

Glycemic Index of Wheat and Rice are Similar When Consumed as Part of a North Indian Mixed Meal

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Abstract

Introduction: Wheat is preferable over rice due to its lower glycemic index (GI). It is not known if the same is true when these staples are a part of mixed meals, hence we compared the Glycemic responses of wheat/rice containing mixed meals. **Materials and Methods:** Glycemic responses of 2 mixed meals were compared with reference meal (glucose) where each was designed to provide a total of 50 g of available carbohydrate (AvCHO), in 10 healthy adult volunteers as per recent recommendations. Test meal 1 comprised of a pulse preparation (green gram *dal*), a vegetable (ladies' finger), and 2 wheat *chapattis*. In test meal 2 these wheat *chapattis* were replaced by cooked rice supplying an equal amount of AvCHO. After an overnight fast of 10- 14 h, capillary blood glucose estimations were done subsequent to eating each test meal or glucose. GI of test meals was calculated by comparing their area under curve (AUCs) with AUC for glucose. GI of test meals were compared using unpaired *t* test. **Results:** The study sample comprised of 7 males and 3 females with mean age 30.9 ± 5.1 y. The GI of test meal 1 ($85.5 \pm 11.8\%$) and test meal 2 ($83.6 \pm 11.4\%$) was not significantly different ($P = 0.7095$). **Conclusion:** The present study found no differences in glycemic index of wheat *chapatti* and rice based mixed meals with equivalent AvCHO content of the staple.

Keywords: Available carbohydrate, diabetes, glycemic index, mixed meal, rice, wheat

INTRODUCTION

Glycemic index (GI) classifies sources of carbohydrates (CHOs) according to their effect on postprandial glycemia.^[1] Therefore, recommendations based on GI rather than CHO content alone are considered more rational and low GI foods are preferred in diabetic patients. However, some recent recommendations have advised against the use of GI in dietary management of diabetes as the GI of individual foods are not maintained in mixed meals.^[2] Also, no study has shown long-term benefit of low-GI foods among diabetic patients.^[3-5]

It has also emerged that AvCHO content of foods should form the basis of determining their GI rather than total CHO content as has been practiced in the earlier studies which has resulted in an overestimation of CHO content in foods.^[6] There has been a preference for advising consumption of wheat over rice for a diabetic patient owing to its lower GI.^[7]

A strong association between deleterious effect of white rice consumption and type 2 diabetes mellitus (T2 DM) has also been reported from India.^[8,9]

However, a diet prescription only advising wheat products not only limits choice of cereal consumption for diabetics, but also affects compliance of those who have been brought up consuming rice traditionally as a staple. Although it is widely known that GI of wheat is lower than that of rice, there are no studies which analyzed GI in these cereals based on AvCHO content, to the best of our knowledge. The glycemic responses that wheat *chapattis*/cooked rice elicit as part of mixed meal may not reflect their GI determined when they were consumed alone. The present study was therefore undertaken to investigate glycemic responses of North Indian mixed meals having wheat or rice as a cereal staple and supplying the same amount of AvCHO, to see if there was any difference in GI of both the mixed meals.

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MATERIALS AND METHODS

Study design

Selection and description of participants

Study sample comprised of 10 healthy adult male and female volunteers. They were recruited from among the staff working in Guru Teg Bahadur Hospital, New Delhi, and attendants of patients attending the endocrine O.P.D. The study was reviewed by the institutional ethics committee. There were 7 males and 3 females (mean age 30.9 ± 5.08 y) who were all working in public sector. Their educational status ranged from high school to post graduation with one of them being educated till secondary level. The mean body mass index was 25.82 ± 1.6 kg/m², and their fasting and post prandial blood glucose levels were 90.1 ± 6.01 mg/dL and 109.2 ± 34.46 mg/dL respectively. Glycemic responses of two test mixed meals were compared with reference meal (glucose) each designed to provide a total of 50 g of AvCHO [Figure 1].

AvCHO was calculated using values from the Recommended Dietary Allowances (RDA)(Indian Council of Medical Research) for different foods, where:

Available carbohydrate (AvCHO) = 100 g of food - [moisture + Protein + Fat + Minerals + Total dietary fiber].^[10]

After calculation of AvCHOs in the reference meal and test meals, the portion sizes of different food components of these meals were determined and administered to the volunteers. The volunteers were instructed that an evening before taking any test or reference meal they should consume a home-cooked meal habitually being consumed by them in dinner and repeat that meal at dinner-time before each test day subsequently. They were asked to avoid any unusual vigorous physical activity before administration of the meals. The subject reported after an overnight fast of 10-14 hours to Centre for diabetes, Endocrinology and Metabolism, Guru Teg Bahadur Hospital, Delhi, where he/she was administered either the reference or the test meal and their blood sampling was done at

specific time points. On day 1, the reference meal 1 comprising of glucose (55.55 g equivalent to 50 g AvCHO) was given along with 250 mL water. After a gap of 2 days to allow for the washout period, test meal 1 was administered on day 4, which comprised of the vegetable preparation (ladies' fingers), a pulse preparation (green gram *dal*) and 2 wheat chapattis. The ladies' fingers vegetable preparation contained ladies' fingers and onion along with oil [Table 1]. The pulse preparation contained green gram *dal*, garlic and ginger. These amounts of vegetables and pulse along with the cereal (wheat or rice) were calculated in a manner so that they together amount to 50 g of AvCHO as a mixed meal.^[10] Another gap of 2 days was observed after which, on day 7, test meal 2 was administered, wherein the 2 wheat chapattis of test meal 1 were replaced by a specific quantity of rice supplying an equal amount of AvCHOs as that of 2 wheat chapattis, keeping the vegetable preparation (ladies' fingers) and a pulse preparation (green gram *dal*) same as that of test meal 1. After allowing another washout period of 2 days, on day 10, the reference meal 2 (glucose) administration was repeated. Capillary Blood Sampling of subjects was done at fasting (0 min) and at 15, 30, 45, 60, 90 and 120 minutes after starting to eat the test or reference meal and capillary blood glucose was estimated by a glucometer.

Statistics

GI of test meals were calculated by comparing their areas under curve (AUCs) with AUC for glucose. For calculating the GI, the mean of the ratios method was used wherein, a ratio of an individual subject's AUC after consuming the test food (f) and AUC for the same subject after consuming the reference food (r) is calculated. For calculating the GI of the meals as well as for the purpose of data representation, mean of the ratios method is used which is more advantageous over the ratio of the means method where ratio of the mean of AUC for all subjects after consuming test meal and the mean of AUC for all subjects after consuming the reference meal is calculated.^[11] GI of the test meals were compared using unpaired *t* test and a significant difference between the groups was considered if the *P* value was <0.05. The methodology for the study was planned taking into consideration the recommendations made by Brouns *et al.*, who discussed in their review about the most relevant methodological considerations and gave specific recommendations regarding number of subjects that may be enrolled, gender of the subjects, subject status, inclusion and exclusion criteria, pre-test conditions, CHO test dose, blood sampling procedures, sampling times, test randomization and calculation of glycemic response area under the curve, in order to achieve high quality results for measurement of GI.^[6] All of these attributes of the methodology were followed to design our study to implement measurement of GI and help to ensure quality of results.^[6]

RESULTS

There were a total of 7 males and 3 females in the study sample with mean age of 30.9 ± 5.08 years, with a mean body mass index of 25.52 ± 2.53 kg/m². The glycemic

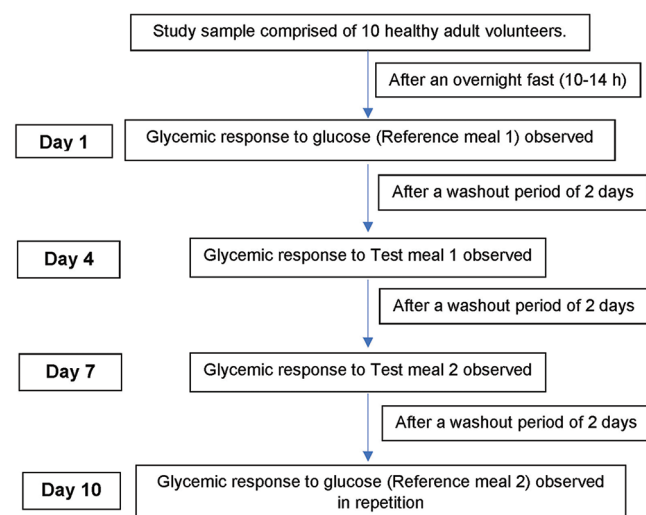


Figure 1: The flow chart of the study

index of test meal 1 (mixed meal with wheat) was found to be $85.527 \pm 11.75\%$ and that of test meal 2 (mixed meal with rice) was $83.57 \pm 11.40\%$, and both were not found to be significantly different ($P = 0.7095$) using unpaired *t* test. The mean area under the curve for reference and test meals is shown in Figure 2 where it indicates no significant difference between the reference and test meals.

The same was observed when the mean peak blood glucose values reached [Figure 3] were compared along with the time that was taken to reach these mean peak blood glucose values for the reference and test meals. The highest mean peak blood glucose reached was for the reference meal (168.5 ± 34.96 mg/dL) at 34.5 ± 34.9 min, followed by test meal 2 (133.3 ± 10.78 mg/dL) at 40.5 ± 7.25 min and the test meal 1 (126.5 ± 11.69 mg/dL) at 57 ± 27.2 min.

Thus, in the present study, GI of the mixed meal with wheat ($85.527 \pm 11.7481\%$) was not significantly different ($P = 0.7095$) than that of rice ($83.5673 \pm 11.4012\%$).

DISCUSSION

The present study found that the glycemic index of the mixed meals with *chapattis* made from wheat and that with rice were not significantly different. This indicates that when wheat and rice having same amount of AvCHOs are exchanged as a part of a mixed meal, glycemic indices of both the meals is similar. The results of this study have implications for dietary recommendations for patients with type-2 diabetes mellitus,

as they imply that rice may not aggravate hyperglycemia and will have similar glycemic response if it is exchanged for equivalent amount of AvCHO derived from wheat in a mixed meal. It can be suggested therefore that CHO exchange lists that take 15 g CHO as a unit for exchange of food items need to be revised in the light of the concept of AvCHO, and the amount of cereal (wheat or rice) reflected in the exchange list should contain 15 g of true “available” carbohydrate.

Our study has several strengths. Firstly, we used true “available” CHO instead of total CHO content for measurement of glycemic index. This is in accordance with the recent recommendation that the measurement of GI of test foods should be based on comparing equivalent amounts of true AvCHO.^[6] The earlier studies which were based on the total carbohydrate rather than on AvCHO may have led to overestimation in the case of products containing indigestible CHO and have thus attracted criticism.^[2,6] Secondly, our study was conducted strictly as per the recent recommendations from an international group of experts for carrying out studies on GI in humans.^[6] Thirdly, all the mixed meals were prepared by a single person using standardized predefined methods.

The findings of our study are in contrast to those of Foster-Powell *et al.*, who pointed out higher GI of rice than that of wheat.^[7] These authors mention that the mean GI values were 64 (SD 7) for white rice, 55 (5) for brown rice, 41 (3) for whole wheat, and 25 (1) for barley in a previous meta-analysis.^[7] The results of glycemic index (GI) studies around the world

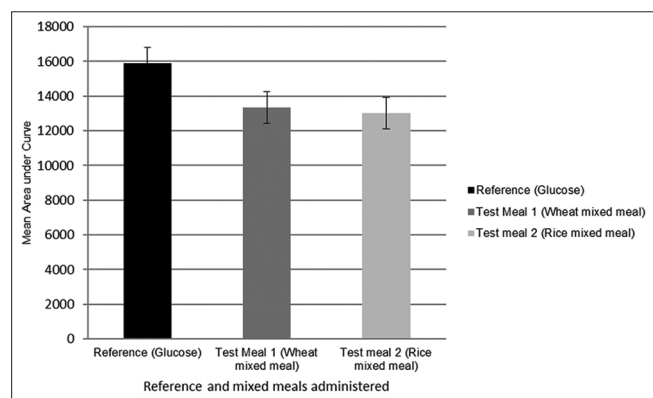


Figure 2: The mean area under curve for reference and test meals

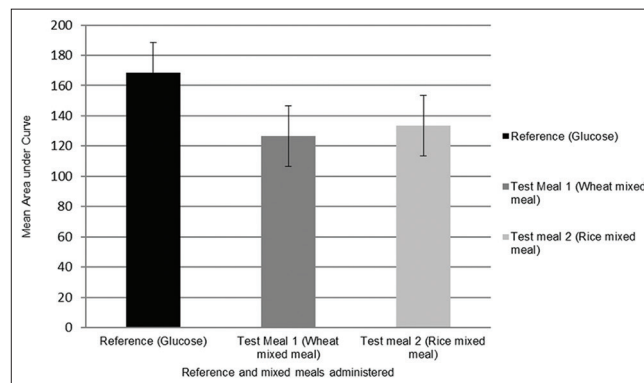


Figure 3: The mean peak blood glucose values reached for reference and test meals

Table 1: The available carbohydrate content of different food items present in the two test meals administered in the study

Food item in the North Indian mixed meal	Ingredients	Amount (g)	Available carbohydrate* (g)
Vegetable preparation (ladies’ fingers)	Ladies’ fingers	87.8	3.51
	Onion (big)	21.96	8.08
Pulse (<i>dal</i>) preparation (Green gram <i>dal</i>)	Green gram <i>dal</i>	21.96	11.529
	Garlic	2.196	0.55
	ginger	3.66	0.063
Wheat Chapattis preparation (2 in number)	Wheat flour	44.0	26.356
Rice preparation	Rice	35.47	26.356

*Available carbohydrate was calculated using values from the Recommended Dietary Allowances^[10] (Indian Council of Medical Research) for different food items

individually for rice, report values ranging from 64 to 93.^[12,13] Although the glycemic index value of a specific white rice variety depends on the processing, cooking time, and amylose content. The glycemic index values of white rice have also been reported to be higher on average than those of whole grains.^[7] In addition, white rice is the primary contributor to dietary glycemic load for populations that consume rice as a staple food.^[14,15] A recent study by Shobhana *et al.* found that GI of WR (white rice) (GI = 79.6) was significantly higher than BR (brown rice) (GI = 57.6) ($P < 0.01$).^[16] They concluded that any degree of polishing in rice leads to higher glycemic responses. Radhika *et al.* (CURES 57), showed that polished white rice consumption was significantly associated with insulin resistance and metabolic syndrome.^[9] It cannot be said with certainty from this study that the reported higher risk of type 2 DM with consumption of white polished rice is entirely or even partly attributable to their glycemic index as direct observation and calculation of diabetes risk on the basis of GI was not done. While it is possible that the higher GI of polished white rice contributes to the associated enhanced diabetes risk, it is also possible that this is attributable to loss of other protective factors after polishing. Systematic longer studied studies preferably intervention studies with careful measurements of GI are needed to reliably settle this issue.

In the food exchange lists, the quantity of cereal supplying 15 g carbohydrates is considered to be one carbohydrate exchange.^[17] According to these lists, 22 g of wheat and 19 g of rice are considered to be 1 carbohydrate exchange, each providing 15 g of carbohydrates.^[18] The AvCHO present in 22 g of wheat was calculated to be 13.17 g (equivalent to AvCHO present in 17.73 g of rice and not 19 g rice).^[10] This value of 13.17 g AvCHO is less than the standard value of 15 g which is taken as the basis of the carbohydrate exchange in the exchange lists used to plan the diabetic diets for patients. This needs to be revised considering the concept of AvCHO, and the amount of cereal (wheat or rice) reflected in the exchange list should contain 15 g of true AvCHO. Such a revision or modification would not only reflect correct amount of cereal in the exchange lists containing the standard value (15 g CHO) in terms of true AvCHO, but also equalize or match the GI effect when any two cereals (here wheat or rice) would be consumed interchangeably on the basis of equivalent AvCHO, as a part of mixed meal. Based on the findings of the study, the prevailing dietary recommendations of wheat based cereals such as *chapattis* in place of rice in meals of Indian patients need to be revised along with the carbohydrate exchange lists.

Our study has a few limitations. While the sample size of ten in this study is as per recommendations, a greater sample size could have added to the precision of the study. Secondly, our study compared only one type of mixed meal containing wheat *chapattis*/rice and testing other wheat/rice containing mixed meals could have further validated the differences between these two staples.

The present study found no differences in glycemic index of wheat *chapatti* and rice based mixed meals with equivalent AvCHO content of the staples. The recommendation that wheat *chapattis* should be preferred over rice in diabetic diets may need to be reviewed.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest

There are no conflicts of interest.

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