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Glycemic properties and subjective satiety responses to four popular Kuwaiti breads

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Summary. *Background:* In Kuwait, Iranian bread, which is made from a mixture of white and brown flour, is regularly consumed as part of the national cuisine as a result of its high organoleptic quality. There is little evidence on how the consumption of Iranian bread can affect the GI. Therefore, the objective of the present study was to determine the GI and subjective satiety of Iranian bread and compare it to other widely consumed types of bread in Kuwait. *Methods:* Nine healthy female college students, mean age 22 (standard deviation 1.6) years and mean body mass index 20.3 (standard deviation 2.1) kg/m^2, were enrolled for the study. On separate occasions, subjects were served different bread meals. Subjective appetite information was collected before and after each meal using visual analogue scales (VAS). Blood glucose was measured from finger-prick samples in fasted subjects and at 0, 30, 60, and 120 minutes after the consumption of each test meal. *Results:* Results showed that high fibrous breads are best to increase the satiety ($p < 0.05$). Barley bread had the slowest effect on blood glucose level followed by Rye and four seed bread, respectively ($p < 0.05$). *Conclusion:* It was concluded that high fibrous breads produces a meal with low glycemic response and high satiety level. The results collected from this paper may be useful in helping people lower their blood glucose levels and increase their satiety after consuming meals that contain breads.

Keywords: mixed flour bread, rye bread, four seed bread, barely bread, Glycemic Index

Introduction

Wheat and wheat products are the most consumed source of carbohydrate across the world (1). Wheat is the greatest of the carbohydrate foods and delivers more nutrients than any other carbohydrates source. Furthermore, wheat is a main food constituent because of its agronomic adaptability, storage simplicity and ease of transforming wheat grains into flour to make palatable and appetizing foods (2).

The consumption of wheat can be used as an excellent source of energy and proteins. More specifically, 100 g of whole wheat flour contains 339 kcal and 72.6 grams of carbohydrate, 13.7 grams of protein and 1.9 grams of fat. Along with this, wheat also contains a number of vitamins including Niacin (6.4 mg), Thiamin (0.4 mg) and Folate (44.0 mcg). Minerals such as iron (3.9 mg), magnesium (138.0 mg), phosphorus (346.0 mg), potassium (405.0 mg) and zinc (2.9 mg) are also found in whole wheat. Because wheat is such a considerable source of carbohydrate in the diet of many individuals, much attention has been paid to its effect on the body's glycemic response (GR) and the glycemic index (GI).

The GI was first introduced in 1981 by Jenkins et al. (3) and is used to classify carbohydrates in terms of their impact on blood glucose levels. In theory, GI is considered as the area under the two-hour blood glucose curve (AUC) after a 12-hour fasting period and consumption of a food with a definite quantity of carbohydrate. The area under the curve of the test food is then divided by the area under the curve of the standard (glucose, white rice or white bread) to determine the GI of the test food (4). There have been numer-

ous studies that have been conducted to examine the health impacts of low GI foods. In the International Scientific Consensus Summit from the International Carbohydrate Quality Consortium (ICQC) twenty experts in the field of carbohydrate research stressed the importance of disseminating information to the public regarding glycemic response and glycemic load due to their impact on the presence and severity of diabetes, lowering incidences of hyperlipidemia, and decreasing cardiovascular diseases (5). Along with this, the consumption of low GI foods also shows evidence of increased and enhanced endurance (Burdon et al. 2017), causes higher insulin sensitivity (6), reduces the probability of breast cancer (7), decreases appetite (8), and better colonic fermentation (9).

Since the first studies on low GI foods began, many different food types have been tested for the GI, including rye, corn, wheat, barley, oats and potatoes. The results of these tests have often differed for the same foods and it has been determined that this is a result of a number of factors including amylose, the degree of cooking and gelatinization, the amount of fiber, how the food is treated after harvesting, the size and shape and the content of fats and proteins (10). The findings of a number of research studies have shown that the excessive intake of high GI foods such as white bread can contribute to insulin resistance and type 2 diabetes (11). In Kuwait, Iranian bread, which is made from a mixture of white and brown flour, is regularly consumed as part of the national cuisine as a result of its high organoleptic quality. There is little evidence on how the consumption of Iranian bread can affect the GI. Therefore, the objective of the present study was to determine the GI and subjective satiety of Iranian bread and compare it to other widely consumed types of bread in Kuwait. The findings of this research will provide support to bread consuming nations on what the best bread is to consume in terms of reducing glycemic index and satiety.

Materials and methods

Subjects

Posters and flyers at the College of Life Sciences at the Kuwait University were used to recruit fourteen healthy university students. Individuals who responded to the advertisement but who had characteristics such as diabetes, the use of medication and those who did no eat breakfast were excluded from the study. In order to the study to commence, the Ethics Committee of the Kuwait University granted the study ethical approval. Ethical considerations were also taken by fully informing all of the study participants on the details of the study procedure, also giving them the opportunity to raise any questions and were required to sign a written consent prior to their participation.

Table 1 below provides an overview of the characteristics of the study participants. In terms of data collection, data was collected while participants were in the fasting state and measurements of participant height and weight were taken using a stadiometer (Seca Ltd, Birmingham, UK) and Tanita BC-418 MA (Tanita UK Ltd, Yiewsley, Middlesex, UK) with participants standing upright, without shoes and wearing only light clothing.

Study protocol

Protocol which was taken from the FAO/WHO (1998) (4) and slightly altered for the purposes of this study was used to measure the GI. This protocol states that to determine GI, six or more participants need to be used which is why the study utilized nine randomly selected participants.

For this study, 50g of bread was the reference food eaten by each subject. The IAUC of the test food was divided by the IAUC of the reference and multiplied by 100 to find the GI for each test meal. Twenty four hours before commencing with the tests, the subjects for the study were required to decrease and limit their caffeine intake and avoid any high intensity physical activity. They were also asked to consume only water for the 12 hours before the commencement of the study. It was recommended to the research subjects that they all consume a meal similar in size and composition the day before the test as this has been known to have an impact on bloody sugar levels (12). Before the testing began, all participants were required to provide a brief on their last meal, details of physical activity undertaken on the previous day and the date of their last period.

Test meals

The test meals for the study consisted of five breakfast meals which each contain different type of bread (Iranian Bread, Rye Bread, Four seed Bread and Barely Bread from Kuwait flour and Bakeries Company). The ingredients for the meals were all sourced locally from shops in Kuwait City, Kuwait. Each test meal contained 384 Kcal consisting of 50 g (142 kcal) of bread with 2 tablespoon of Kraft Philadelphia cream cheese (56 kcal), ½ cup iceberg lettuce (4 kcal), Fruit salad consisting of one medium pomegranate (110 kcal) and one cup of Pomelo (72 kcal). The study subjects were served their meals within 5 minutes of them being prepared. The test meals for the study were served in the morning after the participants had fasted for 12 hours and were all served with 200 ml of water.

Blood glucose measurements

Before the study participants were given the test meals to consume, fasting blood samples were taken from each person. After this, blood tests were again taken at 0, 30, 60, and 120 minutes after eating. To measure the blood glucose levels of participants, the finger prick method was used along with the Accu-Chek Performa Nano glucose meter. Before the finger pricks were done, the study subjects were instructed to open and close their hands in order to increase blood flow. The researchers were careful not to squeeze the fingers that were used for the finger pricks, so that plasma dilution would be lessened. Area under the blood glucose response curves (AUC) was determined by trapezoidal rule using Microsoft Excel 2010.

Subjective appetite

Data on the appetites of the research subject was gathered both before and after each of the four meals using visual analogue scales (VAS) adopted from (Flint et al. 2000). In using this scale, the research subjects were instructed to state their level of agreement to questions by indication a position along a 100mm line between two points. The questions that were asked were: how strong is your desire to eat, how hungry do you feel, how full do you feel, and how much food do you think you could eat? The distance in millimeters from the left end to the position chosen by the subject was used to determine the scale values of the above questions. The appetite of the subjects was then calculated using the formula below:

Statistical analysis

To determine the impact that the four test meals had on subjects blood glucose levels and appetites after consuming meals, the one way analysis of variance (ANOVA) was conducted. Following this, Tukey's post hoc tests were conducted to determine if there were any notable mean differences between the meals. For this, the statistical significance level was set at $p<0.05$. Data were analyzed using the SPSS statistical software package version 20.0.

Results & Discussion

Table 2 below presents the mean IAUC and GI for all of the four test meals. The study determined that there was a notable difference in the IAUC between the 5 types of breads ($p < 0.05$). For the Iranian bread the IAUC differed greatly from rye bread ($P = 0.001$), four seed bread ($P = 0.02$) and barely bread ($P = 0.02$). The four different test meals contained GI values ranging from 66 to 90 while the statistical analysis of the GI values of these meals, shows a notable difference ($p<0.05$).

GI values of foods are most commonly categorized as low (<55), medium (56 - 69) or high (>70)

Table 1. Participant Characteristics

Characteristic	Mean	Standard deviation
Age (years)	22	1.6
Height (m)	1.67	0.1
Weight (kg)	56.7	10.9
Body mass index (kg/m^2)	20.3	2.1
Fasting blood glucose (mmol/l)	4.7	0.4

Table 2. GI values for the four types of breads

Test food	GI	
	Mean	Standard error
Barley Bread	66	8.40
4 seed Bread	73	13.5
Rye Bread	71	11.3
Iranian Bread	90	7.50

(13). In accordance with this, Iranian bread is categorized as very high while rye bread and 4 seed bread are considered medium to high. Barely bread is considered medium. For this study, barley bread measured at a GI value of 66, which is very similar to the result published by Ostman et al. (14).

Average appetite responses for the four bread meals are shown in Table 3. The average appetite responses dropped from the baseline after the intake of all bread meals up to two hours then steadily increased. The 4 types of bread exhibited average appetite responses values ranging from 83.8 to 89.9. Barely bread seemed to promote satiety the best (83.8), followed by Iranian bread (84.1), four seed bread (87.3) and rye bread (89.9). A one-way repeated measures ANOVA followed by Tukey's post hoc analyses showed a significant effect ($P < 0.05$) among the four types of breads after 2 and 4 hours of consumption. There was no statistical difference ($P > 0.05$) among all bread meals before and immediately after the consumption of the meals.

Foods that are high in fiber have a low GI and can therefore be used to reduce appetite. This is in keeping with previous research that determined that reducing high blood glucose levels during a blood glucose spike is related to a reduction in appetite. In their research, Gonzalez-Anton (13), Carolina, et al. (14) found that consumption of the high fiber bread caused improved appetite control by decreasing hunger and increasing satiety. Moreover, ingestion of cereal-based bread improved glycemic, insulinemic, and gastrointestinal hormone responses significantly in 30 healthy adults. Recent research by Belinda S Lennerz et al (15) studied the effects of altered GI on brain activity in the late postprandial period after a typical meal. A high-GI meal consumed by 12 overweight and obese men (ages 18-35) elicited greater brain activity centered in the right nucleus that spread to the olfactory area of the brain. The trial concluded that Compared with a low-GI meal, a high-GI meal increased hunger, increased plasma glucose, and selectively stimulated brain regions associated with cravings and rewards.

From the research conducted above, this study concludes that by consuming barley and rye breads significantly reduced the blood glucose response compared to when eating plain white bread or Iranian bread. These types of breads also suppress the appetite for 2 and 4 hours respectively. This appetite suppression could be a result of the increased dietary fiber content.

In conclusion, replacing white bread and Iranian bread with high fibrous breads like barley and rye make a healthier meal and can be used in essential glucose control.

Table 3. Average appetite of each test food

Test food	Time			
	Before eating	0 hr	2 hr	4 hr
Rye bread	87.4±2.6	5.7±1.9	19.7±3.3	89.9±2.4
Four seed	86.9±5.5	5.5±1.3	18.0±1.5	87.3±1.7
Iranian	86.7±4.7	4.2±1.7	17.4±1.0	84.1±3.3
Barley bread	88.1±3.0	4.2±1.4	17.3±3.8	83.8±4.1

Limitations of the study

One limitation to this research is that all subjects in the study were female college students. This was by no means a diverse sample, and it is unclear whether the same results would relate for men or for old age groups. Another limitation to this study is that the size and composition of the meals consumed by the participants the day before the test have not been recorded. Different meal's compositions may effect blood glucose measurements in different ways even after a 12 hour fast (12).

Ethical considerations

Ethical issues (Including plagiarism, Informed Consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

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Competing interests

There are no competing interests to declare of any kind by the researchers.

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