People consume food with different macronutrient composition and in variable quantities. The quality assessment of whole foods based on knowledge of their glycemic and insulinemic impact in relation to the consumption quantity will be an useful tool for appropriate selection by the people, with or without nutrition knowledge or by glucose intolerant group having insulin resistance or insulin deficient condition or by obese individuals. In the present study, 10 carbohydrate rich foods including bread (standard), were selected and standardized for their postprandial glycemic and insulinemic effect in terms of GI<sub>food</sub> value.

GI<sub>food</sub> values as glycemic response to specific quantity (e.g. 50g) of test foods, compared to that of same quantity of standard, expressed as the Relative Glycemic Impact (e.g. GBE/50g of food) and GI<sub>food</sub> values as percentage of effect of equal quantity of reference food, expressed as the Relative Glycemic Potency (i.e. GBE/100g of food), have been determined to elucidate the role of both the quality (type of sugar present, co-nutrients present, cooking and processing techniques) and quantity (different doses) of whole foods, as consumed by the individual in affecting the overall postprandial metabolic response. Postprandial effect of whole food is best assessed by this equi-quantity comparisons using GI<sub>food</sub> as against GI<sub>carb</sub>.

**Glycemic effect:**

**Wheat products- Chapatti, Thepla, Marie biscuit and Vada Pav:** The GBE for 50g of Chapatti (44 ± 34.5g), Vada Pav (43.8 ± 13.6g) and Marie biscuit (44 ± 30.9g) was found to be in similar range and much lower for Thepla (17 ± 6.4g).
With an increase in food load, the GBE value for all the food products increased, although not in mathematically proportional rate.

The food load related increase in glycemic AUC was found to be significantly high in most foods (p<0.05). However, with increase in food load from 50g to 100g, low fiber food such as Marie biscuit showed a very high glycemic response equivalent to that of 167g of bread, indicating need for monitoring the consumption quantity of these foods at one time. Similarly, despite having higher amounts of protein and fiber, 100g Chapatti, containing concentrated starch and higher total solids, induce more than double hyperglycemic effect (122 ± 25.9g) as compared to 50g dose. It shows that besides the quality and quantity of carbohydrate, the preparation method along with the co-nutrient present, plays an important role in affecting glycemic response, especially when consumed in a larger quantity.

The GI_{food} values are expressed in grams and hence may be used to calculate the approximate predicted glycemic response to varying food load and be useful in food exchange list. For e.g. to induce similar glycemic response we can replace a lesser number of Chapatti or Marie biscuit with larger quantity of Methi Thepla, especially useful when individuals with diabetes are under diet control and still feel hungry. Thepla provides a balanced food option with high amounts of fiber and protein in addition to some fat and this nutritional composition plays a role in tapering down the glycemic response.

The study results projects that 6 ½ slices of bread (100g) can be replaced by 2½ medium Chapattis or 4 cups of cooked Rice to induce similar glycemic response indicating that more
quantity of Rice can replace Chapattis in a mixed meal. Chapatti though made from whole wheat flour, a complex carbohydrate, needs to be consumed in smaller portions at one meal time (e.g. 2 small sized) due to higher starch content on wet weight basis.

**Rice, Rice Kheer and Puffed Rice:** Rice (11 ± 10.9g) and Rice Kheer (19 ± 13.2g) have shown to induce very low glycemic AUC, despite Rice having high GI and Rice Kheer being a sweet dish with higher GL. But present study shows that, even with increased dose, the total glycemic effect of these foods was found to be very low. This may be due to very high moisture content of these foods resulting in low density of the starch in specific amount of food.

On the other hand, Puffed Rice made from same Rice kernel, have found to induce a very high glycemic response, indicating that despite being a light porous snack with low moisture content, the quantity consumed at one time should be limited.

It is also worthwhile to note that all foods that are sweet in taste (e.g. sucrose-containing) may not always produce a high glycemic response. In fact, foods such as bread and Puffed Rice, which are non-sweet tasting foods, lead to higher postprandial glycemic effect as compared to Rice Kheer per serving size.

**Potato and Sago Khichdi:** Potato (32 ± 11.8g) and Sago Khichdi (26 ± 12.8g), being high moisture containing foods with moderate starch content (Potato- 16.4g%, Sago Khichdi-26.1g% starch on wet wt basis), have shown to induce moderate glycemic response at
different doses (50 and 100g). Due to their low protein and fiber content, addition of other co-ingredients when used as part of mixed meals may further attenuate their glycemic and insulin responses along with improving the nutritional value of the food.

Low amylose containing foods such as Rice and Potato are categorized as high GI food and were restricted in the diet for many. In fact, these foods have shown to induce much lower total glycemic effect for both 50 and 100g food load.

Products with higher volume: weight ratio such as Marie biscuit and Puffed Rice need to be consumed in smaller quantities to have lower glycemic effect. Being a snack item or accompaniment to tea, usually the quantity consumed at one time is always low. It is important to remember that one must not over-emphasize these foods in the diet just because they do not contribute apparent sweetness. These may be consumed along with high protein and fiber containing foods to promote slow release of sugars.

**GBE vs calorific value:** The comparison of GBE and calorific value of the selected foods showed that all high calorie foods did not necessarily induce higher glycemic response. Certain foods with high calorie content contributed by higher amounts of fat induced lower glycemic response and hence may be considered suitable for preventing postprandial hyperglycemia in individuals with glucose intolerant group. On the other hand, foods with high calorific value due to high fat content as well as high glycemic response may be considered detrimental to weight management due to postprandial lipogenesis.
Likewise, Rice and Potato having negligible fat content and low glycemic response may be less harmful for both obese as well as individuals with diabetes while Chapatti and Vada Pav having relatively high glycemic response and higher fat content need to be restricted in both the groups. Other foods containing higher amount of fat (e.g. Sago Khichdi, Rice Kheer and Thepla) may be unsuitable for obese group while foods producing higher glycemic response, even though having lower calorific value, (e.g. Puffed Rice) need to be restricted in the diet for glucose intolerant group. But, with food being either hyperglycemic or hyper-caloric in nature, the total quantity of food consumed in one meal holds key for dietary management of either obese or individuals with glucose intolerance.

**Insulin Effect:**

Among wheat products, the AUC insulin response to Marie biscuit (76 ± 56.6g) was highest, followed by Chapatti (39 ± 18.9g) and very low for Thepla (3 ± 1.3g) and Vada Pav (8.7 ± 2.5g). The insulin response to wheat products was found to be parallel to the glycemic response except when higher doses of Thepla and Vada Pav were fed (100g), their insulinemic AUC increased significantly compared to 50g (p<0.05). This could be attributed to the presence of legume flour, known for its insulin secretagogue response.

Also, refined carbohydrate containing bakery products such as bread (AUC for 50g = 1800; 100g = 3705) and Marie biscuit (AUC for 50g = 3000; 100g = 5700) have shown to produce disproportionately high insulinergic effect compared to glycemic response curve.
Rice products such as Puffed Rice (51 ± 24.1g) produced a significantly high insulinergetic effect compared to Rice Kheer (19 ± 10.5g) and Rice (3.5 ± 2.5g) (p<0.05) at 50g dose. The insulin AUC for 100g of Rice Kheer was much higher than that of its glycemic response which can be attributed to the insulinotropic effects of milk proteins and presence of simple sugar and needs further investigation.

Starchy products such as 50g of Potato (9 ± 6.6g) and Sago Khichdi (11 ± 5.8g) showed a moderate insulin response which increased with an increase in food load to 100g.

Insulin response has shown to be more sensitive to dose as compared to glycemic response, as observed in 50g and 100g response curve of all foods (p<0.05). The independent role of insulin secretory response to specific components such as simple sugar, protein and fiber in foods needs to be studied, especially in the insulin resistant or insulin deficient group.