



Abstract

ABSTRACT



The rising prevalence of non communicable diseases (NCDs) is a major public health issue across the globe. Diabetes mellitus is one of the most common NCDs globally. The rise in the prevalence of type 2 diabetes mellitus (T2DM) continues unabated with India bearing a large burden of the global prevalence. The risk for developing T2DM and related metabolic abnormalities is higher among Asian Indians as compared to other ethnic groups. Early identification of risk factors in diabetic individuals and implementing appropriate interventions can be useful in curbing the development of secondary micro and macrovascular complications. The worksite is also an appropriate setting to provide various opportunities to promote the adoption and maintenance of healthy lifestyle behaviours. Diabetes management is expensive and thus newer alternate approaches to manage diabetes are being explored. Traditional medicinal plants have been implicated in diabetes management since ages. Barley grass powder (BGP) is a novel plant product which supposedly has properties that may benefit glycemic and lipemic control in diabetics.

Thus, the present study was planned with the following objectives: 1) To study the metabolic alterations in T2DM subjects and to map the prevalence of microalbuminuria. 2) To study the risk factors for diabetes in an industrial population of Vadodara and to track glycemic and lipemic levels over a period of four years. 3) To develop functional food products incorporating BGP. 4) To determine the acceptable level of BGP incorporation in the developed food products by sensory evaluation. 5) To analyze the nutrient composition of BGP. 6) To study the impact of BGP supplementation in the form of capsules for a period of 60 days on the carbohydrate and lipid metabolism of T2DM subjects. 7) To determine the feasibility of scaling up BGP Khakhra as a functional food.

The study was conducted in four phases which are highlighted below.

In Phase I, 102 stable diabetic subjects were enrolled from two pathology laboratories of Vadodara. Information regarding their socio economic status, educational status, anthropometric measurements and medical history were recorded. The biochemical indicators included fasting blood glucose (FBG), lipid parameters and renal function tests. On the basis of the Asia Pacific Classification the prevalence of overweight was 13.7% and that of obesity was 65.6%. Abdominal obesity was present in both the genders (64.2% males and 91.8% females). Hypertension was a common complication with nearly 50% of the diabetic subjects being hypertensive. The subjects displayed poor glycemic control with around 94.1 % of the subjects having HbA1C levels ≥ 7 . A high prevalence of dyslipidemia was observed among the subjects. Around 93.1% of the subjects were found to be in the high risk atherogenic index of plasma (AIP) category. The overall prevalence of microalbuminuria was 28.4%. Prevalence of microalbuminuria among males was 22.6% and among females was 34.7%. A multiple risk factor scenario was present among the diabetic subjects with 86.2% of the subjects having > 3 risk factors. FBG and HbA1C concentrations were significantly higher in the microalbuminurics as compared to the normoalbuminurics. Hypertensive diabetics had significantly higher urinary microalbumin levels as compared to the normotensives. Irrespective of the presence or absence of hypertension, glycemic control was found to influence the levels of albumin in urine. Diabetics with the metabolic syndrome risk factors had significantly poor metabolic control, dyslipidemia and a higher prevalence of microalbuminuria. Logistic regression analysis showed that FBG, HbA1C, hypertension and a family history for diabetes were the factors influencing urine microalbumin levels.

In Phase II, 54 type 2 diabetics were identified from an industry of Vadodara. A structured questionnaire was used to obtain information pertaining to risk factors like heredity, lifestyle factors and medical history. Anthropometric data, biochemical and biophysical indicators were obtained from medical records. Tracking data for the past four years (2005-2008) was obtained for 43 of the 54 diabetic subjects. All the subjects were in their productive years. The prevalence of pre-hypertension and hypertension was 37% and 53.7% respectively. The prevalence of overweight and obesity was 14.8% and 57.4%

among the subjects respectively using the Asia Pacific criteria. About 14.8%, 22.2% and 13% of the study population were in the habit of smoking, tobacco usage and alcohol consumption respectively. Majority of the subjects (70.4%) reported to be exercising > 3 hours a week. More than thrice a week consumption of fruits and green leafy vegetables was reported by about 57.4 % and 77.8% of the subjects respectively. The subjects had high mean levels for FBG, TG, LDL-C, Non HDL-C, TG/H and low levels of HDL-C. Dyslipidemia prevalence was high among these T2DM subjects. Majority (94.3%) of the subjects had high risk AIP levels. Less than 50% of these diabetic subjects monitored their HbA1C levels and 85.2% of them used to get their serum lipids tested followed by eye examination (72.2%) and kidney function tests (68.5%) excluding microalbuminuria. Alarming, 87.2% of the diabetic subjects had ≥ 5 risk factors. Over a four year duration, the subjects consistently had elevated levels of FBG, TG, LDL, Non HDL, TG/H, SBP, DBP and BMI. There was high prevalence of dyslipidemia among the diabetic subjects over the four year duration. Disturbingly, new cases of hypercholesterolemia, hypertriglyceridemia and hypertension were also identified over the period of four years.

In Phase III (section a), barley grass was cultivated on a large scale in a farm and cut when around 10-12 inches in height. The entire lot was transported to a food industry where it was subjected to subatmospheric dehydration and ground into a powder form. A sample of this BGP was sent to an analysis centre for nutritional analysis. The powder was found to be high in protein, potassium and vitamin C levels and low in sodium content.

In sections (b & c) of Phase III, BGP was incorporated into four traditional Indian recipes namely- Cutlet, Khakhra, Thepla and Muthiya, at different levels (0.5g, 1g and 1.5g per piece) and the acceptability was assessed by 12 semi trained panelists through sensory evaluation using composite rating and ranking tests. Product development with BGP showed that BGP could be effectively incorporated in traditional Indian recipes with high acceptability. On the basis of results of ranking tests, cutlets were ranked 1st followed by Thepla, Khakhra and Muthiya.

In Phase IV (section a), BGP prepared earlier was filled in capsules (300 mg/capsule) in a local pharmaceutical industry. Fifty nine stable T2DM subjects were enrolled for the study from the pathology laboratories of Vadodara and were divided into two groups, control group (N=23) and experimental group (N=36). The experimental group was given four capsules (1.2g) of BGP daily for a period of 60 days. The control group received no supplementation. Baseline data was collected on general information, anthropometry, medical history and 24 hour dietary recall along with FBG, lipid profile and HbA1c. All parameters were monitored at baseline and at 60 days. BGP supplementation led to a significant fall in the FBG (10.8%) and HbA1c (5.2%) values in the experimental group. Such a change was not observed in the control group. A significant reduction in FBG (19.2%) and HbA1c (7.3%) values was observed after supplementation in subjects who had initial FBG greater than 140 mg/dl. A significant change was observed in the lipid profile of the diabetic subjects. TC, LDL-C and Non HDL-C decreased by 5.1%, 8.2% and 7.7% respectively. HDL-C values increased by about 5.0%. There was a slight non significant reduction in the triglyceride values as well. Post BGP supplementation, atherogenic indices also decreased significantly. Around 25%, 21.4% and 21.4% of the subjects attained normal FBG, TC and TG levels respectively after BGP supplementation.

In Phase IV (section b) BGP khakhra were distributed to 45 members of a health club in Vadodara for sensory evaluation and acceptability. The BGP khakhra were found to be acceptable in terms of taste and colour. There was willingness among the respondents to buy the product if made available in the market.

Thus, the present study made an attempt to identify the determinants of MAU. There is a need to promote the health of the industrial diabetic population. BGP showed hypoglycemic and hypolipidemic action in T2DM. There is scope for commercializing BGP khakhra as a functional food.