



The use of Transglutaminase and Gallic acid as Stabilizers and Thickeners in the Production of Ice cream

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Abstract

This study aimed to utilize transglutaminase and gallic acid as stabilizers and thickeners in ice cream production. Additionally, it explored the potential for enhancing the physicochemical properties of ice cream mixtures by partially replacing the stabilizer with transglutaminase (0.36g/100g_{total}) (IC2), gallic acid (2.5g) (IC3), and a combination of transglutaminase (0.22g/100g_{total}) and gallic (1.5g) acid (IC4). These mixtures were compared with a control mixture containing only the stabilizer (IC1). The properties of the prepared ice cream, including titratable acidity, pH, melting time, morphology, thermal stability, and sensory attributes, were studied. The results revealed that IC4 exhibited superior properties compared to the control mixture and other prepared mixtures across all evaluated aspects. Specifically, the study observed a decrease in pH alongside an increase in titratable acidity after aging, and IC4 demonstrated the highest melting time, stability, and overall acceptance. Furthermore, sensory evaluation results showed that the IC4 blend received the highest sensory rating at 91%. Overall, these findings highlight the potential for optimizing ice cream formulations through strategic use of additives, paving the way for advancements in ice cream production and product quality.

Keywords

Enzyme crosslinking
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Introduction

Ice cream is a significant food due to its high nutritional value (da Costa *et al.*, 2023). Typically sought by consumers for its refreshing, hydrating, and nutritious qualities during the summer (Andriani *et al.*, 2022; El-Maksoud, 2023; Elkot *et al.*, 2022), its production represents one of the most advanced technologies in the dairy industry (Mahdian *et al.*, 2023). The inclusion of new additives is expected to improve the sensory and rheological properties of ice cream, ensuring high quality (Asminaya *et al.*, 2022; Khosrow Shahi *et al.*, 2021; Shadordizadeh *et al.*, 2023). Ice cream is a complex colloidal system that, when frozen, includes ice crystals, air bubbles, fat globules, sugars, proteins, salts, and water (Liu *et al.*, 2023; Romulo & Meindrawan, 2021). The desired properties of ice cream depend on the physicochemical properties of the components in the mixture, including milk and its derivatives as well as other food ingredients. In addition, the properties are influenced by the air bubbles present in the liquid phase along with fine ice crystals and the liquid matrix containing

emulsified fat, milk proteins, salts, and sugar crystals (Ghaderi *et al.*, 2021; Goktas *et al.*, 2022).

Functional foods refer to whole foods or food components ingested to boost health and wellness. Nutraceutical foods provide both health benefits, such as prevention, and medical benefits, such as medication for various diseases (Shamshad *et al.*, 2023). Exposing ice cream to temperature fluctuations can lead to deterioration in quality as the ice cream's ability to recrystallize is reduced, thus affecting its sensory properties. To alleviate this problem and make ice cream more resistant to changes while increasing viscosity, transglutaminase is added.

Transglutaminase is considered a safe enzyme and is widely used in various food industries (Rossa *et al.*, 2011). Transglutaminase (EC: 2.3.2.13) is an enzyme found in both the plant and animal kingdoms. It works by forming internal and external cross-links in proteins between lysine and glutamine residues (Al *et al.*, 2020; Motoki & Seguro, 1998). Transglutaminase is widely used to create crosslinks in most

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