

BLOOD GLUCOSE RESPONSES TO THREE INDIGENOUS PAKISTANI VEGETABLES VIZ RED GOURD, WHITE GOURD AND ROUND CUCUMBER IN NORMAL AND DIABETIC HUMAN SUBJECTS

Muhammad Shoaib Akhtar¹, Kausar Almas² & Rehana Akhtar

¹Departments of Physiology & Pharmacology, ²Rural Home Economics, University of Agriculture, Faisalabad

The glycaemic responses of local Pakistani vegetables including Halwa-Kaddu (*Cucurabita maxima*), Ghiya-Kaddu (*Lagenaria siceraria*) and Tinda (*Citru//us vulgaris unitelicize jistulosus*), incorporated into the mixed meals and served with chapatti, as traditionally eaten in the country, were studied in 8 normal and 8 type 2 diabetic subjects. The subjects were given a 50 g carbohydrate portion of different test meals in random order after an over-night fast. Taking the response of chapatti plus egg as 100%, the relative glycaemic responses of the meal containing Halwa-Kaddu, Ghiya-Kaddu and Tinda, respectively were 79 ± 7 , 62 ± 5 and 57 ± 6 % in the normal and 68 ± 5 , 46 ± 5 and 32 ± 4 % in the diabetic subjects. The difference in response from chapatti plus egg was statistically significant for Halwa-Kaddu, Ghiya-Kaddu and Tinda in both the groups of subjects. Therefore, it was concluded that these indigenous Pakistani vegetable meals may be used in the dietary management of diabetes.

Key words: Glycaemic response, Pakistani vegetable meals, Type 2 diabetes mellitus.

INTRODUCTION

Numerous studies have shown that postprandial plasma glucose and insulin responses are influenced by both the amount of carbohydrate consumed and their source (Gannon et al., 1989; Rasmussen et al., 1993; Wolever & Bolognesi, 1996). Effect of the source of carbohydrate on blood glucose responses is indicated by the glycaemic index. Eating food with a low glycaemic index can help people with diabetes to improve metabolic control. For example, Brand et al. (1992) compared low and high glycaemic index diets in the management of diabetes and reported that the low glycaemic index diet improved the overall glycaemic control.

Adequate consumption of vegetables is advised because they are a source of vitamins and minerals, which contribute towards a well-balanced diet. In addition, incidence of ulcerative colitis is inversely related to the amount of vegetable consumed (Palmer & Bakshi, 1983). Also, some factors in vegetables including dietary fibre, protein and antinutrients such as lectins, polyphenol and saponin may contribute toward low glycaemic responses (Wolever et al., 1988). Mani et al. (1992) determined the glycaemic index of conventional Indian foods incorporated into mixed test meals of the type traditionally eaten in that country. In Pakistan, certain unique vegetables are used very frequently. However, studies on vegetable local vegetable dishes commonly consumed in Pakistan have not been carried out. Only Akhtar et al. (2000) have previously determined that Sagh, Phool ghobi, Band ghobi and Methi vegetable meals may be of use in the dietary management of diabetes. Therefore, in this study relative glycaemic responses of common

Pakistani vegetable meals (Halwa Kaddu, Ghiya Kaddu, Tinda) have been determined in both normal and diabetic subjects.

MATERIALS AND METHODS

A group of 8 normal weight subjects with type 2 diabetes were recruited from the local inhabitants of Faisalabad (Punjab). Some were treated with an oral hypoglycaemic agent while others were on diet alone. Another group of 8 normal volunteers were also recruited from the local inhabitants. The sex, age, height, weight and body mass index of subjects are listed in Table 1. Diabetes duration and treatment of the diabetic subjects are given in Table 2. Volunteers came to the laboratory at weekly intervals in the morning after 12-14 h overnight fasts. After a fasting blood sample was obtained, the volunteers were served one of the different test meals containing 50 g available carbohydrate and asked to consume it within 20 minutes. Oral hypoglycaemic agents were given immediately before taking the meal. The order of test meals was randomized.

The test meals included wholewheat and flat baked chapatis prepared fresh daily from a specific flour by the traditional method using a hot metallic plate heated on a gas burner. Chapati served with an egg fried in Season's canola oil was used as the control meal. The other test meals consisted of the following vegetable dishes served with chapati. Halwa-kaddu (*Cucurbita maxima*), Ghiya-kaddu (*Lagenaria siceraria*) and Tinda (*Citru//us vulgaris unitelicize fistulosus*). Test vegetables were purchased from the local vegetable market of Faisalabad and cooked using indig-

enous and original recipes given in the appendix. Cooked vegetables were cooled and stored at -30°C in a deep freezer until use when they were reheated in a microwave oven just before serving. Test meals were analyzed for moisture, protein, fat, ash and dietary fibre using standard methods (AOAC, 1990) and results are presented in Table 3. Soluble carbohydrates were determined by the method of Dubois et al. (1956). A 100 g of each sample was blended with 100 ml distilled water to form homogeneous slurry. Five mL of slurry was centrifuged and to 0.1 ml of the supernatant was added to 1 ml of 0.25N H_2SO_4 , 1 mL 0.85 % aqueous phenol and 5 mL of concentrated $\sim\text{SO}$. The intensity of the resulting orange yellow colour was measured at 490 nm using a spectrophotometer, with the concentration of soluble carbohydrates in the sample determined from a standard curve using glucose solutions of known concentration.

Finger prick capillary blood samples were obtained at 0 min (fasting) and at 30, 60, 90, 120, 150 and 180 min in diabetic subjects and at 15, 30, 45, 60, 90 and 120 min in normal subjects. Blood glucose was measured by glucometer (Glycotronic(R)-C, Macherey-Nagel, Germany). Incremental areas under the blood glucose response curves (JAUC) were calculated using the method described by the FAO/WHO (1997) and Wolever et al. (1991). The IAUC after each test meal was expressed as a percentage of the IAUC after chapati above egg meal taken by the same object and the resulting values averaged to give the relative glycaemic response. Results are expressed as means \pm SEM (standard of error of mean). Blood glucose responses at different intervals and IAUC values were subjected to analysis of variance using MSTATC computer programme. After demonstration of significant heterogeneity, the significance of differences between means were determined using the DMR (Duncan Multiple Range) test to adjust for multiple comparisons (Steel and Torrie, 1984).

RESULTS AND DISCUSSION

Normal Subjects: Fasting blood glucose was similar before each test meal (Table 4). There was highly significant heterogeneity between the IAUC of the 4 test meals in normal subjects ($F=4.68$). The IAUCs after Halwa-kaddu, Ghiya-kaddu and Tinda were significantly less than that after the control meal (chapati plus egg, Table 4). The responses of the 3 vegetable dishes, expressed as a percentage of the control response, are as follows: Halwa-kaddu $79.3\pm7\%$, Ghiya-kaddu $62.3\pm7\%$ and Tinda $57.2\pm6\%$.

Diabetic Subjects: Fasting blood glucose in diabetic individuals was similar before each test meal (Table 4). There were highly significant differences between the test meals ($F=27.29$). The mean IAUCs after Halwa-kaddu, Ghiya-kaddu and Tinda were significantly less than that after

control meal. The relative glycaemic responses of Halwa-kaddu ($68.7\pm5\%$), Ghiya-kaddu ($46.7\pm5\%$) and Tinda ($32.8\pm4\%$) were significantly less than 100%. There was highly significant relationship between the relative glycaemic responses of the 4 test meals in normal and diabetic subjects.

The results of the present study have shown that these indigenous Pakistani vegetable meals have significantly different effects on the blood glucose responses of normal and NIDDM subjects. This suggests that these vegetables are valuable in lowering the blood glucose. These vegetable dishes are usually eaten and liked in rural areas of Pakistan, a population at lower risk of diabetes (Walker and Walker, 1984). In the test meals consumed the difference between glycaemic responses of both the groups of normal and diabetic subjects are similar. As far as ascertained the glycaemic responses of meals containing these vegetables have not been determined before. The mean incremental area under the blood glucose response curve of both normal and diabetic subjects showed highly significant differences.

The vegetable dishes contain amounts of added vegetable oil, so in control meal, i.e. chapati and fried egg, the same vegetable oil was used to make the comparison more reliable. The effect of varying amounts of fat and protein in normal mixed meals containing starchy food may be different from those in which the test carbohydrate was glucose. The effect of adding 25 g protein or fat to a meal already containing some protein and fat may be less than those observed if protein and fat was added to glucose (Wolever and Bolognesi, 1996). A high amount of fat in test meal may alter gastric emptying time and trend to flatten the glycaemic response curve but this high amount of fat was also present in the control diet. In comparison with control, decrease in the glycaemic and IAUC of Halwa kaddu, Ghiya kaddu and Tinda were found to be highly significant. The factors in vegetables which contributed toward lower glycaemic responses by slowing the absorption of carbohydrates or inhibiting its digestion included dietary fibre (Toma et al., 1988, Abrard et al., 1995), protein (Nuttall et al., 1984) and antinutrients such as lectins, polyphenols and saponins (Wolever et al., 1988).

After feeding the Tinda dish, the very first blood glucose value in both normal and diabetic subjects fell significantly below the fasting blood glucose value. This may be due to some antinutrients, such as lectins, polyphenol and saponins present in Tinda dish (Wolever, et al., 1988), which may have contributed towards these very low glycaemic responses. However, Halwa kaddu and Ghiya kaddu also showed low blood glucose responses. Thus making available some unavailable carbohydrates using meals as a variable

showed highly significant differences of Halwa kaddu, Ghiya kaddu and Tinda, whereas control meal was non-significant.

The relative glycaemic responses of Halwa kaddu, Ghiya kaddu and Tinda were roughly 79, 62 and 57, respectively in normal subjects, whereas the values were about 68, 46 and 32 in diabetic subjects. It has been suggested that the knowledge of glycaemic responses of foods may be useful in rationalizing diabetes diet therapy or in interpreting the results of dietary interventions (Jenkins

et al., 1988; Gannon et al., 1989). To facilitate this, the glycaemic responses of foods have been classified using the glycaemic index, GI (Jenkins et al., 1988). To assess the glycaemic effect of an entire diet using GI, the GI value of energy food found in the diet must be known (Wolever et al., 1991), so that glycaemic responses of several other vegetable meals are useful in planning diet for diabetics, especially Tinda and Ghiya kaddu. Further research is needed to determine hypoglycaemic factor(s) in these vegetables and insulin and glucose responses of several other indigenous meals.

Table 1. Sex, age, height, weight and body mass index (BMI) of subjects

	Age (year)	Height (cm)	Weight (kg)	MI (kg/m ²)
Normal subjects	24.7±1.2	164.1±3.0	60.1±3.3	22.3±W.3
Diabetic subjects	50.8±1.9	164.4±3.1	66.1±2.5	24.4±0.5

Table 2. History and treatment of diabetic volunteers

Subject	Diabetic duration (year)	Treatment
1	3	Diet alone
2	5	Tab. Diabetonc (R)
3	3	Diet alone
4	2	Diet alone
5	4	Diet alone
6	8	Tab. Dioneil (R)
7	10	Tab. Dioneil (R)
8	6	Tab. Glucophage (R)

Table 3. Composition of test meals fed to volunteers

Test meal	Name of food	Cooked weight (g)	Carbohydrate (g)	Protein (g)	Fat (g)	Crude fibre
Control	Chapati	115.6	50.0	12.6	1.1	2.33
	Fried egg	45.0	0.3	6.8	2.7	
Total			50.33	19.4	3.8	
Halwakaddu	Halwakaddu	228.9	25	10.0	28.1	102
	Chapati	57.8	25	6.3	0.5	1.1
Total			50.0	16.3	28.6	11.3
Ghiyakaddu	Ghiyakaddu	3499.6	25	15.4	44.0	17.8
	Chapati	57.8	25	6.3	0.5	1.1
Total			50.0	21.7	44.5	18.9
Tinda	Tinda	281.2	25	9.2	30.8	16.9
	Chapati	57.8	25	6.3	0.5	1.1
Total			50.0	15.5	31.3	18.0

Table 4. Fasting glucose (FG) incremental area under the curve (IAUC) and relative glycaemic response (RGR)

Normal subjects	Control	Halwakaddu	Ghiyakaddu	-Tinda
Fasting glucose (mg/dl)	86.7± 1.5	86.7± 3.2	89.2± 2.4	91.2 ± 1.9
JAUC (mg/min/dl)	2248.5 ± 184.7	1853.7±259.7*	1389.5 ± 164.1**	1297.2± 194.0**
RGR(%)	100	79.3 ± 7.8*	62.3 ± 5.7**	57.2± 6.5**
Diabetic subjects				
Fasting glucose (mg/dl)	122.6± 2.8	126.6± 3.5	139.5± 5.0	125.2± 5.0
JAUC (mg/min/dl)	4523.5 ± 246.7	3146.9 ± 342.7	2053.4± 211.10**	1485.4 ± 198.9**
RGR(%)	100	68.7± 5.0*	46.7± 5.6**	32.8± 4.1**

dl = mg/dilution

* = (P>0.05) Significant

** = (P>0.001) Highly significant

NS = (P<0.05) Non-significant

REFERENCES

- Ahmad, I., S.M. Afzal, M. Jabeen, S.A. Siddiqui and Fayyaz-Din. 1995. The effect of guar gum on glucose tolerance, serum insulin and lipid levels in non-insulin dependent diabetics. *Pak. J. Med. Res.* 34: 82-87.
- Akhtar, M.S., T. Kauser, K. Almas and T.M.S. Wolever. 2000. Blood glucose responses to traditional Pakistani vegetable dishes in normal and diabetic subjects. *Int. J. Food Sci. Nutr.* (Submitted).
- AOAC. 1990. *Official Methods of Analysis*. The Assoc. Analyt. Chemists, Arlington, Virginia, USA
- Brand, I.C., S. Colagiuri, S. Crossman and AS. Truswell. 1992. Comparison of low and high glycaemic index diets in the management of diabetes. *Proc. Nutr. Soc. Australia*. 13: 150 ?
- Dubois, K., K.A. Gillies, J.K. Hamilton, P.A. Roberts and F. Smith. 1956. Colourimetric method for the determination of sugars and related substances. *Anal. Chem.* 28: 350 ?
- FAO/WHO. 1997. *Carbohydrates in Human Nutrition*. FAO/WHO Joint Expert Consultation Report, FAO, Rome.
- Gannon, M.C., F.Q. Nuttall, S.A. Westphal, B.L. Neil and E.R. Seaquist. 1989. Effects of dose of ingested glucose on plasma metabolite and hormone responses in Type 2 diabetic subjects. *Diabetes Care*. 12: 544-552.
- Jenkins D.J.A., T.M.S. Wolever, G. Buckley, K.Y. Lam, S. Guidici, I. Kalmsky, A.L. Jenkins, R.L. Patten, J. Bird, G.S. Wong and R.G. Josse. 1988. Low glycaemic index starchy foods in the diabetic diet. *Am. J. Clin. Nutr.* 48: 248-254.
- Mani, U.V., S.N. Pradhan, C. Mehta, C.M. Thakur, U. Iyer, I. Mani. 1992. Glycaemic index of conventional carbohydrate meals. *Brit. J. Nutr.* 68: 445-450.
- Nuttall, F.Q., AD. Mooradian, M.C. Gannon, C. Billington and P. Kozowski. 1984. Effect of protein digestion on the glucose and insulin response to a standardized oral glucose load. *Diabetes Care*. 7: 465-470.
- Palmer, S. and K. Bakshi. 1983. Diet, nutrition and cancer: Interim guidelines. *J. Natl. Cancer Inst.* 70: 1151-1170.
- Rasmussen, O., E. Wmther and K. Hennansen. 1993. Glycaemic responses to different types of bread in insulin dependent diabetic subjects (IDDM): Studies at constant insulinaemia. *Eurp. J. Clin. Nutr.* 45: 79-103.
- Steel, R.F.D. and J.H. Torrie. 1984. *Principles and Procedures of Statistics*. McGraw Hill Inc., NY, USA.
- Toma, E.D., A. Clementi, M. Marcelli, M. Cappelloni and C. Lintas. 1988. Food fibre choices for diabetic diets. *Am. J. Clin. Nutr.* 47: 243-246.
- Walker, AR and B.F. Walker. 1984. Glycaemic index of South African foods determined in rural blacks: A population at low risk of diabetes. *Hum. Nutr. Clin. Nutr.* 38:215-222.
- Wolever, T.M.S., A.L. Jenkins, V. Vuksan, G.S. Wong, R.G. Josse and D.J.A. Jenkins. 1988. Effect of "extra" vegetable added to a starchy meal on blood glucose responses in patients with type 2 diabetes. *J. Cand. Diabetic Assoc.* 49: 168-171.
- Wolever, T.M.S., D.J.A. Jenkins, A.L. Jenkins and R.G. Josse. 1991. The glycaemic index: Methodology and clinical implications. *Am. J. Clin. Nutr.* 54: 846-854.
- Wolever, T.M.S. and C. Bolognesi. 1996. Prediction of glucose and insulin responses of normal subjects after consuming mixed meals varying in energy, proteins, fat,

Blood glucose responses to indigenous vegetables

carbohydrate and glycaemic index. J. Nutr. 126: 2807-2812.

APPENDIX

Recipes of vegetable dishes

1) Halwa kaddu (*Cucurabita maxima*)

<u>Ingredient</u>	<u>Quantity</u>
Halwa kaddu	8.5 kg (raw weight)
Onion	250 g
Garlic	150 g
Green Chillies	100 g
Ginger	150 g
Turmeric powder	1 tea-spoon
Coriander powder	1 tea-spoon
Red chilly powder	2 tea-spoon
Table salt	2 tea-spoon
Season's canola oil	250 g
Coriander	100 g
Spices	1 tea-spoon

Preparation Method: Peeled the Halwa kaddu with a sharp knife and finally cut into pieces. Then put hot oil in a pan and added chopped onions, garlic and ginger. When the onion was light brown, then added red chilly powder, sliced green chillies, salt, coriander powder, turmeric powder and spices. After 2 min, added Halwa kaddu and kept it heating for 45 min. Then sprinkled green coriander over it.

2) Ghiya kaddu (*Lagnaria siceraria*)

<u>Ingredient</u>	<u>Quantity</u>
Ghiya kaddu	9 kg (raw weight)
Onion	300 g
Garlic	160 g
Ginger	160 g
Coriander powder	2 tea-spoon
Coriander leaves	130 g
Red chilly powder	3 tea-spoon
Green Chillies	100 g
Spices	2 tea-spoon
Table Salt	3 tea-spoon
Season's canola oil	250 g
Turmeric powder	1 tea-spoon

Preparation Method: Heated the oil in pan and added sliced onion, chopped garlic and ginger, fried till golden brown colour and added sliced chillies, salt, red chilly powder, turmeric powder, coriander powder and spices. Then added the Ghiya kaddu and cooked it for 35 min. Finally sprinkled the coriander leaves.

3) Tinda (*Citrullus vulgaris unite/icize fistulosus*)

<u>Ingredient</u>	<u>Quantity</u>
Tinda	7.5 kg (raw weight)
Onion	150 g
Garlic	100 g
Ginger	150 g
Green Chillies	100 g
Red chilly powder	3 tea-spoon
Salt	3 tea-spoon
Spices	1 tea-spoon
Coriander powder	1 tea-spoon
Coriander leaves	130 g
Season's canola oil	250 g

Preparation Method: Peeled the Tinda with knife and cut into slices. Then washed in plenty of water. Heated the oil in a pan and added chopped onion, garlic and ginger. These were then fried till golden brown, then added sliced green chillies, salt, red chilly, turmeric and coriander powder and spices. Afterwards Tinda slices were added and cooked for 40 min on medium flame. Finally coriander leaves were sprinkled over it.