Iranian Food Science and Technology Research Journal
Vol. 13, No. 4, Oct- Nov 2017, p. 469-479

نشریه پژوهشهای علوم و صنایع غذایی ایران
جلد 13، شماره 4، مهر - آبان 1396، ص. 479-469

Effect of microbial transglutaminase on physical, rheological, textural and sensory properties of light ice cream

H. Jooyandeh[1*], E. Danesh[2], M. Goudarzi[3]

Received: 2015.11.27
Accepted: 2016.04.16

Introduction: Health-conscious consumers are interested in eating dairy products including ice cream with less fat. As a consequence, the dairy industry has developed a variety of reduced-fat ice cream products. However, quality aspects of many of these products do not meet consumer expectations for ice cream flavor, texture, and appearance. The formation of the ice cream structure is hindered when the fat content is reduced and attributes related to quality, such as viscosity, ice crystallization, hardness, melting rate and flavor, are affected. Low melting resistance, high firmness and undesirable flavor are the most cited defects in reduced-fat ice creams. Enzymatic treatment of reduced-fat milk with microbial transglutaminase has been found to improve the textural and sensory properties of the final dairy products. The transglutaminase enzyme (MTGase; protein-glutamine gamma glutamyl transferase, EC 2.3.2.13) catalyses "acyl" transfer reactions between γ-carboxyamide groups of glutamine residues (acyl donor) and the ε-amino group of lysines (acyl acceptor) in proteins, leading to inter- or intra-molecular cross-linking. The enzyme-catalyzed cross-linking of milk proteins results in the formation of high molecular weight polymers that not only are able to lower the melting rate thorough increasing the viscosity of ice cream mix, but they could also provide a smoother texture for the product by mechanically obstructing ice crystal growth. However, the extensive cross-linking of milk proteins may even adversely affect the physical properties of the resultant ice cream and thus, the added amount of enzyme needs to be adequate for the desired effects. The aim of this study was to investigate the effects of different concentrations of TGase enzyme on physical and sensory properties of light ice cream in order to selct the appropriate amount of enzyme concentration that provides the best results.

Materials and methods: The light ice cream (5% w/w fat) was treated with different concentrations of TGase enzyme (2, 4 and 6 units/g milk protein). The enzyme-treated samples were investigated for flow behavior characteristics (apparent viscosity, flow index, consistency index), overrun, melting rate, hardness and sensory properties (flavor, texture, color and total acceptability) in comparison with control light ice cream with no added Tgase.

Results and discussion: The results revealed that TGase treatment effectively increased the viscosity of light ice cream.The higher the enzyme concentration, the greater the viscosity of ice cream samples. This could be attributed to TGase-catalyzed formation of large protein polymers in ice cream mix that resist to flow. All enzyme-treated ice cream mixes exhibited shear-thinning behavior, where the viscosity decreased with increasing shear rate. The power law model was used to find consistency and flow indices for different treatments. The results showed that consistency index increased and flow behavior index decreased with TGase concentration. The stronger shear-thinning behavior (lower flow index) of the samples treated with higher concentration of TGase might be arisen from formation of higher number of large protein polymers in theses samples, which decrease in size during shearing. The enzyme treatment significantly increased the overrun of the light ice cream that could be due to the increasing effect of TGaes on the viscosity. The increase in viscosity promotes the retention of air in the ice cream which is concomitant with increased overrun; however, high viscosity reduces the whipping rate leading to lower incorporation of air into the ice cream and thus decreased overrun. This may account for significantly lower overrun of the light ice cream treated with 6 units TGase/g milk protein than the samples treated with 4 units TGase /g milk protein. It was observed that the enzyme treatment caused a significant improvement in melting resistance of light ice cream. In fact, the light ice cream treated with 6 or 4 units TGase /g milk protein took the longest time to melt, followed by the samples treated

1 And 2. Associate Professor and M.SC., Department of Food Science and Technology, Ramin Agriculture and Natural Resources University of Khuzestan, Mollasani, Iran.
3. M.SC., Department of Food Science, Technology & Engineering, University College of Agriculture and Natural Resources, University of Tehran, Karaj, Iran.
(*Corresponding Author Email: email: hosjooy@yahoo.com)

with 2 and 0 units TGase /g milk protein. This is somehow in accordance with the results of overrun; that is, the ice cream with higher overrun melted slower attributed to a reduced rate of heat transfer due to a larger volume of air. The overrun could also affect the hardness of ice cream as evidenced by the results of the present study. The results showed that the samples with greater overrun were softer. It could be assumed that the air cells, together with large protein polymers formed via catalytic action of TGase, limited the size of ice crystals by exerting mechanical hindrance, providing a softer texture for the enzyme-treated ice creams. Not surprisingly, the enzyme treatment did not considerably influence the flavor of light ice cream albeit the sample treated with 6 units TGase /g milk protein received significantly lower score than the other samples. Conversely, the color of enzyme-treated samples was more appreciated by consumers than the sample without added TGase possibly because of light scattering properties of enzymatically formed protein polymers in theses samples. Consistent with the results of physical properties, the texture of light ice cream treated with 4 or 6 units TGase /g milk protein were ranked as the most desirable samples, followed by the samples treated with 2 and 0 units TGase /g milk protein. The order of light ice cream samples for total acceptability scores was the same as that for texture scores with the exception of the sample treated with 6 units TGase /g milk protein whose total acceptability score was lower than the sample treated with 4 units TGase /g milk protein.

Keywords: Light ice cream, Microbial transglutaminase, Flow behavior, Hardness, Overrun, Melting resistance