycemic effect of either the fruiting body or the mycelia of various edible and medicinal fungi. The study has been undertaken to develop an instant powder mix for upma, utilizing mushroom and to evaluate its efficiency in non-insulin dependent diabetic and healthy subjects. The glycemic index values were found to reduce from 55.9 for low glycemic index basal upma to 45.8 for low glycemic index mushroom enriched basal upma. The trend was found to be almost similar in normal subjects.

Key words : Glucose, Mushroom, Diabetic, Natural Medicines.

INTRODUCTION

One of the major aims of chronic disease therapy is to normalize the blood glucose profile, including the fasting and postprandial blood glucose concentrations (Trinidad et al. 2004). Many carbohydrate foods provoke variable glycemic responses. Until recently, the carbohydrates have been classified as ‘simple’ and ‘complex’ based on their degree of polymerization. However, their effect on health may be better described on the basis of their physiological effects and their ability to raise blood glucose which depends on the type of constituent sugars and physical form of carbohydrate. This classification is referred as glycemic index, which is a quantitative assessment of foods based on postprandial blood glucose response expressed as a percentage of the response to an equivalent carbohydrate portion of a reference food (Jenkins et al. 1984; Wolver et al. 1995). It is postulated that the slower the rate of carbohydrate absorption, the lower the rise of blood glucose and lower glycemic index value. Several health benefits have been reported to be associated with decreased rate of carbohydrate absorption by means of a low glycemic index diet. These include: reduced insulin demand, improved blood glucose control, and reduced blood lipid levels, all factors that may play important roles in the prevention and management of several chronic diseases including diabetes, coronary heart diseases, and certain cancers (Augustin et al. 2002).

High glycemic foods are characterized by fast-release carbohydrates and higher blood glucose levels, resulting in greater insulin demand. Factors affecting the rate of glucose absorption from starchy foods and therefore, the glycemic value include the nature of the food and the type and extent of food processing (Behall et al. 1988; Jenkins et al. 1978), the presence of large amount of fat or protein (Collier et al. 1986; Bornet et al. 1987), antinutrients such as phytic acid, lectins and tannins (Thompson et al. 1984; Rea et al. 1985) and nutrient-starch interactions in carbohydrate containing foods, such as in wheat products (Jenkins et al. 1987).
Mushrooms are recently being recognized to elicit low postprandial responses, due to the presence of high content of polysaccharides and soluble fiber (Jeong et al. 2010). They are also excellent sources of bioactive components viz., protein, polysaccharides, polyphenols, flavonoids, lectins, isothiocynates, ergosterol, terpenoids, glycosides, alkaloids, significant levels of vitamins and minerals and antinutritional factors viz., tannins, phytates, trypsin inhibitors, saponins and oxalates which may contribute to lower glycemic response (Hwang et al. 2005; Bernas et al. 2006). Therefore, the present study was undertaken to develop an instant powder mix for upma, utilizing mushroom and to evaluate its efficiency in non-insulin dependent diabetic and healthy subjects.

**MATERIALS AND METHODS**

Selection of subjects and experimental design: A total number of 30 diabetic subjects both male (15) and female (15) in the age group of 50 to 55 years with weight ranging from 50 to 60 kgs were selected from the same socio-economic background from various localities of Anantapur viz., Old town, Raninagar, Gandhinagar and Goldstreet. The same number of normal subjects i.e., 30 comprising 15 male and 15 female within age group of 50 to 55 years and weights ranging from 50 to 60 kgs were also selected for the study from various localities of Anantapur viz., Sainagar, L.B. Nagar Colony, Shardanagar and Kamalanagar. Information on dietary patterns and medical history was collected using structured questionnaire.

Volunteers who met the study criteria were selected for the study, the inclusion criteria were: subjects with a diagnosis of type 2 diabetes mellitus with duration of two to three years, fasting blood glucose levels ranging from 110 to 150 mg/dl and body mass index ranging from 21 to 26. The normal subjects had mean glucose levels ranging from 75 to 95 mg/dl and body mass index ranging from 18 to 20. Subjects on insulin, undergoing any medication and suffering from complications such as kidney diseases, liver disease, and other diabetic complications were excluded from the study. The exclusion criteria established for selection of normal subjects were; weight > 60 kgs, blood glucose levels > 95 mg/dl and with higher physical activity. Informed consent was taken from all the subjects for their willingness to participate in the study. The study was approved by the Ethical Committee of the Institute.

The selected subjects belonging to diabetic (n = 30) and normal (n = 30) groups, were divided randomly into three groups containing 10 subjects in each group. The study included one standard group fed on glucose, and two test groups (Group II to III) fed on two experimental diets such as low glycemic index basal upma and low glycemic index + mushroom upma.

**Preparation of products**: Mushroom sample of *Calocybe indica* (Food grade) was procured from Haritha Mushroom Cultivation Centre in Kerala. The other ingredients viz., semolina, whole bengal gram, soya nuggets, specie mix (cumin seeds, onions, green chilies, coriander leaves, curry leaves and garlic) were procured from the local market in one lot. All ingredients used were processed using different cooking methods and subsequently mixed in different proportions (Table 1) to develop instant mushroom mix.

**Diet and feeding**: To study the impact of mushroom feeding on postprandial glycemic response, mushroom was incorporated at the level of 50 per cent (by weight) of the total mix to a normal basal mix (semolina) and a low glycemic index basal mix (semolina, soya nuggets and bengal gram dhal). The reference and the test foods were served to the subjects in portions providing 50 g carbohydrates after an overnight fasting (Table 2). The diets were consumed between 10 to 15 min. Finger prick capillary blood samples were taken at 0, 30, 60, 90, 120, 150 and 180 min after the meal for diabetic subjects and 0, 30, 60, 90 and 120 min after the meal for normal subjects. The increment in the blood glucose levels were analyzed at an interval of 30 min using automatic glucometer (One Touch Horizon II Model).

**Glycemic Index evaluation**: Two and three hrs blood glucose response curves were constructed and the incremental area under the glucose response curve (IAUC) was calculated for normal and diabetic subjects. The glycemic index (GI) for each test food was calculated from incremental glucose area with glucose as reference for diabetic subjects. The incremental area under blood glucose curve was
calculated using the following formula (Jenkins et al. 1981).

\[ IAUC = \frac{At}{2} + A_t + \frac{(A-B) t}{2} + B_t + \frac{(B-C) t}{2} + C_t + \frac{(C-D) t}{2} + Dt \ldots \ldots \text{etc.} \]

\[ GI = \frac{\text{Incremental area under blood glucose response curve for test food}}{\text{Incremental area under blood glucose response curve for reference food}} \times 100 \]

RESULTS AND DISCUSSION

The measurement of glycemic index was carried out in diabetic and normal subjects to study the extent of variation introduced by the type of subject inclusion. The basal characteristics of the diabetic and normal subjects included in the study are given in Table 3. Information regarding the subjects medical history, dietary intake, diabetic complications, general information and anthropometric measurements were collected using a structured questionnaire. The mean dietary intake of carbohydrate, protein and fat within the groups were almost similar. The data on food frequency of the consumption of different foods revealed less variation in their diets.

The experimental diets viz., low glycemic index basal upma and low glycemic index + mushroom upma were fed to provide 50 g carbohydrates and rise in postprandial glycemic response was observed in healthy and diabetic subjects after an overnight fasting for a period of 2 and 3 hours, respectively. The responses of experimental diets were compared with glucose. The mean plasma glucose levels increased in all groups fed test products and the glucose control meal. The levels declined in all groups after the appearance of peak values (Fig. 1 and 2). The mean area under the blood glucose response curve and glycemic index for mushroom based product is presented in Table 4. The incremental area under the glucose response curve for the subjects consuming experimental diets were found to be significantly (p<0.01) lower than that observed with the AUC of subjects consuming standard glucose. The addition of mushroom to low glycemic index basal upma significantly (p<0.01) lowered the postprandial rise in blood glucose.

The calculated glycemic index values were found to reduce from 55.9 for low glycemic index basal upma to 45.8 for low glycemic index mushroom enriched basal upma (Fig. 3). The trend was found to be almost similar in normal subjects. However, the values of glycemic index tended to be more in diabetic than the normal subjects. The results thus, clearly reveal the role of mushroom in reducing the postprandial glycemic response. As expected, the magnitude of reduction was found to be more with low glycemic index basal upma addition than semolina basal upma addition.

<table>
<thead>
<tr>
<th>Ingredients</th>
<th>Processing method</th>
<th>Low glycemic index mix</th>
<th>Low glycemic index mix + mushroom</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mushroom</td>
<td>Drying, powdering</td>
<td>-</td>
<td>45</td>
</tr>
<tr>
<td>Semolina</td>
<td>Roasting</td>
<td>50</td>
<td>25</td>
</tr>
<tr>
<td>Bengal gram dhal</td>
<td>Boiling, drying, roasting, powdering</td>
<td>20</td>
<td>10</td>
</tr>
<tr>
<td>Nuggets</td>
<td>Boiling, drying, roasting, powdering</td>
<td>20</td>
<td>10</td>
</tr>
<tr>
<td>Oil</td>
<td>-</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Spice mix</td>
<td>Powdering</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Salt</td>
<td>-</td>
<td>To taste</td>
<td>To taste</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Diet</th>
<th>Carbohydrate content of diet (g/100g)</th>
<th>Amount of diet providing 50 g carbohydrates</th>
</tr>
</thead>
<tbody>
<tr>
<td>II (Mushroom)</td>
<td>59</td>
<td>85</td>
</tr>
<tr>
<td>III (Semolina upma)</td>
<td>74</td>
<td>66</td>
</tr>
<tr>
<td>IV (Semolina + mushroom upma)</td>
<td>67</td>
<td>75</td>
</tr>
<tr>
<td>V (Low glycemic index mix)</td>
<td>53</td>
<td>94</td>
</tr>
<tr>
<td>VI (Low glycemic mix + mushroom)</td>
<td>57</td>
<td>88</td>
</tr>
</tbody>
</table>
FIG. 1: Post prandial blood glucose response of mushroom products fed to healthy subjects.
FIG. 2: Post prandial blood glucose response of mushroom products fed to diabetic subjects.

FIG. 3: Glycemic index values of mushroom products of healthy and diabetic subjects.
The reduction in postprandial glycemic response of mushroom could be due to the presence of substantial amount of phytochemicals and other bioactive components viz., protein, fiber, polyphenols, tannins, isothiocynates, polysaccharides, α-glucans, lectins, heamagglutinins and the factors such as the nature as starch, the food form, particle size, starch protein and starch-lipid interaction.

**CONCLUSIONS**

Overall, results reveal that feeding of mushroom was able to reduce the glycemic response curve. The reduction with mushroom enriched low glycemic mix was more pronounced than with low glycemic index mix. Therefore, incorporation of mushroom to a composite low glycemic index mix could be a more practical approach.

**REFERENCES**


