The effectiveness of 50% lactose-reduced milk in alleviating milk intolerance

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The level of lactose reduction in milk necessary to alleviate the signs and symptoms of lactose intolerance has received little study. The purpose of this study was to determine whether 50% lactose-reduction in milk is adequate to alleviate the signs and symptoms of lactose maldigestion, even when large amounts of milk are consumed. Seven healthy subjects with proven lactose maldigestion consumed graded doses of whole cow's milk and 50% lactose reduced (LR) whole milk to determine the amount which could be consumed before breath hydrogen rose ≥20 ppm. This threshold was exceeded on average with 500 ml of 50% LR milk and 200 ml of whole milk. Whole milk produced significantly more breath hydrogen ($P<0.05$) and maldigestion symptoms ($P<0.05$) at all levels than the 50% LR milk. These results suggest that milk with as little as 50% lactose reduction can play a major role in the diet of individuals with lactase deficiency.

Introduction

Milk and dairy products are a major source of calcium and people who avoid them because of lactose intolerance may compromise their nutritional status and final bone mass[1,2]. Various low lactose milk products have been developed to reduce the signs and symptoms of lactose intolerance (diarrhoea, flatulence and stomach cramps). However, the palatability and versatility of these products is less than that of normal milk[7]. They are sweeter than normal milk because a large proportion of the lactose has been converted to glucose and galactose. Some are available only as powdered or ultra-high temperature treated, long-life products.

Most of the low lactose milks available have had the lactose reduced to less than 20% of the original value. No scientific evidence however has identified 80% or more as the minimum level of lactose reduction for healthy individuals with lactose maldigestion. A recent study by our group[3] suggested that just 50% reduction of lactose in milk may be as effective in alleviating lactose intolerance as ≥80% lactose reduced (LR) milk. The 50% LR milk had the advantage of being almost indistinguishable in taste and texture from normal whole milk and was marketed as a fresh, pasteurized product in Australia.

The purpose of this study was to determine whether 50% lactose-reduction in milk is adequate to alleviate the signs and symptoms of lactose maldigestion, even when large amounts of milk are consumed. The amounts of normal whole milk and 50% LR milk that corresponded to a breath hydrogen rose ≥20 ppm were compared. Differences in symptom response between the two milks were also investigated. The milks were studied in amounts that correspond with realistic levels of consumption.

Methods

Milk products

Dairy Farmers pasteurized, homogenized whole milk (Australian Co-op. Food Ltd., Sydney, Australia) and a 50% LR milk Lacto Lo™ (Cottee Corporation P/L, Sydney, Australia) were studied. This product is manufactured by a patented process that physically removes the lactose from regular milk. Lactose is then added to 50% of the original value. Glucose is also added to give the product the same sweetness as normal milk. The carbohydrate content of the 50% LR product was 3.2 g/100 ml while the fat and protein levels were the same as regular milk (Table 1).

Table 1. Nutrient content per 100 g of the milks studied (manufacturer's data).

Product	Lactose g	Total carbohydrate g	Protein g	Fat g	Energy kJ
50% LR milk	2.4	3.2	3.4	3.9	263
Whole milk	4.8	4.8	3.4	3.9	279

Study design

To identify lactose maldigestion 19 healthy individuals of Asian origin were recruited from the University of Sydney population and given a challenge of 400 ml of

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normal milk containing 19 g of lactose. Of the 19 challenged seven proved to be maldigestors who went on to participate in the rest of the study. The subject characteristics are outlined in Table 2. To be classified as maldigestors subjects had to show an increase in breath hydrogen ≥20 ppm after an overnight fast followed by the milk challenge. Duplicate end expiratory air samples were collected 5 minutes apart at 0, 2 and 3 hours after the challenge. We chose a three hour period because our previous study[3] had shown that peak breath hydrogen production after 300 ml of normal milk occurred before 3 hours and thereafter declined rapidly. Gas tight 20 ml plastic syringes (Terumo P/L, Melbourne, Australia) with a three way stop clock attached were used to collect the breath samples from the side of a modified Haldane-Priestly tube at the end of aspiration into the tube[4]. Subjects were not permitted to eat, smoke or exercise for the duration of the test. Samples were analysed for oxygen and hydrogen as previously described[3]. Symptoms (diarrhoea, flatulence, abdominal cramps and rumbling) were rated at 0, 2 and 3 hours on the scale of 0, none; 1, mild; 2, moderate or 3, severe.

Table 2. Characteristics of subject.

Subject	Age yr	Weight kg	Sex	Country of origin	Rise in breath hydrogen* ppm
1	26	62	M	India	51
2	26	63	M	Korea	36
3	23	73	M	Sri-Lanka	22
4	27	50	M	Phillipines	49
5	35	50	F	Laos	68
6	34	66	M	Nepal	50
7	29	47	F	Phillipines	64

*Rise in breath hydrogen within 3 hours of a challenge with 400 ml of whole milk containing 19 g of lactose.

The seven maldigestors commenced two series of five challenges each. Series 1 involved 100, 200, 300, 400 and 500 ml of normal whole milk, while series 2 involved 200, 300, 400, 500 and 600 ml of 50% LR milk. The challenges and subsequent analysis were carried out in a blind randomized fashion. Subjects were not able to distinguish between the types of milk. Two-way analysis of variance, the Bonferroni adjustment of the Student 't' test for multiple comparisons and the Chi squared test with Yate's correction were used to detect any differences between the milks[5].

The study was approved by the Medical Ethical Review Committee of the University of Sydney and all subjects gave written, informed consent.

Results

Breath hydrogen excretion

The highest mean change in breath hydrogen (peak) recorded in the three hours after the consumption of each amount of milk is shown in Table 3. The greatest rise was seen after consumption of 400 ml of normal milk (mean ± SE: 45 ± 8 ppm, Fig 1). The peak response to 500 ml of normal milk was similar but occurred at 2 h and

Table 3. Mean peak change in breath hydrogen excretion within 3 h of consumption of each level of milk.

Product (ml)	Peak change in breath hydrogen mean±SEM ppm
Whole milk	
100	−3±6
200	22±3
300	34±6
400	45±8
500	45±10
50% lactose-reduced milk	
200	−3±3
300	−3±5
400	12±7
500	22±6
600	20±8

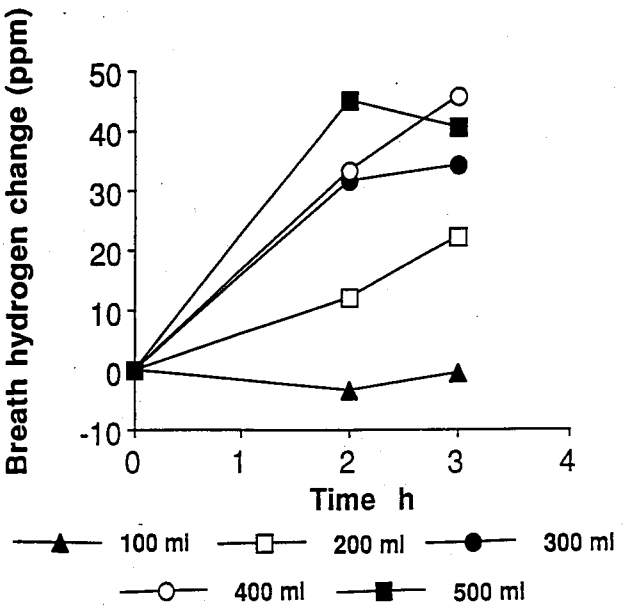

Fig. 1. Mean rise in breath hydrogen at 0, 1, 2 and 3 h after consumption of graded levels of normal milk.

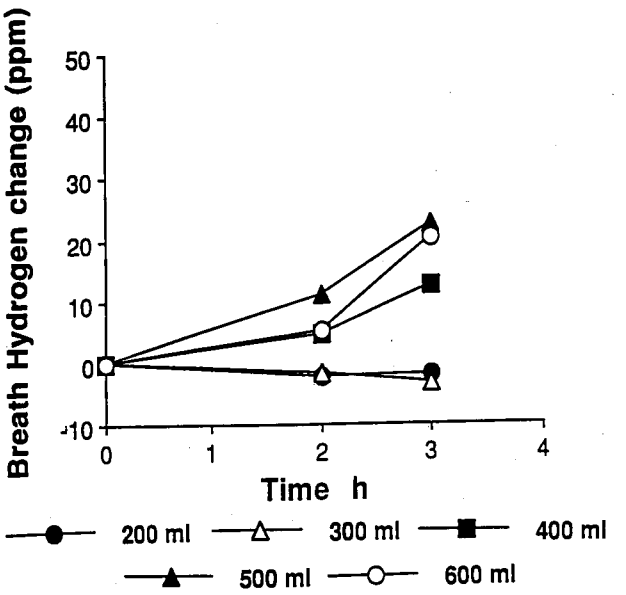

Fig. 2. Mean rise in breath hydrogen at 0, 1, 2 and 3 h after consumption of graded levels of 50% lactose reduced milk.

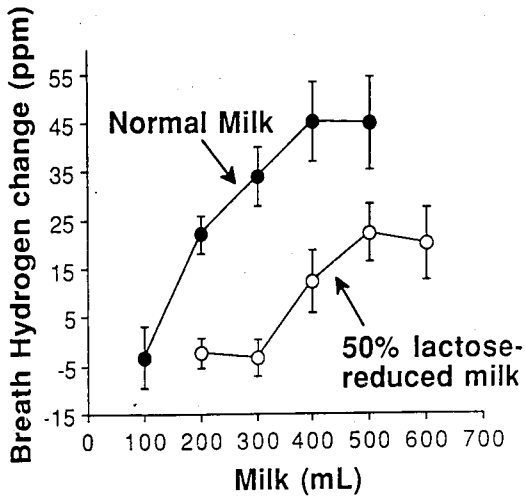

Fig. 3. Peak rise (mean±SE) in breath hydrogen recorded within 3 h of consumption of graded levels of 50% lactose-reduced milk and normal milk.

declined to a level below that of 400 ml normal milk at 3 h. The highest rise in breath hydrogen after 50% LR milk was 22 ± 6 ppm (Fig. 2), occurring after 500 ml of the milk. Statistically significant differences existed between 200, 300, 400 and 500 ml amounts of the two milks ($P<0.01$ in all cases, Fig. 3). The amount of milk corresponding to a rise of 20 ppm was approximately 185 ml for normal whole milk and 480 ml for 50% LR milk.

Symptoms

The number of subjects who developed symptoms for each amount and type of milk is recorded in Table 4. Normal milk produced significantly more symptoms ($p<0.005$, Chi-squared test) than 50% LR milk. Six out of seven subjects recorded symptoms for three levels of normal milk. Only one subject reported symptoms other than flatulence with any amount of 50% LR milk.

Table 4. Number of subjects out of seven reporting symptoms after consuming different amounts of milk containing different levels of lactose.

Whole milk		
100	3/7	4/7
200	4/7	6/7
300	4/7	4/7
400	4/7	6/7
500	4/7	4/7
50% Lactose-reduced		
200	1/7	2/7
300	1/7	3/7
400	1/7	2/7
500	0/7	2/7
600	0/7	4/7

Discussion

These results indicate that a milk with 50% lactose reduction can produce a significant reduction in the signs and symptoms of intolerance in lactose maldigestors. Most studies of lactose maldigestion and milk consumption have investigated milks with lactose reduction of at least 70%[1]. This high level of lactose reduction brings about a decrease in breath hydrogen and symptom response, but the milk may be excessively sweet and therefore unacceptable. A recent study by our group[3] found that a 50% LR milk produced a lowering in breath hydrogen and maldigestion symptoms equivalent to that of ⩾80% LR milk.

The present study determined that at least twice as much of the 50% LR milk could be consumed before breath hydrogen rose more than 20 ppm over fasting levels, compared with that of normal milk. Although subjective symptoms responses should be interpreted cautiously, a significant reduction in symptoms occurred along with the decrease in breath hydrogen production. Only one of the seven subjects recorded symptoms other than flatulence with any amount of the 50% LR milk up to the maximum of 600 ml. Our sample size is small however and limited to a specific age group, warranting a larger study to fully evaluate this milk.

Logically twice as much LR milk could be expected to produce a similar rise in breath hydrogen compared with normal milk. However the results of this study suggest that about 2.5 times as much of the 50% LR milk can be consumed. Breath hydrogen response in lactose maldigestors decreases when lactose is given with a meal[6], thus the same amount of lactose presented in a greater volume of milk, and correspondingly larger amounts of fat and protein, may allow the residual lactase greater opportunity to digest the lactose.

Dairy products provide the majority of daily calcium intake for most people (especially children) as well as making substantial contributions to other nutrient intakes such as riboflavin[8]. Lactase deficiency and consequent milk avoidance has been linked to some forms of osteoporosis[9,10]. The findings of our study strongly suggest a role for a 50% lactose reduced milk and indicate that further work should be pursued.

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摘要

５０％脱乳糖牛奶在减輕牛奶耐受不良的效用

作者指出，用降低牛奶乳糖水平來减輕乳糖不耐受性的研究不多，該研究的目的是降低牛乳中５０％乳糖時，甚至飲用大量牛奶，是否足以减輕乳糖消化不良的症狀和征兆。作者選用７位證實有乳糖消化不良的健康人爲對象，給他們飲用不同劑量的全牛乳和５０％脱乳糖牛奶，測定他們飲用多少牛奶時，氫呼出≥２０PPM。這個臨界值在飲用全牛乳時爲２００毫升，飲用５０％脱乳糖牛奶時爲５００毫升，在飲用相同劑量時，全牛奶氫呼出量和消化不良均明顯高于飲用５０％脱乳糖牛奶（P<0.05），最后作者認爲這些結果指出，５０％脱乳糖牛奶在乳糖醣缺乏個體的膳食中起重要的作用。