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Blood glucose and plasma insulin responses to fat free milk and low-lactose fat free milk in healthy human volunteers

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Summary: The blood glucose and plasma insulin responses to test milk samples were studied in healthy normal volunteers. After an overnight fast the subjects were given 500 ml of either regular fat free milk (~ 25 g lactose) or 500 ml of a new low-lactose fat free milk (3.75 g lactose and 4.25 g fructose). Blood glucose levels were not significantly altered after either milk sample, but plasma insulin responses were significantly elevated after milk consumption. The response was slightly but not significantly higher after regular fat-free milk than after the low-lactose fat free milk. The results suggest that fat free milk does not exert a fast effect on blood glucose concentration and therefore fat free milk and especially low-lactose fat free milk may prove to be suitable for diabetic diets.

Key words: blood glucose, plasma insulin, milk, low-lactose milk

Zusammenfassung: An gesunden freiwilligen Versuchspersonen wurde die Reaktion des Blutglukosespiegels und der Plasmainsulinkonzentration auf Test-Milchproben untersucht. Nach Fasten über Nacht bekamen die Versuchspersonen 500 ml einer gewöhnlichen fettfreien Milch (ca. 25 g Laktose) oder 500 ml einer neuen laktosearmen, fettfreien Milch (3,75 g Laktose und 4,25 g Fruktose). Die Blutglukosespiegel wurden durch keine der beiden Milchproben signifikant erhöht, aber die Plasmainsulinkonzentration erhöhte sich nach der Milchzufuhr signifikant. Diese Reaktion war nach der gewöhnlichen fettfreien Milch geringfügig, aber nicht signifikant höher als nach der neuen laktosearmen, fettfreien Milch. Die Ergebnisse zeigen, daß fettfreie Milch keine rasche Wirkung auf die Konzentration der Blutglukose ausübt und daß deshalb fettfreie Milch, insbesondere solche mit geringem Laktosegehalt, auch für die Diabetesdiät geeignet ist.

Schlüsselwörter: Blutglukose; Plasmainsulin; Milch, laktosearm

Introduction

It has been recommended that diabetic subjects should restrict their consumption of milk to 600 ml of fat free milk daily (1). This recommendation has been based on the thought that dietary lactose exerts a fast action on blood glucose. Recent studies have suggested that lactose is not as effective as glucose (4, 5, 6). Uusitupa et al. have suggested that cooking facilitates the absorption of lactose from milk containing foods. In addition to diabetics data on blood glucose rise after milk consumption is also important for lactose intolerant subjects, who demonstrate a relationship

between their maximum blood sugar rise and the level of lactose activity (5, 6). The rise in blood glucose levels has been faster after lactase-hydrolyzed milk consumption both in healthy volunteers and diabetics (3).

This study was undertaken to compare the blood glucose and plasma insulin effects of a new low-lactose (0.75 % lactose and 0.85 % fructose) fat free milk to a fat free milk with a regular (4.9 %) lactose content. The aim of the study was to initially investigate the suitability of the new milk for healthy human volunteers prior to tests with diabetics and lactose-intolerant subjects.

Materials and Methods

The study group consisted of 8 healthy volunteers (4 females and 4 males) aged 29–40 years. No lactose intolerance had been diagnosed earlier among the volunteers and all of them were regular milk drinkers. On two occasions, after a 12-hour overnight fast the volunteers drank 500 mls of either the regular UHT-treated fat free milk or the new UHT-treated low-lactose fat free milk. The low-lactose fat free milk was made by ultra-filtration to contain 0.75 % lactose and 0.85 % fructose was added to improve the flavor. The test milks were taken 8 days apart in random order and consumed within 5 minutes.

Venous blood was collected through an indwelling cannula before and at frequent intervals for 120 minutes after starting the test. An aliquot was analyzed for glucose using an automated glucose oxidase method. Blood samples were then centrifuged, the plasma separated and analyzed for immunoreactive insulin using a commercial kit. The methodology was essentially the same as described by us earlier (7).

Results and Discussion

All volunteers tolerated 500 ml of the regular fat free or the new low-lactose fat free milk well. Blood glucose changes after the formal fat free milk and the new low-lactose fat free milk are described in Figure 1. The total carbohydrate content was about 24 g lactose in the normal fat free milk sample and 3.75 g lactose and 4.25 g fructose in the new low-lactose fat free milk. No clear rise in mean blood glucose concentrations were

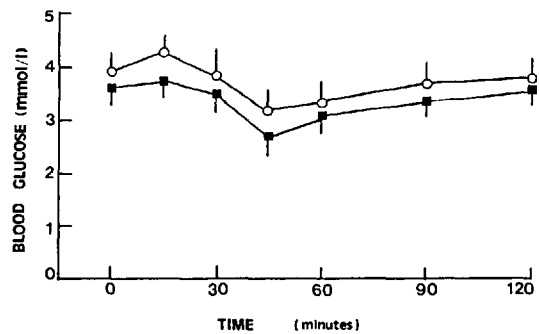

Fig 1. Mean ± SEM blood glucose levels in 8 normal subjects given 500 ml of fat free milk (○) or 500 ml of low-lactose fat free milk (■).

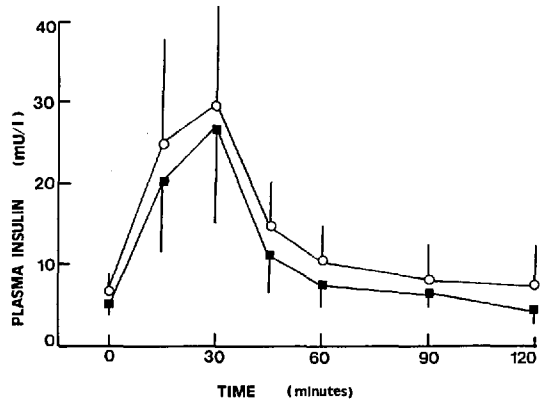

Fig. 2. The effect of 500 mls of fat free milk (○) or low-lactose fat free milk (■) on plasma insulin in normal subjects. Each value is a mean ± SEM for 8 subjects.

observed after either milk samples. Plasma immunoreactive insulin levels rose significantly after both milk samples, though slightly more so after regular fat free milk than after the new low-lactose fat free milk (Fig. 2). Both in the case of blood glucose and plasma insulin the two milk samples were not significantly different from each other.

The results indicate that even the regular fat free milk recommended for diabetic diets did not exert a fast action on blood glucose levels. Plasma insulin values rose in a similar manner after both milks. Similar results have been reported by Iwasaki and Kawanishi (3) for healthy volunteers and diabetics after whole milk consumption, but after lactose-hydrolyzed milk a rapid rise in blood glucose levels was observed. Ionescu-Tirgoviste et al. (4) have reported rapid increases in blood glucose and plasma insulin after a 25 g oral dose of fructose or lactose in type 2 diabetics. Counting the blood glucose increase after glucose as 100 % the corresponding increases in glycaemia for fructose was 81.3 % and for lactose 68.6 %. However, in milk lactose is to some degree bound to the other constituents of milk changing the absorption when compared to pure lactose. Cooking of milk has been indicated to cause a higher blood glucose response than observed with uncooked milk (9) and therefore cooking may release lactose for faster absorption. In our study UHT-treatment (heating both milk types to 135 °C for 2 seconds) was not effective in increasing lactose absorption when compared to the results presented by Iwasaki and Kawanishi (5). Our results indicate that lactose in fat free milk in quantities up to 25 g at a time does not significantly change venous blood glucose levels but increases insulin secretion. Similar results were observed in case of the new low-lactose fat free milk. Arterialized blood obtained from superficial veins of heated hand has been shown to provide an alternative to our venous sampling (2). Since glucose loss in this method is smaller and unaffected by the glycemia differences in blood glucose levels could be better detected (2). Thereby the glucose homeostasis in healthy volunteers after milk consumption could be studied in a

more detailed manner. These results indicate that further studies are needed to test the suitability of low-lactose fat free milk and regular fat free milk for diabetic diets.

References

1. Huttunen JK, Aro A, Pelkonen R, Puomio M, Siltanen I, Åkerblom HK (1982) Dietary therapy in diabetes mellitus. Acta Med Scand 211:469–475
2. Hampton SM, Morgan LM, Tredger IA, Cramb R, Marks V (1986) Insulin and C-peptide levels after oral and intravenous glucose. Diabetes 35:612–616
3. Iwasaki T, Kawanishi G (1983) Commercialization of lactoses and lactose-hydrolyzed milk in Japan. Milk Intolerances and Rejections 72:75–79
4. Ionescu-Tirgoviste C, Popa E, Mihalache N, Cheta D, Mincu I (1983) Blood glucose and plasma insulin responses to various carbohydrate in type 2 (non-insulin-dependent) diabetes. Diabetologia 24:80–84
5. Paige DM, Bayless TM, Dellinger WS (1975) Relationship of milk consumption to blood glucose rise in lactose intolerant individuals. Am J Clin Nutr 28:677–680
6. Paige DM, Mellits ED, Chin F-Y, Davis L, Bayless TM, Cordano A (1978) Blood glucose rise after lactose tolerance testing in infants. Am J Clin Nutr 31:222–225
7. Salminen S, Salminen E, Marks V (1982) The effects of xylitol on the secretion of insulin and gastric inhibitory polypeptide in man and rats. Diabetologia 22:480–482
8. Shively CA, Apgar IL, Tarka SM (1986) Postgrandial glucose and insulin responses to various snacks of equivalent carbohydrate content in normal subjects. Am J Clin Nutr 43:335–342
9. Uusitupa M, Aro A, Korhonen T, Tuunainen A, Sarlund H, Penttilä I (1984) Blood glucose and serum insulin responses to breakfast including guar gum and cooked or uncooked milk in type 2 (non-insulin-dependent) diabetic patients. Diabetologia 26:453–455

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