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Bioevaluation of agro-waste for postprandial glucose and insulin concentration in blood

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Abstract

Objective: To evaluate the effect of cookies supplemented with apple pomace and mango-peel powder on postprandial glucose and insulin concentration.

Method: The experimental study was conducted from February to August, 2018, at the Nutrition Counselling Centre, Government College Women University, Faisalabad, Pakistan. Different cookies with apple pomace and mango-peel powder were prepared and the most nutritive acceptable cookies were used to determine their postprandial effect on glucose and insulin concentrations against the control cookies made with white flour only in female subjects. Adult women were selected through advertisement with normal body mass index. Data was analysed using SPSS 17.

Results: All the 30 subjects received enriched and control cookies at different time slots during the study. The overall mean age of the sample was 25±10 years and each subject had body mass index <25kg/m^2. Overall blood glucose and insulin concentrations were significantly lower with treatment cookies , compared to the control cookies ($p<0.05$).

Conclusion: It was evident that fruit processing waste can be used as a nutraceutical agent in diet-based modules.

Key Words: Glycemic response, Type 2 diabetes mellitus, Insulin control.

Introduction

Postprandial hyperglycaemia (PPHG) is linked with the concentration and rate of glucose absorption due to starch intake in the diet[1]. PPHG and hyperinsulinaemia (HI) are early detectors of various cardiovascular diseases (CVDs) and type 2 diabetes mellitus (T2DM)[2]. Studies have demonstrated that dietary fibre and some phytochemicals may play significant role in the reduction of postprandial glycaemia and insulinaemia. Polyphenols present abundantly in plant food show their efficacy against PPGH by interfering with the metabolic enzymes present in the intestine[3]. Moreover, the plant dietary fibre hinders the transport of glucose into the blood by decreasing its digestion and absorption through intestinal wall[4]. Among the plant-derived economical and abundantly available indigenous resources, the study on apple pomace and mango-peel has demonstrated that these by-products of fruit processing industries are marvellous sources for both high-quality dietary fibres and bioactive compounds[5]. These can readily be used for the improvement of postprandial glucose and insulin concentration in healthy subjects. Furthermore, in Pakistan the production of apples is about 598,804 tons, while mango occupies 14% of the total cultivated area for fruits and is the second largest fruit grown after citrus[6]. The estimated capacity for juice production is almost 400,000 Mt and processing results in wastage of valuable material[7].

Further, cookies are considered superior products for supplementation due to higher acceptance by community, better sensory acceptability and longer shelf-life[8]. The current study was planned to evaluate the hypoglycaemic potential of apple pomace enriched cookies (APECs) and mango-peel enriched cookies (MPECs) to assess postprandial glycaemic response in humans.

Materials and Methods

The experimental study was conducted from February to August, 2018, at the Nutrition Counselling Centre, Government College Women University, Faisalabad, Pakistan. After approval from the institutional ethics review committee, the sample was raised through advertisement posted and distributed at different clinics of the city. Written informed consent was obtained from all the subjects. Those included were adult females with normal body mass index (BMI). Those having obesity, diabetes, hypertension or allergic reaction to any of the contents were excluded.

Apple pomace and mango peels were obtained from the local fruit processing industry. Apple pomace was blanched, dried (60ºC) and was ground to a particle size of 500–600µm. The same procedure was adopted for mango peels[5]. Different levels of apple pomace powder (APP) and mango-peel powder (MPP) were supplemented in white flour (WF) (5-25g/100g of WF) to prepare the cookies using the method as described by the American Association for Clinical Chemistry (AACC)[9]. The supplemented cookies were analysed for various sensory properties, like colour, flavour, taste, texture, crispness and overall acceptability, against the control cookies that had 0% level of supplementation. The comparison was made by a panel of experts using 9-point Hedonic Score System[10]. The best found cookies were used subsequently.

The subjects were given different cookies as control (C), APEC and MPEC groups in different sessions with a washout period of 10 days between each treatment. The subjects were provided the food frequency and discomfort questionnaire to record any discomfort[11].

The volunteers were offered cookies (50g) in fasting state of at least 12 hours along with one glass of plain water. The blood was drawn for glucose and insulin concentration at baseline, 30, 60, 120 and 180 minutes post-ingestion. The blood was tested for glucose concentration using glucometer and venous

blood (2mL) was collected in tubes, allowed to stand till clot was formed and was centrifuged to get clear serum sample. The serum was analysed for insulin concentration following enzyme-linked immunosorbent assay (ELISA) kit protocol (immune-reactive insulin by double antibody technique) using ELISA plate reader[12].

It was a single-blind study where the subjects were not informed about the type of cookies they were consuming. The same subjects acted as control and treatment groups at different sessions with washout period of 10 days. Data was analysed using SPSS 17. Analysis of variance (ANOVA) was done to see the level of significance. For post-hoc test, the least significant difference was calculated at $p \leq 0.05$.

Results

All the 30 subjects received enriched and control cookies at different time slots during the study. The overall mean age of the sample was 25±10 years and each subject had BMI <25kg/m^2. Sensory evaluation of control and supplemented cookies were significantly different ($p \leq 0.05$) (Figure). The best selected cookies were used for further analyses (Table 1).

The mean values for blood glucose concentration showed a significant difference between the patterns of glucose concentrations at different time intervals ($p < 0.05$) (Table 2).

Overall insulin concentration was highest at 30 minutes which fell down with time (Table 3).

Discussion

The findings showed that the dietary intervention in the form of cookies proved to be a better strategy to improve fibre and phytochemical content of daily diet. A study [13] also observed sensory properties of orange pulp and peel powder supplemented cookies and found these acceptable up to 15%. Above this level,

the cookies gave the feeling of dryness and became difficult to swallow without water. In the present study, with increase in the level of supplementation the texture of cookies became hard and the shape was also not up to the mark due to higher content of fibre. Similarly, a study[14] described that cookies supplemented with mango/cassava/soybean composite flours were more acceptable compared to wheat flour cookies.

Studies have shown that increase in postprandial glucose concentration results in the development of T2DM and CVDs[15-17]. The results of blood glucose and insulin concentrations clearly showed that glycaemic response decreased significantly with the addition of MPP as well as APP compared to the control cookies. This may be attributed to higher dietary fibre content in APP and MPP[5]. Dietary fibre is well known for decreasing postprandial glycaemia and insulinaemia because it delays and slows down glucose absorption and in return the level of insulin is also regulated[16]. Also, the consumption of dietary fibre has an inverse relation with glycaemic load, and repeated higher glycaemic load may lead towards the incidence of T2DM and insulin resistance (IR). Similar results were also demonstrated for cookies made with the addition of resistant starch[17] and those supplemented with viscous fibre[18]. Moreover, it is well established that a low-glycaemic index diet may positively change β-cell function, coagulation ability and lipid profile[19].

Conclusion

The waste from the fruit processing industry can be successfully used for the preparation of cookies which were liked by the consumers even more than the control cookies without supplementation. The supplemented cookies managed well postprandial glucose and insulin concentrations compared to the control cookies.

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Disclaimer: It is notified that the address of Principal author, Huma Umbreen has been changed to "Institute of Home and Food Sciences, Govt. College University, Faisalabad, Pakistan".

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Table 1: Composition of selected cookies for postprandial trial

Parameter	Control Cookies	Apple Pomace Powder Enriched Cookies (APEC)	Mango-Peel Powder Enriched Cookies (MPEC)
Portion Weight (g)	50.**00**	50.**00**	50.**00**
Energy (Kcal)	247.47	219.82	218.99
Total Carbohydrates (g)	35.**00**	35.**00**	35.**00**
Available Carbohydrates (g)	33.70	28.65	28.89
Total Dietary Fibre (g)	1.3**0**	6.35	6.11
Fat (g)	10.43	9.78	9.63
Protein (g)	4.7**0**	4.3**0**	4.23

Table 2: Effect of different treatments on blood glucose concentration (mg/dL±SEM) at various time spans

Treatments	Baseline	30min	60min	120min	180min	Overall Means
Control	96.67±0.88	145.00±1.15^{a}	134.33±1.15^{a}	122.32±2.02^{a}	101.00±0.57^{a}	119.87±5.02^{A}
APEC	96.69±1.20	126.34±1.76^{b}	110.68±1.76^{b}	103.00±1.15^{b}	98.00±0.58^{b}	106.93±2.59^{B}
MPEC	96.68±0.89	120.67±0.88^{c}	104 63±1.45^{c}	98.67±0.89^{b}	97.00±0.57^{b}	103.53±2.44^{B}
Overall Means	97.67±0.50^{D}	130.67±3.37^{A}	116.56±4.50^{B}	108.00±3.71^{C}	98.67.00±0.67^{D}	

$^{a-c}$ different letters in a column show significant difference at $p \leq 0.05$
^{AB} different letters in a column show significant difference at $p \leq 0.05$
$^{A-D}$ different letters in a column show significant difference at $p \leq 0.05$
APEC: Apple pomace enriched cookies
MPEC: Mango-peel enriched cookies
SEM: Standard error of mean.

Table 3: Effect of different treatments on blood insulin concentration (pmol/L±SEM) at various time spans

Treatments	Baseline	30min	60min	120min	180min	Overall Mean
Control	85.00±1.52	357.67±0.88^{a}	226.67±0.87^{a}	168.00±1.53^{a}	95.00±1.52^{a}	186.47±26.47^{A}
APEC	85.00±1.67	223.34±1.45^{b}	205.67±33.15^{b}	127.00±1.15^{b}	88.34±1.2^{b}	145.86±16.54 ^{B}
MPEC	84.35±1.86	205.33±0.88^{c}	162.29±0.86^{c}	113.33±4.17^{c}	87.00±0.57^{b}	130.48±12.52^{B}
Overall Means	84.77±0.83^{D}	262.11±24.03^{A}	198.22±13.47^{B}	136.11±8.3^{C}	90.11±1.3^{D}	

$^{a-c}$ different letters in a column show significant difference at $p \leq 0.05$
^{AB} different letters in a column show significant difference at $p \leq 0.05$
$^{A-D}$ different letters in a column show significant difference at $p \leq 0.05$
APEC: Apple pomace enriched cookies
MPEC: Mango-peel enriched cookie
SEM: Standard error of mean.

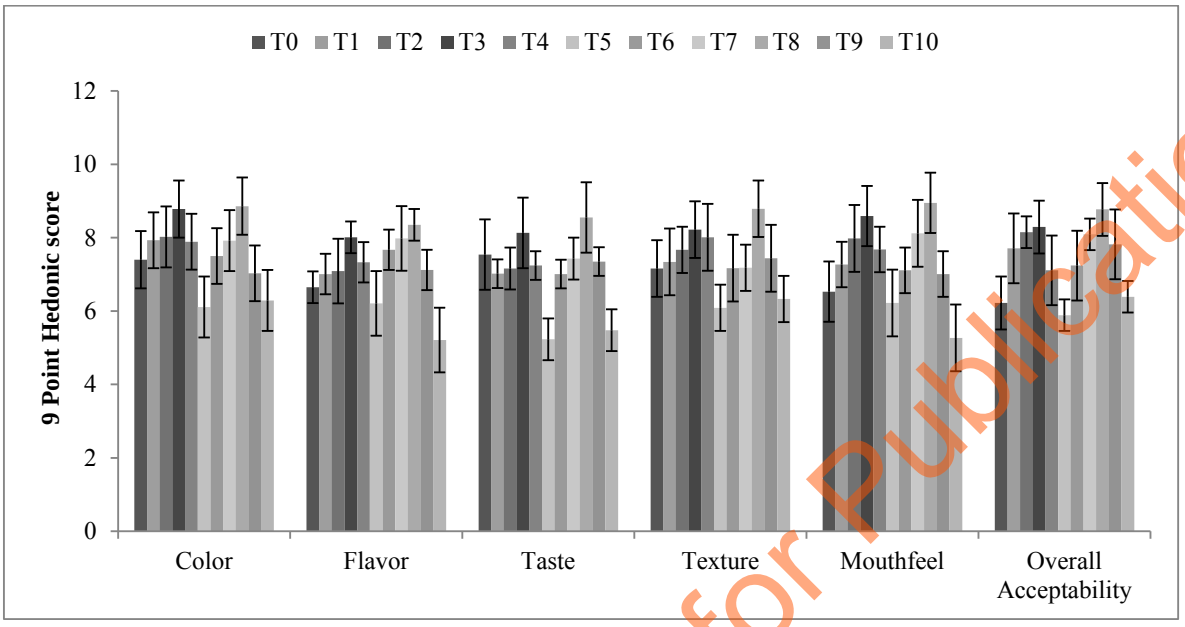

Figure: Sensory evaluation score (±SEM) of apple pomace and mango-peel cookies to get the best accepted cookies for further use. The values are means of 10 replicates along with standard error of mean (**SEM).**