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Non-dairy based beverages: An insight

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Introduction

The demand for non-dairy based beverages in form of non-dairy beverage is on rise due to several reasons. Firstly, the prevalence of lactose intolerance and milk allergy is amongst the major percentage of population.[1] The need for functional drinks is also a major factor which contributes to the increase in demand of milk-alternatives. It has also been reported that milk processors around the world face an uphill battle, including the dominance of private labels; growing consumer concerns over the presence of growth hormones in non-organic milk; fluctuations in commodity prices and supply shortages for organic milk. With that long list of challenges, the market has had few growth opportunities even though consumers continue to prize milk for its nutritional benefits.

Need for non-dairy beverages

Prevalence of lactose intolerance

Lactose intolerance is estimated to affect 33 % of the global population, but the prevalence of the condition varies from country to country. It is also estimated that an average of 75 % of human adults have decreased intestinal lactase activity after weaning.[2]

The map shown in Figure 1 presents the spatial distribution of lactose intolerance worldwide.[3] It is very clear from the map that lactose intolerance is prevalent worldwide with high percentages of cases being reported especially in sub-Saharan Africa, South and East Asia. South America has lactose intolerance in the range of 80-90% whereas in Northern parts of America it is up to 40%. In India, it has been observed that around 60-70% of the population is lactose intolerant.[1] It was also observed that adult subjects and the children over 3 years of age were not accustomed to drinking milk, whereas the infants were receiving either breast milk or cow's milk and their lactase activity was normal. The possible reason for this may be an adaptive decline in the enzyme following withdrawal of milk from the diet after weaning.[4]

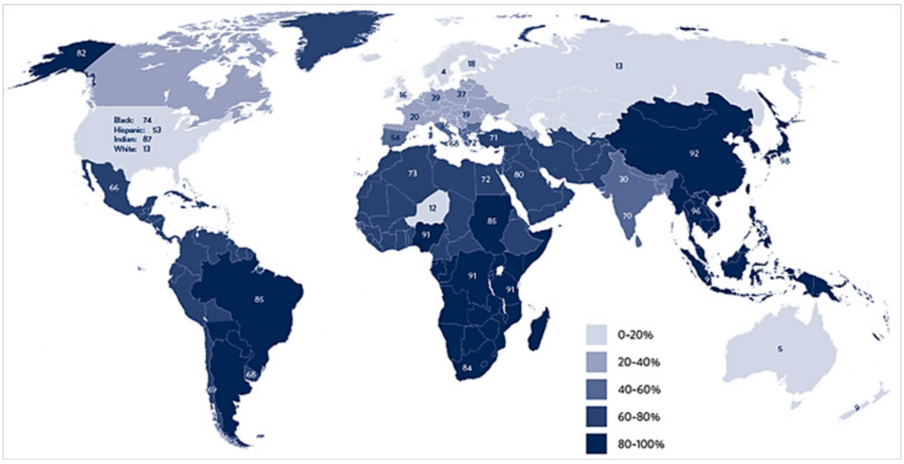

Figure 1 CAD and the corresponding finite element mesh for selected geometric models of L/D ratio (a) 833.3 and (b) 1666.7.

In India, the frequency of lactose intolerance is higher among healthy populations from southern India than from northern India. In a study, incidence of lactose intolerance was found to be 66.6% in the subjects from two South Indian centers at Trivandrum and Pondicherry. In contrast, the incidence in the subjects from a north Indian centre in New Delhi was much lower, i.e., 27.4%. The lower incidence in the North Indian subjects may perhaps be due to the fact that they are descendants of the Aryans who have been dairying for long and are known to be lactose tolerant.[5-6]

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Lactose intolerance: causes, symptoms and treatment: Lactose is a disaccharide sugar composed of glucose and galactose and is unique to mammalian milks. Lactose intolerance is the inability or insufficient ability to digest lactose, when ingested. Lactose intolerance is caused by a deficiency of the enzyme lactase which breaks down lactose into two simpler forms of sugar called glucose and galactose, which are then absorbed into the blood stream. Lactase enzyme is present in high quantities in infants and children whereas as the child grows, a dramatic reduction in the activity of the enzyme after weaning is observed.[7-9] Symptoms of lactose intolerance generally develop about 30 min to 2 hours after consuming foods or beverages that contain lactose. Symptoms often include nausea, gut pain and distension, headache, severe tiredness, flatulence, cramping and diarrhea.[10-12] Abdominal pain and bloating are typically caused by colonic fermentation of unabsorbed lactose by the bacterial microflora leading to the production of short chain fatty acids, hydrogen, methane and carbon dioxide, thus increasing gut transit time and intra-colonic pressure.[13]

Dietary management is the basis of therapy for lactose intolerance. The consumption of fermented dairy products such as yoghurt and labaneh, Fermented milk drinks and jameed are main forms of dietary management for lactose intolerance. Reduction of lactose intake rather than exclusion is recommended because in blinded studies most patients with self-reported lactose intolerance can ingest at least 12g lactose (equivalent to 250 mL milk) without experiencing symptoms.[14-15] Another form of therapy for managing lactose intolerance in people who show symptoms even after dietary restriction is administration of exogenous β-galactosidase[16] in the form of "preincubated milk" in which the lactase enzyme is added few hours before consumption to obtain lactose hydrolyzed milk.[17-18]

Milk protein allergy: Milk allergy is a type of food allergy, an adverse immune reaction to one or more of the constituents of milk, especially protein. This milk-induced allergic reaction can involve anaphylaxis, a potentially life-threatening condition. Approximately 2.5% of children younger than three years of age and 0.3% of adults are allergic to milk.[19] Nearly all infants who develop an allergy to milk do so in their first year of life. Symptoms of milk allergy may induce cutaneous, respiratory (rhinitis, asthma, cough) and gastrointestinal reactions. This allergy is normally outgrown in the first year of life; however, 15% of allergic children remain allergic.[20] α-lactalbumin and β-lactoglobulin are the major whey protein of cow milk, responsible for cow milk allergy.[21-22] The main treatment for milk allergy is total avoidance of milk proteins. Similar to lactose intolerants, milk substitutes like soy, rice, almond beverages and hypoallergenic formulas based on partially or extensively hydrolyzed protein, and free amino acid-based formulas are possible solutions.[20]

Health benefits of oats

The non-dairy beverages can be developed from many sources like plant materials, nuts, legumes and cereals. The first ever non-dairy beverage available in market is soy based produced from soybeans, which is a legume. Soy based beverage have been used as a milk substitute in various parts of the world. The increasing consumption of soy beverage has triggered interest in developing functional drinks from other sources. Also, because of the allergic reactions to soy proteins and bean-like taste associated with soy beverage, there is a need for alternatives. Oats are one of the promising raw materials for developing health beverage. The health effects attributed to the consumption of oats in humans have been well documented. Many studies have established the relationship between intake of oats and reduction in blood cholesterol levels as well as glucose and insulin response.[23-26] It has also been proven scientifically that the cholesterol lowering property of oats is due to the presence of the soluble fibre, β-glucan[27-31]. In 1997, therefore, the US Food and Drug Administration (USFDA) allowed the health claim that a diet high in soluble fibre from whole oats (3g soluble oat β-glucan) and low in saturated fat and cholesterol may reduce the risk of cardiovascular diseases[32].

Oat based beverages

Oat based beverage is made from whole oat groats which looks like dairy milk. Few processes are mentioned in the literature for making oat based beverages from oats. One process involves soaking and grinding of whole oats followed by homogenization.[33] The other process is an enzymatic process, wherein whole oat groats are converted into liquid milk like product involving a number of steps like flaking, wet milling, amylase hydrolysis, decanting, formulation, UHT treatment and aseptic packaging.[34]

A US patent has disclosed the preparation of water-soluble dietary fiber compositions by treating ground oat products with α-amylases. The α-amylase serves to thin the oat starch, and any α-amylase may thus be used. The produced liquid dietary fiber compositions are used as additives in food products, such as fat substitutes. However, these products not only lack desirable aromatics of natural oats, but are also deprived of agreeable natural oat flavorings.[35] Another US patent (No. 5,686,123) revealed a homogeneous and stable cereal suspension having the taste and aroma of natural oats. This oat suspension is a milky product, which can be used as an alternative to milk, especially for lactose-intolerant people. It may also be used as the basis of or an additive in the manufacture of ice cream, gruel, yogurt, milk shakes, health beverages, and snack.[34]

Apart from these patents, very little scientific literature is available on oat based beverages. The effect of different processing and storage conditions on nutritional properties of oat-based beverages has been reported in literature. In a study, the decanting process caused a 47% increase of vitamin B6 and a 45–74% loss of phosphorus, zinc, calcium and iron. The steam-injection UHT treatment caused a 60% loss of vitamin D3 and a 30% loss of vitamin B12.[36] Many studies have been done to determine the effect of fermentation on properties of oat-based beverages.[37-39] The relationship between changes in serum lipids and postprandial glucose and insulin concentrations after consumption of beverages with β-glucans from oats has been established in many studies. For example, it has been reported that consumption of oat milk for 5 weeks lowers serum cholesterol and LDL cholesterol in men with moderate hypercholesterolemia.[40-41] Another study reported that compared to control, 5g of β-glucans from oats significantly lowered total-cholesterol by 7.4% ($p < 0.01$), and postprandial concentrations of glucose and insulin.[29]

A group of scientists investigated the effect of oat fibres on perceived satiety of beverages and reported that the beverage containing oat β-glucan increased fullness and showed a trend of having a higher satiety index and decreased the 'desire to eat something' more than the beverage without fiber.[42] Another group of researchers also found out similar results and reported that viscous fibers, including β-glucan in oat bran, favorably affect satiety as well as postprandial carbohydrate and lipid metabolism.[43]

In our past work,[44] we reported the optimized process conditions for the development of non-dairy based oat milk by enzymatic process.

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The effect of temperature and total soluble solids concentration on rheological parameters of developed oat based beverages has also been reported.[45]

Enzymatic liquefaction

Application of enzymes for preparation of non-dairy beverages has been mentioned by few researchers for production of rice milk and other cereal based beverages.[34,46-48] Production of cereal based beverages comprising of an aqueous extract of a blend of soybean, sesame, and maize has been mentioned in the literature.[47] Pectinase enzyme was used in this process for extraction. It was found that the enzymatic assisted method resulted in a higher amount of reducing sugar, protein, fat, and antioxidant activity. Thus, disrupting the plant cell wall component network by using cell wall degrading enzymes can increase extractability of protein, fat, and antioxidant activity in cereal beverages.[47]

In another study, a method has been mentioned wherein the starch present in rice is gelatinized which is then liquefied, preferably with α-amylase enzymes, and then treated with relatively high levels of glucosidase enzyme and/or a β-amylase enzyme in a saccharifying step for production of rice milk. Rice milk thus developed was found to have a milk-like texture and can be used for the preparation of its beverages and frozen desserts. The rice milk thus produced was characterized by its absence of a rice-like flavor.[46]

In a study, the application of enzymes in soy based beverage production was investigated and reported that enzymes improve the yield of soy milk as compared to traditional process. Of the different enzymes tested, the neutral proteinase was found to produce superior results at neutral pH. At 0.5% level the protein and solids yields obtained at 1 hour of reaction were 73% and 66%, respectively, compared to 33% and 42%, respectively, of the control at pH 6.7.[49] Hence, application of enzymes, namely, pectinases, proteinase and amylases have been shown to yield better quality non-dairy milk. Enzymatic process has also been shown to increase the extraction yield and sensory properties of developed non-dairy milk.

Conclusion

The demand for non-dairy based beverages will continue to rise and companies would need to invest Research and Development activities in this direction. Oat is now universally known to consumers for its health benefits. Also, the commercialization of oat milk would certainly support the large population suffering from lactose intolerance and would be an alternative option for the major percentage of the population who cannot consume dairy milk and look for alternate sources of protein. Functional food drinks will continue to evolve in the market and oat beverages hold a promising alternative.

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