

Chapter I

Introduction

1.1. Background

High sugar consumption from ultra-processed foods has remained a major contributor to the global rise in NCDs. Global data from the WHO shows that NCDs account for approximately 71 to 74% of all deaths (Ramesh & Kosalram, 2023). In response to this, the WHO recommends limiting sugar consumption to under 10% of total energy intake. This initiative prompted many countries to initiate national reformulation programs aimed at reducing sugar levels in processed food products (Amies-cull et al., 2019; WHO, 2023). For instance, the United Kingdom implemented a national sugar reduction program with a goal of reducing sugar content in certain food categories by 20% between 2015 to 2020. Similarly, Indonesia has promoted sugar reduction through dietary guidelines and recommendations that limit sugar consumption to a maximum of 50 g per day (Kementrian kesehatan Republik Indonesia, 2024).

As these programmes are evaluated and improved over the years, the overall target has not been fully achieved. This limited success is partly related to the complex technological and sensorial challenges in sugar reformulation. In many food systems, sucrose plays a multi-functional role that is difficult to replicate without compromising product quality (Oneyeaka et al., 2023). These reformulation challenges are particularly evident in popular dessert categories where high consumption rates increase the demand and need for effective, consumer-acceptable sugar alternatives. Dairy-based desserts are among the major categories targeted for sugar reduction interventions, with global consumption rates reported to exceed 67% worldwide. Regional reports also showed that custard products are consumed by approximately 54% of the European population (Industry Research Reports, 2024), suggesting that these desserts contribute significantly to dietary sugar intake.

Custard pudding is a semi-solid dairy dessert characterized by a smooth texture (Aguilar-Raymundo & Vélez-Ruiz, 2018). During thermal processing, starch gelatinization and egg protein denaturation form the pudding matrix. Within this system, sucrose serves multiple functions beyond sweetness. Secondly, it acts as a structural stabilizer by increasing the protein coagulation temperature and controlling starch swelling through hydrogen bonding with water (Desam et al., 2020). As a result, the reduction of sugar within a product may result in a weakened structure, leading to undesirable changes such as syneresis and thinning (Louie, 2025; Lin et al., 2025). Therefore, current research has focused on identifying ingredients capable of mimicking the functional roles of sucrose.

Among these alternatives, polyols have gained popularity because of their ability to mimic several functions of sucrose while providing lower caloric value. Erythritol is a four-carbon polyol that provides about 70% sweetness relative to sucrose, has virtually zero calorie content, and high thermal stability (Dragomir et al., 2025; Erickson & Carr, 2020). Its hydroxyl-rich structure promotes hydrogen bonding within food systems. Furthermore, its lower molecular weight relative to sucrose generates a higher osmotic pressure which helps to bind water more effectively and lower the overall water activity (Rapaille et al., 2016). However, erythritol alone might not be able to fully compensate for the functional properties of sucrose in the final product.

Dietary fibers are therefore commonly used in combination with sweeteners to enhance the final product's texture and mouthfeel. Inulin is a soluble dietary fiber made up of fructose units held together by β -(2 $\rightarrow$ 1) glycosidic bonds. Its structure consists of amorphous regions that are very rich in hydroxyl groups, enabling it to participate in hydrogen bonding interactions that increase water retention and stability (Khetu et al., 2023; Petrović et al., 2025). Beyond water binding, inulin can form microcrystals that mimic fat and provide a creamy and thick mouthfeel (Canazza et al., 2025; Tang et al., 2025; Furlán & Campderrós, 2017). Due to these properties, inulin has gained attention as a potential ingredient in sugar-reduced formulations. However, despite there being extensive research on sugar reduction, most studies tend to focus on single sugar replacers or compare

different sweeteners by itself. Few studies have evaluated the combined use of polyols and dietary fibers in a single product system, especially in semi-solid dairy desserts. Therefore, this study aims to evaluate the effects of sucrose substitution with erythritol alone and an erythritol-inulin blend at different substitution levels on the quality characteristics of custard pudding.

1.2. Objective

The objectives of this research are:

- To evaluate the effect of sucrose substitution with erythritol and an erythritol-inulin blend at different substitution levels on the physical properties of custard pudding, including viscosity, texture, color, water activity and syneresis.
- To evaluate the effects of sucrose substitution with erythritol and an erythritol-inulin blend at different substitution levels on the sensorial properties of custard pudding, including sweetness intensity, texture, mouthfeel, and overall acceptability using hedonic and JAR analyses.

1.3. Hypothesis

1.3.1. Hypothesis 1

H_0 (Null Hypothesis): Sucrose substitution with erythritol or an erythritol-inulin blend at varying substitution levels will have no significant effect on the physical properties of custard pudding.

H_1 (Alternative hypothesis): Sucrose substitution with erythritol or an erythritol-inulin blend at varying substitution levels will significantly affect the physical properties of custard pudding.

1.3.2. Hypothesis 2

H_0 (Null Hypothesis): Sucrose substitution with erythritol or an erythritol-inulin blend at varying substitution levels will have no significant effect on the sensorial properties of custard pudding.

H_1 (Alternative hypothesis): Sucrose substitution with erythritol or an erythritol-inulin blend at varying substitution levels will significantly affect the sensorial properties of custard pudding.