RESEARCH ARTICLE

A Comparative study of food products developed from standard dairy milk and lactose hydrolysed milk on their organoleptic qualities

Debanjana Bhattacharyya, Mini Sheth and Vijayata Sengar

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Abstract: In Lactose intolerance, human body is unable to digest lactose present in milk and milk products due to the absence of lactase enzyme and leads to gastrointestinal symptoms. Such individuals are deprived of consuming normal dairy milk and milk products which is an important source of various nutrients. The objective of the study is to develop food products from lactose hydrolysed milk (LHM) and evaluate its organoleptic properties in comparison to regular milk products. Standard methods were used to develop six food products namely *cold cocoa, rose milk, white sauce pasta, vegetable au gratin, kheer and Sandesh* using standard dairy milk and lactose-free milk. Organoleptic evaluation was performed in duplicates using nine point hedonic scale by 50 semi-trained panel members who qualified the threshold test. No significant difference was observed in the organoleptic qualities of all the products except mouth feel and overall acceptability of white sauce pasta prepared from LHM which increased significantly by 6.8% ($p< 0.001$) and 4.12 % ($p< 0.05$) respectively. However, after taste and taste of rose milk prepared from LHM decreased significantly by 3.8% ($p<0.05$) and 5.1% ($p<0.01$) respectively. All the six food products namely *cold cocoa, rose milk, white sauce pasta, vegetable au gratin, kheer and Sandesh* prepared from lactose hydrolysed milk were accepted by the sensory panelist for most organoleptic qualities. Thus, products prepared from lactose hydrolysed milk can be recommended to lactose intolerant individuals which will serve as an important food group full of vital nutrients in their daily diet.

Keywords: Food products, Lactose intolerance, Lactose hydrolysed milk, lactase, Organoleptic evaluation

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Introduction

Milk and dairy products are nutrient-dense foods, supplying energy and high-quality protein with a range of essential micronutrients (especially calcium, magnesium, potassium, zinc, and phosphorus) in an easily absorbed form. (Rizzoli, 2014; Black et al. 2002; Bailey et al. 2010; Bechthold et al. 2019; Kardinaal et al. 1999; Pfeuffer and Watzl, 2017; Burgess, 2014). Globally the prevalence of lactose intolerance is observed to be 5-15% among British population, whereas almost 100% is observed in Asia. In India, it is reported to be 27.4% in north India and 66.6% in southern India (Tandon et al. 1981).Lactose intolerance is an inability to digest lactose present in milk and milk products due to the absence or decreased production of lactase enzyme and leads to gastrointestinal symptoms such as bloating, stomach pain, vomiting, diarrhoea etc. Lactose intolerance are of various types depending upon its cause. Primary lactose intolerance-genetically predetermined reduction of enzyme activity during childhood and adolescence, Secondary lactose intolerance-reduction in enzymic activity in response to intestinal injury and surgery or diseases like inflammatory bowel diseases, giardiasis, rotavirus, celiac disease, tropical sprue etc. Congenital lactose intolerance- enzyme activity absent from birth. Lactose intolerance is one of the factors that may influence milk consumption. Studies suggest that lactose maldigests consume less milk than digesters, possibly as a result of experiences of unpleasant symptoms after ingestion of lactose-containing dairy products. Such individuals are deprived of consuming standard diary milk and milk products (Bayless et al. 2017; Rosado et al. 1987).

Materials and Methods

Procurement of milk and other raw ingredients

Lactose hydrolysed milk was procured from Gujarat Cooperative Milk Marketing Federation (GCMMF), Anand, Gujarat, India and standard milk of the same brand was procured from the local market. The nutritive value of LHM is similar to standard dairy milk except for the value of lactose present in both.
All other ingredients of standard brands that were needed to make the food products were purchased from the local market.

Standardisation of the recipes

A total of six products were standardised two in each category of beverages, main course and dessert respectively namely *cold cocoa, rose milk, white sauce pasta, vegetable au gratin, kheer and Sandesh.*

Cold cocoa was made from cocoa powder (1 tbsp), milk (500ml), sugar (4 tbsp) and corn flour (2 and 1/2 tsp). Milk was boiled with sugar, cocoa powder was added to it and was boiled further. When the sugar and cocoa powder dissolved completely in the milk then we took corn flour dissolved in cold milk (1/4 cup) and added it to the above mixture. Once it thickens as our desired consistency then we allow it to cool. It was garnished with chopped dry fruits and grated chocolate. The entire process of making cold cocoa required 15 minutes.

Rose milk is another beverage wherein milk (500 ml) was boiled with sugar (2tbsp), rose syrup (2 tbsp) was added to it, stirred and garnished with chopped dry fruits.

White sauce pasta is an Italian cuisine. In a cooking pan, onion and garlic was sautéed till they were softened, we added 3-4 tbsp of refined flour into the above sautéed onions and cooked it for more 5 mins, now we poured milk (500ml) and allowed it to boil. Then we added the boiled pasta (250gm) in to it and boil it further for more 10 mins. It was flavoured using oregano, Italian herbs and chili flakes.

In Vegetable au gratin onion and garlic were sautéed till they softened. Vegetables (1 cup) such as carrots, onions, tomatoes, beans were added into it and sautéed further. Now 3-4 tbsp of refined flour was added to it and sautéed for more 5 mins, now we poured milk (500ml) into it and allow the vegetables to cook further and flavouring was incorporated using oregano, Italian herbs and chilli flakes.

Kheer is an Indian porridge. In this milk (1 litre) was boiled with sugar (120 gm) and cardamom (5-6 pieces), vermicelli (240 gm) was added into the milk and boiled further for more 10 minutes. Once the vermicelli were cooked and desired consistency was achieved then it was ready to be served. (vermicelli used in this recipe was roasted from before, if not then one need to roast the vermicelli and then add it into the milk).

Sandesh is a popular dessert from West Bengal in India. Firstly we added sugar (320 gms) and cardamom powder (1 tbsp) into the milk (1.5 l) and stirred it continuously for a period of 20 mins in an open vessel on low flame and allowed it to cook till it became thick in consistency thereafter it was given desired shape. 1.5 litre of milk condensed to give *Sandesh* of around 250 grams.

Threshold test

Threshold test is a test conducted to select panelist who will perform organoleptic evaluation of all the developed food products. In this, sweet, salt, sour and bitter solutions were developed and tasted by the panelists. Panelists who were able to identify the solutions correctly were selected for conducting organoleptic evaluation. Thus the selected panelist performed organoleptic evaluation of the various food products developed from both standard milk and lactose hydrolysed milk.

Organoleptic evaluation

Sensory evaluation of the food products was performed using 9 point hedonic scale by 25 panelists in duplicates wherein panelists were asked score the food products for the various sensory attributes such as colour and appearances, texture, aroma, mouth feel, after taste etc.

Statistical analysis

Statistical analysis was performed using statistical package for social sciences (SPSS) software (version 25). Results were expressed in terms of mean and standard deviation for all the six food products. Students t test was used to determine the significance difference between both the two food products prepared from LHM and standard milk at a p value of 0.5.

Results and Discussion

Organoleptic qualities of Beverages (cold cocoa and rose milk)

As seen in table 1 below, no statistical differences were seen any of the organoleptic properties for cold cocoa. However there was statistically significant reduction in after taste and taste by 3.8% (p value < 0.05) and 5.1% (p value <0.01) respectively.

Organoleptic qualities of white sauce pasta and veg au gratin with and without lactose hydrolysed milk

As mentioned in Table 2 no significant difference was observed in the organoleptic qualities between pasta made from both the standard milk and LHM, except mouth feel and overall

acceptability of white sauce pasta prepared from LHM which was significantly higher by 6.8% ($p < 0.001$) and 4.12 % ($p < 0.05$) respectively. Similarly no difference were observed in veg au gratin prepared from both standard milk and lactose hydrolysed milk. However, score of mouth feel of standard milk was higher than score of moth feel of veg au gratin prepared from lactose hydrolysed milk.

Organoleptic qualities of *kheer* and *Sandesh* with and without lactose hydrolysed milk

As seen in Table 3, No differences were observed in *kheer* and *Sandesh* prepared from standard milk and LHM. However, taste, after taste and over all acceptability of standard milk were reported to be higher in score for *kheer* whereas texture and mouth feel received higher score for *kheer* made up of lactose hydrolysed milk. Visually *Sandesh* prepared from lactose hydrolysed milk was much darker (brownish) in colour. Overall acceptability of *Sandesh* prepared from standard milk received higher score compared to *Sandesh* made from LHM.

Milk is an important source of nutrients. In one of the studies, when lactose consumption was equivalent to 240 ml of milk or less a day, symptoms are likely to be negligible. (Suarez et al. 1995).

Table 1 Organoleptic evaluation of beverages made out of standard milk and LHM

Beverages	Organoleptic properties	Mean ± S.D (Standard milk)	Mean ± S.D (LHM)	t value	P value	%diff
Cold cocoa	Colour and appearance	7.48 ± 0.974	7.56 ± 0.884	0.496	0.622^{NS}	1.06
	Aroma	7.44 ± 0.951	7.48 ± 0.909	0.265	0.792^{NS}	0.53
	Texture	7.36 ± 0.964	7.4 ± 1.01	0.260	0.796^{NS}	0.54
	After taste	7.52 ± 1.182	7.42 ± 0.95	0.532	0.597^{NS}	1.32
	Taste	7.52 ± 1.126	7.66 ± 0.96	0.312	0.757^{NS}	1.86
	Mouthfeel	7.6 ± 0.969	7.42 ± 1.032	1.055	0.297^{NS}	2.36
	Over all acceptability	7.58 ± 0.992	7.58 ± 0.81	0.000	1.000^{NS}	0
Rose milk	Colour and appearance	7.82 ± 1.119	7.5 ± 1.093	1.719	0.092^{NS}	4.09
	Aroma	7.58 ± 1.108	7.26 ± 1.084	1.908	0.062^{NS}	4.22
	Texture	7.72 ± 0.991	7.48 ± 1.092	1.288	0.204^{NS}	3.10
	After taste	7.74 ± 0.986	7.44 ± 0.951	1.976	0.054^{*}	3.87
	Taste	7.82 ± 0.919	7.42 ± 0.928	2.694	0.010^{**}	5.11
	Mouthfeel	7.72 ± 1.011	7.44 ± 0.951	1.705	0.095^{NS}	3.62
	Over all acceptability	7.8 ± 0.969	7.56 ± 0.884	1.731	0.090^{NS}	3.07

Note: NS=non-significant; *= <0.05, **= <0.01, ***=<0.001

Table 2 Organoleptic evaluation of white sauce pasta and veg au gratin made out of standard milk and LHM

Main course		Mean ± S.D (Standard milk)	Mean ± S.D (LHM)	t value	P value	%diff
White sauce pasta	Colour and appearance	6.98 ± 1.204	6.78 ± 1.016	1.167	0.249^{NS}	2.86
	Aroma	6.68 ± 1.115	6.78 ± 1.093	0.573	0.569^{NS}	1.49
	Texture	6.98 ± 1.04	7.08 ± 1.007	0.598	0.553^{NS}	1.43
	After taste	6.72 ± 1.196	6.96 ± 1.009	1.205	0.234^{NS}	2.98
	Taste	6.7 ± 1.074	6.9 ± 0.995	0.953	0.345^{NS}	2.98
	Mouth feel	6.76 ± 1.17	7.22 ± .996	2.837	0.007^{**}	6.80
	Over all acceptability	6.78 ± 1.055	7.06 ± 0.998	1.705	0.095^{*}	4.12
Vegetable au gratin	Colour and appearance	7.46 ± 1.147	7.28 ± 1.179	1.219	0.229^{NS}	2.40
	Aroma	7.28 ± 1.246	7.5 ± 1.111	1.355	0.182^{NS}	3.02
	Texture	7.42 ± 1.162	7.52 ± 1.015	0.626	0.534^{NS}	1.34
	After taste	7.42 ± 1.197	7.52 ± 1.035	0.670	0.506^{NS}	1.34
	Taste	7.4 ± 1.143	7.5 ± 1.035	0.590	0.558^{NS}	1.35
	Mouth feel	7.38 ± 1.93	7.42 ± 1.052	0.252	0.802^{NS}	0.54
	Over all acceptability	7.48 ± 1.216	7.54 ± 1.054	0.387	0.700^{NS}	0.80

Note: NS=non-significant; *= <0.05, **= <0.01, ***=<0.001

Table 3 Organoleptic evaluation of desserts (*kheer* and *Sandesh)* made out of standard milk and Lactose hydrolysed milk

Desserts		Mean ± S.D (Standard milk)	Mean ± S.D (LHM)	t value	p value	%diff
Kheer	Colour and appearance	7.9 ± 0.909	7.76 ± 0.894	0.943	0.35^{NS}	1.77
	Aroma	7.8 ± 0.99	7.68 ± 1.039	0.759	0.452^{NS}	1.53
	Texture	7.8 ± 0.756	7.9 ± 0.863	0.670	0.506^{NS}	1.28
	After taste	7.84 ± 0.912	7.76 ± 1.001	0.496	0.622^{NS}	1.02
	Taste	7.96 ± 0.781	7.9 ± 0.931	0.417	0.679^{NS}	0.75
	Mouthfeel	7.8 ± 0.782	7.92 ± 0.877	0.759	0.452^{NS}	1.53
	Over all acceptability	8.02 ± 0.685	7.92 ± 0.752	0.962	0.341^{NS}	1.24
Sandesh	Colour andappearance	7.64 ± 1.174	7.62 ± 0.987	0.110	0.913^{NS}	0.261
	Aroma	7.62 ± 1.008	7.52 ± 0.931	0.538	0.593^{NS}	1.31
	Texture	7.5 ± 1.055	7.62 ± 0.945	0.651	0.518^{NS}	1.6
	After taste	7.58 ± 1.247	7.64 ± 0.875	0.335	0.739^{NS}	0.79
	Taste	7.54 ± 1.216	7.64 ± 0.985	0.509	0.613^{NS}	1.32
	Mouthfeel	7.44 ± 1.198	7.66 ± 0.798	1.244	0.219^{NS}	2.95
	Over all acceptability	7.56 ± 1.181	7.74 ± 0.853	1.055	0.297^{NS}	2.38

Lactose intolerance problems can be controlled by using b galactosidase which hydrolyses lactose into glucose and galactose and provides a sweet flavour. Glucose is a source of energy and galactose plays a vital function in brain development (Adam et al. 2004; Aggarwal et al. 2019).

Lactose hydrolysed milk can be further utilized in preparation of fermented dairy products such as cheese, yoghurt, *dahi* and heat desiccated products such as *khoa*. Lactose hydrolysis in milk imparts better digestibility and sweet taste, leading to a recent rise in the demand for lactose hydrolyzed dairy products (Aggarwal et al. 2019).

In a study in India, sensory evaluation of low lactose *khoa* prepared from hydrolysed buffalo milk was performed on the basis of 100 point composite card. Statistical analysis revealed no significant change ($p>0.05$) in flavour and body and texture in *Khoa* prepared from lactose hydrolyzed milk compared with fresh milk *Khoa* samples until the 21st day of storage but a significant change ($p<0.05$) was observed on the 28th day. However, the flavour scores of *Khoa* prepared from fresh milk had slightly higher scores than *Khoa* prepared from lactose hydrolyzed milk. The variation can be attributed to the development of a sweet flavour owing to the release of monosaccharides i.e. glucose and galactose released upon lactose hydrolysis in milk used for the preparation of *Khoa* (Aggarwal et al. 2019) unlike the present study. Similar results were obtained where higher sweetness in lactose hydrolysed *gulab jamun* (a deep-fried *khoa* Indian dessert) compared with control was observed (Harini & Rao. 2011). In the present study also, *Sandesh* prepared from lactose hydrolysed milk had higher sweetness compared to *Sandesh* prepared from standard dairy milk. While heating, during *Sandesh* preparation a slight brown colour appeared due to Maillard reaction in lactose hydrolysed milk compared to *Sandesh* prepared from standard dairy milk. Well known, that lactose hydrolyzed milk has a sweeter taste and more prone to strong Maillard reaction. (Csanádi et al. 2010). In one of the study, organoleptic properties of yogurt made up of lactose hydrolysed milk and standard revealed no significant changes between control and the test samples upon evaluation by triangle test, however the addition of fruit and sugars increased sweetness when detected by triangle test (Ismail et al. 1983).

In another study, the use of low lactose milk with varying degree of hydrolysis of lactose may have an impact on the textural properties of yogurt. In a study, yogurt prepared using 50%, 70% and 90% hydrolysed lactose revealed significantly higher scores for body and texture, flavour and overall acceptability than control ($P<0.05$). whereas lower scores were observed for 90% hydrolysis. (Nagaraj et al. 2009). From the above studies we can say that a wide variety of food products can be developed from lactose hydrolysed milk without compromising on its organoleptic properties at both household and commercial level.

Conclusions

On the basis of the results obtained the sensory panelist accepted all the six food products prepared from lactose hydrolysed milk based upon organoleptic qualities. Milk and milk products are highly nutritious food especially in calcium and protein. In a predominant vegetarian population milk is the only good quality protein consumed by the people. Thus, food products derived from lactose hydrolysed milk can be replaced by those prepared from conventional standard milk as avoidance of milk and milk products have been the most common method of treating lactose intolerance. Lactose present in lactose hydrolysed milk is broken down into glucose and galactose thus resulting into sweeter taste compared to standard milk. Therefore, milk based recipes

which requires added sugar can be developed using LHM with lesser amount of sugar and may be recommended to lactose intolerant individuals. Also, development of various recipes can help in adding variety to the diet as many children and elderly do not like plain milk.

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Determination of Lactose Intolerance and Effect of Supplementing Lactose Hydrolyzed Milk among Elderly Population of Urban Vadodara

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Abstract

Lactose intolerance is the inability to digest lactose which may lead to gastrointestinal symptoms. These symptoms hinder nutrient absorption and cause discomfort. The objective of the study was to determine lactose intolerance and determine the effect of lactose hydrolyzed milk supplementation to lactose intolerants among geriatric population. A semi-structured questionnaire was developed to assess gastrointestinal symptoms post-consumption of various foods. Hydrogen breath analyser test (HBT) was conducted to determine lactose intolerance and further divided into mild, moderate, and severe categories of lactose intolerance. Lactose intolerants are supplemented with lactose hydrolyzed milk (LHM) for 6 weeks. The highest gastrointestinal symptoms were observed in 37.4% of the subjects' post-milk and milk products consumption whereas cereal products exhibited the least (2.73%). HBT revealed that 55.5% of the subjects were lactose intolerant. A significant improvement ($P < 0.05$) in energy, protein, calcium, and fat intakes was observed post-supplementation by 3%, 3.30%, 43.62%, and 4.19%, respectively. There was an increase in normal category body weight by 6.7% post-LHM supplementation. No significant changes ($P < 0.05$) were observed in quality of life before and after intervention. Conclusion: Lactose-intolerance was 55.5% among the studied geriatric population. All the elderlies (100%) were able to tolerate LHM without experiencing any gastrointestinal disturbances for 45 days.

Keywords: Lactose intolerance, Hydrogen breath analyser test, Lactose hydrolyzed milk

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Introduction

Milk and milk products are nutritious and an excellent source of calcium and protein, with a range of essential micronutrients (especially calcium, magnesium, potassium, zinc, and phosphorus) in an easily absorbed form.[1-5] Lactose is a disaccharide present in milk and milk products. It consists of monosaccharide glucose and galactose. Hydrolysis of lactose is carried out by enzyme-Lactase–phlorizin hydrolase (commonly known as lactase. Lactose intolerance is an inability to digest lactose due to less or no lactose produced by the brush border of the small intestine.[6] Lactose intolerance is characterized by gastrointestinal symptoms such as vomiting, diarrhea, stomach pain, nausea, and headache. Such individuals are unable to drink milk and have other milk products diary milk and milk products.[7,8]

Lactose intolerance is of four types – primary lactose intolerance, secondary lactose intolerance, developmental lactose intolerance, and congenital lactose intolerance.[9] There are various methods for detecting lactose intolerance, namely, lactose tolerance test, breath analyser test, intestinal biopsy, and genetic analysis.[10,11] The objective of the study was to assess the presence of lactose intolerance among elderlies and the effect of lactose hydrolyzed milk (LHM) supplementation on their dietary intake, anthropometry, and quality of life.

Methodology

Using cross-sectional study design and purposive sampling technique, 219 elderlies (60 and above year) were enrolled and screened for the presence of gastrointestinal symptoms using semi-structured questionnaire. Hydrogen breath test (HBT) was conducted to determine the lactose intolerant elderlies ($n = 54$) and classified them into mild, moderate, and severe categories followed by supplementing them with 250 ml Lactose hydrolyzed milk (LHM) [procured from Amul® dairy] daily for a period of 6 weeks. Nutrient intake (24 h dietary recall), anthropometry (standard methods), and quality of life (semi-structured questionnaire) were determined before and after the intervention period. Statistical analysis was performed using Statistical Package for the Social Sciences (SPSS) software (version 25).

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Results and Discussion

Gastrointestinal Symptoms Post-consumption of Various Foods

Food intolerances are opposing reaction to foods, the immune system does as not play a role in this.[12] Symptoms of intolerance toward carbohydrates are caused mainly due to deficiency of enzymes or transporters or overloading of a transport system located on the brush border of the epithelium lining present in the small intestine. Fermentable oligosaccharides, disaccharides,

monosaccharides, and polyols (FODMAPs) are some of the short-chain carbohydrates that are poorly absorbed at the intestinal level.[13] Prevalence of food intolerance among FGID (functional gastrointestinal disorders) was 60% intolerance toward fructose whereas 51% intolerance was detected toward lactose and 33% subjects showed intolerance for both. Any undigested fructose will lead to gastrointestinal discomfort and show symptoms similar to lactose.[14] In this, gastrointestinal symptoms were observed in 28% of the subjects' post-milk and milk products consumption followed by vegetables (13%), pulses (7%), fermented foods (10%), fruits (9%), and cereal products (3%). Among milk and milk products, 65% of elderlies suffered from gastrointestinal symptoms due to milk followed by cheese (7%) [Table 1].

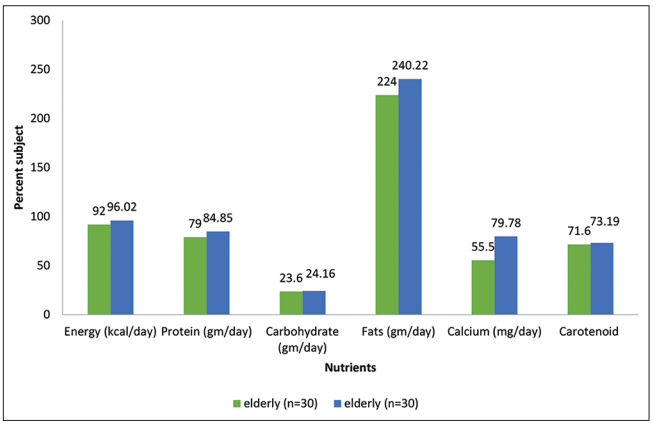

Figure 1: Impact of lactose hydrolyzed milk supplementation on dietary intake

Table 1: Gastrointestinal symptoms experienced by elderlies after milk and milk products consumption (*n*=82)

Milk and milk products	*n (%)*
Milk	53 (64.6)
Lassi	2 (2.43)
Kadhi	4 (4.87)
Milk powder	0 (0)
Chaach	3 (3.65)
Milk sweets	2 (2.43)
Milk chocolates	0 (0)
Ice cream	1 (1.21)
Cheese	7 (8.53)
Fruit custard	6 (7.31)
Yogurt	4 (4.87)
Condensed milk	0 (0)

Detection of Lactose Intolerance

HBT is the most used method because it is non-invasive, inexpensive, and highly sensitive and specific, as well as easy to perform.[6,15] The principles of breath test are based on the concept that part of the gas produced by colonic bacteria fermentation diffuses into the blood, is rapidly excreted by breath, and can be consequently measured and quantified by dedicated instruments.[16-19] Solomons *et al*. 1980 mentioned in their study that 50 g of lactose was used for the breath test but that lead to diarrhea and flatulence among patients during the test. Therefore, another study was conducted by[20] in which the amount of lactose used was modified for conducting lactose hydrogen breath test. Patients positive with 50 g lactose were repeated with 25 and 12.5 g lactose in 1-week interval. About 91.4% patients were detected of LI with 25 g lactose and 42.8% with 12.5 g lactose. Symptoms of diarrhea (63%) and flatulence (97%) decreased to 22.8 and 34.2%, respectively with 25 g lactose. Therefore, 25 g of oral lactose dose was used for detecting the occurrence of lactose intolerance in our study. Post-conducting HBT, it was revealed that 55.5% of the subjects were lactose intolerant and divided into three categories – mild, moderate, and severe [Table 2].

Impact after Lactose Hydrolyzed Milk Supplementation

Milk is beneficial for overall nutritional intake among elderly. Wall *et al*. 2014 concluded that proteins such as whey protein that are rapidly digested and absorbed lead to greater muscle protein synthesis than proteins that are more slowly digested such as casein and those in soya. Thereby emphasizing the importance of dairy protein for elderly. In this study, mean energy intake at baseline was 1788.85 ± 272.40 whereas post-intervention, it was 1847.93 ± 273.3 with a % diff of 3.30. Calcium intake at baseline was 333.35 ± 118.05 whereas post-supplementation, it was 478.77 ± 117.19 [Table 3]. Significant improvement ($P < 0.05$) in energy, protein, calcium, and fat intakes was observed post-supplementation by 3%, 3.30%, 43.62%, and 4.19%, respectively [Figure 1].

Post-LHM supplementation, there was an increase in normal category body weight by 6.7%. Obesity and overweight remained the same whereas post-LHM supplementation underweight

Table 2: Presence of lactose intolerance and its severity among subjects

Presence of lactose intolerance (n=54)		*Categories of lactose intolerant subject (n=30)*	
Lactose intolerant	30 (55.5%)	Mild malabsorption (>20 ppm)	26 (86.6%)
Non-lactose intolerant	24 (44.4%)	Moderate malabsorption (>60 ppm)	4 (3.3%)
		Severe malabsorption (>80 ppm)	0 (0%)

Table 3: Effect of lactose hydrolyzed milk supplementation on dietary intake (n=30)

Nutrients	*Pre-supplementation*	*Post-supplementation*	*Paired t test*	*% Difference*
Energy	1788.85±272.40	1847.93±273.3	83.7***	3.30
Protein	45.06±6.19	48.01±5.16	5.3***	6.54
Carbohydrate	225.69±75.84	235.16±77.99	2.21*	4.19
Fat	48.35±8.41	51.90±8.22	42.63***	7.34
Calcium	333.35±118.05	478.77±117.19	244.25***	43.62
Carotenoid	3437.8±584.78	3583.08±584.62	1025.19***	4.22

***Significant at 0.001, **Significant at 0.01, NS: Non-significant

Table 4: Effect of lactose hydrolyzed milk supplementation on anthropometry (BM)

Categories	*Pre-supplementation %*	*Post-supplementation %*
Underweight	14	7
Normal	33	40
Overweight	33	33
Obese	20	20

decreased by 6% [Table 4].

The health-related quality of life (HRQOL) is a patient-focused concept, referring to an impairment of functional status (physical or mental) and the sense of well-being. The health-related quality of life was significantly impaired in subjects with GERD, un investigated dyspepsia and IBS in this community.[21] In this study however, no significant changes ($P < 0.05$) were observed in quality of life post-intervention.

Conclusion

A study conducted in Indonesia revealed the prevalence of lactose intolerance among elderlies amounted to 66% (57–75%), 54% (37–70%), and 73% (61–84%) in the total population, dairy and non-dairy users, respectively.[22] In the present study, 37.4% of subjects suffered from gastrointestinal symptoms post-milk and milk products intake. The presence of lactose intolerance among elderly is 13.7% of the total population studied. In this study, lactose intolerance was determined using hydrogen breath analyser test. For further research, methane and hydrogen breath analyser can also be used along with genetic analysis and intestinal biopsy.

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DETERMINATION OF GASTROINTESTINAL SYMPTOMS UPON CONSUMPTION OF VARIOUS FOODS AND PRESENCE OF LACTOSE INTOLERANCE AMONG CHILDREN, ADULTS AND ELDERLY POPULATION OF URBAN VADODARA

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ABSTRACT

Several studies globally have reported that consumption of various foodsleads to the occurrence of gastrointestinal discomfort.Lactose intolerance is a condition caused due to the inability to digest lactose present in milk and milk products thereby leading to gastrointestinal symptoms such as stomach pain, acidity, vomiting, diarrhoea, bloating, nausea and so on.Often it gets undetected as patient might not be aware regarding the cause behind the occurring gastric discomfort. These symptoms and discomfort will hinder the absorption of nutrients derived from foods. **Objective:** The objective of the study was to determine occurrence of gastrointestinal discomfort caused due to consumption of various foods and to detect the presence and severity of lactose intolerance among the children, adults and the elderly population in urban Vadodara.**Hypothesis**: 1) Gastrointestinal symptoms can occur post consumption of various foods. 2) Lactose intolerant subjects will be detected among children, adults and elderly population. **Methodology:** Gastrointestinal symptoms were analysed using a semi-structured questionnaire for several food groups including milk and milk products. Those responding symptoms from milk and milk products were enrolled for hydrogen breath analyser test to detect lactose intolerance.**Findings:**Around 27.5% of the subjects reported to have experienced gastrointestinal symptoms due to the consumption of milk and milk based products followed by vegetables (14.2%), pulses (5.8%), fermented foods (6.9%), fruits (8.8%) and cereal products (3.2%).The present study revealed that 49.7% of subjects were lactose intolerant and classified into three categories: mild (>21 ppm), moderate (>60 ppm) and severe (>80 ppm). Lactose intolerance was found to be 11.02%, 8.75 % and 13.7% amongst children, adult and elderly population respectively. **Conclusion**: The present study was conducted in a population of urban Vadodara and prevalence of Lactose intolerance was detected to be 11.02%, 8.75 % and 13.7% amongst children, adult and elderly population respectively.

Keywords: lactose intolerance, hydrogen breath analyser, lactase and lactose.

INTRODUCTION

Milk and milk products are an excellent source of calcium and protein. Lactose is a form of disaccharide occurring in milk and milk derived products. It is comprised of the monomers glucose and galactose. Intestinal absorption of lactose is caused due to the enzyme lactase present in the brush-border of the intestine.From 8thweek of intra-uterine life, lactase activity can be observed at the surface mucosa in our intestine.Lactose intolerance is an inability to digest lactose present in milk and milk products due to the absence or decreased production of lactase enzyme and leads to occurrence of gastrointestinal symptoms such as bloating, stomach pain, vomiting, diarrhoea, nausea, constipation etc.Globally the incidence of lactose intolerance prevailing is found to be 5-15% among British population, whereas almost 100% of Asian population reported lactose intolerant. 25% of adults show decreased lactose digestion in North America.Worldwide, the prevalence of lactose intolerance is found to be 50% in South America, Asia, and Africa and is reported to be almost 100% in some Asian countries (Vesa H et al 2000). Lomer, 2008 mentioned in their study that Northern Europeans, North Americans, along with Australians have the lowest

rates of lactose intolerance. North India has reported to have 27.4% and whereas southern India has reported to have 66.6% of lactose intolerant (Tandon et al. 1981).

The present study was conducted in Vadodara with the following objectives.

OBJECTIVES

1. To determine the presence of gastrointestinal symptoms post consumption of various food products including milk and milk products

2. To detect presence of lactose intolerance among children, adults and elderly of urban Vadodara using Hydrogen Breath Analysis test

METHODOLOGY

Study design

Using cross-sectional study design and purposive sampling technique the study was conducted.

Screening subjects for gastrointestinal symptoms

A total of 3000 adults consisting of staff members and their families working in a university of Vadodara, 272 school going children (10 to 17 years old) and 950 people from elderly population were screened for the presence of any gastric discomfort after consumption of various foods by means of a semi-structured questionnaire.

Screening subjects for lactose intolerance

Subjects reporting gastric discomfort post consumption of milk and milk products were enrolled for **Hydrogen breath analyser test** to confirm the presence and determine the degree of lactose intolerance after obtaining their consent.

Hydrogen breath analyser test

Breath analyser is a device which analyses human breath. Breath analyser is substrate non-specific. The breath analyser can be hydrogen, methane or both analyser. The device used in this study is a hydrogen breath analyser. In this test, an oral dose of 25gm of lactose powder dissolved in 250 ml of water is orally administered to the subjects after an overnight fast and after 30 mins they had to blow out air through their mouth into the device for 6 times with a interval of 30 mins between each breath. This calculates the hydrogen emitted by the human gut post consumption. The subjects were not allowed to eat anything during the test period. However, drinking water was allowed. Patients were advised to avoid food rice in fats and spices the previous night of the test and antibiotics were avoided for 1 week before the test.

FINDINGS AND DISCUSSION

General information of Respondents

A semi-structured questionnaire was developed and 994 individuals comprising of 503 adults, 272 children and 219 elderly responded to the questionnaire given to them. Most subjects belonged to the age group of 17 to 35 years followed by 13 to 17 years (table 1). Around 42% respondents belonged to nuclear family whereas 15% belonged to joint family.

Table 1 General information of the respondents (N=994)

Parameters	Total subjects N(%)
Age	
10-12yrs	**92 (9.25%)**
13-17yrs	**180 (18.1%)**
18-35yrs	**397 (39.93%)**
36-50yrs	**52 (5.23%)**
51-60yrs	**54 (5.43%)**
61-80yrs	**165 (16.59%)**
80 and above	**54 (5.43%)**
Sex	
Female	**550 (55.3%)**
Male	**444 (44.6%)**
Types of family	
Nuclear family	**421 (42.3%)**
Extended family	**394 (39.6%)**
Joint family	**159 (15.9%)**

Gastrointestinal symptoms experienced by respondents upon consumption of the various food groups:

Food intolerances are opposing reaction to foods, the immune system do not play a role in this (Turnbull,2015).Symptoms of intolerance towards carbohydrates are caused mainly due to deficiency of enzymes or transporters or overloading of a transport system located on the brush border of the epithelium lining present in the small intestine. Fermentable oligosaccharides, disaccharides, monosaccharides, and polyols (FODMAPs) are some of the short-chain carbohydrates that are poorly absorbed at the intestinal level (Berni Canani, et al, 2016).Wilder-Smith, et al (2013) mentioned in their study that prevalence of food intolerance among FGID (functional gastrointestinal disorders) was 60% intolerance towards fructose whereas 51% intolerance was detected towards lactose and 33% subjects showed intolerance for both. Any undigested fructose will lead to gastrointestinal discomfort and show symptoms similar to lactose

intolerance or IBS. Joshi et al (2015) found that 15.49% of children with type 1 diabetes had celiac disease. Makharia, et al (2011) also reported prevalence of celiac disease (1.04%) in a community of norther India. Simrén, M. et al (2001) mentioned that foods rich in carbohydrates, coffee, alcohol and hot spices along with fatty foods were most frequently reported to cause symptoms, most commonly such as gas problems and abdominal pain among IBS patients compared to healthy individuals. Lactose intolerance leads to symptoms such as abdominal pain, bloating, borborygmi, diarrhea along with nausea, dizziness, fatigue, constipation, pain in muscle and joints, tachycardia etc (Campbell, et al ,2004; Matthews, S. et al 2000). Burgio, et al (1984) showed the presence of lactose intolerance in more than half of the population in two groups of Italy, namely north and Sicily.

Gastrointestinal symptoms post consumption of food-groups such as milk and milk products, cereals, pulses, fermented foods, fruits and vegetables was assessed. It was observed that nearly 22.1% of the subjects reported to have experienced gastrointestinal symptoms due to the consumption of milk and milk-based products followed by vegetables (14.2%), pulses (5.8%), fermented foods (6.9%), fruits (8.8%) and cereal products (3.2%) (Table 2). As seen in table 3, majority of the subjects had gastrointestinal discomfort post consuming of milk followed by cheese and kadhi. Nearly one third of the respondents didn't experience any adverse gastrointestinal symptoms after consumption of various foods.

Table 2- Gastrointestinal symptoms experienced after consumption of various Food

Various food groups	Children(n=272)	Adult (n=503)	Elderly(n=219)	Total (N=994)
Milk and milk products	24.26% (66)	18.4% (93)	27.85% (61)	220 (22.1%)
Vegetables	19.85% (54)	14.31% (72)	13.24% (28)	154 (15.5%)
Pulses	1.01% (3)	8.15% (41)	7.30% (16)	60 (6.03%)
Cereal products	4.04% (11)	2.9% (14)	2.73% (6)	31 (3.11%)
Fermented foods	5.88% (16)	6.56% (33)	10.04% (22)	71 (7.14%)
Fruits	16.9% (46)	5.16% (26)	9.13% (20)	92 (9.25%)

Table 3 Gastrointestinal symptoms experienced by subjects of various age groups after consumption of various milkand milk products (N=274)

Milk and milk products	Children (n=99)	Adult (n=93)	Elderly (n=82)	Total -274 (N)
Milk	15 (15.15%)	57(61.3%)	53 (64.6%)	125(45.6%)
Lassi	5 (5.05%)	6 (6.45%)	2 (2.43%)	13 (4.74%)
Kadhi	9 (9.09%)	7 (7.52%)	4 (4.87%)	20ss (7.29%)
Milk powder	8 (8.08%)	5 (5.37%)	0 (0%)	13 (4.74%)
Chaach	8 (8.08%)	4 (4.30%)	3 (3.65%)	15 (5.47%)
Milk sweets	9 (9.09%)	2 (2.15%)	2 (2.43%)	13 (4.74%)
Milk chocolates	0 (0%)	0 (0%)	0 (0%)	(0%)
Ice cream	12 (12.12%)	3 (3.2%)	1 (1.21%)	16 (5.83%)
Cheese	17 (17.17%)	4 (4.3%)	7 (8.53%)	28 (10.21%)
Fruit custard	4 (4.04%)	2 (2.15%)	6 (7.31%)	12 (4.37%)
Yogurt	6 (6.06%)	3 (3.22%)	4 (4.87%)	13 (4.74%)
Condensed milk	6 (6.06%)	0 (0%)	0 (0%)	6 (2.18%)

Occurrence and severity of lactose intolerance (N=181)

Solomons et al (1980) mentioned in their study that 50 g of lactose was used for the breath test but that lead todiarrhoea and flatulence among patients during the test. Therefore another study was conducted by (Rana et al, 1995) in which the amount of lactose used was modified for conducting lactose hydrogen breath test. Patients positive with 50 g lactose were repeated with 25 and 12.5 g lactose in 1-week interval. 91.4 % patients were detected of LI with 25 g lactose and 42.8 % with 12.5 g lactose. Symptoms of diarrhoea (63 %) and flatulence (97 %) decreased to 22.8 and 34.2 % respectively with 25 g lactose. Therefore, 25 g of oral lactose dose was used for detecting the occurrence of lactose intolerance in our study. Yang Y et al (2000) mentioned in their study conducted in China, lactose intolerance occurred in 38.5% of children in the 3-5 year age group, and 87% of the 7-8 year and 11-13 year old groups. As seen in table 4, a total of 181 subjects- 62 children, 65 adults and 54 elderly were screened for presence of LI using hydrogen breath analyser test and it was concluded that 49.72% of them were lactose intolerant. The subjects with lactose intolerance in present study were divided into mild, moderate and severe categories depending on the severity of lactose intolerance. Majority of the subjects (80%) fell in the mild malabsorption category (Table 5).

Table 4- Presence of lactose intolerance amongst post HBA test (N=181)

Presence of lactose intolerance	Children (n=65)	Adult (n=62)	Elderly (n=54)	Total N (%) (N=181)
Lactose intolerant	30 (46.15%)	30 (48.3%)	30 (55.5%)	90 (49.72%)
Non- lactose intolerant	35 (53.84%)	32 (51.6%)	24 (44.4%)	91 (50.27%)

Table 5- Severity of lactose intolerance amongst the subjects (N=90)

Category	Children (n=30)	Adult (n=30)	Elderly (n=30)	Total N (%) (N=90)
Mild malabsorption (>21 ppm)	28(93.3%)	26 (86.6)	26 (86.6%)	**80 (88.8%)**
Moderate malabsorption (>60ppm)	2 (6.6%)	3 (10)	4 (13.3%)	**9 (9.4%)**
Severe malabsorption (>80 ppm)	0 (0%)	1(3.3%)	0 (0%)	**1 (1.1%)**

Mean values of Hydrogen breath analyser test (HBT) conducted (N=181)

Mean baseline readings amongst lactose intolerant subjects was higher than the mean baseline readings amongst non-lactose intolerant subject.

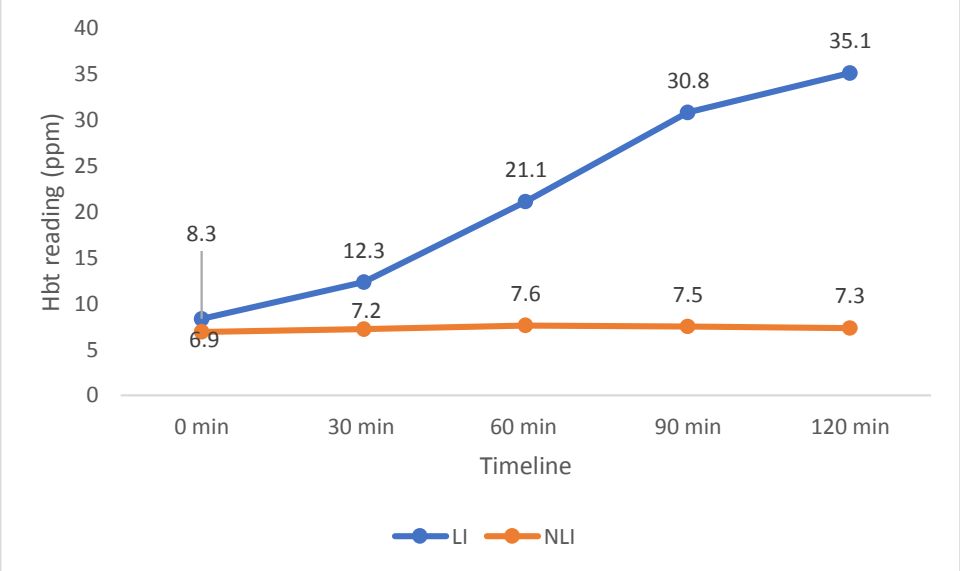

Figure 1 - Hydrogen Breath Analyser readings for Lactose Intolerant and Non-Lactose Intolerant subjects among children (N=65)

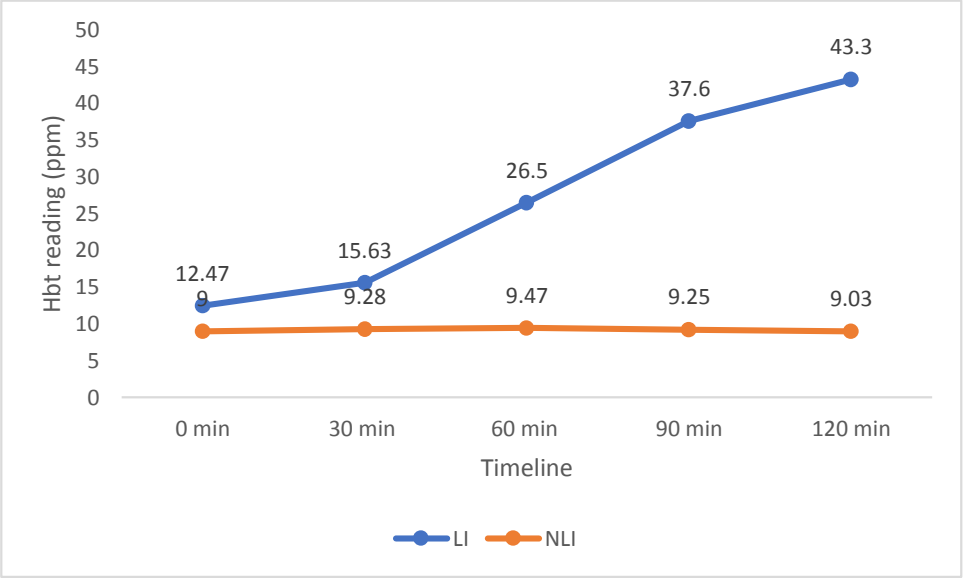

Figure 2 - Hydrogen Breath Analyser readings for Lactose Intolerant and Non Lactose Intolerant subjects among adult subjects (N=62)

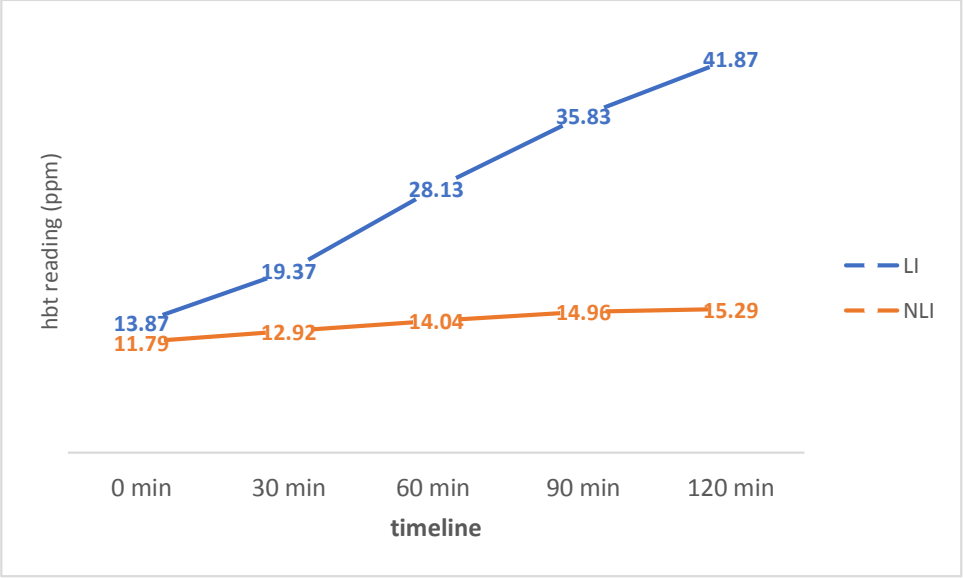

Figure 3 - Hydrogen Breath Analyser readings for Lactose Intolerant and Non-Lactose Intolerant subjects among elderly subjects (N=54)

SUMMARY, CONCLUSION AND IMPLICATIONS

The present study was conducted in a population of urban Vadodara comprising children, adults and elderlies to determine the presence of gastrointestinal symptoms experienced by them post consumption of various foods using a semi-structured questionnaire and to detect the presence and degree of severity of lactose intolerance using hydrogen breath analyser test and classifying

them into mild, moderate and severe category.On the basis of the result obtained from the present study, Hydrogen breath analyser test revealed that 49.72% of them were lactose intolerant and 88.8% subjects fall into the mild intolerance category. Prevalence of Lactose intolerance was found to be 11.02%, 8.75 %and 13.7% amongst children, adult and elderly population respectively. Hydrogen breath analyser is one of the effective devices to detect Lactose intolerance. The breath analyser used in this study was a hydrogen breath analyser. For further research, Lactose intolerance can be detected using a methane and hydrogen breath analyser and also genetic analysis. Intestinal gut microflora can also be analysed to understand lactose intolerance further.

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