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Evaluation of Blood Glucose Response after Consumption of Food and Extracts from Field Crops in University Students

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Abstract: This study examined the glycemic response of healthy university students after consuming rice, bulgur, and extracts of fenugreek, cinnamon, and coriander. Blood glucose was measured at seven time points: baseline (0 minutes) and at 20, 40, 60, 80, 100, and 120 minutes. The research was conducted on five groups of students, each receiving one of the test foods or extracts in standardized amounts (300 g of rice or bulgur and 300 ml of each extract). At the same time, all participants remained seated and inactive during monitoring to ensure controlled experimental conditions. The findings showed distinct differences among the tested substances, reflecting their varying nutritional and metabolic characteristics. Rice produced the most significant rise in blood glucose, especially between 20 and 40 minutes, consistent with its high glycemic index and rapid starch digestion. Bulgur demonstrated a slower, more moderate increase, with glucose levels rising gradually and then declining steadily from minute 80, due to its fiber content and coarse grain structure, which slows absorption. The plant extracts showed markedly lower responses than the starchy foods. Fenugreek extract produced the lowest rise, maintaining minimal changes over 120 minutes due to its viscous fibers and insulin-enhancing compounds. Cinnamon extract generated a moderate peak and approached baseline values between 100 and 120 minutes, while coriander extract showed a low, stable response with no sharp increases. Overall, the results demonstrate that the type of consumed substance strongly shapes postprandial glycemic behavior, with whole grains and plant extracts promoting a more stable and less pronounced response than refined starchy foods.

Keywords: Bulgur, Cinnamon Extract, Coriander Extract, Fenugreek Extract, Rice.

Introduction

The post-meal glycemic response is a key indicator of how the body processes carbohydrates, revealing the speed and degree of blood sugar rise after consuming starchy foods. This response depends on several factors, including the type of food, its fiber content, the starch composition, and the preparation method. Recent studies suggest that controlling post-meal glycemic spikes is crucial for reducing the risk of metabolic disorders in young adults, particularly given the high prevalence of high-glycemic dietary patterns among university students (Nematollahi et al, 2022).White rice is considered a high-glycemic index food due to its low fiber content and the ease with which its starches break down during digestion, leading to a rapid rise in blood glucose levels. In contrast, bulgur has a more complex structure and retains a higher fiber content, resulting in a slower, more stable glycemic response. Recent evidence supports these differences, with updated glycemic index tables confirming a clear difference in effect between whole and processed grains (Atkinson et al, 2021). Analyzing these differences among university students is a crucial step in understanding the impact of everyday dietary choices.

Advanced scientific literature indicates that fenugreek, cinnamon, and coriander extracts possess potent blood glucose-regulating properties. A recent review demonstrated that fenugreek can improve insulin sensitivity and effectively lower fasting glucose levels (Mahboubi & Haghighi, 2024). Recent analyses have also shown that cinnamon contributes to lowering fasting glucose and the HOMA-IR insulin resistance index, as well as improving HbA1c in individuals with impaired glucose control (Zarezadeh et al., 2023). A recent pilot study demonstrated that coriander can alleviate hyperglycemic disturbances by enhancing antioxidant balance and reducing metabolic stress (Sorial & Adly, 2024). These findings provide an essential scientific basis for evaluating the efficacy of these extracts in healthy university students. Additionally, a recent narrative review highlights that several culinary spices possess metabolic benefits that support glucose regulation (Singletary, 2024).

This article aims to evaluate the glycemic response of healthy university students after consuming various foods and extracts, such as rice, bulgur, fenugreek, cinnamon, and coriander. This includes measuring fasting glucose and postprandial peak glucose levels, according to the international protocol for measuring glucose at different time points, to monitor the glucose curve after consuming these meals. This combination of starchy food analysis and plant extract analysis aims to provide a deeper understanding that can help guide students' dietary behavior, promote metabolic health, and reduce the risk of future disorders (Geneş, 2025).

Effect of Field Crop-Derived Foods on the Glycemic Response in Young Adults

Figure 1. Presents a visual representation of a group of common foods and plant extracts—rice, bulgur, cinnamon extract, coriander extract, and fenugreek extract—which differ radically in their nutritional composition and their ability to influence the glycemic response. While rice is a high-glycemic index food, bulgur is a granular alternative rich in fiber that helps slow glucose absorption. The three plant extracts contain active compounds that may enhance insulin sensitivity and mitigate post-meal blood glucose spikes. This

figure highlights the importance of comparing these food choices to understand their physiological impact on blood glucose regulation in young adults.

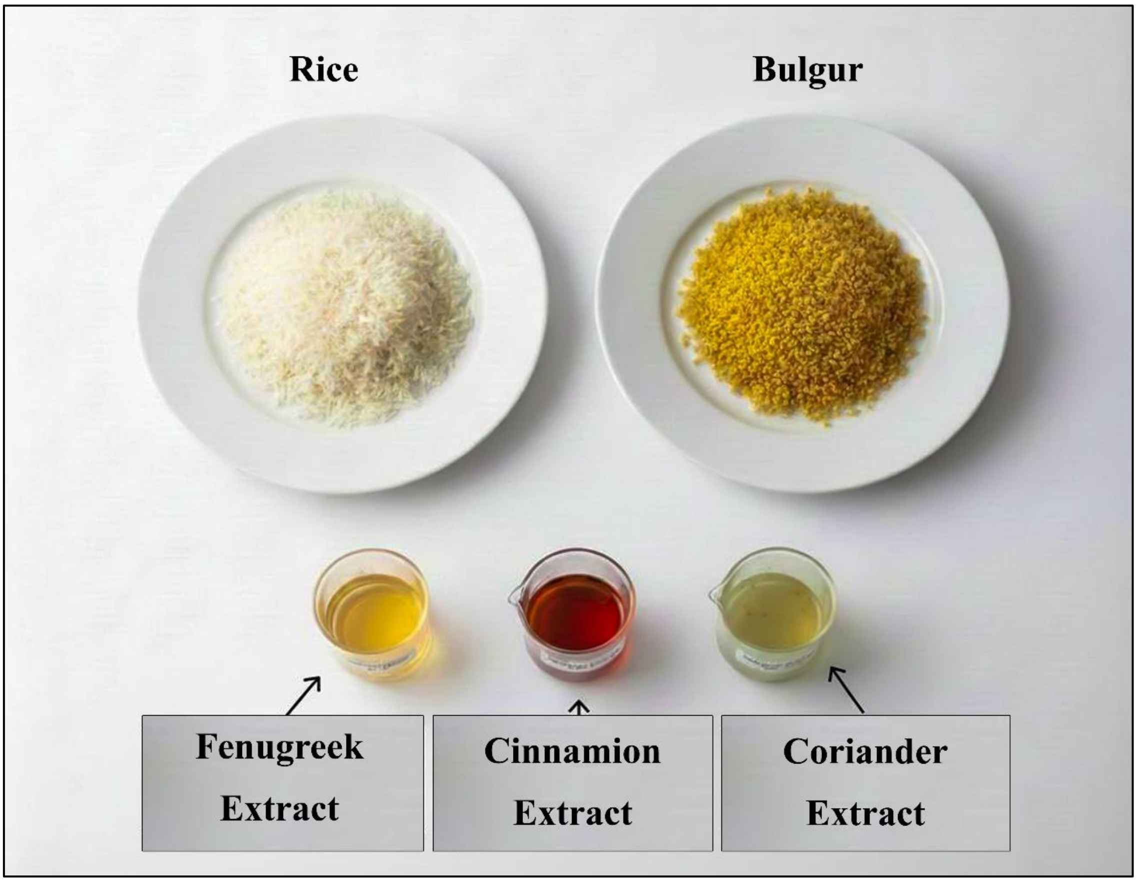

Figure 1. Some foods and extracts and their potential effect on the glycemic response

Methodology

The present study was conducted on healthy university students majoring in Physical Education, aged 20 to 22 years, with body weights ranging from 60 to 68 kg and heights from 170 to 180 cm. All participants were free from chronic illnesses or metabolic disorders. The experimental protocol involved five groups, each consisting of 30 students, as detailed in Table 1. Each group received a specific meal or extract: Rice, Bulgur, Fenugreek, Coriander, or Cinnamon.

The meal portions were standardized at 300 g for solid foods (rice and bulgur) and 300 ml for extracts (fenugreek, coriander, cinnamon). Participants were seated and did not engage in any physical activity during the two-hour experimental period. Blood glucose measurements were taken at multiple time points: baseline (0 min), 20, 40, 60, 80, 100, and 120 minutes after consumption, to assess the postprandial glycemic response. This design enabled comparison of the glycemic effects of different foods and plant extracts under controlled conditions (Yoshikawa, 2023).

Table 1. Experimental Design for Blood Glucose Response Study

Group	Number of Students	Meal	Dosage amount	Activity	Blood Glucose Measurement
A	30	Rice	300 g	None	0, 20, 40, 60, 80, 100, 120) min
B	30	Bulgur	300 g	None	0, 20, 40, 60, 80, 100, 120 min
C	30	Fenugreek	300 ml	None	0, 20, 40, 60, 80, 100, 120 min
D	30	Coriander	300 ml	None	0, 20, 40, 60, 80, 100, 120 min
E	30	Cinnamon	300 ml	None	0, 20, 40, 60, 80, 100, 120 min

Statistical Analysis

All data were entered into SPSS (version 2024) for statistical analysis. First, the analytical assumptions were verified, including normality of the data using the Shapiro-Wilk test and homogeneity of variances using the Levene test.

To compare mean blood glucose levels across the five groups at each time point, a one-way ANOVA was used. After obtaining the initial statistical results, Duncan's Multiple Range Test was applied to determine which groups differed from one another at a significance level of $\alpha = 0.05$.

The results were presented as mean ± standard deviation (Mean ± SD), and line graphs were used to compare the post-meal glucose response curves across groups. This method allows identification of subtle statistical differences between food groups and extracts while controlling for within-data variance.

Results and discussion

Figure 3, which illustrates the glycemic response after consuming five types of food and plant extracts (rice, bulgur, fenugreek, cinnamon, and coriander), demonstrates that the curves represent an advanced explanatory model of the mechanisms of glucose absorption and metabolism after a meal. The rice curve in the figure shows its highest rise during minutes 20–40, a period that generally coincides with the highest rates of gastric emptying and absorption of rapidly digestible carbohydrates. This aligns with the scientific classification of rice as a high-glycemic index food due to its low fiber content and its starch structure, which relies on a high proportion of rapidly hydrolyzed amylopectin, as confirmed by international glycemic index tables (Atkinson et al. 2021). This composition leads to rapid glucose transfer into the bloodstream, resulting in a clear peak, as illustrated in the figure, especially with a hefty dose of 300 grams of rice (Özdemir, 2020). This increases the overall glycemic load resulting from the meal, as outlined in the study design.

Evaluation of Blood Glucose Rates

Bulgur, as shown in Figure 3, exhibits a slower rise and a lower peak than rice. This is due to the whole-grain structure of bulgur, which retains a large portion of the bran and cell walls, thus limiting the rate of starch digestion and slowing glucose release in the intestines. Additionally, bulgur contains soluble fiber, which contributes to a gel-like structure that reduces the rate of sugar absorption. Recent research indicates that cereal foods with a complex granular structure, such as bulgur, are associated with more stable glycemic curves and do not cause sharp spikes in blood glucose. Instead, they contribute to a lower peak and a longer absorption time (Tekin-Çakmak et al., 2024). This pattern is clearly illustrated in the figure, where the bulgur curve rises slowly and then gradually declines without a sharp drop (Gajski, 2019).

The three plant extracts (fenugreek, coriander, and cinnamon) exhibit low-peak, low-fluctuation curves, reflecting their biochemical properties. The fenugreek curve in Figure 3 shows the lowest post-meal rise. It remains close to the baseline, indicating that fenugreek compounds, particularly the viscous fiber galactomannan, can effectively slow absorption. Furthermore, 4-hydroxyisoleucine enhances cellular insulin sensitivity, thereby reducing the sharp rise in blood glucose, a finding confirmed by recent meta-analyses (Vajdi et al, 2024).

The cinnamon curve in the figure also exhibits a moderate rise with a low peak, due to cinnamon's phenolic compounds, which improve insulin sensitivity and slow gastric motility, thereby reducing the rate at which glucose enters the bloodstream. Recent studies have supported this pattern of effect, indicating that cinnamon reduces post-meal spikes (Zarezadeh et al, 2023). The coriander curve, as shown in the figure, exhibits a limited rise and a rapid return to baseline, consistent with recent scientific reports on the effects of coriander phenolic compounds, which inhibit oxidative stress and help regulate glucose (Scandar et al, 2023).

The similarity of the three curves suggests that the plant extracts act through similar mechanisms, most notably: slowing starch absorption, inhibiting certain carbohydrate-digesting enzymes, improving cellular insulin sensitivity, and reducing the rapid rise in glucose.

A general comparison of Figure 3 reveals the following sequence of glycemic response: rice > bulgur > coriander ≈ cinnamon > fenugreek. This logical sequence aligns with the glycemic index, biochemical data, and composition of each substance. Thus, Figure 3 transforms from a mere graph into a dynamic representation of food's ability to alter the metabolic environment immediately after a meal, clearly demonstrating that dietary modification—rather than pharmacological intervention—is the primary key to controlling blood sugar levels in healthy young adults (Bigdelu, 2023).

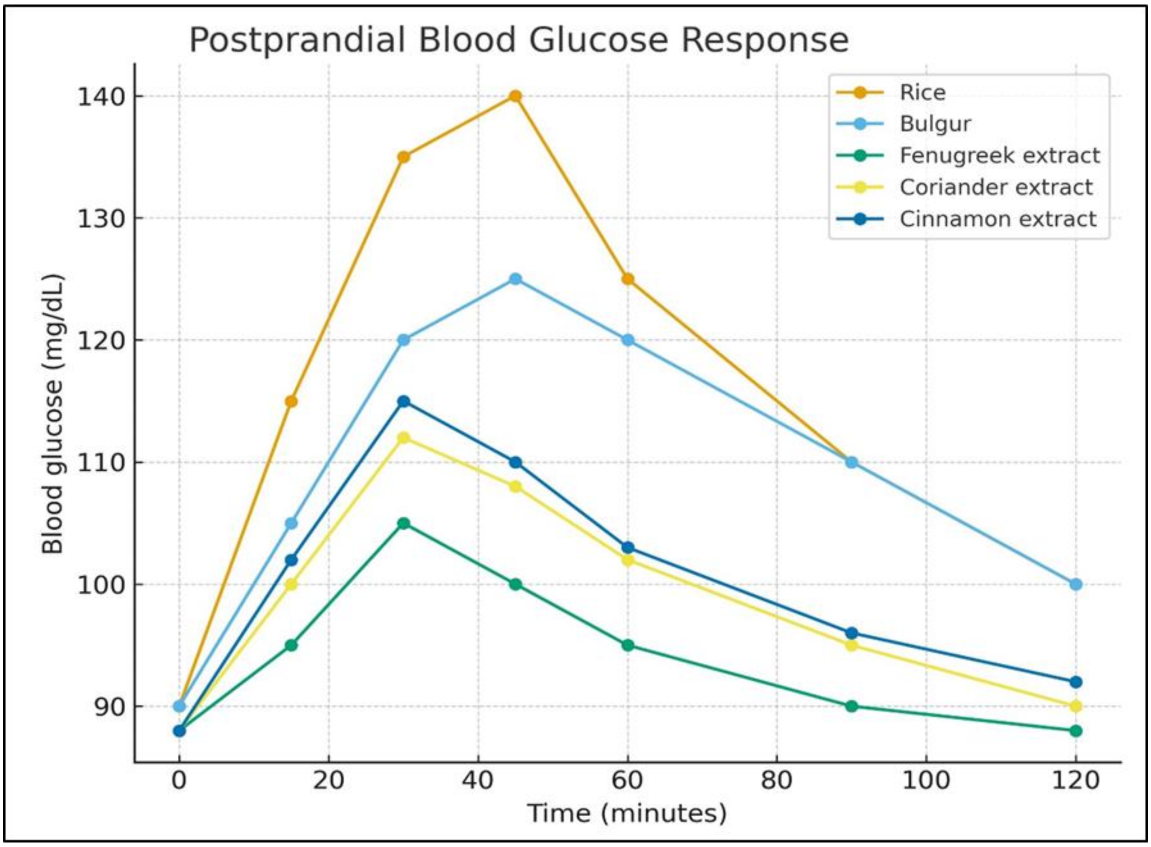

Figure 2. Effect of foods and extracts on the glycemic response of healthy young adults

The curves shown in Figure 2 are clearly consistent with recent scientific evidence from 2020 to 2025 on the properties of starchy foods and plant extracts for controlling glycemic response. For example, meta-analyses indicate that fenugreek has a proven effect on reducing fasting glucose and the post-meal rise, in addition to improving insulin sensitivity through specific compounds such as 4-hydroxyisoleucine and by activating insulin receptors (Shabil et al, 2023) (Vajdi et al, 2024). This evidence shows that fenugreek is one of the most potent herbs capable of modulating the response immediately, which accurately explains the low peak in the fenugreek curve shown in Figure 2.

Regarding cinnamon, comprehensive meta-analyses show that supplementation lowers HbA1c, fasting glucose, and postprandial glucose by improving insulin sensitivity and inhibiting intestinal α-glucosidase activity (Zarezadeh et al, 2023) (Moridpour et al, 2024). These results are consistent with the cinnamon curve shown in Figure 2, which exhibits a limited rise and a rapid return to normal values, compared with those of rice and bulgur.

As for coriander, recent studies (Scandar et al, 2023) (Nouioura et al, 2024) have highlighted the roles of phenolic compounds and terpenes in glucose regulation by enhancing antioxidant activity, reducing oxidative stress associated with sharp blood glucose spikes, and improving hepatobiliary balance during glucose responses. These mechanisms are directly reflected in Figure 2, where the coriander curve exhibits a low rise and remarkable stability.

On the other hand, post-2022 studies on cereals have shown that bulgur—as a complete grain food—has a lower glycemic index than white rice due to its grain structure, high bran content, and high fiber content, resulting in slower digestion and absorption (Tekin-Çakmak et al, 2024). This confirms the difference in the curve between bulgur and rice in Figure 2, where the bulgur curve tends toward a moderate pattern without any sharp spikes.

Recent research on refined white rice (Chu et al, 2025) indicates that it elicits a rapid, sharp glycemic response due to rapid starch breakdown and low digestive resistance. The contribution of this factor is clearly shown in the figure, as rice alone exhibits the highest peak among all the tested materials.

Thus, interpreting Figure 2 in light of modern scientific evidence shows that the difference in curves is not only a result of variation in the type of food, but also a result of a complex interaction between the glycemic index, starch composition, fiber content, and bioactive plant compounds, making the figure a direct reflection of physiological mechanisms documented in contemporary studies, and reinforcing the importance of choosing the type of food to reduce glucose fluctuations in healthy individuals.

Conclusion

The analysis of glycemic responses following intake of rice, bulgur, fenugreek extract, cinnamon extract, and coriander extract revealed distinct differences in postprandial glucose patterns over the 120-minute monitoring period. Rice induced the highest and fastest rise in blood glucose, reflecting the metabolic impact of high-glycemic, rapidly digestible starches. In contrast, bulgur and the three plant extracts produced more moderate and stable responses, characterized by lower peaks and smoother returns toward baseline. These findings highlight the role of fiber content, grain structure, and bioactive plant compounds in delaying glucose absorption and improving insulin-related responses.

Recommendation

Based on these outcomes, it is advisable to prioritize whole-grain options, such as bulgur, over refined rice to minimize sharp postprandial glucose elevations. Incorporating naturally occurring plant sources rich in fenugreek, cinnamon, and coriander or their standardized extracts may further support glucose stability through their functional metabolic effects. Implementing such dietary strategies can enhance metabolic resilience in healthy young adults and contribute to long-term prevention of glucose-related metabolic disruptions.

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