CHAPTER 1

INTRODUCTION

1.1 Background

The increasing popularity of Western-style diets consisting of processed foods that are high in fats, sugar, and salt has also been accompanied by a growing scientific consensus on its negative impacts on health. Subsequently, awareness amongst consumers regarding these risks have led to an increased demand for healthier alternatives to such foods. Dairy products, often associated with high levels of saturated fats, are not immune to this demand, sparking the innovation of plant-based milks such as soy, coconut, and rice milks. More so, the phenomenon of lactose intolerance and an allergy to a protein in cow's milk is also a considerable factor in the increasing demand for plant-based alternatives (Deep et al., 2017). However, despite these plant-based alternatives being a healthier option, they are not without their downsides, as they tend to exhibit undesirable properties such as off-flavors (e.g. beany flavor in soy milk) (McClements *et al.*, 2019). To combat this, technological and research enhancements have made way for the current development of methods that could potentially produce plant-based milks with minimal undesirable properties. An example involves grinding soy in a vacuum during the production of soy milk to minimize its beany flavor, among other methods.

Given that plant-based milks such as soy, coconut, and rice milks can and are already being produced and available in markets, it can be inferred that in turn the production of other processed dairy products, such as yoghurt, derived from these milks would be within the realm of possibility. Both plant-based milk and cow milk share similarities component-wise and in biochemical properties. For instance, the proteins found in plant-based milk exhibits a similar isoelectric point as proteins in cow milk, thus allowing plant-based milk to be manufactured into yoghurt through protein coagulation by acidification, leading to the typical thick texture and sour taste observed in yoghurt (Walstra, Geurts, & Wouters, 2006). This implies that plant-based milks

could potentially be processed in a similar way to cow milk to form dairy products, but a substantial difference in sensorial and nutritional characteristics is expected (Mital & Steinkraus, 1979).

Yoghurt is a fermented dairy product that is made through the presence and action of lactic acid bacteria (*Streptococcus thermophilus* and *Lactobacillus delbrueckii* ssp. *Bulgaricus*), which preserves the milk by making it thicker and sourer, yet still edible (Walstra, Geurts, & Wouters, 2006). The presence of the aforementioned lactic acid bacteria gives yoghurt a probiotic effect, which can improve gut health. It also consists of important nutrients for health such as vitamin A, vitamin B2, vitamin B12, and calcium. Moreover, the 2013 Australian Dietary Guidelines attributed yoghurt in its ability to help prevent various health diseases and conditions such as osteoporosis, high blood pressure, and cancer (Dairy Australia, 2019). Interestingly, yoghurt can also be consumed by individuals that are lactose-intolerant due to lactose being utilized for fermentation by the lactic acid bacteria, making this dairy product very popular and widely-accepted.

There is a promising potential of manufacturing plant-based yoghurt given its health benefits and appeal to the growing segment of consumers that would prefer to consume healthier alternatives to existing dairy products. This experiment focuses on soy milk as the raw ingredient for yoghurt making due to its popularity especially in Asia the current lack of presence of soy yoghurt products in the market, thus presenting a potential for the development of soy-based yoghurt.

Another consideration to make in the production of yoghurts in general is the occurrence of syneresis, where whey separates from the yoghurt matrix, resulting in an undesirable appearance and texture of the yoghurt (Damodaran et al., 2008). A number of methods have been explored to address this phenomenon, but this experiment will focus on the use of the enzyme Transglutaminase (TGase) due to the lack of studies available on its usage on soy yoghurt,

providing the potential to explore its efficacy and potential effects on other physicochemical properties of plant-based yoghurt.

Nevertheless, current knowledge on plant-based yoghurts is still lacking simply due to the lack of research conducted on this topic to date. Hence, this thesis aims to review any available relevant literature to supplement this topic. Furthermore, this thesis also aims to observe the initial effect of TGase at different concentrations on the physicochemical properties of soy yoghurt, the ability of the enzyme to mitigate syneresis in soy yoghurt, and finally determine which TGase concentration is best for the most desirable properties of soy yoghurt. The physicochemical properties that are to be analyzed and compared include the pH, hardness, degree of syneresis, and total soluble solids (^{o}Brix).

1.2 Problem Formulation and Hypothesis

From the background section, it can be inferred that the demand for plant-based alternatives to milk and its constituent products has risen mainly due to the increasing public awareness of the negative impacts of a Western diet as well as allergy concerns. The case for yoghurt as the selected focus for the experiment is its global popularity and consumption, especially since it is touted for its probiotic properties. Additionally, soybean was selected as the plant-based alternative on the basis that it is already popularly accepted worldwide, especially in Asia, along with the lack of soy yoghurt products in the market.

The enzyme TGase was selected to observe its effectiveness in mitigating syneresis as well as its effect on other physicochemical properties of soy yoghurt. As such, the formulated research problems that this research will attempt to address are as follows:

- What physicochemical properties in soy yoghurt are influenced by the addition of TGase?

- Is the TGase enzyme effective in addressing the problem of syneresis in soy yoghurt?
- Is there a significant effect of different concentrations of TGase enzyme added on the physicochemical properties of soy yoghurt?
- Which is the best TGase concentration out of the treatments that would result in the most desirable physicochemical properties in soy yoghurt?

The null hypothesis for this study would be that TGase would not cause a notable difference in the physicochemical properties of soy yoghurt. On the other hand, the alternative hypothesis would be that TGase causes a notable difference in the physicochemical properties of soy yoghurt.

1.3 Objectives of the Research

The main objectives of this research are to determine the extent of the initial effects to the physicochemical properties of soy yoghurt by the addition of varying concentrations and determining which TGase concentration results in the most desirable properties for soy yoghurt. The emphasis on initial effects means that the analyses will be conducted only on day 0, as a result of time constraints during the thesis project period. The physicochemical properties that are to be analyzed and compared include the pH, hardness, degree of syneresis, and total soluble solids (^{o}Brix) of the yoghurts. Moreover, another objective of this research is to compile and review relevant literature that would supplement the topic and provide relevant comparisons.

1.4 Scope of the Research

The scope of this research encompasses several areas. Firstly, the research will touch on the background information regarding yoghurt products including yoghurt and the motives behind the increasing demand for its plant-based alternatives. Secondly, the research will attempt to compare the effect of the addition of different concentrations of TGase to the physicochemical

properties of soy yoghurts. Finally, physicochemical properties of the soy yoghurt will be compared in terms of pH, hardness, degree of syneresis, and °Brix.

Initially, the presence of off-flavors and its mitigation in plant-based yoghurts was included as a characteristic to be investigated for this experiment. However, this approach has been omitted due to the difficulty of preparing sensory evaluations amidst the COVID-19 pandemic. Consequently, the sensorial properties of the soy yoghurt such as flavor and aroma are not as heavily prioritized as the physicochemical properties. This leads to the omission of ingredients that are aimed to improve the sensory properties of the soy yoghurt, such as sugars/sweeteners and extracts used to mask odors. Nonetheless, the subjective observation regarding odor in this experiment can be used as additional information to supplement further research focusing on the potential off-flavors in soy yoghurt.

Since TGase was selected as the main factor of potential changes in physicochemical characteristics in soy yoghurt, other additives that could also cause such changes such as stabilizers and emulsifiers will not be added during the production of the soy yoghurts. This is to ensure that any changes in characteristics of the soy yoghurts is primarily caused by TGase itself, and not from other ingredients.

Currently, the findings of this research are limited to providing insight into the potential initial physicochemical changes that could be caused by TGase when added at different concentrations to soy yoghurt. The author believes that future research can be conducted based on these results by incorporating combinations of different additives to address syneresis, researching the optimum method for off-flavor mitigation, testing the effect of TGase in soy yoghurt over an extended storage period, and specifically addressing the acceptability and marketability of these soy yoghurt through sensory and market analyses, as well as shelf-life testing.

1.5 Importance of the Research

This research bears importance in that it leverages the rising trend of healthy eating and subsequently the increasing demand for plant-based alternatives to dairy products, in this case, for yoghurts. Furthermore, it also leverages the lack of soy yoghurts currently available in markets and uses this as an opportunity for preliminary research towards the development of a soy yoghurt product. It also has the potential for expanding the reach of yoghurts into the market as the plant-based alternatives can be marketed to those with milk protein allergies, are health conscious, and those in the vegetarian/vegan demographic. Thus, the results obtained from this research can be used as a stepping stone towards the product development of plant-based yoghurts as a means of seizing a market opportunity.