Summary and conclusions

CHAPTER 6

SUMMARY AND CONCLUSIONS

Lactose intolerance is a condition in which humans are not able to digest milk sugar- lactose due to the lack of enzyme – lactase. Lactase is disaccharides- composed of two mono saccharides- glucose and galactose. Lactase (β-galactosidase) enzyme is required for enzymatic hydrolysis of lactose (Harvey L et al 2018), (Szilagyi A et al 2018) (Misselwitz B et al 2019). Hippocrates first used the term lactose intolerance around 4000 BC (Lomer MCE 2007). When body is unable to synthesise enough lactase then lactose consumed through food is not digested leading to colonic fermentation. This causes gastrointestinal symptoms such as bloating, nausea, flatulence, diarrhoea, vomiting etc. intestinal injury can be one of the several causes leading to lactose intolerance (Matthews SB et al 2005) (Misselwitz B et al 2019).

In lactose tolerant individuals, the enzyme lactase phlorizin hydrolase (lactase, a b- galactosidase) hydrolyses lactose into monosaccharides, glucose n galactose. These are then absorbed by intestinal enterocytes into the bloodstream, where glucose is utilized as a source of energy and galactose becomes a component of glycolipids and glycoproteins.

In the absence or low production of lactase, lactose hydrolysis does not take place. This undigested lactose leads to fermentation in colon due to bacteria present in it. This results in massive production of short chain fatty acids, methane, carbon dioxide etc. leading to gastrointestinal symptoms such as bloating, acidity, diarrhoea, vomiting, borborygmi etc. Headache and nausea might also occur as a result of indigestion. Severity of symptoms occur with severity in maldigestion of lactose.

In adults, white north Europeans, North Americans and Australasians have the lowest rates ranging from 5% in a British population to 17% in Finland and northern France. In South America, Africa and Asia, over 50% of the population has lactase non-persistence and in some Asian countries this rate is almost 100% (Lomer MCE 2007). In Indian sub-continent it is observed to be 70% in southern India whereas 30% in northern India (Vrese MD 2001).

Various modes of treatments are available such as avoidance of milk, consumption of plant-based milk, introduction of yogurt and other probiotics and enzyme replacement therapy.

Milk is a one of the most important sources of nutrients for children, adults and elderly and plays a significant role in maintaining the health of the individuals.

Several children (at varying stages-early childhood, childhood, adolescence) suffer from lactose intolerance leading to occurrence of symptoms such severe abdominal pain, nausea, diarrhoea and dehydration, these symptoms eventually interfere with the growth of children.

However very few literatures are available upon consumption of hydrolysed milk and food products developed from hydrolysed milk.

This study titled **"Assessing the presence of Lactose Intolerance among Children, Adults and Elderly of Urban Vadodara and Evaluating the Impact of Supplementing Lactose Hydrolysed Milk on their Quality of Life and Nutritional Status"** is been divided into four phases.

Phase I- Screening and identification of Lactose Intolerant (LI) subjects. Hydrogen breath analyser was used to detect Lactose intolerant subjects.

Phase II- Supplementation of Lactose intolerant subjects with Lactose hydrolysed milk (LHM).

Phase III- Organoleptic evaluation of food products such as ***cold coco, rose milk, white sauce pasta, veg au gratin, Sandesh*** and ***kheer*** development from Lactose hydrolysed milk and Standard milk.

Phase IV- Development of IEC material.

The results and major highlights of all the phases of the study are summarized below-

6.1. Phase I

This phase of the research was designed to obtain data on several foods causing gastrointestinal symptoms and identify lactose intolerant subjects using Hydrogen Breath Test. A Hydrogen breath analyser was used to detect lactose intolerance and was further divided into mild, moderate and severe category.

Salient features of Phase I

6.1.1 Screening on the basis of gastrointestinal systems

- In this phase, semi-structured questionnaire was developed to screen individuals belonging to three categories- children, adult and elderly and gastrointestinal symptoms post consumption of food-groups such as milk and milk products, cereals, pulses, fermented foods, fruits and vegetables were assessed.
- It was observed that 27.5% of the subjects reported to have experienced gastrointestinal symptoms owing 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%).
- Among milk and milk products, it was observed that majority of the subjects had gastrointestinal discomfort post consuming of milk followed by cheese (28%) and *kadhi* (20%).

6.1.2 Identification of lactose intolerance among the subjects using Hydrogen Breath Analyser test.

- Respondents (N=220) who reported adverse gastrointestinal symptoms post consumption of milk and milk-based products were enrolled and hydrogen breath analyser test was performed in the 181 subjects who consented for HBT.
- An oral dose of 25 gm of lactose powder dissolved in 250 ml of water was orally administered to the subjects and after 30 mins they had to blow out air through their mouth into the device for six times (with 30 mins break between each breath out) which calculates the hydrogen emitted by the human gut post consumption of lactose powder.
- A total of 62 children, 65 adults and 54 elderlies were screened using hydrogen breath analyser test till we achieve 30 lactose-intolerant subjects in three age groups- children, adults and elderlies. The HBT revealed that 46% children; 48% adult and 56% elderlies are lactose intolerant.
- Majority of the subjects (80%) fell in the mild lactose malabsorption category.

6.2. Phase II

In this phase 250 ml lactose hydrolysed milk (LHM) per day was supplemented for a period of 6 weeks to all the lactose intolerant subjects (children, adults and elderly) and the subjects were

assessed for dietary intakes, BMI and Quality of life before and after supplementation. Feedback of the subjects upon consumption of LHM was taken post supplementation.

Salient features of Phase II

6.2.1 Dietary intakes of the lactose intolerant subjects before and after supplementation with LHM.

- Carbohydrate, protein, fat, energy, calcium, and carotenoids was estimated both at baseline and after supplementation.
- Among children, the percent difference of protein, carbohydrate, fat, calcium and carotenoid post consumption of lactose hydrolysed milk was 3.85, 7.08, 2.73, 5.76, 35.48, 0.61 respectively.
- Among adults, the percent difference of protein, carbohydrate, fat, calcium and carotenoid post consumption of lactose hydrolysed milk was 8.45, 3.76, 7.26, 58.9, 1.73 respectively.
- Among elderly population, the percent difference of protein, carbohydrate, fat, calcium and carotenoid post consumption of lactose hydrolysed milk was 3.30, 6.54, 4.19, 7.34, 43.62, 4.22 respectively.
- All the nutrients increased significantly post supplementation.

6.2.2 BMI of the lactose intolerant subjects before and after supplementation with LHM

- BMI was determined in terms of height, weight and Z score for BMI was calculated (for children) using WHO anthroplus software and subjects were categorised into thin, normal, overweight and obese.
- Among children, there's an increase in the moderately overweight category by 3.4%.
- Based on the BMI score, adult subjects were categorised into underweight, normal, overweight and obese. It was observed there was a decrease in underweight category post supplementation by 3.5%, eventually improving subjects under normal category by 4%.
- In elderly, post supplementation with lactose hydrolysed milk there was increase in normal category by 6.7%.

6.2.3 Quality of life of the lactose intolerant subjects before and after supplementation with LHM

- A semi-structured modified questionnaire comprising of ten questions was used to assess the quality of life of the lactose intolerant subjects.
- Depending upon the severity of lactose intolerance, the subject's quality of life might get affected. Around 16% elderly showed to have poor quality of life which higher than children and adult whereas maximum 93% of children showed to have good quality of life.
- Post supplementation of lactose free milk, 100% of children supplemented with lactose free milk had good quality of life.
- Majority (87%) of the lactose intolerant adults reported to have good quality of life as most of them had stopped completely consumption of milk completely. Since there was no consumption of milk.
- Therefore, lactose intolerance did not affect their quality of life that explains the reason for them having good scores for quality of life. Majority 70% of the lactose intolerant elderly reported to have average quality of life and 16% had poor quality of life.

6.2.4 Feedback from lactose intolerant subjects regarding lactose hydrolysed milk

- Acceptance of the product was determined in terms of human senses, such as sight, smell, taste, texture by the lactose intolerant subjects and lastly their desire to purchase the product commercially.
- The product was accepted unanimously and adult and elderly subjects accepted lactose-free milk to make it a part of their daily food consumption.
- Few adult subjects (10%) reported it to be sweeter post boiling compared to normal milk and had to add less amount of sugar (this was mentioned to them before that it will be sweeter than normal milk considering lactose is broken into-glucose and galactose).
- However, 33.3% of the subjects felt that the product is costly compared to normal milk to be consumed daily.
- Around 20 % subjects reported undesirable smell. On further enquiry it showed that these children disliked the smell of milk, whereas among children, all the parents of the lactose-intolerant children showed willingness to purchase it.

6.3 Phase III

In this phase of the study, we have developed food products from lactose hydrolysed milk (LHM) and standard milk products and compared their organoleptic properties. 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.

6.3.1 Organoleptic evaluation of beverages with lactose hydrolysed milk and standard dairy milk

- Cold cocoa and Rose milk was developed from lactose hydrolysed milk and standard dairy milk.
- 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.

6.3.2 Organoleptic qualities of white sauce pasta and veg au gratin with lactose hydrolysed milk and standard dairy milk

- We have observed no significant difference between the organoleptic qualities among pasta made from both the standard milk and LHM.
- However, 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.
- Likewise, no difference was 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 mouth feel of veg au gratin prepared from lactose hydrolysed milk.

6.3.3 Organoleptic qualities of kheer and Sandesh with and without lactose hydrolysed milk and standard dairy milk

- We have observed no differences between ***kheer*** and ***Sandesh*** prepared from standard milk and LHM.
- Yet, taste, after taste and over all acceptability characteristics of standard milk had shown to be more in score for kheer, texture and mouth feel received higher score for kheer made up of lactose hydrolysed milk.

- Visually, compared to standard milk Sandesh prepared from lactose hydrolysed milk was darker (brownish) in colour.
- Overall acceptability of Sandesh prepared from standard milk received higher score compared to Sandesh made from LHM.

Hence, null hypothesis was rejected and following alternative hypothesis was accepted:

a) Hydrogen breath analyser can detect lactose intolerant subjects.
b) LHM supplementation for a period of 6 weeks to LI subjects will bring about improvement in BMI, QOL and nutrient intake.
c) Recipes prepared from lactose hydrolysed milk was accepted by the panellists for most of the organoleptic attributes.