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Glycemic response of QPM based extruded nutri-rich snack product

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Glycemic response of the selected Quality Protein Maize based nutri rich product was determined. The selected product was an extruded ready to eat snack product which was developed and standardized in the Lab of College of Dairy and Food Science Technology, Udaipur for its processing parameters and acceptability scores. Moisture, Protein, Fat, Carbohydrate, Ash and Fibre content of the product were 6.05 g, 11.24 g, 6.71 g, 63.81 g, 6.48 g and 5.71 g per 100 g, respectively. An interview schedule was developed to collect the information on general profile, health habits and food habits. Results revealed that of the total subjects 76.66 per cent were vegetarian 23.33 per cent were ovo- vegetarian and none of them were non- vegetarians. Out of the selected subjects 23.33 per cent consumed four meals, 66.66 per cent consumed three meals daily, and 10 per cent consumed two meals par day. About 56 per cent subjects consumed snacks in between the meals. The commonly consumed snacks included biscuits, fruits, wafers, sprouts, samosa etc and 43.33 per cent skipped one or two meals in a day. The dietary modification was made by 73.33 per cent subjects whereas 26.66 per cent did not modify their diet. Anthropometric measurements showed that the mean weight of the subject was 57.17kg, whereas mean height was 157cm. The mean of waist and hip circumference of the subjects were 82.5cm, 103.83cm, respectively. Body mass index and waist hip ratio were determined. The mean BMI was 23.11 kg m^2 whereas mean WHR was 0.79. The mean systolic blood pressure was 108.33 mm Hg whereas mean diastolic blood pressure was 71.13mm Hg. Glucose Tolerance Test was conducted for the glucose and test recipe at fasting (0), 30, 60, 90 and 120 hours after feeding the test recipe to determine glycemic index. It was found that glucose response of the subjects reached its peak at half an hour whereas for the test recipe it reached at one an hour for majority of the subjects which indicates delay in absorption of test recipe. Glycemic index calculated from Area Under Curve for the test recipe was 48.10 which is low when compared with classification suggested by Monro *et al.* (2008), which is low suggesting the positive effect of test recipe in the management of diabetes.

Key Words : QPM, Pearl millet, Morigna leaf powder, Glycemic index, Area under curve, Insulin

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INTRODUCTION

Diabetes Mellitus (DM) also called "Madumeham'' has been known for centuries as a disease related to sweetness. A common effect of diabetes is hyperglycemia or increased blood sugar. Diabetes causes some serious health issue including blindness, kidney failure, stroke and heart disease.

Type 1 diabetes occurs when the body produces insufficient quantities of insulin. It is usually detected more in children. Type 2 diabetes occurs when the body does not effectively use the insulin produce. It is generally due

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to lack of physical activity, obesity or incorrect dietary habits. Gestational diabetes occurs among pregnant women. In about 90 per cent of cases, it is type 2 diabetes that people are suffering from. The occurrence of type 2 diabetes or diabetes mellitus may be prevented or delayed by adopting a healthy lifestyle.

In 2000, India (31.7 million) topped the world with the highest number of people with diabetes mellitus followed by China (20.8 million) and United States (17.7 million. The prevalence of diabetes is predicted to double globally from 171 million in 2000 to 366 million in 2030 with a maximum increase in India according to (Wild *et al*., 2004). It is predicted that by 2030 diabetes mellitus may afflict upto 79.4 million individuals in India, while China (42.3 million) and the United States (30.3 million) will also see significant increase in those affected by the disease (Whiting *et al.*, 2011). The aetiology of diabetes in India is multi factorial and includes genetic factors coupled with environmental influences such as obesity associated with rising living standards, steady urban migration, and lifestyle changes.

Obesity is one of the major risk factors for diabetes, yet there has been little research focusing on this risk factor across India (Rao *et al*., 2011). Despite having lower overweight and obesity rates, India has a higher prevalence of diabetes compared to western countries suggesting that diabetes may occur at a much lower body mass index (BMI) in Indians as compared with Europeans. Therefore, relatively lean Indian adults with a lower BMI may be at equal risk as those who are obese (Zargar *et al.*, 2000). Furthermore, Indians are genetically predisposed to the development of coronary artery disease due to dyslipidaemia and low levels of high density lipoproteins (Misra and Khurana, 2011). These determinants make Indians more prone to development of the complications of diabetes at an early age (20-40 years) compared with Caucasians (>50 years) and indicate that diabetes must be carefully screened and monitored regardless of patient in India (Misra and Khurana, 2011).

The glycemic response to a food may be quantified in term of the Area Under Curve (AUC-G) following ingestion of the food as a percentage of the AUC –G following a reference food such as glucose or snack product. The number listed next to each food is its glycemic index. This is a value obtained by monitoring a person's blood sugar after eating the food. The value can vary slightly from person to person and from one type or brand of food to another.

Quality protein maize (QPM), improved variety of maize has added advantages of higher biological value due to its amino acid content. Utilization of QPM, as food ingredient instead of maize help in adding benefits of amino acid lysine and tryptophan which are generally lacking in common maize. Extrusion-cooking technique can also be used to produce specific precooked pasta or pasta-like products. Such precooked products do not require the traditional cooking process before serving and are more convenient requiring only addition of hot water for a brief period for preparation (Dong *et al*., 2010).

In Indian traditional system of medicine, *Moringa oleifera* Lam. Syn. Moringa pterygosperma Gaerth (*Moringaceae*) is commonly used as healing herb to treat diabetes. *Moringa oleifera* Lam is native to South Asia, but grows in tropical Africa and Latin America. Different parts of this plant are used in the indigenous systems of human medicine for the treatment of a variety of human ailments. The leaves of *Moringa oleifera* are reported to be used as a hypocholesterolemic agent, and hypoglycemic agent (Dangi *et al*., 2002 and Ghasi *et al*., 2000).

Yet despite the increase in diabetes there remains a paucity of studies investigating the precise status of the disease its causes and dietary management using low GI foods because of the geographical, socio-economic, and ethic nature of such a large and diverse country. Utilization of moringa powder, maize and pearl millet may prove to provide low GI RTE snack. Therefore, the present study is planned with following objective

– To assess the nutritional characteristics of selected QPM based extruded nutri rich snack product.

– To study effect of QPM based extruded nutri rich snack product on blood glucose level of selected subjects.

METHODOLOGY

Snack food product developed and standardized at Centre of Excellence (COE) on Maize Processing and Value Addition, CDFST was taken for the study. The product comprised of combination of QPM flour, pearl millet and morigna leaf powder. QPM was selected as a source of good quality protein, pearl millet due to its high dietary fibre and mineral content. Moringa leaf powder was selected due to its high dietary fibre and protein

content. Besides these, secondary raw material such as chilli, salt, maggie masala (spices), baking powder and benzoic acid were added for taste and flavour.

Proximate analysis:

One serving of the recipe was homogenized and used for analyzing the proximates in triplicate. The analysis was conducted in the laboratory of Agricultural University, Junagadh, Gujarat in the academic year of 2016 by the researcher.

Selection of subjects:

A total of 30 female subjects residing in Udaipur city were selected randomly in the age group between 30-50 years and having no biochemical evidence of any other known disease. Each subject was explained in detail about the experiment and objectives of the study. A informal written consent was taken from each participant for prior to the study.

An interview schedule was developed and pretested to collect the following information about the subject i.e. food habits, education status, occupation, anthropometric measurements (BMI, WHR), and blood pressure. Appointment was taken telephonically and each subject was described in detail about the experiment.

Determination of glycemic index of snack product:

Oral glucose tolerance test :

On the first day after overnight fast the blood glucose fasting (0 hour) was estimated, than 30 g of glucose diluted in 100ml of water was given orally to the subjects. Blood glucose levels were estimated at 30, 60, 90, 120 minutes using glucometer (Alera GI) based on glucose – oxidase mediated reaction.

Feeding of test recipe :

Next day 30g carbohydrate selected snack product was served to each member after an overnight fast taking fasting (0 hour) blood sample. The subject was asked to consume the snack product sitting comfortably within a time span of 15-20 minutes. The blood glucose levels were estimated at 30, 60, 90, 120 minutes.

Blood glucose test :

Serial estimation of blood glucose used for deriving area under the 2 hour glucose curve (AUC-G) as per the given formula :

$$GI = \frac{\text{Area under blood glucose response curve for 30 g of test carbohydrate food}}{\text{Area under blood glucose response for 30 g of glucose}}$$

Data analysis :

The data on religion, caste family type size, food habits, educational information, marital status, family history, blood pressure and food consumption pattern was expressed as frequencies and percentages. Height, BMI, Waist circumference, hip circumference, WHR was calculated. Area Under Curve (AUC) formula was used to calculate glycemic index and Mean $\pm$ SD were also calculated of glycemic values of the subjects. Mean $\pm$ SD were also calculated by help of statistical software (SSPS).

OBSERVATIONS AND ASSESSMENT

A total of 30 females in the age group between 30-50 years were included in the study. All the participants belonged to Hindu religion, 80% from nuclear family with average income of 33850/- Rs. per month. Majority of the subjects *i.e.* 36.66 per cent were having professional degree, 33.33 whereas per cent were graduates or remaining 30 per cent had passed senior classes. Only 46.66 per cent of the subjects were engaged in professional and 53.33 per cent were unemployed or housewives. Maximum subjects in the study 96.66 per cent were married and only one (3.33) subject was widow.

Dietary habits:

It was found that 76.66 per cent of the subjects were vegetarian whereas 23.33 per cent were ova-vegetarian and none of them were non-vegetarian.

Meal pattern :

Four meal pattern *i.e.* breakfast, lunch, evening tea and dinner was followed by 23.33 per cent, 66.66 per cent consumed three meals and 10 per cent consumed two meals. 56.66 per cent subjects consumed snacks in between meals and 43.33 per cent skipped meals. Those who consumed snacks mostly ate samosa 1.78 per cent, biscuits, 10.71 per cent, fruits 14.28 per cent, wafers 1.78 per cent, and sprouts 1.78 per cent.

Dietary modifications:

About 73.33 per cent subjects modified their diet

and remaining 26.66 per cent did not modify their diet. Type of modifications made by subjects in the diet is suggested that 36 per cent restricted number of meals, 43.33 per cent restricted amount in meals, 63.33 per cent restricted frequency of carbohydrate food and 53.33 included low carbohydrate food in their diet.

Anthropometric measurements:

The mean weight of the study group was 57.17 kg, mean height was 157.38 cm, BMI was 23.11kg/m^2, WHR was 0.79 and the mean systolic blood pressure was 108.33 mm Hg and diastolic blood pressure 71.13 mm Hg.as shown in Table 1.

Proximate composition of the product:

The minimum ash content was 6.48 per cent. Protein content was 11.24 per cent in the selected snack product. Carbohydrates content was 66.45 per cent in the snack product. According to Shumbo and Ikujenola (2014) carbohydrate content was 73.98 per cent in QPM whereas the available carbohydrate content of peal millet was 59.80 per cent. Dietary fibre content of the selected extrudate was 5.71g. Fat content of extrudate was 6.71 per cent obtained through soxhlet method (Table 2).

Glycemic index:

The findings revealed that the glycemic index was low of the selected snack product prepared with pearl millet, morigna powder and QPM. was 48.10 (Table 3). Similarly in a study conducted by Nambiar *et al.* (2011) reported that the pearl millet is rich in several nutrients as well as non-nutrients such as phenols. It has high energy, less starch, gluten free, high fibre (1.2g/100g, most of which is insoluble), 8-15 times greater α-amylase activity as compared to wheat and has low glycemic index. In another study by Panlasigui *et al.* (2010) results show that the average glycemic index for milled rice (119.89) was higher while that of the pure QPM grits (80.29) was lower than the control food. The mixed rice-QPM grits had higher GI (91.29) than the pure QPM grits. The GI of the selected product may be low due to use of Pearl millet having lower glycemic index. Similarly selection of morigna leaf powder has medicinal application. It is used as potential antioxidant, anticancer, anti inflammatory, anti diabetic and anti microbial agents which medicinal values deals with nutrition, commercial and pharmacological properties of this miracle tree. QPM is high in energy and content approximately 9-12 per cent crude protein with two essential amino acids lysine and tryptophan.

Conclusion :

Diabetes Mellitus is reaching potentially epidemic proportions in India. The level of morbidity and mortality due to diabetes and its potential complications are enormous, and pose significant healthcare burdens on both families and society. It has become demand of time to

Table 1 : Mean ± SD values of body measurement /indices

Sr. No.	Details	Total 30
1.	Weight (kg)	57.17 ± 6.59
2.	Height (cm)	157.38±8.54
3.	BMI (kg/m^2)	23.11±2.12
4.	Waist circumference (cm)	82.5±10.18
5.	Hip circumference (cm)	103.83±9.06
6.	WHR	0.79±0.076
7.	Systolic blood pressure (mmHg)	108.33±11.18
8.	Diastolic blood pressure (mmHg)	71.13±8.03

Table 2 : Proximate composition of product per 100g

Sr. No.	Name of nutrients	Per cent
1.	Moisture	6.05
2.	Ash	6.48
3.	Fat	6.71
4.	Protein	11.24
5.	Carbohydrate	63.81
6.	Crude fibre	5.71

Table 3 : Glycemic index by using area under the curve

Sr. No.	Area under the curve of snake product	Area under the curve of glucose	Glycemic index	Mean GI
1.	12225	7305	59.75	48.10 ±7.79
2.	15525	6765	43.57	
3.	14445	6105	42.26	
4.	12255	6555	53.49	
5.	14745	6240	42.32	
6.	11280	6705	59.44	
7.	12000	6225	51.88	
8.	13800	6840	49.57	
9.	15375	8250	53.66	
10.	14340	6855	47.80	
11.	15075	7200	47.76	
12.	14655	7305	49.85	
13.	15000	6225	41.50	
14.	13380	6360	47.53	
15.	14070	6675	47.44	
16.	16800	5850	34.82	
17.	15750	7155	45.43	
18.	13770	5265	38.24	
19.	12300	6450	52.44	
20.	13020	5805	44.59	
21.	14325	6030	42.09	
22.	14460	7950	54.98	
23.	13950	4260	30.54	
24.	11400	5880	51.58	
25.	12150	5535	45.56	
26.	12630	6615	52.38	
27.	11880	6105	51.39	
28.	10725	6075	56.64	
29.	11580	7740	66.84	
30.	13725	5175	37.70	

develop of low GI products which is not only helping to deal with this disease but also scrumptious. Therefore, the study conducted to prepare low GI snack product by using of moringa leaf powder, QPM and pearl millet. The fasting blood glucose level of the subject was in normal range 80-120mg/dl. Glucose response in case of test recipe reached its peak half an hour later than glucose. The glycemic index calculated from area under curve of glucose and test recipe was lowest for selected snack product that *i.e.* 48.10. The glycemic load as calculated for the test recipe was 9.20 which is also low when compared with classification by Monro and Shaw (2008). From the above study which concluded that the glycemic index is low in selected snack product prepared with the combination of QPM, pearl millet and morigna leaf powder. The study recommends the use of selected snack product as beneficial in diabetes management.

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