Glycaemic and insulin responses of diabetic patients to traditional Malaysian meals and the effect of guar gum

Bin AK Khalid PhD, FRACP, Lai-Fun Lee BSc, Abu Hassan Samad MRCP, Mee-Lian Ng* PhD

Departments of Medicine and Biochemistry Universiti Kebangsaan Malaysia, Kuala Lumpur, Malaysia.*

The aims of the project were to determine the glycaemic and insulin responses of non-insulin dependent diabetic patients (NIDDM) to 3 traditional Malaysian meals compared to oral glucose, and to determine whether guar gum would affect these responses. Patients with NIDDM were tested with 75 g oral glucose and three common breakfast meals of the three main ethnic groups of Malaysia. When compared with the oral glucose group, significantly by lower blood glucose responses were seen at 90 and 120 minutes post prandial for nasi lemak ($p<0.05$) and at 60, 75 and 90 minutes for mee sup ($p<0.05$). No significant difference was seen for roti telur. There was no significant difference in plasma glucose at any time point of the study when the three test meals were compared with each other. Addition of 5g granulated guar gum mixed with water taken prior to the glucose significantly lowered the plasma glucose at 60, 120 and 150 minutes postprandially ($p<0.05$). Similarly for the test meals, guar gum significantly lowered plasma glucose concentration between 15 and 45 minutes ($p<0.03$) postprandial for nasi lemak and between 15 and 30 minutes ($p<0.03$) for mee sup but not with roti telur. With addition of guar gum, there was no significant change of insulin responses with the three meals but a significant increase was seen at 30 minutes ($p<0.02$) after ingestion of glucose.

Key Words: Diabetes, nutrition, breakfast, Malaysian, guar gum, glycaemic index, insulin, sugar

Introduction

Guar gum is a form of dietary fibre which is obtained from endosperm of the Indian cluster bean, Cyamopsis tetragonoloba. It is used widely as an animal feed, in the food industry as a thickening and emulsifying agent and in pharmaceutical production as an additive to tablets. It was first suggested to have a possible role in the management of diabetes by Jenkins and colleagues[1] in 1976. Most[1-8] studies, but not all[9], showed a reduction of fasting blood glucose levels and/or glucose insulin responses to a test meal. These studies had been done on Western foods which were obviously different from Asian foods. Malaysia is a multiracial Asian country with a good variety of foods. Rice is the staple while dough/bread and noodles are also popular among the locals. In comparison to Western meals, in general, local Malaysian meals are higher in carbohydrate which is more unrefined.

In previous studies, guar gum has been administered as pre-meal aqueous drinks[5,10-14] or mixed into a food[14-15]. To our knowledge, no local Malaysian test meals have been evaluated with guar gum. The present study was designed to investigate the glycaemic and insulin responses of Malaysian diabetic patients taking the three common ethnic breakfast meals and to determine whether guar gum has any significant effect in altering these responses.

A common meal for Malays is nasi lemak, for Chinese mee sup, and for Indians roti telur. Nasi lemak consists of rice cooked in coconut milk with sambal ikan bilis (dried anchovies cooked in chili paste), fresh cucumber, fried groundnuts, fried dried anchovies and half of a hard boiled egg. Roti telur is a traditional Indian-style pancake fried with an egg served with dhal curry. Mee sup consists of noodles (mee), egg, cabbage, mustard leaves, tomato and sliced chicken meat. The compositions of the meals calculated from the food composition table[16] are shown in Table 1.

Table 1. Composition of test meals

Test Meal	Energy (kcal)	Energy (kJ)	Protein (g)	Fat (g)	Carbohydrate (g)
Nasi lemak	570	(2386)	31	29	45
Roti telur	525	(2198)	19	20	67
Mee sup	640	(2679)	20	24	85

Nasi lemak (Malay): Rice in coconut milk (160g), anchovies in chili (30g), fried anchovies (15g), cucumber (15g), groundnuts (15g), half-boiled egg (25g).
Roti telur (Indian): Fried pancake with an egg (165g), dhal curry (120g).
Mee sup (Chinese): Wheat noodles (180g), egg (50g) chicken (20g),cabbage (30g), mustard leaves (10g), tomato (30g).

Materials and methods

In the first part of the study, non-insulin dependent diabetes mellitus (NIDDM) volunteers were recruited from the Endocrine Clinic, Universiti Kebangsaan Malaysia. They were free from other major illness and were between 30 and 75 years of age. Eleven NIDDM (9 men, 2 women) of mean age ± standard deviation 43.5± 12.6 years and mean body mass index (BMI) of 25.2 ± 3.7 kg/m were studied.

After an overnight fast without taking the usual hypoglycaemic drugs, an indwelling catheter was inserted in an antecubital vein for collection of blood samples. An oral

Correspondence address: Professor BAK Khalid, Faculty of Medicine, Universiti Kebangsaan Malaysia, Jalan Raja Muda, 50300 Kuala Lumpur, Malaysia.
Tel: +603-298-3419 Fax: +603-291-8381
Email: kak@pksun5.medic.ukm.my

glucose tolerance test (OGTT) using 75g glucose diluted in a glass of water was performed. Two basal blood samples at -15 and 0 minutes were collected before the meal followed by blood samples taken 7.5, 15, 30, 45, 60, 75, 90, I20, 150 and 180 minutes after the meal. On the following day, 5g of granulated guar gum preparation (Guarem®, Finland) mixed in a cup of water was consumed immediately before the oral glucose load meal was given.

In the second part of the study, groups of 6 to 10 subjects from a pool of 12 NIDDM (9 men, 3 women) were recruited. They were of mean age 56.8 ± 13.3 years and of mean body mass index of 23.3 ± 2.9 kg/m^2. Six subjects completed all the three test meals. Three of the 12 NIDDM were treated with diet only, while nine were on sulphonylurea only or with metformin. The subjects were in fairly good diabetic control with fasting plasma glucose ranging from 5-12 mmol/l. The procedure used for the glucose tolerance test was repeated.

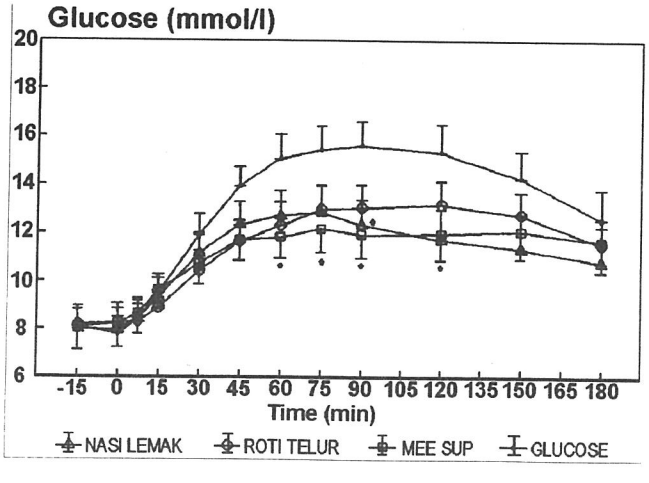
Three common ethnic breakfast meals were given following the overnight fast, and the blood samples as for the glucose tolerance test were taken. The whole procedure of testing the three different meals with or without guar gum were conducted with at least a week between each type of meal.

Blood samples collected in heparin tubes for glucose analysis were separated immediately and the plasma stored before analysis. Sera obtained for insulin were stored at -20°C until assayed. Blood glucose was measured by glucose oxidase method using a Beckman analyser (Beckman® Instruments, USA) while serum insulin was measured by radioimmunoassay using a commercial kit (NOVO®, Denmark). The intra-assay coefficient of variation for glucose was 5% and for insulin was 15%. Results are expressed as mean ± standard error of means (SEM) and analysed by student's paired t-test or analysis of variances (ANOVA) where appropriate.

Results

The OGTT group and test meals group were not comparable in age and weight, but each group formed its own control for guar gum. Comparison between test meals were made for six NIDDM who completed all the three test meals.

Figure 1. Glycaemic responses of diabetic patients to different test meals and oral glucose load. Values are mean±SEM (n=6), * p<0.05 compared to OGTT (n=11).



In Figure 1, when the glycaemic responses for the six subjects who completed all the three test meals were compared with the OGTT glycaemic responses, significant differences (lower for test meal) were seen at 90 and 120 minutes for nasi lemak (p<0.05) and at 60, 75 and 90 minutes for mee sup (p<0.05). No significant difference was seen for roti telur.

When comparing the mean individual peak plasma glucose level with the glucose group, all three test meals had significantly lower levels (p<0.05), but there was no significant difference in mean peak plasma glucose time.

Among the three test meals, there were no significant differences in the plasma glucose levels for any time point of the study. Mean peak plasma glucose time for mee sup was achieved significantly later than nasi lemak (p<0.05) (Figure 1).

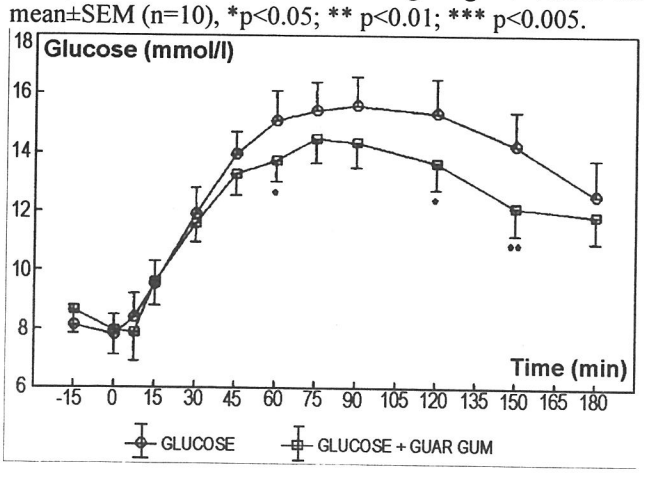
When subjects took 5g of guar gum immediately before the glucose drink, the mean peak plasma glucose level was reduced by 1.4 mmol/1 and occurred significantly earlier (p<0.03) (Table 2). Glucose concentrations tended to be lower with the administration of guar gum but this was statistically significant only at 60 min (p<0.05), 120 min (p<0.05) and 150 min (p<0.01) (Figure 2).

Table 2. Peak plasma glucose and peak time achieved after meals with or without guar gum

Type of Meal	Glucose concentration mean±SD (mmol/l)	Time mean±SD (min)
Glucose load (n=11)		
without guar gum	16.6±3.6	95.4±27.3
with guar gum	15.1±2.3	77.7±14.0*
Nasi lemak (n=10)		
without guar gum	13.4±2.6	67.5±15.4
with guar gum	13.2±2.0	111.0±39.8**
Roti telur (n=7)		
without guar gum	13.0±2.2	98.6±29.8
with guar gum	13.0±2.1	122.1±28.2
Mee sup (n=8)		
without guar gum	12.2±2.6	106.9±47.7
with guar gum	11.8±2.6	118.1±38.6

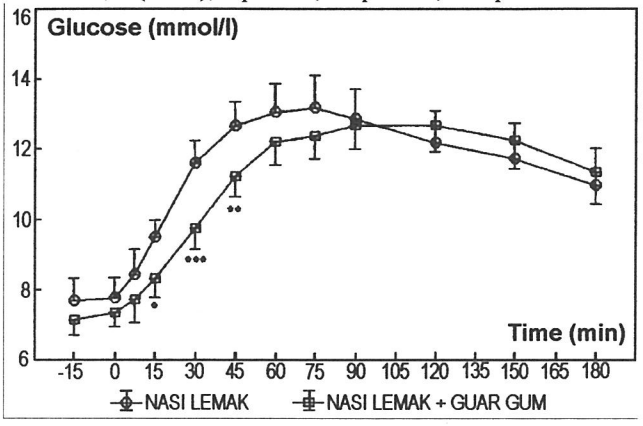
Values significantly different from those taken without guar gum * p < 0.03, ** p < 0.002

Figure 2. Glycaemic responses of diabetic patients to 75g oral glucose load with and without guar gum. Values are mean±SEM (n=10), *p<0.05; ** p<0.01; *** p<0.005.



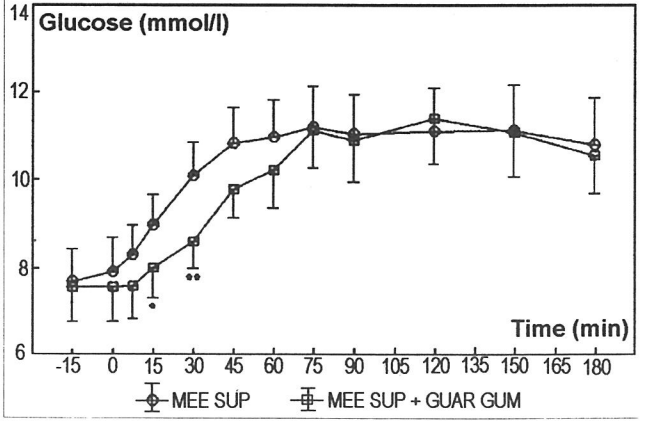
A similar pattern was seen when the nasi lemak test meal was preceded by consuming guar gum (Figure 3). There was no significant decrease in mean peak plasma glucose levels. The mean peak glucose level, however, was significantly delayed ($p<0.002$). Significantly lower mean plasma glucose occurred at 15 minutes ($p<0.05$), 30 minutes ($p<0.05$) and 45 minutes ($p<0.01$).

Figure 3. Glycaemic responses of diabetic patients to nasi-lemak test meal with and without guar gum. Values are mean±SEM (n=10), * $p<0.05$; ** $p<0.01$; *** $p<0.005$.



There was significant change in the mean peak plasma glucose levels and the mean peak times for both mee sup and roti telur meals with the addition of guar gum (Table 2). The mean plasma glucose concentration decreased significantly at 15 minutes ($p<0.03$) and 30 minutes ($p<0.01$) for mee sup when subjects were given guar gum (Figure 4). There was no significant decrease in plasma glucose levels when guar gum was consumed prior to roti telur (Figure 5).

Figure 4. Glycaemic responses of diabetic patients to mee sup test meal with and without guar gum. Values are mean±SEM (n=8), * $p<0.05$; ** $p<0.01$.



Serum insulin concentration tended to be greater when guar gum was taken with a large load of glucose (Figure 6) but this was only significant at 30 minutes for oral glucose load ($p<0.02$). No significant differences were seen in the mean serum insulin levels at different time points for the three test meals when guar gum was given compared to without guar gum (data not shown).

Figure 5. Glycaemic responses of diabetic patients to roti telur test meal with and without guar gum. Values are mean±SEM, (n=7).

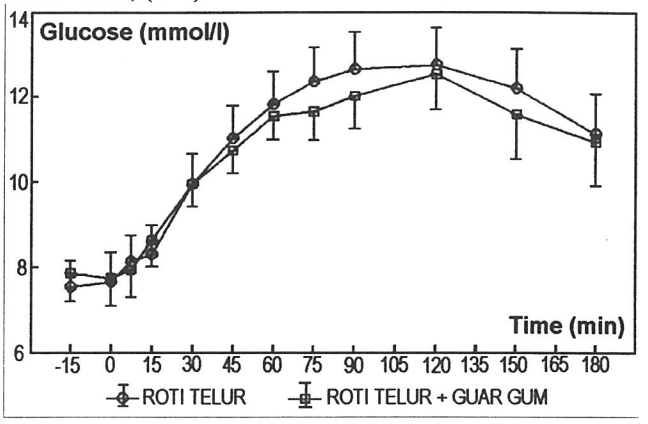
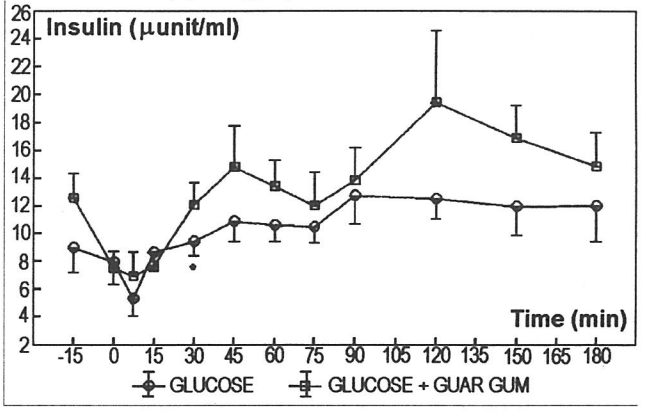


Figure 6. Serum insulin responses of diabetic patients to 75g oral glucose load with and without guar gum. Values are mean±SEM, (n=11), * $p<0.02$.



Discussion

Only results of the six subjects who completed all three test meals were used to make comparisons for the three test meals. When compared with OGTT, which contained solely simple carbohydrate (75g glucose), only nasi lemak (45g carbohydrate) and mee sup (85g carbohydrate) yielded significantly lower glucose concentrations. Despite the differences in carbohydrate content, ranging from 45 to 85g, the plasma glucose concentrations were not significantly different among the three meals. This suggests that NIDDM patients need not adhere to strict carbohydrate exchanges to achieve similar postprandial plasma glucose concentration if the total difference of carbohydrate of the meal does not exceed 40g for these mix meals. In contrast to an earlier study[17] that reported similar glycaemic responses of mixed meals with the same contents of carbohydrate, protein, fat and energy, our study shows that these effects can be obtained with normal serves of test meals of different composition.

This study also shows that not all local breakfast meals tested resulted in lower plasma glucose responses when guar gum was administered prior to the meal. Roti telur, which is a dough fried with an egg, did not show any difference in glycaemic responses when guar gum was added. The reason for this is uncertain and possibly is that the contribution that guar could make has already been made by the dhal in roti telur.

Guar should ideally be intimately mixed with carbohydrate as timing is critical for its effectiveness. The action of guar gum on carbohydrate is explained by its marked gel-forming capacity and the resulted delayed emptying of the stomach and delayed intestinal absorption of nutrients. The viscosity of the gel attained is dependent on time, temperature and pH[11]. However, as a good number of local Malaysian meals consists of wet meals like curries, porridges or soups it would be rather unpalatable due to the viscosity of guar gum if it were pre-mixed into the meal. For this reason, in this study guar was administered as a premeal drink instead.

The mean plasma glucose concentration when guar gum was consumed prior to nasi lemak or mee sup was significantly less than the control at earlier time points, that is between 15 and 45 minutes after meal. This suggests a delay in the absorption of digested carbohydrates. When guar gum was given prior to glucose load, significantly lower plasma glucose levels were achieved later at 60, 120 and 150 minutes. Since glucose does not require digestion for absorption, the differences in time of significant glucose lowering can only be attributed to some effect of guar gum on the digestion of carbohydrate in nasi lemak and mee sup. No similar effect, however, was observed with the roti telur test meal.

In some studies when guar gum was taken separately as a premeal drink before a glucose load[18] or a meal[13], no significant effect on glycaemic response was reported. However, in our present study, significant decreases in glycaemic responses were shown with nasi lemak and mee sup test meals, but not with roti telur when guar was pre-fed to diabetic subjects. Although guar gum was effective in decreasing the rate and delaying the peak time for glucose absorption[1-8] it did not lower peak glucose levels for the three test meals. Thus, results obtained from studies on Western meals cannot be extrapolated to local settings. Other types of traditional Malaysian meals have not been tested, however, and the limited sample size make caution advisable in the interpretation of the effectiveness of guar gum. Of particular interest is the question of how difference in serving size, for a particular ethnic breakfast, might allow lower peak plasma glucose responses. There is also a need for further studies to be done to investigate the effectiveness of guar gum in longer term studies in local diabetic patients.

Acknowledgments:
This project was funded by Universiti Kebangsaan Malaysia research grant 17/88 and Biotechnology Research grant BU 4 from the Ministry of Science and Technology. We thank Orion Pharmaceutical, Finland for the supply of Guarem and Nurshireen Abdullah for her technical help.

Glycaemic and insulin responses of diabetic patients to traditional Malaysian meals and the effect of guar gum

Bin AK Khalid, Lai-Fun Lee, Abu Hassan Samad, Mee-Lian Ng

Asia Pacific Journal of Clinical Nutrition (1996) Volume 5, Number 4: 239-243

進食傳統的馬來西亞膳食和纖維（Guar Gum）對血糖和胰島素反應的影響

摘要

這項研究的目的是要測定以及比較馬來西亞三種傳統餐食和葡萄糖對第二型糖尿病（NIDDM）患者所引起的血糖和胰島素反應。這項研究也同時測定纖維（Guar Gum）對這些反應的影響。對病患者進行研究時，實驗是用 75 克的葡萄糖和本國三大種族的三種常用早餐。研究結果顯示，與葡萄糖這一組比較，病人的血糖反應在用過椰漿飯之後的 90 和 120 分鐘時，有顯著的差異（$p < 0.05$）。而用麵湯後，顯著差異也見於 60、75 以及 90 分鐘時（$p < 0.05$）。至於加蛋印度麵飽則沒有顯著的差異。但是在比較這三種早餐時，血糖反應在任何時間內都沒有顯著的差異。服用 5 克滲與水的粒狀纖維於葡萄糖之前，顯著地減低了病人的血糖。此顯著變化是在服食後的 60、120 以及 150 分鐘（$p < 0.05$）。至於椰漿飯和麵湯，服用纖維也同樣地減低了病人的血糖；椰漿飯 —— 於餐食後的 15 至 45 分鐘（$p < 0.03$）；麵湯 —— 於餐食後的 15 至 30 分鐘（$p < 0.03$）。而加蛋印度麵飽則沒有顯著的差異。對這三種餐食，服用纖維並沒有造成胰島素的顯著變化。但是服用纖維對飲食葡萄糖過後，胰島素則有顯著的變化。胰島素反應在服食後的 30 分鐘時，會有顯著的增加（$p < 0.02$）。

Glycaemic and insulin responses of diabetic patients to traditional Malaysian meals and the effect of guar gum

Bin AK Khalid, Lai-Fun Lee, Abu Hassan Samad, Mee-Lian Ng

Asia Pacific Journal of Clinical Nutrition (1996) Volume 5, Number 4: 239-243

Tujuan projek ini ialah untuk menentukan tindakan glisemik dan insulin bagi pesakit-pesakit diabetik tidak bergantung insulin (NIDDM) terhadap 3 makanan traditional Malaysia berbanding dengan glukosa oral serta untuk menentukan kesan guar gum terhadap tindakan-tindakan ini. Pesakit-pesakit NIDDM telah diuji dengan 75g glukosa oral dan 3 jenis sarapan pagi menurut kumpulan etnik utama Malaysia.

Perbezaan ketara telah diperhatikan terhadap tindakan glukosa pada 90 dan 120 minit selepas memakan nasi lemak ($p<0.05$) dan pada 60, 75 dan 90 minit selepas memakan mee sup ($p<0.05$) bila dibandingkan dengan kumpulan glukosa oral. Namun, tiada perbezaan ketara diperhatikan untuk kumpulan yang memakan roti telur. Tidak terdapat perbezaan yang ketara bagi glukosa plasma pada kesemua poin masa kajian ini bila ketiga-tiga makanan ujian ini dibandingkan antara satu sama lain.

Penambahan campuran 5 g granul guar gum dengan air yang diambil sebelum glukosa oral telah dapat merendahkan glukosa plasma pada 60, 120 dan 150 minit posprandial ($p<0.05$). Dengan cara yang sama untuk ujian makanan, guar gum didapati merendahkan glukosa plasma dengan ketara antara 15 dan 45 minit ($p<0.03$) posprandial untuk nasi lemak dan antara 15 dan 30 minit ($p<0.03$) untuk mee sup tetapi tidak untuk roti telur.

Penambahan guar gum tidak memberi kesan yang ketara terhadap tindakan-tindakan insulin untuk ketiga-tiga jenis makanan tetapi perbezaan yang ketara diperhatikan pada 30 minit ($p<0.02$) selepas pengambilan glukosa.

References

1. Jenkins DJA, Goff DV, Leeds AR, et al. Unabsorbable carbohydrates and diabetes:- decreased post-prandial hyperglyeaemia. Lancet 1976; 2:172.
2. Gassull MA, Goff DV, Haisman, et al. The effect of unavailable carbohydrate gelling agents in reducing postprandial glycemia in normal volunteers and diabetics. J Physiol Lond 1976; 259:528.
3. Jenkins DJA, Leeds AR, Gassull MA, et al. Decrease in postprandial insulin and glucose concentrations by guar and pectin. Ann Intern Med 1977; 86:20.
4. Jenkins DJA, Nineham R, Craddock C, et al. Fibre and diabetes. Lancet 1979; 1:434.
5. Aro A, Uusitupa M, Voutilainen G, et al. Improved diabetic control and hypercholesterolemic effect induced by long term dietary supplementation with guar gum in type 2 (non-insulin dependent) diabetics. Diabetologia 1981; 54:1.
6. Smith U, Holm G. Effect of modified guar gum preparation on glucose and lipid levels in diabetics and healthy volunteers. Atherosclerosis 1982; 45:1.
7. Uusitupa M, Aro A, Korhonen T, et al. Blood glucose and serum insulin responses to breakfast including guar gum and cooked or uncooked milk in type 2 (non-insulin dependent) diabetics patients. Diabetologia 1984; 26:453.
8. McIvor ME, Cummings CC, Leo TA, Mendeloff AI. Flattening postprandial blood glucose responses with guar gum - acute effects. Diabetes Care 1985; 8:274.
9. Holman RR, Steemson J, Darling P, Turner RC. No glycaemic benefit from guar gum administration in NIDDM. Diabetes Care 1987; 10:68.
10. Jenkins DJA, Wolever TMS, Leeds AR, et al. Dietary fibre, fibre analogues and glucose tolerance: importance of viscosity. Br Med J 1978; 1:1992.
11. O'Connor N, Tredger J, Morgan L. Viscosity differences between various guar gum. Diabetologia 1981; 20:612.
12. Najemik C, Krits H, Irsiglar K, et al. Guar and its effects in metabolic control in Type II diabetic subjects. Diabetes Care 1984; 7:215.
13. Fuessi S. Advian TE, Barcarese-Hamilton AJ, Bloom Sr. Guar in NIDD: effect of different modes of administration on plasma glucose and insulin responses to starch meal. Practical Diabetes 1986; 3:259.
14. Ebeling P, Yki-Jarvinen H, Aro A, Helve E, Sinisalo M, Koiristo VA. Glucose and lipid metabolism and insulin sensitivity in type-I diabetes: the effect of guar gum. Am J Clin Nutr 1988; 48:98.
15. Van Duyn MAS, Leo TA, McIvo ME, et al. Nutritional risk high carbohydrate, guar gum dietary supplementation in non-insulin dependent diabetes mellitus. Diabetes Care 1986; 9:497.
16. Tee ES, Mohd IN, Mohd NA, Khatijah I. Nutrient Composition of Malaysian Foods (ASEAN Food Habits Projects) - preliminary report, 1988.
17. Colaquin S, Miller JJ, Holliday JL, Phela E. Comparison of plasma glucose, serum insulin and C-peptide responses to three isocaloric breakfasts in non-insulin dependent diabetic subjects. Diabetes Care 1984; 9:250.
18. Jenkins DJA. Dietary fiber, diabetes and hyperlipidaemia. Lancet 1979; 2:1287.