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Hypoglycemic Effect of Barley (*Hordeum vulgare*) in Diabetics

Amna Azam, Nizwa Itrat* and Uswa Ahmed
School of Dietetics and Nutritional Sciences,
The University of Faisalabad

Abstract:- Barley (Hordeum vulgare L.) is a functional food and one of the ancient cultivated cereal grains in the world. Many potential benefits have been linked to intake of barley as it contains pharmaceutical properties. Barley aids in lowering blood sugar, blood pressure, cholesterol and for the promotion of weight loss. Barley contains fiber in significantly high quantity (about 15.6 g/100g). The present study is devised to investigate the effect of barley on postprandial blood glucose response in diabetics. The research study was conducted on 20 individuals with Type 2 diabetes. Subjects were divided into two groups: G0 and G1; with G0 being the control group (0g barley diet) while G1 group being the experimental group (100g barley diet). This trial was done for the course of one month. The blood glucose of each subject was checked at fasting and after the consumption of barley porridge i.e. Postprandial blood glucose level at 90 minutes. The data thus obtained was subjected to statistical analysis. Hence the human study showed that barley caused significant reduction in blood sugar level.

***Keywords*: -** *Barley, Beta Glucan, Postprandial Blood Glucose Level, Porridge, Diabetics.*

I. INTRODUCTION

A high fiber diet impart several health benefits which include increased satiety, low energy density, increased fecal bulk, lowered cholesterol levels and hypoglycemic response. The term Glycemic Index was introduced for the identification and classification of carbohydrate rich foods responsible for raising the postprandial blood glucose levels. High-glycemic index foods are significantly related with increased risk of Type 2 diabetes (Barclay and Lie, 2007; Villegas *et al*., 2007) and coronary heart disease. Likewise, low-glycemic index foods, on the other hand, reduce the risk of diabetes and cardiovascular diseases and have gained much popularity among the vulnerable as well as healthy individuals.

The significant use of functional foods that provide health benefits beyond their nutritional contribution has raised the educational, industrial and public interest. Such foods are significantly related to improved health and nutritional status of human as well as reducing the risk of acute and chronic diseases like diabetes, obesity, cardiovascular diseases and cancer (Hetson *et al*.,2008).

Barley (*Hordeum vulgare L.*) is a functional food and one of the ancient cultivated cereal grains in the world. In countries like Tibet and Morocco, barley is used as a staple food (Thondre *et al*., 2012) whereas considered as the second most important crop in UK.

In North America, barley is also used as animal feed and for malting purpose.

The selection of foods which elicit the postprandial glycemic response (PPGR) without increasing the insulin level, helps to improve the glycemic control and barley is one of the food (Dworatzek *et al*., 2013). The evaluation of barley has been performed by incorporating into several food products including pasta, bread, tortillas, biscuits, chips and noodles (Jacobs *et al*., 2008). Factors that optimize the PPGR due to the consumption of barley foods include the amount and type of fiber and the type of starch.

Barley is famous for its high dietary fiber content that provides 11-34% of the total dietary fiber, and the soluble fiber comprises of 3-20% of the total dietary fiber. Additionally, barley also provides 65-68% starch, 10-17% protein, 4-9% beta glucan, 2-3% free lipids and 1.5-2.5% minerals along with bioactive compunds like proanthocyanidins, catechins and phenolic acids (Izydotczyk *et al*., 2000; Quinde *et al*., 2004). The major nutritional component of barley is Beta-glucan which helps to lower the blood glucose level and cholesterol. The varying responses of beta glucan containing foods depend on its cooking or processing techniques. (Andersson *et al*., 2004; Keogh *et al*., 2007 and Poppitt *et al*., 2007).

The soluble fiber beta glucan in barley has been shown to lower the blood glucose levels by several mechanisms in upper gastrointestinal tract and lower intestinal tract (Tosh SM 2014). Barley genotypes from different origins have large variation in fiber composition and concentration (Anderssone*tal*, 2008). There are two types of starch in barley: amylose and amylopectin. It has been confirmed by studies that barley foods prepared with high-amylose starch reduces the PPGR as compared with high-amylopectin starch.

The nutritional profile of barley has contributed to the tremendous attention in among the public. Beta glucan is one of the soluble fiber presents in cereals like oats, barley, rye and wheat (Lazaridou *et al*., 2007). The presence of beta glucan in barley influences the malting and brewing yield in barley, thus regulating the endosperm modification rate. The beta glucan concentration varies in different barley varieties. Barley can be used partially or fully in a number of cereal based food products as a substitute for

wheat, rice, maize and oats (Bail and Ullrich, 2008). The latest research based findings on barley will increase its anticipation in food industries and ultimately become the part of daily diet by the consumers.

The primary indicators for Type 2 diabetes are increased blood glucose and insulin concentrations. Insulin resistance increases the risk of obesity, hyperlipidemia, hypertension, glucose intolerance and type 2 diabetes. Aging and increased weight have a significant effect on the abnormal carbohydrate metabolism particularly associated with increased blood glucose and insulin levels. (Bloomgarden, 2004). Therefore, the scientists have started focusing on development of foods with low glycemic index by introducing dietary fiber from different cereals in foods like pasta, bread and beverages (Panahi et al.,2007). Glycemic index is used to represent the glycemic response of food

The objectives of the current study are:

- To prepare a barley product (barley porridge).
- To investigate a hypoglycemic effect of barley porridge against diabetic individuals.

II. MATERIALS AND METHODS

- *Selection of Raw Material*

Barley seeds were procured from Ayub Agriculture Research Institute (AARI), Faisalabad. For the development of barley porridge, optional ingredients like milk and water were procured from commercial market of Faisalabad.

- *Product Development*

Barley was weighed into a pan, washed thoroughly, brought to boil with water and allowed to simmer until cooked. The barley porridge was prepared by using 100g of barley. (Thondre *et al*., 2012). (Table 1).

Treatment	Description
T_0	No barley
T_1	100g of barley

Table 1:- Treatment Plan

- *Efficacy Trial*

The bio evaluation was performed to investigate the hypoglycemic effect of barley. The selection of procedure was done on the basis of anthropometric evidences, medical history, current medications and lifestyle practices. Diabetic individuals (n=20) were selected and divided evenly into two groups. One was control group as (G_0) and other was experimental group as (G_1) having 10 human subjects in each group. G1 group was served with barley porridge prepared from 100g of barley and G0 group consumed no barley diet for 4 weeks. Blood sample was taken from each subject and blood glucose level was checked at fasting condition and after the consumption of barley porridge i.e. postprandial blood glucose level at 90 minutes (Thondre *et al*., 2012). Capillary Blood Sugar monitoring was done by Glucometer.

- *Statistical Analysis*

By using the methods explained by Steel et al. (1997), complete randomized design was applied to find out the significance level. The statistical analysis of data was performed using two-way ANOVA.

III. RESULTS AND DISCUSSIONS

Barley porridge was prepared and then evaluated for sensory evaluation to check consumer acceptability. Blood glucose response in diabetics were fed on barley porridge and compared with the control group. Results of present research approve that barley porridge significantly lower the serum blood glucose level. This result is also supported by study previously done (Katherine Steele and Gray Frost, 2013). A study was conducted to detect the health related advantages especially for diabetic patients. Barley was introduced to Type II diabetic patients for 1 month. Study proved that barley aids in lowering post-prandial blood glucose response in Type II diabetes (Nancy Ames and J. Storsley, 2015).

- *Efficacy Study*

20 diabetic patients of different age groups were voluntarily involved in this study. They were divided into two equal groups. One group was the control group (G_0) and the other was intervention group (G_1). G_0 group consumed 0g of barley and G_1 group consumed 100g of barley. Barley porridge was given to G_1 group for 4 weeks and then blood glucose level of each subject was checked at fasting and after the consumption of barley porridge i.e. postprandial blood glucose level at 90 minutes. There was reduction in serum blood glucose level of patients consuming barley based diet due to having low glycemic index (Katherine Steele and Gray Frost, 2013).

The subjects participated in this study were divided into two groups as control and experimental. The subjects of both groups were taken from family, relatives and from family friends. A patient detail and consent form was being filled by both control and intervention groups. Mean age, height and weight of diabetic patients of control group and diabetic patients of intervention group are in follows (Table 2)

Subject	Age (year)	Height (cm)	Weight (kg)
Control group	40.4 ± 6.0	160.8 ±3.75	60.1±5.8
Intervention group	37.8± 5.308	165.8± 3.67	62.5±4.2

Table 2:- Means for Age, Height and Weight

- *Results*

Blood glucose level of control group and intervention group was checked at fasting condition and after the consumption of meal i.e. post-prandial blood glucose level. The results of present study revealed that by consuming barley based diet, showed significant reduction in postprandial serum glucose level as compared to consuming non barley diet. Mean fasting blood glucose

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levels of diabetic patients of control group were recorded as 142.5±9.4 for 1st week, 150±5.7 for 2nd week, 149±8.5 for 3rd week and 151±7.9 for 4th week. Mean postprandial blood glucose levels of control group were recorded 160±9.2 for 1st week, 170.5±11.2 for 2nd week, 161±11.9 for 3rd week and 163±11.5 for 4th week (Figure 1) Mean fasting blood glucose levels of diabetic patients of experimental group were recorded as 139±7.8 for 1st week, 140±9.4 for 2nd week, 137±6.5 for 3rd week and 135±9.7 for 4th week. Mean postprandial blood glucose levels of intervention group after consuming 100g barley porridge were recorded 157±7.2 for 1st week, 153±8.2 for 2nd week, 152±5.4 for 3rd week and 150±11.1 for 4th week are shown below (Fig 2) according to protocols by (Khan et al., 2009). The comparison between postprandial blood glucose levels of control and intervention group I shown in Figure 3. The statistical analysis of data was performed using two-way ANOVA (Table 3).

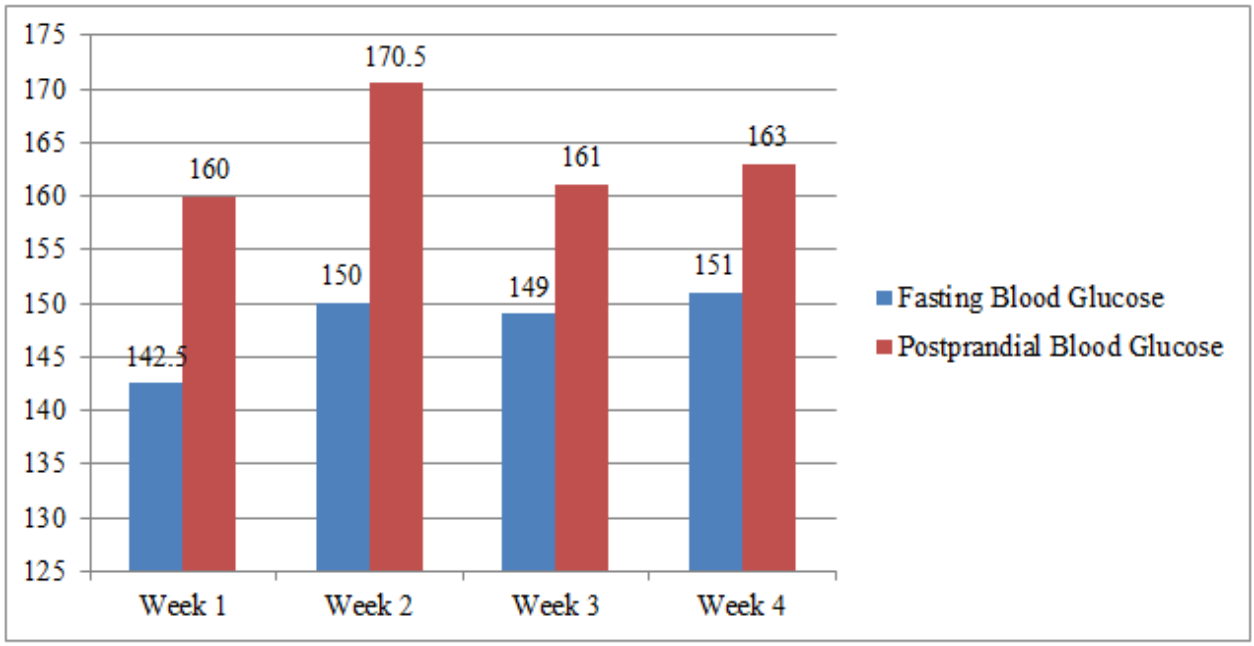

Fig 1:- (Means of Fasting and Postprandial Blood Glucose Levels of G0)

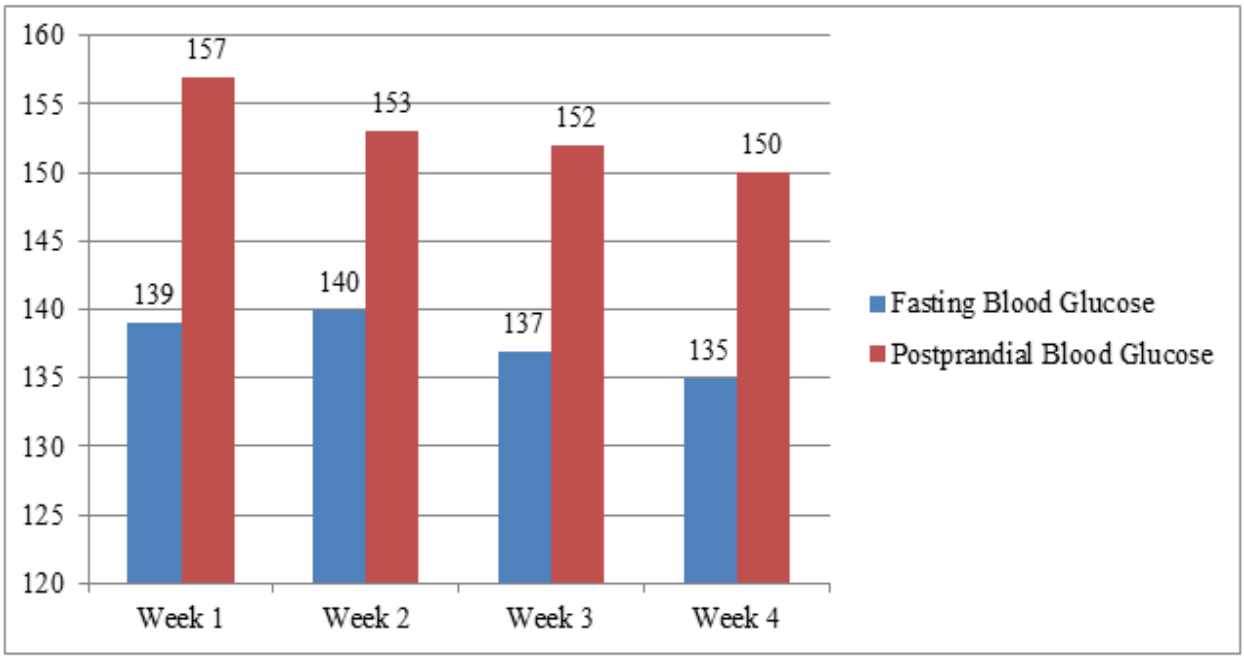

Fig 2:- (Means of Fasting and Postprandial Blood Glucose Levels of G1)

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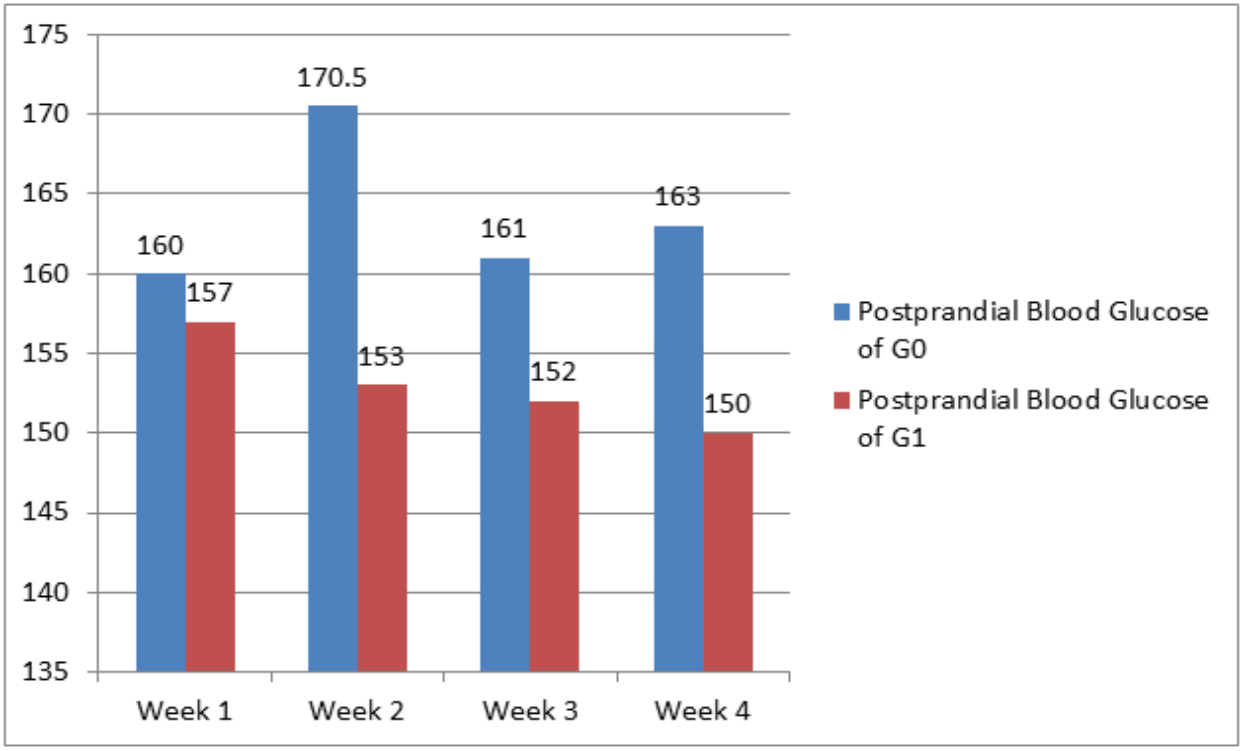

Fig 3:- (Means of Postprandial Blood Glucose Levels in G0 and G1)

Source of variance	Degree of freedom	Sum of square	Mean squares	F-value
Treatments	1	554.95	138.7375	20.29909**
Duration	3	158.05	52.68333	16.44213**
Error	12	38.45	3.204167	
Total	16	751.45		

Table 3:- Analysis of Variance for Blood Sugar Level

**Highly significant value p≤0.01
**=Highly significant

IV. SUMMARY

Barley (*Hordeum vulgare L.*) is a functional food and one of the ancient cultivated cereal grains in the world. In countries like Tibet and Morocco, barley is used as a staple food (Thondre *et al.*, 2012) whereas considered as the second most important crop in UK.

In North America, barley is also used as animal feed and for malting purpose. Barely accounts for 7% of the global cereal crop production. It is known as "poor man's crop". Barley includes in grass family poaceae and almost consists of 350 species which includes both cultivated and wild species. It can easily be grown in any of the environment and this makes variety in species and cultivation. Its diversity also includes physiological and genetics behavior. It has been proven to be a quality cereal because of its nutritional and therapeutic contributions in improving the human health.

Barley is famous for its high dietary fiber content that provides 11-34% of the total dietary fiber, and the soluble fiber comprises of 3-20% of the total dietary fiber. Additionally, barley also provides 65-68% starch, 10-17% protein, 4-9% beta glucan,2-3% free lipids and 1.5-2.5% minerals along with bioactive compunds like proanthocyanidins, catechins and phenolic acids (Izydotczyk *et al.*, 2000; Quinde *et al.*, 2004). The major nutritional component of barley is Beta-glucan which helps to lower the blood glucose level and cholesterol. The varying responses of beta-glucan containing foods depend on its cooking or processing techniques. (Poppitt *et al.*, 2007). The soluble fiber beta-glucan in barley has been shown to lower the blood glucose levels by several mechanisms in upper gastrointestinal tract and lower intestinal tract (Tosh SM, 2014).

In present study, 20 diabetic patients of different age groups were voluntarily involved in this study. 10 patients consumed barley based diet (100g of barley) and 10 patients consumed non barley diet. Barley porridge was given to selected individuals for 4 weeks and then blood glucose level of each subject was checked at fasting level and after the consumption of millet cookies i.e. postprandial blood glucose level at 90 minutes.

The results of present study revealed that by consuming barley based diet, showed significant reduction in postprandial serum glucose level as compared to consuming non barley diet.

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V. CONCLUSION

- The current efficacy study concluded that barley reduces the post-prandial blood glucose response significantly in Type 2 diabetes patients
- This therapeutic property of barley makes it a functional food

Potential diabetes is proving to be at greater risk to develop the disease with the passage of time if no protective measures are adopted.

RECOMMENDATIONS

- Addition of barley in food products should be encouraged to enrich the formulations with functional ingredients
- The multiple therapeutic effects of barley in human subjects should be discovered
- Suggest effective strategies to promote the consumption of barley foods to improve the nutrition profile

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