EFFICACY OF THERAPEUTIC EXTRUDED SNACK FOOD CONSUMPTION ON GLYCEMIC RESPONSE IN TYPE-2 DIABETIC PATIENTS

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Abstract

The therapeutic extruded snack was prepared from the composite flour (Foxtail millet, Amaranth seeds, Rice, Bengal gram and Cow pea). The extruded product was analyzed for its chemical composition and further, studied the effect of therapeutic extruded snack food consumption on type-2 diabetic patients. The selected 12 subjects were received therapeutic extruded snack food (50 g) once in a day in the morning during the fasting stage along with their usual conventional treatment. The fasting blood glucose level (FBG) was assessed at a definite intervals for the period of 30 days. With intervention of therapeutic extruded snack food, significant reduction was recorded in fasting blood glucose level after 10^{th} day of supplementation period in age group of 40-50 years. However there after changes in blood glucose were found to be minimum. It was also found

that in the age group of 50-60 years, the glucose level was reduced after 15th day of supplementation of extruded snack food.

Introduction

Diabetes mellitus (DM) is the failure of the body to metabolize carbohydrates properly, together with altered lipid and protein metabolism. It is characterized by hyperglycemia (fasting BSL at or above 126 mg/dl), glucosuria (presence of glucose in urine), polyuria (frequent urination), polydipsia (increased thirst) and polyphagia (increased appetite).The World Health Organization (WHO) classifies DM into: Type 1 DM (insulin-dependent diabetes mellitus; IDDM), which is caused by insufficient or non-existent production of insulin and Type 2 DM (non-insulin-dependent diabetes mellitus; NIDDM), which is caused by decreased tissue response to insulin (insulin resistance).

According to recent estimate, the prevalence of diabetes mellitus in adults is around 4% worldwide, and this means that over 143 million people are now affected. It is projected that the disease prevalence will be 4.5% by the year 2025, with global diabetic population reaching 300 million of which nearly 77% of the global burden of disease is projected to occur in the developing countries (Park K and Park T, 2000).

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A recent world Health Organization (WHO) press release stresses the point that India will have the great magnitude of increase approximately 170 % by the year 2025. Within the allotted span India shall also have the dubious distinction of having the maximum number of diabetics in the world. To note most of these diabetic individuals in India shall be in the most productive years of their lives. It is a fearful scenario for India since it has to tackle twin problem of communicable and non communicable diseases in the next millennium.

There has been an extensive ongoing research on the benefits of chromium in the diet. Most often, diabetics consume far too little micronutrients for successfully treating their diabetes and helping them cope with the condition. Among the insufficient micronutrient is chromium. Trivalent chromium is found in a wide range of foods, including egg yolks, whole-grain products, high-bran breakfast cereals, coffee, nuts, green beans, broccoli, meat, brewer's yeast, and some brands of wine and beer. The U.S. National Academy of Sciences has established the Recommended Daily Allowances for chromium as "**0.005–0.2 mg/day**" for adult men and women, which is also the Estimated Safe and Adequate Daily Dietary

Intake (ESADDI) for chromium for children aged 7 years to adulthood and No toxicity in patients with diabetes has been reported with high doses of chromium when taken daily, chromium is a great supplement to help to treat diabetes (Anderson R.A, 1997).

The principal carrier protein for chromium is transferrin, which also plays a critical role in the movement of chromium from blood to LMWCr (Hepburn D.D and Vincent J B, 2003). It has been suggested that migration of transferrin receptors to the plasma membranes of insulin-insensitive cells after insulin stimulation is the initial step in this process. Insulin is a hormone produced by the β- cells in the pancreas (Jan N.Y, 2007). After consumption of a meal containing carbohydrates, blood sugar increases. In response to rising blood sugar levels, insulin is released by the pancreas, which enables the cells of the body to extract glucose (sugar) from the bloodstream. As such, insulin decreases blood sugar and provides cells with the glucose they require for energy production. Without the help of insulin, it cannot get into cells properly.

In the view of the promising health benefits of chromium, low glycemic index of carbohydrates of millets, cereals and pulses are incorporated as natural functional ingredients in chick pea rice - blends to develop acceptable therapeutic snack food products using extrusion technology.

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The present study is undertaken to see the impact of supplementation of extruded product prepared from composite flour (Foxtail millet; Amaranth; Rice; Bengal gram; Cow pea in the ratios of 60:05:05:20:10) on the Fasting Blood Glucose (FBG) level of selected diabetics.

Materials and Methods

Raw materials

Foxtail millet, Amaranth seeds, Rice, Bengal gram and Cow pea were purchased from local commercial suppliers and grounded separately in hammer mill to pass through a 2.5 mm screen. All the chemicals used were analytical grade.

Extrusion cooking

The composite flour blend was prepared by mixing Foxtail millet flour, Rice flour, Amaranth seed flour, Bengal gram flour and Cow Pea flour (60:05:05:20:10) in the ratios on a dry-to-dry weight basis. The pre conditioned composite flour (20-21% moisture level) fed to a twin screw extruder, was accomplished by using a twin screw volumetric gravity feeder. The optimum temperature of the two barrel zones of extruder from feeder end were set at 90^0C and 110^0C respectively. Samples were collected at the most stable die temperature which was around 80^0C. Screw speed was set up at 130 rpm and equipped with 3-mm restriction die or nozzle to extruder. Constant feeding rate was kept throughout the experiment. The Extrudates were dried to about 5% moisture level. The dried samples were coated with spice mix (Dry mango powder (Amchur powder), Black pepper powder, Cumin powder, Chilli powder and Black salt) and edible oil.

Chemical Composition of Extruded Snack Food

Moisture, Protein, Fat, Carbohydrates, Ash and Crude fiber were estimated according to approved methods (AOAC, 1999) and analysis for calcium, phosphorus and Iron was carried out according to the procedure given in laboratory manual of National Institute of Nutrition (ICMR) Hyderabad.

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Chromium

The chromium content extruded snack food was determined by the following method. Suitable food sample masses were placed in micro-Kjeldahl flasks and then were wet digested with a mixture of nitric and sulphuric acids (Cary and Allaway, 1971; Tinggi *et al*,. *1997*). The Cr VI was reduced to Cr III with sodium sulphite, the Cr III was complexed with pentane-2, 4-dione and the complex formed was extracted in 4-methylpentan-2-one following the procedure of Jackson *et al.,* (1980). Two reagent blank solutions were prepared similarly at the same time with each set of samples.

Samples were analyzed using a Perkin–Elmer Model 3030 atomic absorption spectrometer, equipped with a deuterium-lamp background corrector, a HGA-600 graphite furnace and a AS-60 auto sampler. Analyses were carried out by using

Platforms inserted into pyrolytically coated graphite tubes and measurements (integrated absorbance peak areas) were made by using single-element hollow cathode lamp.

Time and temperature programs for drying, mineralization and atomization in the graphite furnace were assayed for a sample Volume of 20µl (Table 1). Chromium atomization was performed at a wavelength of 357.9 nm. Magnesium nitrate was used as a chemical modifier 10ml of the chemical modifier containing 50 mg Mg (NO). By stopping the flow of the 32 argon purge gas during atomization step, sensitivity was increased without altering the lifetime of the tube. The furnace was cleaned by raising the temperature to 2650^{o}C and the graphite tube was allowed to cool to 20^{0}C between each analysis. The chromium concentration was measured in triplicate in each sample.

Table: 1 Instrumental condition for chromium determination in foods by GFAAS

Step	Temperature-time program for graphite furnace			
	Temperature °C	Ramp time (s)	Hold time(s)	Gas flow rate Ar (ml/min)
Dry	100	5	15	300
	300	10	30	300
Char	1650	20	30	300
Atomise	2500	0	6	0
Clean	2650	1	3	300

Wavelengths = 357.9 nm; slit widths = 0.7 nm; lamp intensity = 20mA; background corrections=deuterium; integration times = 6s; matrix modifiers5 = 0µg Mg $(NO_3)_2$; sample volumes = 20µl; matrix modifier volumes = 10µl.

Selection of Diabetic Subjects for the Study

A purposive sampling technique was followed to select the subjects (patients). The lists of subjects suffering from Diabetes Mellitus were procured from the physician of Health center of MAU, Parbhani. A total number of 12 subjects in the age group of 40- 50 years and 50-60 years, who volunteered to co-operate were purposively selected for the present study. The purpose and discipline involved in the study were explained to all the subjects. During

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the study period, instruction for the diet control, exercise and also for intake of any medicines were not given to the selected subjects.

Administration of Therapeutic Extruded Snack Food

The subjects were allowed to continue to follow their usual living style and food intake without any disturbance. The subjects were received Therapeutic extruded snack food (50gm) once a day in the morning during fasting stage for a period of 30 days. The Fasting Blood Glucose (FBG) was assed at definite intervals like 1st day, 10th day, 15 th day and 30 th day (Arora *et al.*, 2009).

Diagnosis of Diabetes Mellitus

Diabetes Mellitus (DM) was diagnosed by Fasting Blood Glucose Level (FBG) at or above 126 mg/dl. The Fasting Blood Glucose (FBG) level was assed at definite intervals by the Gluco-meter (One touch horizon, Blood Glucose monitoring system).

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Results and Discussion

The chemical composition of the extruded snack food is presented in table 2. From the table it can be inferred that it contain more protein (12.43g/100g), crude fiber (6.03 g/100g) and minerals viz. calcium (87.01mg/100g), phosphorus (286 mg/100g) and essential trace mineral chromium (0.032 mg/100 g) than that of commercial extruded products. It was also found to be having less fat (7.8 g/100g) than commercial extruded snack foods. This may be attributed to large quantity of Foxtail millet flour in the composite flour sample.

Table: 2 Chemical composition of the accepted Extruded food (Sample-B)*

Nutrient Parameters	Content
Moisture (%)	5.00±0.05
Protein (g)	12.43±0.08
Fat (g)	7.80±0.09

Total Carbohydrates (g)	60.40±0.02
Crude Fiber (g)	6.03±0.04
Ash (g)	3.08±0.05
Energy (Kcal)	362.0±0.02
Chromium (mg)	0.032±0.01
Calcium (mg)	87.01±0.03
Iron (mg)	3.60±0.09
Phosphorus (mg)	286.0±0.07

* Each value was an average of three determinations

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Blood glucose is a useful index for the assessment of overall nutritional status of the community. Moreover, it plays significant role in diabetic mellitus. The chromium content in therapeutic snack food is very effective and best in controlling Blood Glucose Level of diabetic patents.

The impact of therapeutic extruded snack food on Fasting Blood Glucose (FBG) level of the study groups before and after the study period is depicted in table 3 and 4.

Table 3 and 4 highlights the data regarding initial level of Fasting Blood Glucose Levels and 10th, 15th and 30th day levels of Fasting Blood Glucose Levels of subject groups of 40-50 and 50-60 years of old subjects.

From the table 3, in the age group of 40-50 years old subjects, it was clearly indicated that the mean fasting Blood Glucose Level of the control group was 174 mg/dl. The initial mean value was reduced gradually to 159 mg/dl on 10th day, 155mg/dl on 15th day and at the end of the supplementation period, the value was reduced to 150 mg/dl. Statistical comparison was carried out and indicated that there

was no drastic reduction in glucose level after 10th to 30th day of research study. Similar findings were observed by Arora *et al.*, (2009) in scientific literature.

From the table 4, in the age group of 50-60 years old subjects, it was clearly indicated that the mean fasting Blood Glucose Level of the control group was 199 mg/dl. The initial mean value was slightly reduced to 190 mg/dl on 10th day, 178 mg/dl on 15th day and at the end of the supplementation period, the value was drastically reduced to 176 mg/dl. Statistical comparison was carried out and indicated that there was no drastic reduction in glucose level after 15th to 30th day. Hence, it may be concluded that after supplementation of the therapeutic extruded snack food to the diabetic patient's Blood Glucose Level was reduced significantly after 15th day of supplementation, but thereafter no drastic change in Fasting Blood Glucose Level was observed. Similar findings were observed by Anuradha and Anusuya Devi (2004) in scientific literature.

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Table: 3 Blood Glucose Levels (mg/dl) of experimental groups (Age group 40-50 years) before and after the study period.

Number of Subjects	Fasting Blood Glucose Levels(mg/dl)			
	Initial	**10th day**	**15th day**	**30th day**
S1	128±2	117±4	128±1	120±2
S2	234±5	201±3	198±2	190±1
S3	190±1	167±2	156±3	142±3
S4	160±2	147±1	142±2	155±3
S5	177±5	168±3	159±2	140±1
S6	155±1	157±3	148±1	154±2
Mean	174	159	155	150
S.E±	14.7	11.28	9.69	9.49
C.D at 5 %	36.16	27.7	23.8	23.25

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Table: 4 Blood Glucose Levels (mg/dl) of experimental groups (Age group 50-60 years) before and after the study period

Number of Subjects	Fasting Blood Glucose Levels(mg/dl)			
	Initial	10th day	15th day	30th day
S1	175±2	168±1	149±3	150±1
S2	189±1	177±2	179±4	172±2
S3	174±4	171±1	163±3	155±3
S4	197±2	191±1	182±2	191±1
S5	202±1	189±3	197±2	188±3
S6	257±1	247±3	201±5	204±2
Mean	199	190	178	176
S.E±	12.48	11.92	8.10	8.8

C.D at 5% level	30.6	29.23	19.85	21.37

Conclusion

The prepared extruded snack food was analyzed for its chromium content. Further it was evaluated for its therapeutic value by supplementing to the diabetic patients. The Fasting blood glucose level was found to reduce drastically through the daily intake of extruded product up to 10^{th} day of supplementation period in age group of 40-50 years. However there after changes in blood glucose were found to be minimum. It was also found that in the age group of 50-60 years, the glucose level was reduced after 15^{th} day of supplementation of extruded snack food.

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