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Studies on the glycemic response of wheat at various level of processing fed to normal healthy rats

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ABSTRACT: In this study, glycemic response was studied using wheat at various forms of processing. The study was aimed at estimating the glycemic index of various processing effect subjected to wheat, in normal rats using white bread as standard (control). Twenty rats were separated into four groups of five rats: one control group and three experimental groups. Group one was given durum wheat spaghetti, group two was given whole wheat, group three was given dehulled wheat and group four was given white bread (control). For the purpose of consistency, the samples were ground into flour and made into viscous paste using flour and water in a ratio of 1:3 respectively. Blood samples were collected from the tip of rats' tails at fasting and also at 30, 60, 90 and 120 minutes post feed respectively. Blood glucose level was determined using Accu-Chek glucometer and test strips. Dehulled wheat showed the highest blood glucose level at 30 minutes and 60 minutes post feeding, while whole wheat showed the highest blood glucose level at 90 minutes. Durum wheat showed the lowest blood glucose level at 30 minutes, 60 minutes, 90 minutes and 120 minutes.

In conclusion, the study revealed that dehulled wheat has the highest glycemic response while durum wheat spaghetti has the lowest glycemic response.

Keywords: Wheat; Nutritional evaluation; Glycemic response; Diabetes mellitus.

Introduction

The estimation of glycemic response is an important parameter to take into consideration in order to better understand the physiologic effects of foods with high carbohydrate levels. Among cereals, which are the major sources of carbohydrate, wheat has been considered as particularly interesting plant from a nutritional point of view

Most cereals are ground into flour, which is milled. The outer layers of bran and germ are removed during milling which reduces the vitamin, mineral and fiber content of the cereal. However, milling makes the cereal more resistant to degradation and makes the grain more appealing to many palates. Health conscious people tend to prefer whole grains, which are not milled. Over-consumption of milled cereals is sometimes blamed for obesity (www.wikpedia.org).

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There is evidence to suggest that regular consumption of cereals, especially whole grains, may have a role in prevention of chronic diseases. Although cause and effect has not been established, people who consume diets rich in wholegrain cereals have a lower incidence of many chronic diseases such as coronary heart disease and type 2 diabetes (Hallfrisch and Behall, 2002; Liu *et al*., 2000).

Glycemic index (GI) is a measure of the glycemic effect of carbohydrate in a particular food, compared to an equivalent amount of carbohydrate in a standard amount of glucose or white bread (Jenkins *et al*, 1981). The GI is also a ranking (on a 100 point scale) of how quickly 50g of carbohydrates from foods elevates blood sugar levels. The higher the number, the quicker the carbohydrate enters the blood stream.

Although glycemic index, glycemic load and glycemic response each helps provide a better understanding of how the foods we eat can impact blood glucose levels, glycemic response seems to be a better reflection of how people really eat, because in addition to carbohydrates, it also considers the fiber, protein and fat content found in a typical meal (www.store.kasi.com). The study was aimed at estimating the glycemic index of wheat at various levels of processing using white bread as standard.

Materials and Methods

Animals

The animals used for this experiment were white albino rats obtained from Veterinary Research Institute (VRI) Vom, Plateau State. The rats were divided into four groups of five rats each. The rats weighed between 125 and 176 grams.

Preparation of samples

Three samples of wheat flour were used at various levels of processing. The first 2 were common wheat but differ in their level of processing; one was whole wheat, while the other was dehulled and milled, that is its bran and germ were removed. The third sample was durum wheat spaghetti (commercially prepared). All the three samples were obtained from Maiduguri Market, and were positively identified by a wheat breeder at Lake Chad Research Institute.

Whole wheat grains were washed clean with tap water and sun-dried on a mat. Part of it was milled directly into powder form using a hammer mill. This powder was called whole wheat flour. The other part was dehulled to remove the bran and germs using pestle and mortar. The dehulled grains were milled into powder form with a hammer mill. This powder was called dehulled wheat flour.

Durum wheat spaghetti (commercially prepared) was also ground into flour for uniformity, using harmer mill. It was unpacked and placed in a plastic container. It was then ground into flour and stored in air-tight plastic container. For the purpose of consistency, all three samples (flour) were made into a hot paste before feeding to animals. The paste was made with water and flour in a ratio of 1:3 (w/w).

Experimental design

The rats were grouped into 4 groups of 5. Groups 1, 2, 3 were experimental groups and group 4 was white bread control. They were fed with the diet for seven days to get them accustomed to it, with a preliminary monitory of the glycemic level. The rats were fasted for 18 hours after the seven day period, and their fasting blood glucose was determined with oncall-plus glucose meter and test strips.

Group 1 was fed with durum wheat spaghetti flour paste.
Group 2 was fed with whole wheat flour paste.

Group 3 was fed with dehulled wheat flour paste.
Group 4 was fed with 50g of white bread

The experimental groups and control group were allowed access to diet for 60 minutes and then the diet was withdrawn. Blood glucose level of all groups was monitored with glucometer at time intervals of 30 minutes, 60 minutes, 90 minutes and 120 minutes after diet withdrawal.

Blood collection and determination of blood glucose level

The blood used for this work was collected by cutting the tip of the rat's tail using a surgical blade. The blood glucose level was determined using Oncall-plus glucose meter and Oncall-plus glucose test strips.

Results and Discussion

The results are presented in Table 1 and Figs. 1 – 6. Figure 1 shows the fasting blood sugar while Figures 2-5 show the glycemic response at 30, 60, 90 and 120 minutes respectively. Figure 6 shows the graph of glycemic response of the three samples of flour at various time intervals. White bread was used as standard.

Table 1: Blood glucose level of the three experimental groups, with white bread as standard, at various time intervals.

Group	Time Interval				
	0 min	30 min	60 min	90 min	120 min
Durum Wheat Spaghetti	5.9 ± 0.12	5.9 ± 0.52	6.1 ± 0.64	5.9 ± 0.58	6.6 ± 0.15
Whole Wheat	5.7 ± 0.29	6.5 ± 0.16	6.2 ± 0.43	6.5 ± 0.54	7.3 ± 0.39
Dehulled Wheat	7.6 ± 2.34	6.7 ± 0.59	6.9 ± 0.15	6.4 ± 0.21	7.3 ± 0.88
White Bread (Control)	5.9 ± 0.09	6.3 ± 0.09	7.1 ± 0.00	6.0 ± 0.09	5.4 ± 0.20

All values are mean ± SD based on 5 observations.

From Figure 1, it can be observed that the fasting blood glucose of Durum wheat spaghetti is the lowest followed by that of whole wheat. The fasting blood glucose of dehulled whole wheat is the highest at 7.6 mmol/l while that of white bread control is higher than that of both durum wheat spaghetti and whole wheat. At 30 minutes post feeding, shown in Figure 2, durum wheat spaghetti blood sugar level increased from 5.6 mmol/l at fasting blood sugar to 5.9 mmol/l. Whole wheat also had an increase in blood sugar level from 5.7 mmol/l at fasting blood sugar, to 6.4 mmol/l at 30 minutes. Dehulled wheat showed a decrease in blood sugar level from 7.6 mmol/l at lasting blood sugar to 6.7 mmol/l at 30 minutes post feeding, which is higher than that of white bread control.

At 60 minutes after feeding shown in Figure 3, durum wheat spaghetti showed a slight increase in blood sugar level from its previous value of 5.9 mmol/l at 30 minutes to 6.1 mmol/l at 60 minutes. Whole wheat however, induced a decrease in blood sugar level from previous value, dropping from 6.5 mmol/1 at 30 min while dehulled wheat produced an increase in blood sugar level from 6.7 mmol/l to 6.9 mmol/l.

At 90 minutes after feeding shown in Figure 4 durum wheat spaghetti blood sugar level decreased to 5.9mmol/1 while whole wheat blood sugar level increased to 6.5mmol/l. Dehulled wheat also showed a decrease in blood sugar level from 6.9mmol/l at 60 minutes, to 6.4mmol/1. At 120 minutes after feeding, as shown in figure 5, durum wheat spaghetti showed its highest blood sugar level at 6.6 mrnol/l. Whole wheat also showed its highest blood sugar level at 7.3 mmol/l. Dehulled wheat showed a significant increase in blood sugar level from its previous value of 6.5 mmol/l at 90 minutes to 7.3 mmol/l at 120 minutes post feeding. The glycemic index of foods is affected by factors such as variety, processing effects (Hermansen *et al*, 1992) and particle size (Heaton *et al*, 1988). In this study, only the level of processing vary in the samples used. From the results, whole wheat which is the least processed showed its peak value of blood glucose level at 120 minutes after feeding; which suggests slow digestion. This is due to anti nutrients (phytate and tannins) contained in the seed coat and aleuron layer which forms part of the bran. These nutrients interfere with the digestion, vis-a-vis absorption of nutrients from whole cereal grains by complexing with these nutrients and making them unavailable. Durum wheat spaghetti also had its peak blood sugar level at 120 minutes which was higher than that of white bread control at 120 minutes after feeding, thus indicating gradual digestion and release of glucose. Dehulled wheat showed a higher blood sugar level than white bread control at 30 minutes after feeding which reflects rapid digestion and the absence of interference due to the presence of germ and bran which were totally removed during processing.

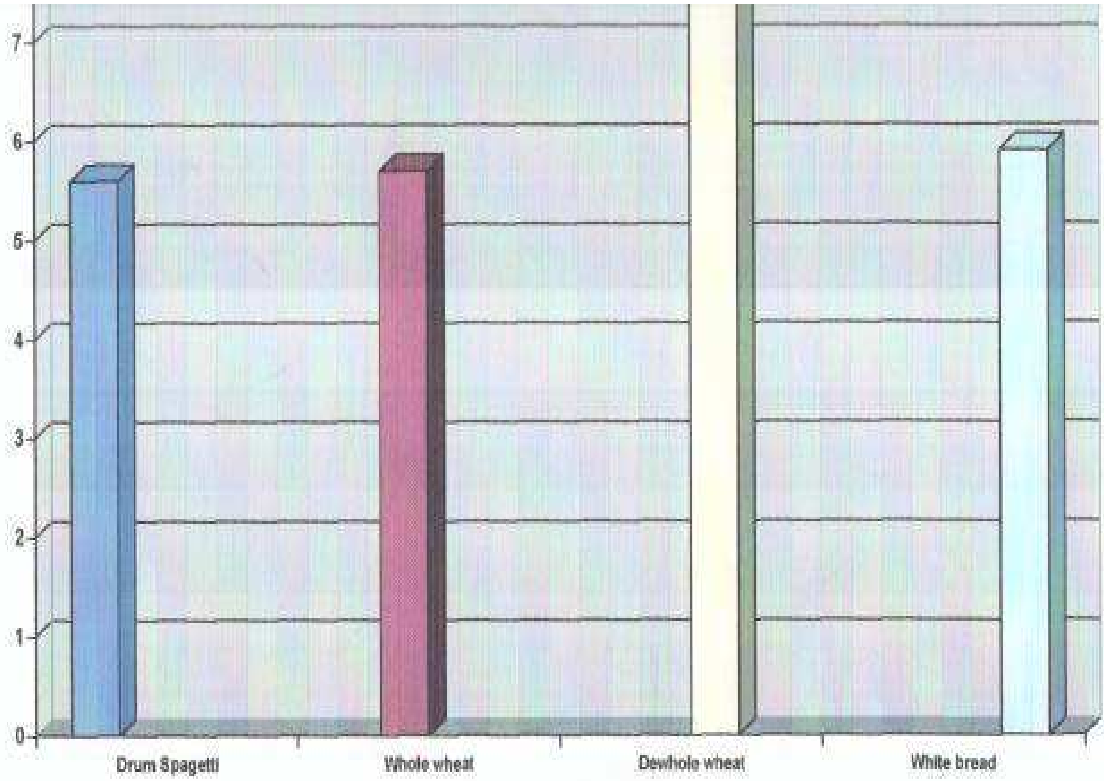

Fig. 1: Graph of fasting blood sugar (FBS) level after feeding for 7 days.

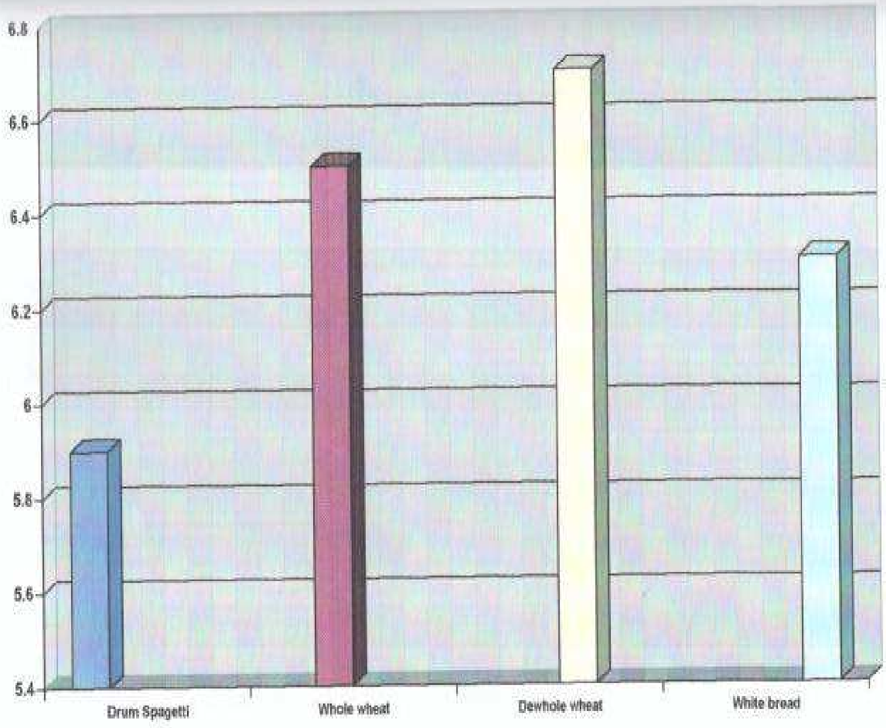

Fig. 2: Graph of Glycemic response at 30 minutes after feeding.

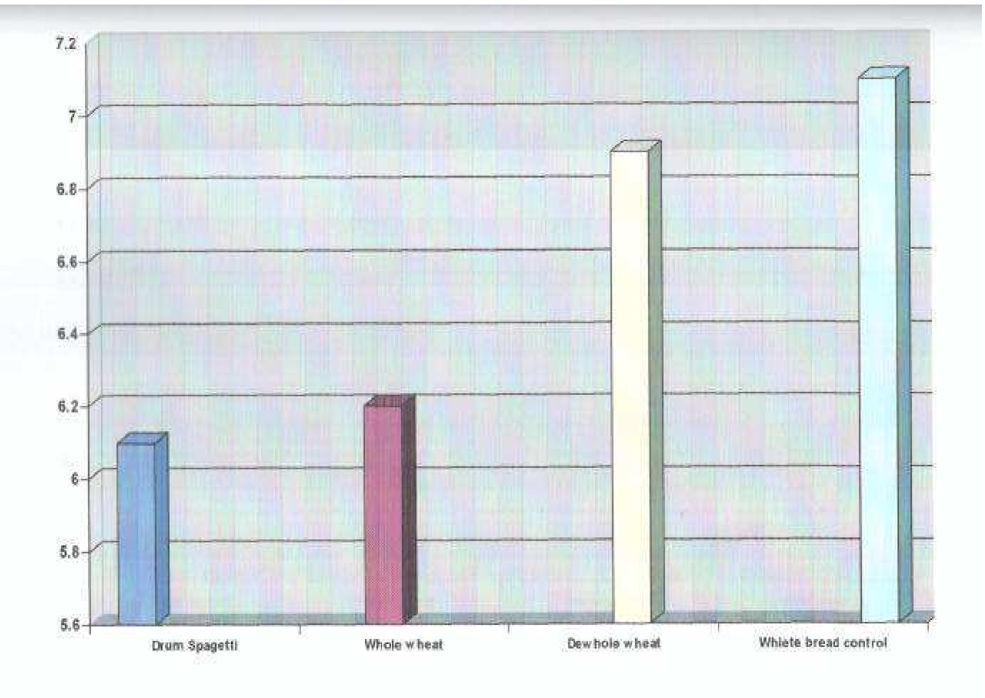

Fig. 3: Graph of glycemic response at 60 minutes after feeding.

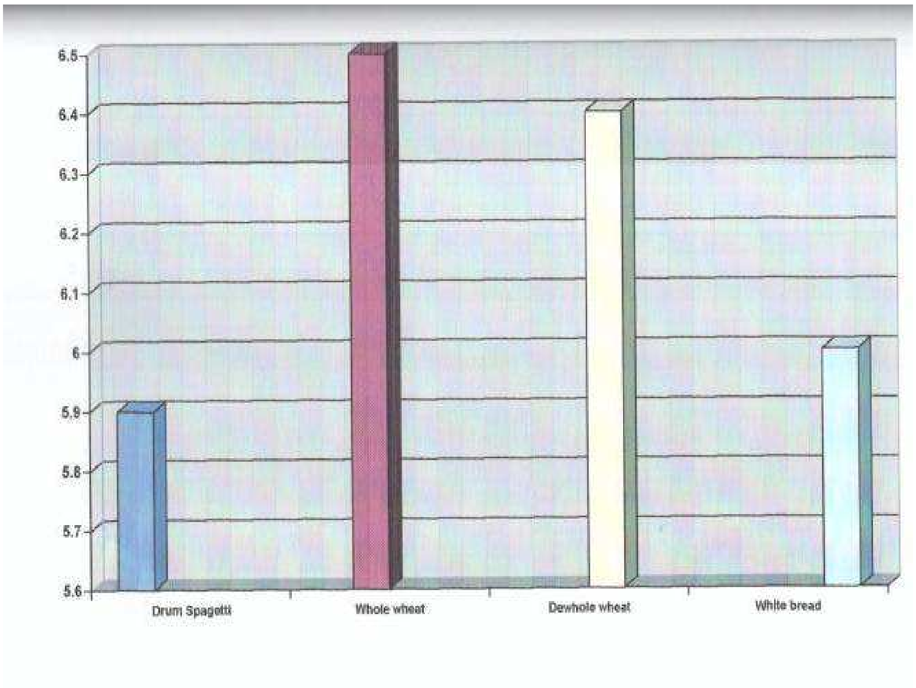

Fig. 4: Graph of Glycemic response at 90 minutes after feeding.

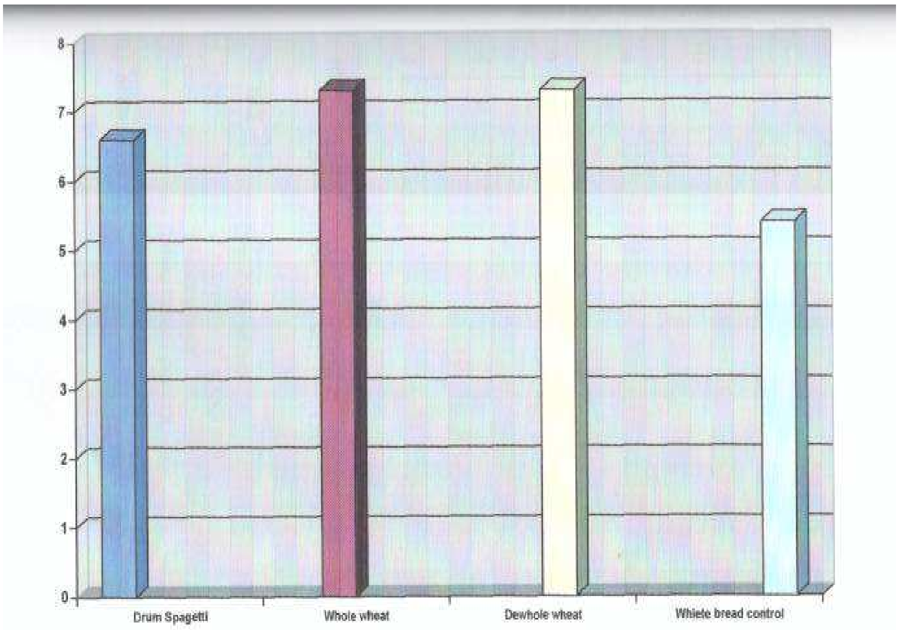

Fig. 5: Graph of Glycemic response at 120 minutes after feeding.

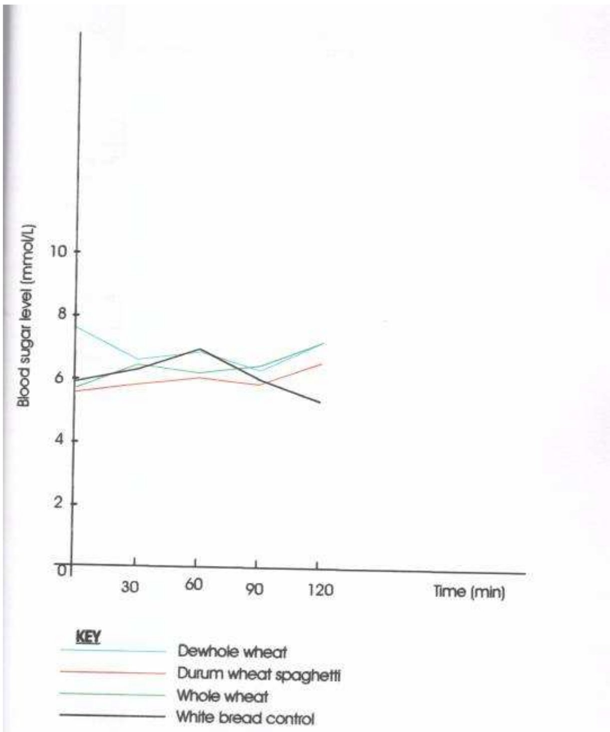

Fig. 6: Graph of Glycemic Response of the three samples at various time intervals.

The basic building block of every carbohydrate is a sugar molecule, a simple union of carbon, hydrogen and oxygen. Starches and fibres are essentially chains of sugar molecules. Some contain hundreds of sugar. Some chains are branched wildly, others are straight. The digestive system handles all carbohydrates in much the same way, it breaks them down into single sugar molecules, since only these are small enough to cross into the blood stream. It also converts most digestible carbohydrates into glucose because cells are designed to use this as a universal energy source. Fibre contained by whole cereal grains is an exception to t his. It is put together in such a way that it can not be broken down into sugar molecules and so, it passes through the body undigested. Fibre comes in two varieties: soluble fibre dissolves in water, while insoluble fibre does not. Although neither type nourishes the body, they promote health in many ways. Soluble fibre binds to fatty substances in the intestines and carries them out as waste, thus lowering low-density lipoprotein (LDL). It also helps regulate the body's use of sugars, helping to keep hunger and blood sugar level in check. Insoluble fibre helps push food through the intestinal tract, promoting regularity and helping prevent constipation. All these make whole grains important in weight management and control of diseases like heart failure and diabetes (Johnson and Ideinstock, 2006).

A high consumption of whole grains is associated with decreased risk of diabetes. The majority of nutrients are digested and absorbed in the small intestine soluble fibre such as β-glucan and soluble arabinoxylan contained in whole grains may slow the evacuation of stomach contents into the small intestine by increasing viscosity of the food mass. This leads to the delayed hydrolysis of starch and the absorption of nutrients, which helps to slow down the changes in glucose levels. Whole wheat grain has a high content of soluble fiber. A number of clinical studies support the hypothesis that whole grain consumption is associated with reduced risk of type 2 diabetes (Venn and Mann, 2004; Brand Miller, 2003, Egbunike, 2006). Normally, blood sugar level stays within narrow limit of 4 to 8m mol/I throughout the day.

Conclusion

From the results obtained form this study, dehulled wheat showed the highest glycemic index while durum wheat spaghetti showed the lowest. The glycemic response after two hours stayed within the narrow limit of 4-8mmol/l, thus indicating that the samples do not have hyperglycemic effect. However, due to the gradual release of glucose shown by durum wheat spaghetti and whole wheat, they can be a good source of energy for endurance athletes. They can also be employed in management of diabetes and obesity.

References

Brand Miller (2003). Low Glycemic Diets in Management of Diabetes; a Meta analysis of randomized controlled Trials. Diabetes Care: 26; 2261-2267.

Egbunike, A. O. (2006). Studies on Glycemic Index of five varieties of Dates in Normal rats. B. Sc. Project Department of Biochemistry, University of Maiduguri, Nigeria.

Heaton Keneth lal *et al* (1988). Particles size of wheat, maize and oat test meals: Effects on plasma glucose and insulin responses on the rate of starch digestion *in vitro*. American Journal of Clinical Nutrition. 47: 675-682.

Hermansen K. L. *et al* (1992). Influence of ripeness of banana on the blood glucose and insulin response in type 2 diabetic subjects. Diabetic Medicine 9:739-43.

Jenkins, D. J. *et al* (1981). Glycemic Index of Foods: A physiological basis for carbohydrate exchange. American Journal of Clinical Nutrition 34:363-366.

Johnson L. W. and Ideinstock R. S. (2006). The metabolic syndrome: concepts and controversy. Mayo Clinic Proceedings. 81: 1615-20.

Hallfrisch, J. and Behall, K. M. (2002). Mechanism of the effects of grains on insulin and glucose responses. British Journal of Nutrition; 88:255-262.

Liu S., Willet W. C. and Stampfer M. J. (2000). A Prospective study of dietary glycemic load, carbohydrate intake, and risk of coronary heart disease in U. S. Women. American Journal of Clinical Nutrition, 71: 1455-61.

Pereira M. A. and Liu S. (2003). Types of carbohydrates and risk of cardiovascular disease. Journal of Women's Health; 12:115-22

Venn B. J. and Mann J. 1. (2004). Cereal grains Legumes and diabetes. European Journal of Clinical Nutrition, 58:1443- 1446