Chapter I:
Introduction

1.1 Background

The rising health-related problems due to high sugar intake have led to the need for sugar-free products, especially in popular product classes like desserts (Stanhope, 2015). One such type of dessert, which is also a spoonable dessert, is the dairy dessert custard pudding. Custard-based and pudding-based desserts are said to make up around 14% and 12%, respectively, of the global dairy dessert market (Industry Research Reports, 2024). In line with these concerns, reducing sugar content in dessert products has become an important focus in food reformulation. Excessive sugar consumption in Indonesia has become an area of concern, as stated by the Kementerian Kesehatan Republik Indonesia (2024), which suggests that consumption of sugar should not go beyond 50 grams per day, which translates to about 10 percent of energy consumption. However, the reality on the ground shows that consumption is even higher, especially through regular consumption of desserts.

The sugar used in custard pudding is sucrose, which not only acts as a key ingredient for adding sweetness to this dessert but also provides an important function in terms of contributing to the quality of the final output. It helps in making the pudding viscous, gelled, and capable of retaining water (Khemakhem et al., 2019). Sucrose is a disaccharide that comprises glucose and fructose units joined through a glycosidic bond. It has several hydroxyl (-OH) groups that help form hydrogen bonds with water molecules (Shiraga et al., 2017). This has guided research into the potential of using erythritol as an alternative sugar in reduced-sugar products.

Sugar alcohols, including erythritol ($C_4H_{10}O_4$), have been increasingly popularized as sugar substitutes due to their lower energy density (0.2-0.4 kcal/g) relative to sucrose (4 kcal/g) (Rapaille et al., 2016; Moriconi et al., 2020). Although erythritol is made up of hydroxyl groups that allow for hydrogen bonding with water molecules and other food polymers (Shah, 2024), it is unable to fully replicate the functions of sucrose in starch-protein complexes, such as custard pudding. Hence, structuring agents are required to compensate for the lack of functionality by sucrose (Copper, 2017). Nonetheless, reducing sugar content in custard pudding is difficult since it fulfills several functions in the product formulation. Lowering sugar concentration in such foods poses a considerable technological challenge. Partial sugar reductions (about 20-30%) are usually achieved in most cases since sucrose still contributes to the formation of a viscous liquid-gel matrix (Dadalı & Elmacı, 2025; Lê et al., 2016). Higher levels of sugar reduction tend to weaken gel structure, reduce viscosity, and increase syneresis due to the loss of sucrose functionality in water binding and network stabilization (Ghebremedhin et al., 2024).

Hydrocolloids, such as k-carrageenan and Locust Bean Gum (LBG), are common ingredients in dairy products and desserts to enhance texture, stabilize weak gels, and increase the retention of water. These large polymers can interact with water molecules and food macromolecules to regulate rheology and texture (Li & Nie, 2016; Spena et al., 2024). Nonetheless, current investigations have predominantly concentrated on conventional sucrose-containing systems, with little work exploring the synergistic effects of hydrocolloids with novel sweeteners like erythritol in composite dairy products. Thus, it is unknown how hydrocolloid systems may compensate for the structural differences caused by sucrose replacement in custard pudding (Mahato et al., 2020). Although there have been multiple studies concerning the reduction of sugar content, there is still insufficient research about the possible combination of hydrocolloids and sugar replacers like erythritol in more complex formulations of dairy desserts. It is especially unclear how a blend of hydrocolloids like k-carrageenan and LBG may be used to counteract the effects of sucrose replacement (Lin et al., 2025; Zarzycki et al., 2019).

k-carrageenan and LBG were chosen due to the complementary functions of the two gelling agents. k-carrageenan forms firm gels through its interaction with milk proteins, while LBG is known as an excellent thickener with high water-binding capability (Lu et al., 2025). The combination of the two hydrocolloids will demonstrate synergistic effects, leading to higher strength, better structural stability, and less syneresis. Because the texture of the custard pudding is highly sensitive to formulation modification, this product could be used as an ideal system for testing this purpose (Sutariya & Salunke, 2023). Thus, determining an appropriate degree of sugar reduction remains an important challenge in formulation studies; therefore, this research focuses on evaluating the performance of κ-carrageenan and LBG as textural modifiers in erythritol-based custard pudding formulations.

1.2 Objective

- To evaluate the effects of sucrose replacement with erythritol and the addition of hydrocolloids on the physical properties of reduced-sucrose custard pudding.
- To assess the effects of sucrose replacement with erythritol and the addition of hydrocolloids on the sensory properties of reduced-sucrose custard pudding.

1.3 Hypothesis

1.3.1 Hypothesis 1

H_0: The replacement of sucrose with erythritol and the addition of hydrocolloids will not significantly affect the physical properties of reduced-sucrose custard pudding.

H_1: The replacement of sucrose with erythritol and the addition of hydrocolloids will significantly affect the physical properties of reduced-sucrose custard pudding.

1.3.2 Hypothesis 2

H_0: The replacement of sucrose with erythritol and the addition of hydrocolloids will not significantly affect the sensory properties of reduced-sucrose custard pudding.

H_1: The replacement of sucrose with erythritol and the addition of hydrocolloids will significantly affect the sensory properties of reduced-sucrose custard pudding.