ERI-ONLINE-1-BFT(R)-04

LACTOSE INTOLERANCE AND ORAL HEALTH

Student Reni Syarova
Student Tsanka Nedyalkova
Biotechnology Department, "Prof. Dr Assen Zlatarov" University, Burgas, Bulgaria
E-mail: renisyarova@gmail.com, tsanka_nedialkova@abv.bg

Dr Petar Shentov
Dental Clinic, Plovdiv, Bulgaria
E-mail: p.shentoff@gmail.com

Assis. Prof. Zlatina Chengolova, PhD
Biotechnology Department, "Prof. Dr Assen Zlatarov" University, Burgas, Bulgaria
E-mail: zlatinabe4eva@abv.bg

Abstract: *Lactose intolerance has various manifestations and symptoms. It can be congenital - alactasia, but it can also be acquired over the years. Approximately 65% of the world's population has this condition since birth. On closer inspection, approximately 70% of East Asian adults are found to be lactose intolerant. The paper reviews the lactose intolerance worldwide, paying particular attention to the available information for Europe. European Dairy Association reported that Hungary, Estonia, Greece and Italy had over 40% frequency of lactase deficiency. There are not enough studies about the problem in Bulgaria. Original results from a questionnaire survey conducted in Bulgaria are presented. The possible connection of the ethnicity of the people with possible lactose intolerance was traced. Facts related to the change in oral health while avoiding the consumption of lactose-containing products (milk and dairy products) are presented and discussed. A group of foods that would be useful for people with lactose intolerance to protect their oral health are presented.*

Keywords: *lactose intolerance, oral health, vitamin D, calcium, milk.*

INTRODUCTION

Milk and dairy products are an essential nutrient for everyone from their birth. Approximately 6 billion of the world's population use milk as a staple food, supplying important nutrients to the body. However, there is a large proportion of the population (about 65%) who are unable to digest the lactose in milk and suffer from lactose intolerance (Katoch et al., 2021). This makes people avoid milk and dairy products. European Dairy Association (2021) recommended a particular amount of milk (in grams) per day that each country citizen needs. More than two large glasses of milk are recommended for residents of several countries: Spain (699 g/day), Netherland (678 g/day), Romania (647 g/day), Portugal (647 g/day), Germany (610 g/day), Greece (517 g/day), Hungary (517 g/day). Two standard glasses of milk will be enough for people from: UK (414 g/day), Italy (388 g/day) and France (310 g/day). The least amount of milk is needed in Bulgaria (207 g/day) and Poland (259 g/day). Therefore, all the beneficial substances from milk begin to decrease in the body, clinical deficiencies and other conditions develop. One of the things that are extremely vulnerable is our teeth and our oral health. Milk is a good source of vitamin D and calcium, but by excluding it and dairy products from our diet, we need to look for other alternative depots of these important nutrients. This study discusses the types of lactose intolerance and its relationship to oral health, and presents the results of a survey. The text also mentions foods that would be useful for people who avoid lactose.

EXPOSITION

Lactose and milk sugar digestion

Lactose is a disaccharide and it is found in mammalian milk (also called "milk sugar"). The name "lactose" comes from the latin "*lac*" and it is translated as "milk". It should be mentioned

that lactose is 4-O-(β-d-galactopyranosyl)-d-glucopyranose, according to the IUPAC name. Lactose is a disaccharide composed of a molecule D-galactose linked to a molecule D-glucose via a β-(1,4′) glycosidic bond (Robert et al., 2018). The enzyme which cleavages that bond is β-galactosidase (lactase). The enzyme-substrate reaction takes place in the small intestine and it is critical for digestion and energy production from milk sugar (Catanzaro et al., 2021). Schematic presentation of the enzymatic reaction is shown on Figure 1.

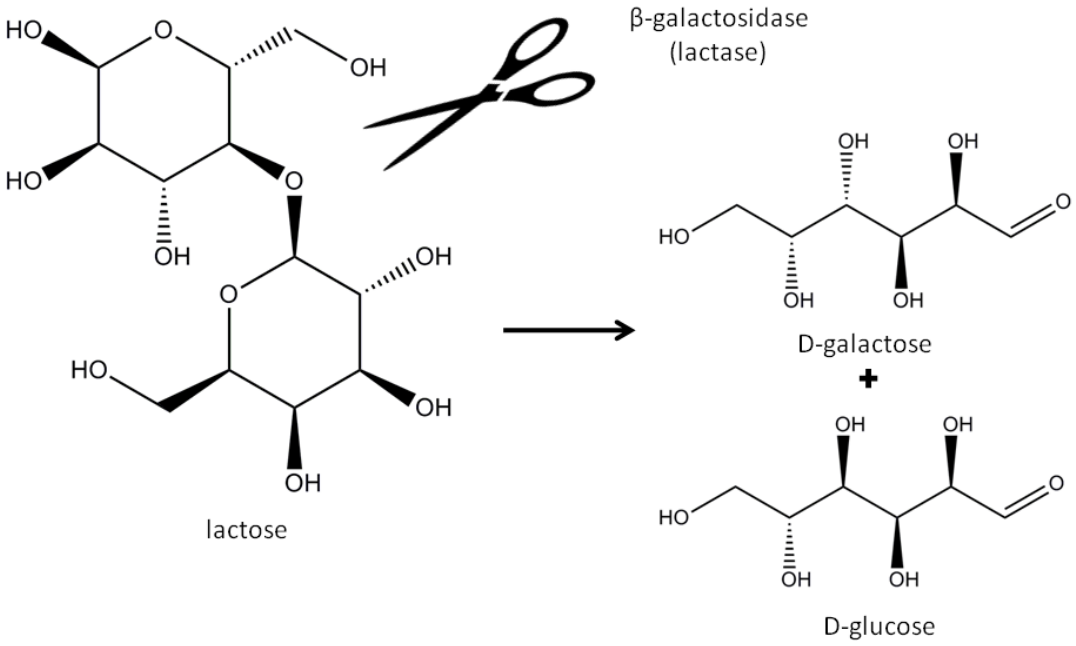

Fig. 1 Scheme of enzymatic cleavage of lactose by β-galactosidase (lactase)

Types of lactose intolerance

It has been observed that at birth, mammals have a high ability to digest lactose. Subsequently, the enzyme lactase decreases over the years and can reach critically low levels in adulthood. This, on the other hand, leads to a reduced absorption of dietary lactose which leads to symptoms called lactose intolerance (LI) (Forsgård, 2019). This alteration determines an increased osmotic load in the small intestine and the fermentation of lactose by the bacterial flora, which leads to a high production of short-chain fatty acids and gas (Catanzaro et al., 2021). That disorder is called primary lactase deficiency - adult-onset hypolactasia (Porzi et al., 2021). Some authors reported that psychosocial stress and functional gastrointestinal disorders can also impact the subjective perception of LI (Casellas et al, 2010; Zheng et al., 2015; Rocco et al., 2021). Also, LI can be induced by small intestine disease or injury. Those cases of induced LI are secondary lactase deficiency (acquired LI). It should also be mentioned that lactose intolerance could be caused genetically in the absence of lactase gene expression - congenital lactase deficiency (alactasia) (Porzi et al., 2021).

Lactose intolerance in Europe

Worldwide, about 30% of the population manages to maintain satisfactory amount of the enzyme that digests lactose, even in old age. This ability is most likely determined by populations and ethnicities (Forsgård, 2019, Porzi et al., 2021). LI is rare in European population and the others with a long history of obtaining and consuming dairy products. The spread of farming during the Neolithic period caused lactose gene expression in human populations, with the earliest appearance estimated ~8000–9000 years ago in Europeans (Porzi et al., 2021). One of the theories describes that in Northern Europe, dairy products were an important part of the diet. Therefore, consumers had a natural selection of substrates capable of absorbing lactose. Subsequently, a

number of migrations took place, and nowadays we can see a mixed type of populations (with and without lactose intolerance) in the same territory (Catanzaro et al., 2021). European Dairy Association (2017) reported that Europeans also suffer from lactase deficiency. In Denmark and Ireland that condition is very rare (4%), unlike Hungary (40%), Estonia (43%), Greece (46%) and Italy (56%). There is not enough information about Bulgaria and where is the country in the chart.

Oral health support

To date, it appears that not many studies have been done to investigate the relationship between lactose intolerance and oral health (Vasthare et al., 2019). It is well known that complete cutoff of milk and milk-based products may reduce the levels of calcium and some vitamins in the body (Ogata and Trahms, 2003; Katoch et al, 2021) and this may endanger oral health (Antonenko et al., 2015; Zulhendri et al., 2021). Young women who follow an improper diet are especially at risk (Antonenko et al., 2015). Oral health has a great impact on general health. The bacterial accumulation of *Staphylococcus aureus* and *Pseudomonas aeruginosa* in dental plaque is one of the main reasons for their accumulation in the trachea and bronchi, which in turn are important reservoirs of infection causing mechanical ventilation-associated pneumonia. *Candida albicans* and other fungi may be the cause of the growing number of fungal infections as a complication in the recovery of COVID-19 (Santosh et al, 2021; Eghbali Zarch and Hosseinzadeh, 2021). It is reported that habitual use of vitamin D supplements is related to a lower risk of COVID-19 infection (Ma et al., 2021), including better oral health.

Humans obtain vitamin D from exposure to sunlight, diet, and dietary supplements. Vitamin D deficiency could be avoided by sunlight exposure for 20 min in spring or summer, when the daily requirement of the vitamin is 7.5 g per day (Bakar et al., 2017). Vitamin D, here in the text, refers to ergocalciferol (Vitamin D2) and cholecalciferol (Vitamin D3). Chemical structures of those compounds are shown on Figure 2. Vitamin D2 is formed in plants, fungi and invertebrates from an initial compound – ergosterol, by UVB irradiation (wavelength 280-315 nm). On the other hand, Vitamin D3 is formed in vertebrates (including humans) from 7-dehydrocholesterol, by the sunlight (Schmid and Walther, 2013). Vitamin D has an impact on the human skeletal system and also decreases the risk of cardiovascular diseases, diabetes, autoimmune diseases and cancer (Zmijewski, 2019). Leszczyszyn and colleagues (2021) reported that a link has been found between Vitamin D deficiency and oral health, in particular – development of malocclusions.

Main natural food sources of Vitamin D are oily fish and eggs (Goldring et al., 2011). Especially, fish liver and offal provide good amount of the vitamin, next is egg yolk, and then muscle meat. Milk and dairy products have low concentrations of Vitamin D. For example, the yield in whole cow milk is 0.3 – 1.0 μg/kg, but butter and cheese are better sources of the vitamin (butter 5.9 – 14.1 μg/kg, semihard and hard cheese 2.0 – 18.1 μg/kg).

Vitamin D, with hormones: parathyroid hormone, fibroblast growth factor 23 and calcitonin, has a great impact in bone mineral metabolism and regulate three bone minerals: calcium, magnesium and phosphorus (Shaker and Deftos, 2018). Consequently, foods rich in Vitamin D and calcium are preferable. Natural calcium could be provided from spinach, broccoli, soya beans, cereals and cereal products, eggs, and also water. Good source of calcium is milk and milk products due to mineral high content and bioactivity (Theobald, 2005). But if we are interested in foods rich in both vitamin D and calcium, excluding the milk, we should focus on salmon and egg yolk. Theobald (2005) reported that the calcium content in salmon was 91 mg per 100 g, and in raw egg yolk – 130 mg per 100 g. It should be noted that the reference nutrient intake of calcium depends on age and gender of the individual: for adolescents – from 450 to 1 000 mg/day, and for mature individuals - 700 mg/day.

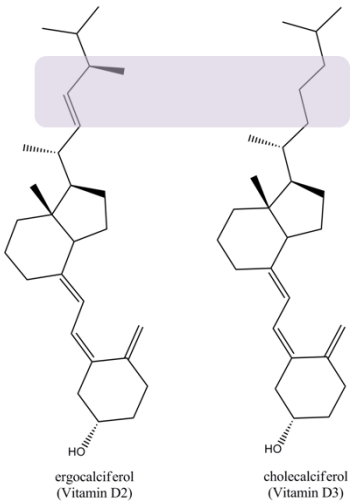

Fig. 2. Structure of ergocalciferol (Vitamin D2) and cholecalciferol (Vitamin D3).

It is reported that supplementation with Vitamin D3 and calcium reduces the risk of tooth loss in the elderly (Leszczyszyn et al, 2021).

Questionnaire survey

The questionnaire was prepared in two forms: physical completion on paper with questions (2.7%) and on-line (97.3%). The on-line form was prepared by freely available Google Forms. Anonymous volunteers from different age groups were interviewed. Selected questions were asked in order to understand the habits and way of life of the consumers.

Most of the surveyed volunteers (77.1%) say they know what lactose intolerance is and say they do not have lactose intolerance (93.3%), but only 55.8% of them know what the symptoms are. The study shows that 11.6% (38 people) of respondents often (each year) suffer from tooth decay. A closer look at their responses shows that these people also do not or rarely drink milk, which in turn has most likely contributed to this problem. Less than half of them (15 people) state that they often consume milk but it is only from 0 to 350 mL/day (235 mL/day) or in a starch cream. Only 38 from 313 answers are positive for the question “Have you ever bought lactose-free milk?”. This low percentage is probably due to the relatively small percentage of people with lactose intolerance, as well as the poor supply of the market. But it is probably normal to have little choice, given that people in our latitudes rarely suffer from this problem.

CONCLUSION

Lactose intolerance is a common health problem worldwide, but in Bulgaria it is a relatively rare diathesis. Among the surveyed volunteers, few people were aware of the symptoms of this condition, hence the question “Does each respondent really have altered lactose absorption?”. There is also a possible relationship between the incidence of caries and the frequency and amount of milk consumed. This link is also supported by literature studies involving the key roles of vitamin D and calcium present in a person's diet. Salmon and egg yolk are good sources of both nutrients.

REFERENCES

Antonenko, O., Bryk, G., Brito, G., Pellegrini, G., & Zeni, S. N. (2015). Oral health in young women having a low calcium and vitamin D nutritional status. Clinical oral investigations, 19(6), 1199–1206.

Bakar, H. A., Rauf, A., Sarwar, M. H., & Sarwar, M. (2017). Essential Vitamin and Mineral Nutrients Body Needs and Their Best Food Sources. American Journal of Economics, Finance and Management [Internet], 3(4), 36-41.

Casellas, F.; Aparici, A.; Casaus, M.; Rodríguez, P.; Malagelada, J.R. Subjective Perception of Lactose Intolerance Does Not Always Indicate Lactose Malabsorption. Clin. Gastroenterol. Hepatol. 2010, 8, 581–586.

Catanzaro, R., Sciuto, M., & Marotta, F. (2021). Lactose intolerance: An update on its pathogenesis, diagnosis, and treatment. Nutrition Research.

Eghbali Zarch, R., & Hosseinzadeh, P. (2021). COVID-19 from the perspective of dentists: a case report and brief review of more than 170 cases. Dermatologic Therapy, 34(1), e14717.

European Dairy Association (2017) Lactose intolerance – Questions and Answers. https://eda.euromilk.org/fileadmin/user_upload/Public_Documents/Nutrition_Factsheets/2017_08_30_EDA_Lactose_intolerance_final.pdf

European Dairy Association (2021) Daily dairy recommendations: Are we eating enough dairy?
https://eda.euromilk.org/fileadmin/user_upload/Public_Documents/EDA_Position_papers_-_Fact_Sheets/Fact_sheets/EDA_Factsheet_-_Daily_Dairy_Recommendations.pdf

Forsgård, R. A. (2019). Lactose digestion in humans: intestinal lactase appears to be constitutive whereas the colonic microbiome is adaptable. The American journal of clinical nutrition, 110(2), 273-279.

Goldring, S., O Warner, J., O Shaheen, S., & J Boyle, R. (2011). Early life vitamin D status and lung development. Current Respiratory Medicine Reviews, 7(6), 396-403.

Katoch, G. K., Nain, N., Kaur, S., & Rasane, P. (2021). Lactose Intolerance and Its Dietary Management: An Update. Journal of the American College of Nutrition, 1-11.

Leszczyszyn, A., Hnitecka, S., & Dominiak, M. (2021). Could Vitamin D3 Deficiency Influence Malocclusion Development. Nutrients, 13(6), 2122.

Ma, H., Zhou, T., Heianza, Y., & Qi, L. (2021). Habitual use of vitamin D supplements and risk of coronavirus disease 2019 (COVID-19) infection: a prospective study in UK Biobank. The American journal of clinical nutrition, 113(5), 1275-1281.

Ogata, B., & Trahms, C. (2003). Nutrition and oral health for children. Nutrition, 18(6), 6.

Porzi, M., Burton-Pimentel, K. J., Walther, B., & Vergères, G. (2021). Development of Personalized Nutrition: Applications in Lactose Intolerance Diagnosis and Management. Nutrients, 13(5), 1503.

Robert J. Ouellette, J. David Rawn. Carbohydrates, in Organic Chemistry (Second Edition), 2018

Rocco, A., Compare, D., Sgamato, C., Martino, A., De Simone, L., Coccoli, P., ... & Nardone, G. (2021). Blinded Oral Challenges with Lactose and Placebo Accurately Diagnose Lactose Intolerance: A Real-Life Study. Nutrients, 13(5), 1653.

Santosh, A. B. R., Muddana, K., & Bakki, S. R. (2021). Fungal infections of oral cavity: diagnosis, management, and association with COVID-19. SN comprehensive clinical medicine, 1-12.

Schmid, A., & Walther, B. (2013). Natural vitamin D content in animal products. Advances in nutrition, 4(4), 453-462.

Shaker, J. L., & Deftos, L. (2018). Calcium and phosphate homeostasis. Endotext [Internet].

Theobald, H. E. (2005). Dietary calcium and health. Nutrition Bulletin, 30(3), 237-277.

Vasthare, R., Choong, E. K., Nayak, P. P., Bhagavath, R., & Shanthi (2019). Lactose intolerance and oral health: A public health promotional perspective. Indian Journal of Public Health Research and Development, 10(5), 221-227.

Zheng, X., Chu, H., Cong, Y., Deng, Y., Long, Y., Zhu, Y., Pohl, D., Fried, M., Dai, N., Fox, M. Self-reported lactose intolerance in clinic patients with functional gastrointestinal symptoms: Prevalence, risk factors, and impact on food choices. Neurogastroenterol.Motil. 2015, 27, 1138–1146.

Zmijewski, M. A. (2019). Vitamin D and human health. International Journal of Molecular Sciences, 20, 145; doi: 10.3390/ijms20010145

Zulhendri, F., Felitti, R., Fearnley, J., & Ravalia, M. (2021). The use of propolis in dentistry, oral health, and medicine: A review. Journal of Oral Biosciences.

