Glycemic Response to Products Containing Himalayan Tartary Buckwheat Flour

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Abstract

In this uncontrolled exploratory study, the effects of Himalayan Tartary buckwheat (HTB) flour on glycemic status were examined using continuous glucose monitoring technology (CGM). Over 14 days, nine adults without diabetes (7 women, 2 men; ages 32-75) consumed various combinations of HTB as well as 50 grams of available carbohydrates from white bread after a 10+ hour fasting period, and the peak postprandial glycemic excursions were tracked and compared. The HTB combinations were designed to mimic real-life application and therefore were not standardized in carbohydrate content relative to the white bread. Compared to the white bread intervention, the HTB containing-interventions showed a lower pooled average peak glycemic excursion over the 120 minute observation window.

Introduction

Global rates of type 2 diabetes mellitus (T2DM) have quadrupled in the last several decades, with the condition now affecting 1 in 11 adults.[1] Similarly, pre-diabetic states including elevated fasting glucose and impaired glucose tolerance have dramatically risen, with an estimated rate of pre-diabetes in the United States of 37% in adults older than age 20 and 51% in those older than 65.[2] It is well known that both T2DM and prediabetes confer a risk for a variety of associated negative health outcomes including increased morbidity and mortality. It is also understood that lifestyle factors including diet play a significant role in the pathophysiology of both prediabetes and diabetes.

To more concretely connect specific dietary components with their effect on blood glucose (the glycemic response), the glycemic index (GI) was introduced by Jenkins et al. in 1981.[3] This ranking system sought to characterize the relative impact of dietary carbohydrates on postprandial blood glucose to guide diabetics in dietary choices. The concept was expanded to account for the quantity of carbohydrate consumed, and the resultant metric was named glycemic load (GL). Both GI and GL are widely used as means of determining glycemic effects of various foods, but as new data come to light, some have voiced reservations regarding overreliance on these tests. Expanded understanding of metrics related to glucose metabolism have shed light on the significance of additional glycemic measurements including the height and timing of postprandial glycemic peaks which may have relevance for diabetics and pre-diabetics alike, and these measurements have been greatly facilitated with the use of continuous glucose monitor (CGM) technology.[4]

In addition to explicit glycemic influences, it is also proposed that we consider the metabolic benefits of consuming glucose-stabilizing carbohydrates including dietary fiber and carbohydrates such as inositol in conjunction with plant-derived phytonutrients.[5,6,7] A richer knowledge of foods conferring these benefits is therefore of importance in crafting recommendations to address the worldwide burden of metabolic dysfunction related to glucose and insulin homeostasis.

One crop that may meet the aforementioned criteria for viability as a food intervention for glycemic dysfunction is Himalayan Tartary buckwheat (HTB). This ancient buckwheat cultivar has historically constituted a very small percentage of the Western pattern diet, in which caloric intake is largely directed by highly refined grains and added sugars known to have a negative impact on metabolic state including imapaired glucose tolerance and insulin resistance.[8]

Buckwheat is found in two major genetic variants, common buckwheat *(Fagopyrum esculentum)* and Himalayan Tartary buckwheat (*Fagopyrum tataricum).* Himalayan Tartary buckwheat is a 2500-year-old food crop with a different germplasm than that of common buckwheat. It is known to have a different macro and micronutrient composition, and two orders of magnitude higher phytochemical portfolio of immune-active polyphenols.[9] It is a self-pollinator as contrasted to common buckwheat, which is insect pollinated. This may account for the preservation of the unique genetics of HTB over the centuries that it has been cultivated. It is high in soluble fiber and contains the non-digestible carbohydrate D-chiro inositol that is known to help stabilize post-prandial glucose and insulin.[10] The polyphenolic phytonutrient compounds in buckwheat have been shown to have a positive impact on blood pressure, blood glucose and inflammation.[11] For example, addition of the polyphenol flavonoid quercetin, which is found in high levels in HTB, was shown in a recent study to lessen the glycemic potential of bread.[12] While the concentrations of phytochemical components of HTB have been analyzed, less is presently understood about HTB's effect on glycemia when consumed.

Given the potential for HTB to represent a viable recommendation as a food in the management of metabolic health, a study was initiated to evaluate the glycemic effects of consuming HTB in a range of forms using CGM. These data were contrasted with the glycemic effects of 50 grams of carbohydrate derived from white bread.

Research and Design Methods

Subjects

Ten non-diabetic individuals volunteered for the 14-day study (7 women, 3 men; ages 32-75). One participant dropped out prior to the start of the study for unexpected medical reasons.

Experimental Design of Study

This uncontrolled clinical study measured 14 days of glycemic responses to a variety of foods in 9 participants using CGM technology. Nine non-diabetic individuals volunteered for and completed the 14-day study (7 women, 2 men; ages 32-75). All participants applied the Libre Freestyle CGM to the upper arm at the start of the trial. All participants observed an overnight adjustment period with the CGM in place prior to data collection for the trial. After an overnight fast of at least 10 hours, participants measured and recorded their blood sugar, then consumed the daily test food. Participants were instructed to refrain from consuming anything other than the study food and water during the 2 hour data collection period (fasting to 120 minutes post-intervention). Participants were instructed to avoid exercise immediately prior to and during the 120 minute data collection period. Participants were also instructed to avoid major dietary changes or the start of any new supplements during this period.

On day 1, 5 and 9, all study participants were instructed to consume 50 grams of available carbohydrate from white bread to establish a reference range of peak glycemic excursion. The results of each subsequent test food were then compared to the average impact of the 50 grams of white bread carbohydrate control to determine a relative glycemic response.

HTB Preparation

HTB was administered in 4 forms in the study. These included raw HTB flour as a component of a proprietary nutritional shake mix (HTB Superfood Shake Mix), a standalone raw HTB flour, raw HTB flour as part of a supplementary phytonutrient concentrate capsule (HTB Rejuvenate™) and a cooked preparation of HTB flour. The various forms of HTB were alternated in various pairings to investigate the effects of variable quantities and contexts of consumption. See Figure 1 for a full study schedule.

Figure 1: Two-week schedule of study foods

Day 1: 50 grams available carbohydrate from white bread

Day 2: 50 grams boiled Himalayan Tartary buckwheat flour

Day 3: 47 grams HTB Superfood Shake Mix

Day 4: 32 grams HTB Superfood Shake Mix plus 16 grams of raw Himalayan Tartary buckwheat flour

Day 5: 50 grams available carbohydrate from white bread

Day 6: 32 grams of HTB Superfood Shake Mix plus 16 grams of raw Himalayan Tartary buckwheat flour

Day 7: 47 grams HTB Superfood Shake Mix

Day 8: 50 grams available carbohydrate from white bread plus 2 grams (2 capsules) HTB Rejuvenate™

Day 9: 50 grams available carbohydrate from white bread

Day 10: 32 grams HTB Superfood Shake Mix plus 16 grams of Himalayan Tartary buckwheat flour

Day 11: 47 grams HTB Superfood Shake Mix

Day 12: 50 grams available carbohydrate from white bread plus 2 grams (2 capsules) HTB Rejuvenate™

Day 13: 47 grams of HTB Superfood Shake Mix plus 2 grams (2 capsules) HTB Rejuvenate™

Day 14: 50 grams of dates or mango

Data Collection

Blood glucose measurements using the CGM were made by study volunteers at time 0, 30, 60, 90, and 120 minutes after the test food was consumed and recorded by each study participant on a shared online spreadsheet.

Statistical Analysis

Maximum postprandial glycemic excursions (relative to fasting) were calculated for each participant for each intervention. The results were pooled. When the maximum glycemic excursion was less than the fasting glucose, the highest post-intervention glucose recording was recorded and the relative difference was recorded as a negative value and incorporated into the pooled average value. The maximum postprandial glycemic excursions were then compared with a semi-standardized pooled average of the three days of glycemic excursion data from white bread. Due to high heterogeneity in foods consumed on day 14, these data were not included in analysis. Additionally, when participants deviated significantly from the study protocol or when individual data points were not charted by participants, all data from that study day from that participant were not included in the final analysis.

Results

The pooled average maximum relative glycemic excursion for each study food is as shown in Figure 2.

Figure 2: Group Average Glycemic Excursions for Each Study Food

Average Maximum Postprandial Blood Glucose Elevation (From Fasting)

White Bread……………………..……………………..…..+51.7 mg/dl
Cooked HTB Flour………………………………..……….+41.4 mg/dl
HTB Superfood Shake Mix…………………………..…..+11.9 mg/dl
2:1 HTB Superfood Shake Mix: HTB Flour…………………………………………………………..…..+18.5mg/dl
HTB Superfood Shake Mix + 2 gm HTB Rejuvenate™……………………………………..……………+20.1 mg/dl
White Bread + 2 gm HTB Rejuvenate™…………………...………………………………+52.3 mg/dl

Peak Glycemic Response of Interventions Relative to White Bread

Cooked HTB Flour………………………………………………….80.0%
HTB Superfood Shake Mix……………………………………….23.0%
2:1 HTB Superfood Shake Mix:HTB Flour…………………35.8%
HTB Superfood Shake Mix + 2 gm HTB Rejuvenate™…38.9%
White Bread + 2 gm HTB Rejuvenate™…………………….101%

Discussion

The purpose of this study was to gain preliminary insights on relationships between Himalayan Tartary buckwheat and glycemic response in non-diabetics in a real-world setting by looking at postprandial maximum glycemic excursions.

The primary endpoint was comparison between peak glycemic excursions of various preparations of HTB and the 50 grams of carbohydrate from white bread. The study did not match the carbohydrate content of the interventions with that of the control food. Instead, the interventions were designed to mirror real-world application, with 50 grams of the HTB flour, 47 grams of the shake mix, and 48 grams of the shake mix + HTB flour used to approximate real-life application.

The baseline data of the response to the white bread control challenge demonstrates a more than two-fold maximum interindividual variation in peak glycemic response. This interindividual variation in glycemic response has been observed in monogenetic twins indicating that this variation among individuals is not under strict genetic control.[13] In a CGM dataset from 800 individuals, variability in postprandial glycemic response was partially attributable to differences in the microbiome and other variables, which speaks to the potential for personalizing diet to achieve optimal glycemic control.[14]

While this was not a controlled study, it was notable that the pooled peak average glycemic excursion of HTB Superfood Shake Mix was a full 77% lower than that of the white bread intervention. When the combination of HTB Superfood Shake Mix + raw HTB flour in a 2:1 ratio was consumed, these pooled data resulted in a 64.2% lower peak glycemic value than the white bread intervention. Compared with white bread alone, the addition of HTB capsules (2 gm HTB Rejuvenate) increased the peak average glycemic excursion by 1%. Compared with the shake mix alone, the addition of the HTB Rejuvenate™ capsules increased the peak average glycemic excursion by 15.9%.

The effect of boiled HTB flour on peak glycemic response was 80.0% of the 50 grams carbohydrate white bread. It has been demonstrated that boiling and cooking of buckwheat flour alters the starch structure of the flour and changes its glycemic response.[15] Overcooking common buckwheat in the manufacture of noodles results in gelatinization and an increase in its glycemic response, and this may partially explain what was seen in this study with the boiled Himalayan Tartary buckwheat flour.[16] In comparison with the combination of HTB Superfood Shake Mix and HTB flour, the boiled HTB flour alone had a 2.24x higher average peak glycemic response.

This study had several limitations including small sample size, self-reporting of glycemic data and variability in adherence to the initial study design. In addition, due to the free-living element of the study, variables including physical activity, sleep habits, alcohol consumption and other dietary influences outside of the designated testing and fasting window were not controlled for. This did enable the study to more closely approximate real life application of the various interventions.

As metabolic dysfunction, especially diabetes and prediabetes continue to represent a major threat to the health of people worldwide, further exploration of the relative effect of various foods on glycemia will be necessary. The aforementioned data provide preliminary insight into the postprandial glycemic effects of HTB in various permutations when delivered in real-world friendly formats. These appear to indicate a relatively lower peak glycemic response of ra HTB flour when consumed in combination with the HTB Superfood Shake Mix compared with a similar amount of boiled HTB flour. It is notable, however, that the studied metabolic effects of HTB consumption in this trial were limited to one variable, and that many of the metabolically active components in HTB may induce their changes over a longer timespan.

Conclusion

The ongoing burden of death and disability resulting from metabolic dysfunction necessitates a continued search for novel mitigation strategies. While much focus has been on pharmaceutical management, research supports a role for nutritional strategies in ameliorating aspects of glycemic imbalance. A dietary focus on foods rich in fiber, phytonutrients, and other components known to have beneficial effects on metabolism may provide benefits beyond basic GI and GL measurements. Of these foods, HTB is especially promising for its physical makeup.

This uncontrolled study provided preliminary data for the postprandial effects of HTB on glycemic response. Research should continue to explore the potential beneficial impact of a variety of foods on metabolism. In this, early data suggest that HTB may have favorable effects, which may be attributable to its phytochemicals, carbohydrates like D-chiro-inositol and high fiber composition. Metabolic effects of HTB may not have been optimally captured with the postprandial metrics used in this study, and additional insights could be derived from longer-term evaluation of metabolic parameters. Further studies may benefit from exploring the impact of HTB on other markers of metabolism and in conditions including insulin resistance, metabolic syndrome, and type 2 diabetes.

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