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Blood glucose and plasma insulin responses to fat-free milk and low-lactose fat-free milk in young type 1 diabetics

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Summary: The blood glucose and plasma insulin responses to test milk samples were studied in eight insulin-dependent diabetics. After an overnight fast, the subjects (aged 20–45 years) were given a breakfast containing two Weetabix biscuits (20 g carbohydrate) with 500 ml of either regular (S) fat-free milk (25 g lactose) or 500 ml of a new low-lactose (D) fat-free milk (3.75 g lactose and 4.25 g fructose). The regular morning insulin dose was omitted. Mean basal plasma glucose level was slightly higher before S milk (11.4 vs. 10.1 mmol/l). The peak increment in plasma glucose was higher in S milk (9.4 vs. 6.6 mmol/l). The rise was 83 % above basal (S) vs. 65 % (D). Although the final mean plasma glucose concentration was not significantly higher 3 h after S milk compared with D milk (17.9 vs. 14.3 mmol/l) the incremental area under the plasma glucose curve was much greater ($p < 0.001$) with S milk than with D milk (1266 ± 295 units vs. 909 ± 242 units). No galactose was detectable in any sample and there was no difference in plasma β-hydroxybutyrate levels. The results suggest that the low-lactose fat-free milk (D) may be suitable for diabetic diets and weight reducing diets due to the lower contribution of energy. The results suggest that fat-free milk does not exert a fast action on blood glucose concentration and therefore fat-free milk and especially low-lactose fat-free milk may also prove to be suitable for diabetic diets.

Zusammenfassung: Die Reaktionen des Glucosegehaltes im Blut und des Insulingehaltes im Plasma auf die Gabe von Milchproben wurde bei acht insulinabhängigen Diabetikern studiert. Nach Fasten über Nacht wurde den 20–45 Jahre alten Versuchspersonen ein Frühstück verabreicht, das zwei sogenannte Weetabix-Kekse (20 g Kohlenhydrate) sowie 500 ml normale Magermilch mit 25 g Lactose (S-Milch) oder Magermilch mit nur 3,75 g Lactose (+4,25 g Fructose) (D-Milch) enthielt. Die normale morgendliche Insulindosis wurde ausgelassen. Der mittlere basale Glucosespiegel im Plasma war bei den Versuchspersonen, die S-Milch erhielten, geringfügig niedriger als in der anderen Gruppe (11,3 bzw. 10,1 mmol/l). Der Anstieg der Plasmaglucose war nach S-Milch stärker als nach D-Milch (9,4 bzw. 6,6 mmol/l). Obwohl 3 Stunden nach der Ingestion die mittleren Plasmaglucosekonzentrationen sich nicht signifikant unterschieden (17,9 bzw. 14,3 mmol/l), war doch die Fläche unter der Kurve für die Plasmaglucose bei S-Milch-Gabe viel größer ($p < 0{,}001$) als nach D-Milch (1266 ± 295 Einheiten gegenüber 909 ± 242 Einheiten). In keiner Probe konnte Galactose gefunden werden; auch lag kein Unterschied im β-Hydroxybutyratgehalt vor. Die Ergebnisse zeigen, daß lactosearme Milch für Diabetiker- und Reduktionsdiäten geeignet ist. Sie ruft keine schnellen Änderungen der Blutglucosekonzentrationen hervor.

Key words: blood glucose, galactose, low-lactose milk, insulin-dependent diabetes

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 belief that dietary lactose exerts a fast action on blood glucose. Recent studies have suggested that lactose is not as glycaemic as glucose (4, 6), although Uusitupa et al. (10) have suggested that cooking facilitates the absorption of lactose from milk-containing foods. Data on the rise in blood glucose after milk consumption are important in patients with diabetes as well as in those with lactose intolerance, who demonstrate a relationship between their maximum blood sugar rise and the level of lactase activity (5, 6). The rise in blood glucose levels is said to be faster after consumption of lactose-hydrolyzed milk both in healthy volunteers and diabetics (3). When low-lactose and normal lactose milks have been compared in healthy human volunteers, no changes have been observed in blood glucose or plasma insulin values (8).

This study was undertaken to compare the blood glucose effects of a new low-lactose (0.75 % lactose and 0.85 % fructose) fat-free milk with that of a fat-free milk with regular (4.9 %) lactose content. The aim was initially to investigate the suitability of the new milk for the diets of insulin-dependent diabetics.

Materials and Methods

The study group consisted of eight insulin-dependent diabetics (four females and four males) aged 20–45 years. None was lactose intolerant. On two separate occasions, after an overnight fast, the volunteers drank 500 ml of either the regular UHT fat-free milks or the new UHT low-lactose fat-free milk (D) with a breakfast containing two Weetabix "biscuits" (20 g carbohydrate). All subjects omitted their regular insulin dose on the morning of the investigation. The low-lactose fat-free milk was adjusted by ultra-filtration to contain 0.75 % lactose: fructose (0.85 %) was added to improve the flavor. The test milk was taken 8 days apart in random order and milk was consumed within 5 min.

Arterialized blood was collected through an indwelling catheter from a superficial vein of a heated hand before starting the test and at frequent intervals for 180 min after it. An aliquot was analysed for glucose and galactose using automated glucose oxidase and galactose oxidase methods. The remaining sample was centrifuged, the plasma separated and analysed for β-hydroxybutyrate (7).

Results and Discussion

All subjects tolerated the Weetabix breakfast well with 500 ml of the regular fat-free (S) or the new low-lactose fat-free milk (D). Blood glucose changes after the normal fat-free milk and the new low-lactose fat-free milk are described in Table 1. The total carbohydrate content of the normal fat-free milk was about 24 g, present entirely as lactose, and that of the new low-lactose fat-free milk was 8 g (3.75 g lactose and 4.25 g fructose).

A clear rise in mean plasma glucose concentration was observed after ingestion of the breakfast, but the peak increment was significantly higher after S milk (9.4 vs. 6.6, Table 1), the mean rise being 83 % above basal levels after the S milk breakfast and 65 % after the D milk breakfast. The

Table 1. Plasma glucose responses to 500 ml fat-free (S) milk and low-lactose fat-free (D) milk in eight diabetics.

Time (mins)	S milk (fat-free milk)			D milk (low-lactose fat-free milk)		
	Plasma glucose (mmol/l)		% Rise	Plasma glucose (mmol/l)		% Rise
	Mean	S.D.		Mean	S.D.	
−10	11.3	5.2	0	10.1	5.5	0
0	11.4	5.2		10.0	5.5	
15	13.0	5.5	15	11.9	5.4	18
30	16.2	4.9	42	14.9	5.1	48
45	18.4	4.8	62	16.0	5.2	59
60	20.3	4.9	78	16.7	5.7	66
90	20.8	5.7	83	16.6	6.1	65
120	20.1	6.0	77	16.0	6.1	59
150	19.1	5.8	68	14.4	5.7	43
180	17.9	5.2	57	14.3	5.2	42
AUC* (Units)	1266	295		909	242	

* = Area under the curve

mean plasma glucose concentration was higher following S milk (17.9 vs. 14.3 mmol/l at 180 min), but due to large inter-individual variation, this difference was not statistically significant. No galactose was detected in any sample following either meal. There was also no difference in plasma β-hydroxybutyrate levels after either milk.

The results indicate that even the regular fat-free milk recommended for inclusion in diabetic diets increases blood glucose levels in insulin-dependent diabetics. The rise, though still discernible, was smaller after D milk. The incremental area under the plasma glucose curve was 35 % greater (1266 ± 295 units vs. 909 ± 242 units; $p < 0.001$) with S than D milk. Similar results have been reported by Iwasaki and Kawanishi (3) for healthy volunteers and diabetics after whole milk consumption. A rapid rise in blood glucose levels has also been observed after lactose-hydrolyzed milk.

Ionescu-Tirgoviste et al. (4) reported rapid increases in both blood glucose and plasma insulin levels after ingestion of 25 g of either fructose or lactose by type 2 diabetics. Taking the blood glucose rise after glucose as 100 %, the corresponding increases for fructose and lactose were 81.3 % and 68.6 %, respectively (4). In milk, however, lactose is to some degree, bound to the other constituents of the milk, changing the pattern of its absorption compared to that of pure lactose. The cooking of milk is said (9) to cause an increased glycaemic response, possibly due to the release of lactose from its unspecified binding sites, leading to its faster absorption. In our study, UHT-treatment (both milk types were heated to 135 °C for 2 S did not appear to increase lactose absorption when compared to the results presented by Iwasaki and Kawanishi (5).

In our study, the increment in plasma glucose was significantly less following ingestion of the lactose-free D milk. However, the contribution

of dietary milk to energy intake in diabetes varies a lot and a thorough evaluation of each individual case is needed to justify a role for it in patient management. Nevertheless, a role for the fat-free, low-lactose milk may be in the diet of lactose-intolerant subjects, as well as in people on weight reducing diets.

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