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Efficiency of Madhavshakti Atta Containing Barley on Maintaining Postprandial Blood Glucose Levels in Type 2 Diabetic Patients

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Abstract: Barley, a low glycaemic index carbohydrate facilitates the reduction in postprandial sugar levels in diabetic patients. This prospective study helps to observe the effect of diet containing barley flour mix as a source of carbohydrate on the post-prandial blood glucose levels in known diabetic patients. The patients were given lunch and dinner that contained barley flour mix as a carbohydrate source. The blood glucose level was continuously monitored and noted before consuming the food and up to 180 minutes after eating with an interval of 15 minutes for 10 days. The study enrolled 29 patients (mean age: 55.79 ± 8.88 years, 66% males). Based on the HbA1c levels (%) the study population was divided into 3 groups- Group A (5.7 to 7), Group B (7.1 to 10) and Group C (> 10). The maximum post-prandial blood glucose level was maintained below 200 mg/dL in all groups. The study highlights that diet containing barley, wheat bran, fenugreek and cinnamon is useful in controlling the postprandial blood glucose levels in all diabetic patients irrespective of the severity of their condition.

Keywords: Barley, Postprandial, Glycaemic Index, HbA1c Levels, Type 2 Diabetes Mellitus, β Glucan

1. Introduction

Diabetes compromises a persons' functional capacity leading to the development of morbidities and early mortality. The most common cause of elevated fasting blood sugar may be unhealthy eating habits and a sedentary lifestyle. This leads to an increase in the body mass index (BMI) [1]. Individuals with a BMI of more than 25 and less than 30 are overweight and those with a BMI of more than 30 are obese. Risk of acquiring type II diabetes mellitus (T2DM) increases with high BMI and due to this relation, Astrup and Finer proposed the term diabesity in 2000 [2]. Obesity is linked to high-fat content in diet and it seems that by reducing the fat content and increasing the carbohydrate and protein content in the diet the weight issue can be addressed. However, carbohydrates in potatoes, bread and some cereal products, that are easy to digest and absorb, have a high glycaemic index (GI). Such foods rapidly increase the post-prandial glucose levels in the blood causing a burden on the body's insulin to reduce the blood sugar [3].

A hypothesis has been earlier stated that an elevated chronic and early glycaemic response and then late drop in blood glucose levels along with high concentration of free fatty acid leads to the development of insulin resistance. T2DM which is characterised by the presence of insulin resistance can lead to the development of cardiovascular diseases, nephropathy, blindness and premature death [4, 5]. It is therefore important to monitor the postprandial glucose levels in T2DM patients. Glucose levels can be monitored using continuous glucose monitoring (CGM) device that detects any change in the blood glucose levels (BGL) at regular intervals.

Postprandial glucose levels depend on the glycaemic index of the food consumed. Food with same amounts of carbohydrates can have different GI thus, having a different impact on the blood glucose levels. GI is dependent on the type of carbohydrate that is present in the food [6]. Therefore, if T2DM patients are prescribed a diet with low GI, the postprandial glucose levels can be reduced thus lowering the risk for the development of other diseases and premature mortality.

Barley is a cereal that has a low GI due to the presence of high soluble dietary fibre like β glucan [7]. We, therefore, conducted a study to understand the glycaemic response of barley-based flour in T2DM patients.

2. Material and Methods

2.1. StudyDesign andPopulation

We carried out a prospective study on known T2DM male and female patients between 30 to 80 years of age at the in-patient department (IPD) of Madhavbaug hospital, Khopoli, Maharashtra, India. All known diabetic patients who were ready to follow the diet and CGM monitoring were included in the study. Patients unable or unwilling to comply with the study procedures were excluded from the study.

2.2. Study Evaluation

The participants were admitted to Madhavbaug hospital for 10 days. On the first day after admission, the patient's height, and weight were measured to calculate the BMI along with measurement of the abdominal girth. Glycosylated haemoglobin (HbA1c) test was carried out so that their estimated average glucose levels for last 90 days could be calculated. The lunch and dinner times of the participants were noted down. Freestyle libre Pro device was used for continuous glucose monitoring. The device sensors were attached to the patients and the blood glucose levels were monitored for 24 hours for 10 days.

The patients were given lunch and dinner meals prepared at the hospital. The CGM sensors were monitoring the blood glucose levels for a total period of 10 days during which data for each day was printed. From the 24 hour data, readings of 15 mins before food, during food and up to 180 mins (at 15 mins intervals) after food (lunch and dinner) were noted for each patient.

2.3. Study Intervention

Each patient was provided 2 meals per day consisting of 1 Chapati consisting of 30gm of Barley Atta (MadhavshaktiAtta), 1 portion of salad, 1 bowl of mixed vegetable soup and 1 small bowl of veg curry. The principle ingredient in the study was Madhavshakti Atta which was made of 78% barley flour, 10% wheat bran, 1% fenugreek seeds and 1% cinnamon powder.

2.3.1. Steps Used to Obtain the BarleyAtta

Step 1 – Procure raw barley from Uttar Pradesh, India.

Step 2 – The barley was cleaned, graded and sorted. The quality of the grains was checked for moisture content (< 4%) and full intact grain was used.

Step 3 – The grains were then roasted at 45-50°C.

Step 4 – Post roasting the grains were cooled.

Step 5 – Once the grains were completely cooled they were ground till coarse pieces of grains were obtained.

Step 6 – The coarse grains were mixed with other ingredients (cinnamon powder, fenugreek powder, wheat bran).

Step 7- The final mixture was ground into a fine powder.

Step 8 – This powder was sieved to separate any large particles.

Step 9 – The ready Atta was fumigated.

Step 10 – Post fumigation, the Atta was packaged and stored in a controlled environment.

Step 11 – The Atta is now ready for consumption.

2.3.2. Procedure for Making BarleyAttabhakri

(1) In deep bottom bowl, take 30 g BarleyAtta and add approximately 50 ml water, knead the dough till it becomes soft, if required then take little water.
(2) Now with the use of hand, spread dough and form round medium size bhakri.
(3) On hot Tawa roast bhakri from both sides till become golden brown colour.

2.4. Statistical Analysis

Based on the HbA1c test results taken on day 1, the study population was divided into 3 groups- group A (HbA1c between 5.7 and 7), group B (HbA1c between 7.1 and 10) and group C (HbA1c above 10). Two sets of data were obtained daily, one for lunch and the other for dinner, from each patient and the average of each time interval in the set for 10 days was calculated. Thus, for each patient, a single reading for a particular time interval was obtained. The change in the glucose levels during lunch and dinner was studied with the help of bar graphs. Microsoft Excel was used to generate the graphs for each group by using the mean ± standard deviation (SD) of each interval for the patients in that group.

3. Results

3.1. Study Population

The 10 days study included 29 patients (65.52% males and 34.48% females) with a known case of stable T2DM. The average age of the participants was 55.79 ± 8.88 years (mean ± standard deviation).

3.2. Study Evaluation

3.2.1. Baseline Investigations

The average anthropometric parameters of the study population were measured as follows- height (161.03 ± 8.37 cm), weight (68.49 ± 10.40 kgs) and abdominal girth (ABG) (96.45 ±11.77 cm). The average BMI was calculated to be 26.54 ± 4.34 kg/cm^2.

3.2.2. Continuous Blood Sugar Monitoring

The study population was divided into three groups based on the HbA1c levels.

(i). Group A (HbA1c Levels Between 5.7 to 7)

The glucose level before lunch was similar to that before dinner. During lunch and dinner, the blood glucose levels gradually increased and reached a maximum at 120 min and then decreased. The maximum glucose value obtained was more at dinner (123.1 mg/dL) as compared to that of lunch (119.24 mg/dL). The glucose level reduced below the threshold value of 120mg/dL after 165 minutes post start of dinner. (Figure 1 and Figure 2).

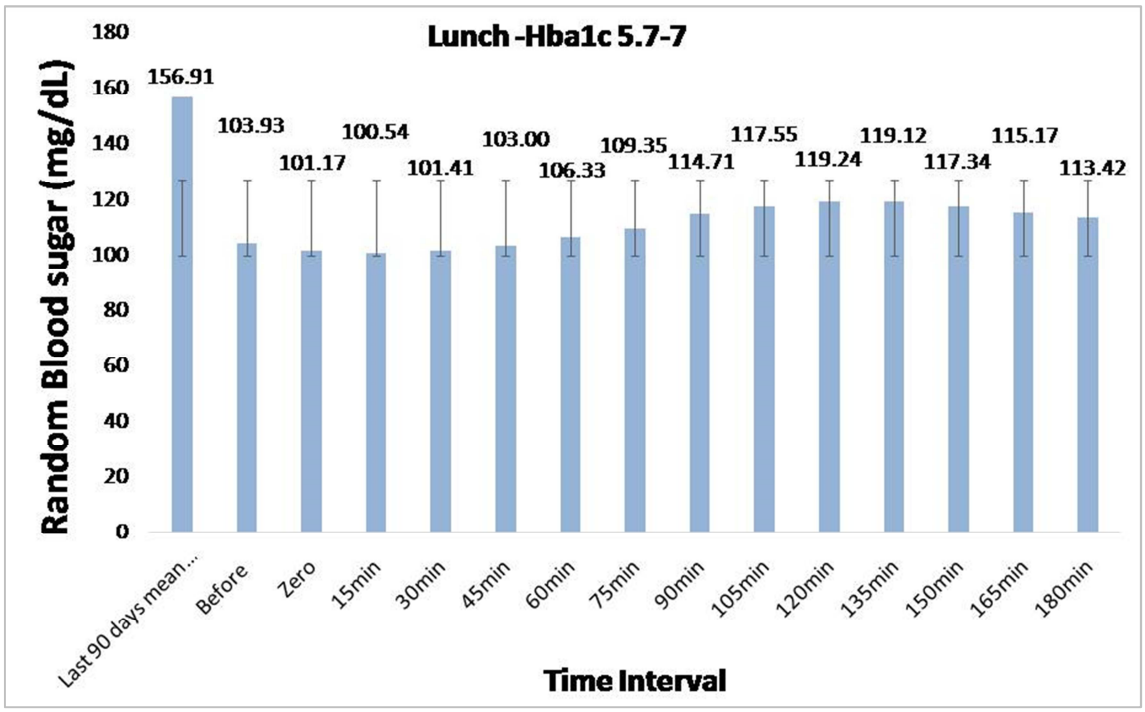

Figure 1. *Fluctuations observed in the blood glucose levels during lunch of patients in group A.*

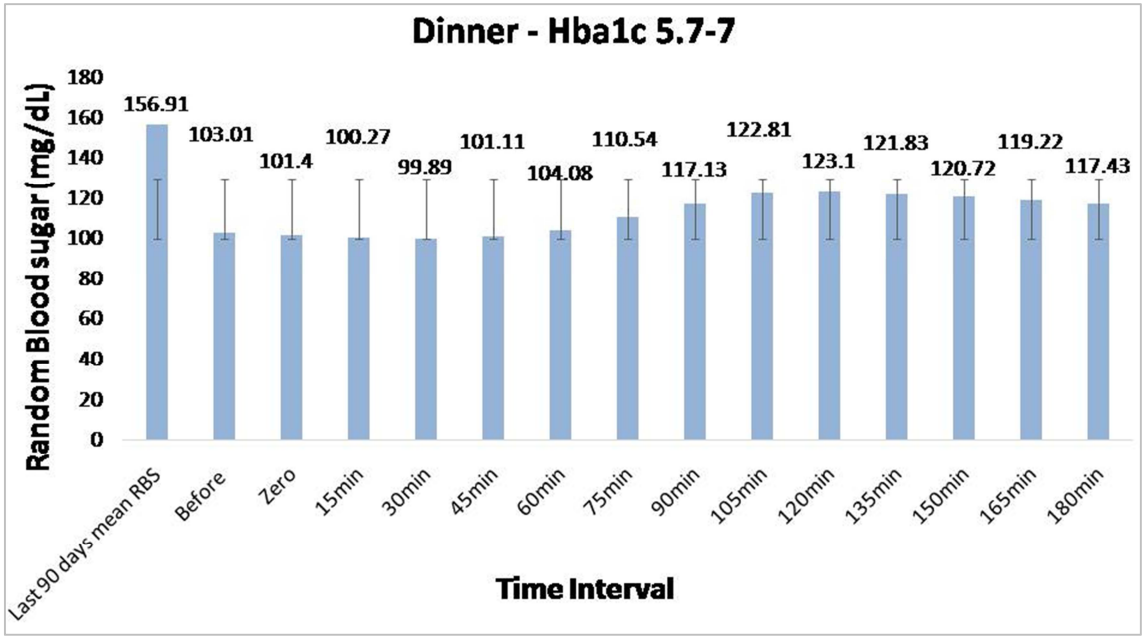

Figure 2. *Fluctuations observed in the blood glucose levels during dinner of patients in group A.*

(ii). Group B (HbA1c Levels Between 7.1 to 10)

The maximum glucose level was observed at 120 mins after the start of both lunch and dinner with the value at lunch (159.58 mg/mL) being slightly higher than that during dinner (158.22 mg/dL) with a gradual decrease in the blood glucose levels.

(iii). Group C (HbA1c Levels Above 10)

The average glucose level of this group before the start of the meals was higher as compared to the other two study groups. During lunch, a decrease in the glucose levels from the start was seen till 45 mins after which a gradual increase was observed. The maximum glucose in the blood was seen at 165 minutes (152.55 mg/dL). (Figure 5) During dinner, the blood glucose level showed a drop 15 minutes after the start of the meal followed by a gradual increase till 165 minutes (159.67 mg/dL). (Figure 6).

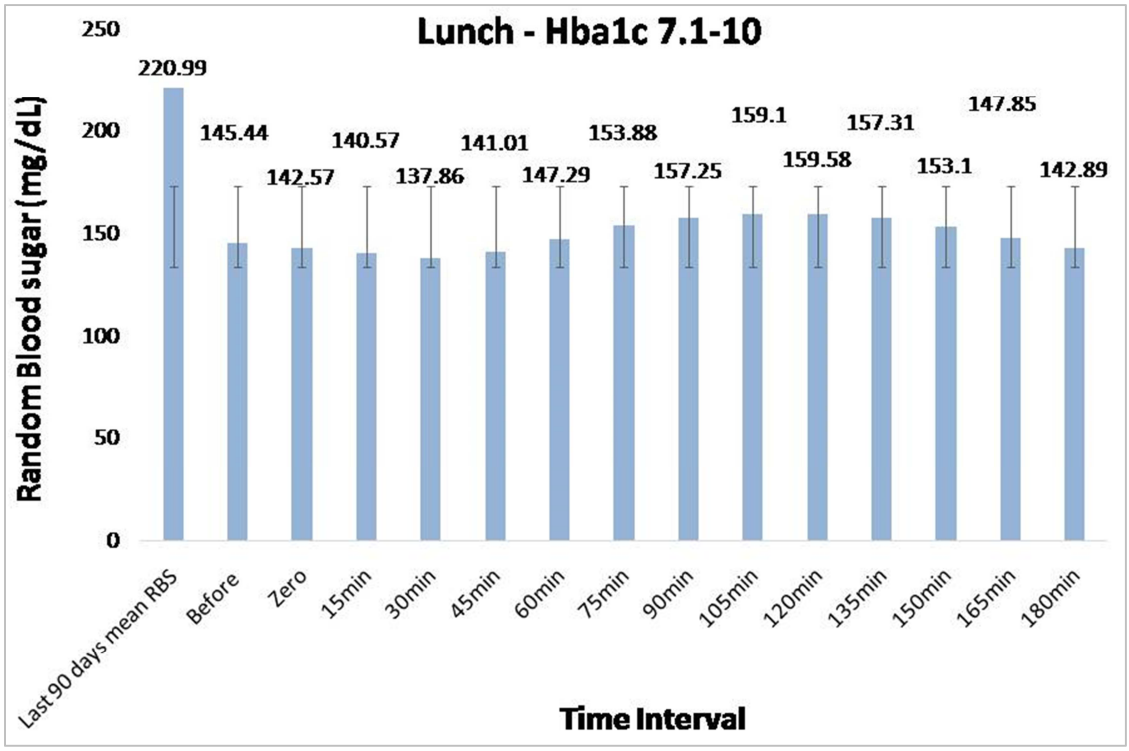

Figure 3. *Fluctuations observed in the blood glucose levels during lunch of patients in group B.*

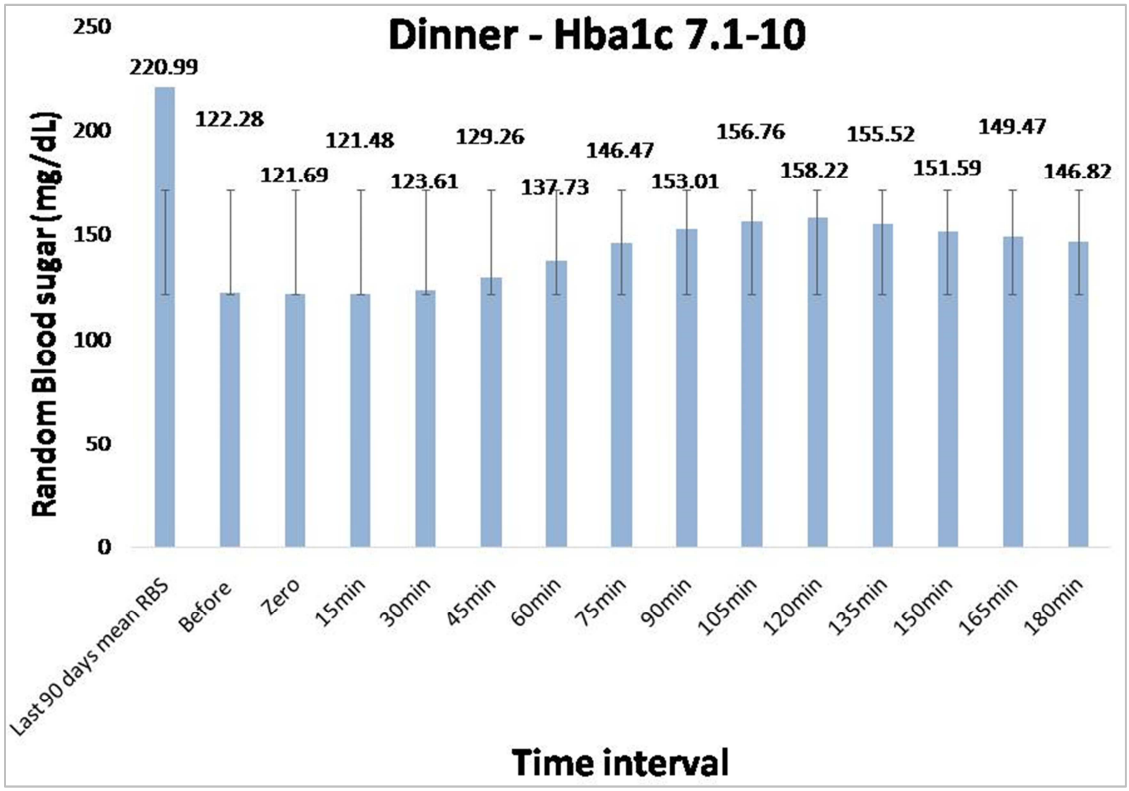

Figure 4. *Fluctuations observed in the blood glucose levels during dinner of patients in group B.*

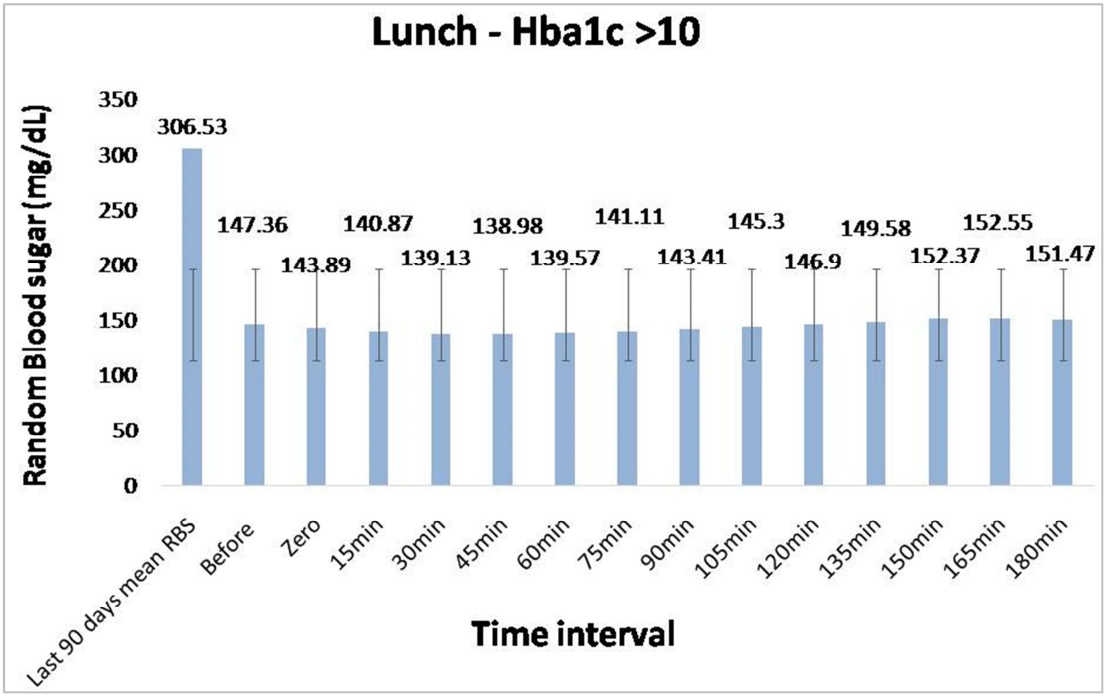

Figure 5. *Fluctuations observed in the blood glucose levels during lunch of patients in group C.*

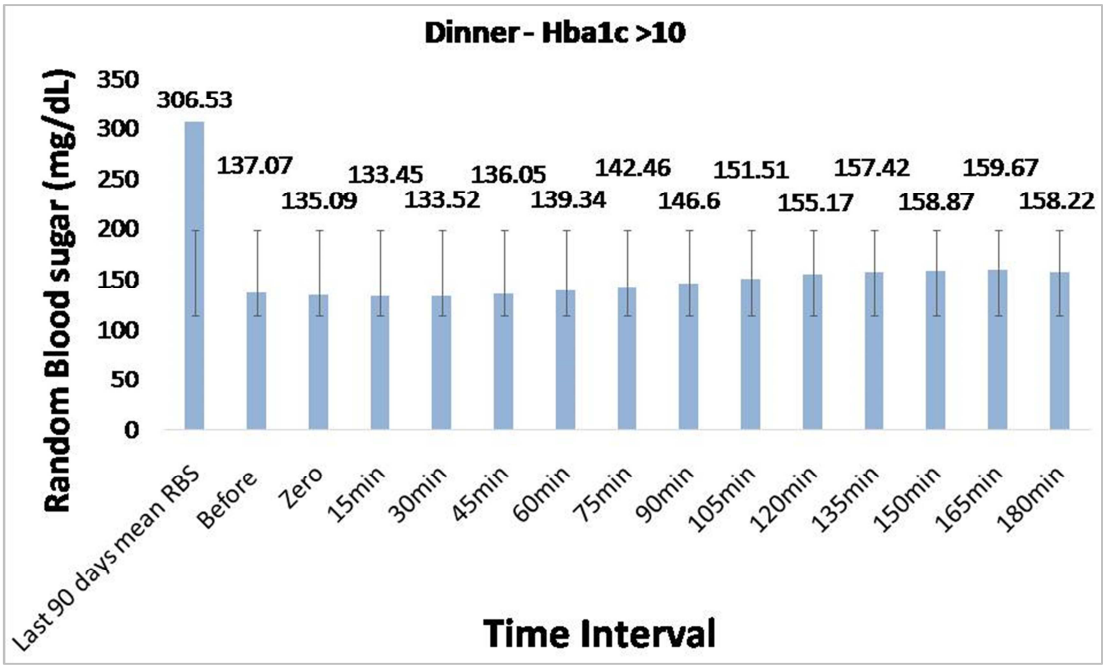

Figure 6. *Fluctuations observed in the blood glucose levels during dinner of patients in group C.*

4. Discussion

Management of post- prandial hyperglycaemia is of utmost importance as it is a risk factor for atherosclerosis, endothelial dysfunction and other cardiovascular diseases [8]. We carried out a prospective study on the effect of meals containing barley on the postprandial glucose levels of 29 T2DM patients at Madhavbaug Hospital, Khopoli, Maharashtra, India.

Barley Atta contains barley, wheat bran, fenugreek and cinnamon. Barley contains 3- 11% βglucan which is a soluble fiber that has been proved to be beneficial in reducing the risk of T2DM, cardiovascular disease, obesity and cancer. β glucan has high viscosity which results in slow mixing of the digestive enzymes and delayed emptying of the stomach [9]. This results in a low glycaemic index (GI) of barley.

Cinnamon has been used as a dietary component and in the management of diabetes mellitus. Cinnamon reduced FBG and HOMA-IR levels in T2DM and pre-diabetes patients [10,

11]. Cinnamon is capable of activating insulin receptor kinase similar to that of insulin, thus increasing glucose uptake [12, 13].

Wheat bran contains high amount of fibre and this fibre slows down digestion process and leads to slow release in blood glucose levels [14]. It thus helps to reduce the risk of T2DM by reducing the fasting and postprandial blood sugar levels as seen in previous studies [15, 16].

Fenugreek seed has been used as an antidiabetic seed. A simple complementary addition of fenugreek seeds can have a synergistic effect along with diet control and exercise on fasting blood glucose and HbA1c. This diet is useful to all diabetic patients irrespective of the severity of their condition [17-19].

During the study, known diabetic patients were admitted for 10 days and their blood glucose levels were monitored using a CGM sensor. Before the start of the study, each patient was tested for their HbA1c levels and based on the HbA1c values, they were divided into 3 groups- Group A (HbA1c between 5.7 and 7), group B (HbA1c between 7.1 and 10) and group C (HbA1c above 10). Using the calculation derived by Nathan et al., we converted the HbA1c values obtained from each patient into random blood sugar values [20]. Division of the study population into groups helped us to determine the effect of barley atta based diet on patients with different severity of T2DM.

To determine the post-prandial excursions, we first had to determine the baseline value (pre-prandial value) before each meal. This value varied among the three groups with group A having the lowest followed by group B and then group C.

For patients in group A, it was expected that the postprandial BGL should go above the last 90 days of BGL. Such a trend was not observed and the post-prandial BGL remained below 120 mg/dL. Post dinner the BGL crossed 120 mg/dL at 105 minutes but then dropped at 165 minutes. The low carb content of barley did not allow the post-prandial BGL to reach the value seen for the average 90 days BGL but due to the lower physical and mental activity post-dinner the highest blood sugar value was obtained was more than that after lunch.

Patients of group B are inclined towards post-prandial hyperglycaemia. The diet provided is still capable of maintaining the postprandial BGL level below 200 mg/dL both after lunch and after dinner. The glucose levels after each meal reached the maximum at 120 minutes for group A and group B.

Patients in group C are considered to have uncontrolled diabetes and have a high chance of showing post-prandial BGL greater than 200 mg/dL. The study showed that the post-prandial BSL is still lower than 200 mg/dL after lunch and dinner. The BGL did not rise as expected due to the consumption of the food prepared using barley atta. A low glycaemic spike can be helpful to prevent micro vascular damage and dependency on higher oral hypoglycaemic agents (OHAs)/Insulin. For group C however, the rise in the glucose levels continued till 165 minutes after which there was a decline.

The reason for such an observation in all the three groups is explained by Ames 2015is the high viscosity of barley in the gut due to the inactivation of endogenous β glucanases [21]. Previous studies on the effect of barley based diet on postprandial BGL levels have also shown that barley reduces the BGL as compared with a diet with no barley [22].

Even after 3 hours, the glucose levels did not reach the baseline indicating that the time to achieve the baseline glucose value may be more.

5. Conclusion

We wanted to study the effect of a carbohydrate diet having a low GI on the post-prandial BGLof known diabetic patients. It was found that food containing barley (a carbohydrate with a low glycaemic index) helps in preventing the excessive postprandial increase in BGLas the value was maintained below 200mg/dL and it is beneficial to all patients with a known case of DM irrespective of the severity. Thus, we can conclude that Barley Atta containing barley as major source of carbohydrate may be ~~is~~ beneficial in controlling the postprandial blood glucose levels in known T2DM patients. Long term follow-up study in larger population with different ethnicity is warranted to generalize the outcomes.

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