CHAPTER I

INTRODUCTION

1.1 Background

The constant growing number of populations affects both food security and waste management. As an effort to preserve sustainability, there is an ongoing demand for food alternative. There has been a development of plant-based foods to mirror the functionality and organoleptic properties for the derivatives of meat, milk, and eggs products (Mustafa and Raeney, 2020).

The production of plant based food is deemed as a means of inclusivity and providence of lifestyle for vegetarians and vegan consumers. The population of vegetarians in western countries accounts for 10% of the total population (Mustafa and Raeney, 2020). The production of eggless cake production is available in the market for both vegan consumers and consumers with egg allergies (Alsaman *et al.*, 2020).

Proteins are often used in the production of food products due to its many functions, including functional properties, nutritional quality, and as an aid to sensory characteristics (texture, flavor, and color). Protein source used by food industry are mostly sourced from egg white, soybean, whey, and wheat. However, there is a limited usability of those sources of protein due to several reasons, including dietary restrictions, allergenicity, vegetarian diet, and halal requirement which prompted an alternative for protein sources. Legumes can be considered as a highly satisfactory source of protein due to its high protein content, inexpensive, and broad application. There has been a developing interest in using legumes based on its chemical compositions (protein, starch, and fiber) and to incorporate those compositions into ingredients in food products. Consequently, gathering knowledge on chemical, physical, and functional properties of protein concentrates in legumes are considered as an essential step in incorporating legumes to food products (Ettoumi *et al.*, 2015).

Aquafaba is defined as a viscous liquid produced upon the cooking of legumes. Aquafaba is known to have many functional properties such as water holding capacity, oil holding capacity, emulsion stabilizer, foaming properties, gelling and lastly thickening properties (Mustafa and Raeney, 2020). Many researchers have proved that aquafaba, particularly made from canned chickpeas, have a high foam forming ability. The use of aquafaba has been applied in making cold vegan desserts, cake, mayonnaise, and meringue (Nguyet *et al.*,2021; Aslan and Nilgün, 2020; Mustafa *et al.*, 2018; He *et al.*, 2021; Raikos *et al.*, 2019; Novianti, 2017).

Other types of beans also possess a similar functional properties to chickpea. The legumes include whole green lentils, haricot beans, and split yellow peas. (Echeverria-Jaramillo *et al.*, 2021). The nutritional composition of lentils in regard to total carbohydrate and protein content in aquafaba is higher in comparison to raw lentils. Moreover, the functionality of lentils in regard to foaming and is also higher in cooking water in comparison to raw lentils. According to Jarpa-Parra (2017), red lentil protein foaming capacity is 24-43% at pH 7 while green lentil protein foaming capacity is 42-68% at pH 7. On the other hand, red lentil foaming capacity 21-32% at pH 7 while green lentil protein foaming capacity is 13-62% at pH 7. However, there is no research conducted on the foaming properties of brown lentils based on the different time of cooking process.

According to Samaranayaka (2017), protein functionality is the main factor in determining the application of aquafaba. Protein functionality affect several properties, including solubility, water-binding, fat-binding, emulsification, foaming, gelation, thickening, and flavor-binding. Protein functionalities are affected by amino acid composition, protein structure, and protein conformation (hydrophobicity and hydrophilicity) that are affected by heat processing temperature. In this research different cooking time might influence the foaming properties of aquafaba. Boiling of legumes will resulted in the migration of water into the seeds that resulted in the leeching of solid matter of legumes into the cooking water. The leeching of seeds compositional nutrients resulted in aquafaba having functional properties. However, excessive heat may cause further denaturation of protein that will alter the effectiveness of cooking water functional properties.

In this research 2 types of lentils and chickpea was compared in terms of nutritional composition of the cooking water and their foaming ability. Different cooking time will also be applied to observe the effect of cooking toward the functional and nutritional composition of the cooking water of lentils (aquafaba). In this research, cooking water of green lentils and brown lentils and chickpea as a comparison was made into aquafaba. The effect of legume types to aquafaba foaming properties was evaluated. Furthermore, different cooking time was applied to the production of aquafaba.

1.2 Research Problem

The functionality of the aquafaba is depended on the type of chemical composition of aquafaba itself. Processing temperature, legumes type, and cooking time may affect the amount of substrate extracted upon cooking. Water-soluble protein that leached during cooking might be one of the main contributor of the foaming capability of the aquafaba. In this research optimum cooking time that can produce aquafaba was analyzed in terms of foaming properties. Cooking will soften the seeds tissue thus increasing the amount of protein that leached into the cooking water however prolong heat might alter the functional properties of the protein. Different types of legumes also possess different types of protein. Thus, in this research the effect of cooking time and types of legumes toward foaming properties were evaluated.

According to Luo *et al.* (2022), heat denaturation of proteins resulted in conformational changes and weakening chemical bonds that supports structural integrity of protein molecules. Heat denaturation resulted in changes in protein viscosity causes by molecules aggregation. Protein aggregation is a condition in initial stage of protein unfolding in which the aggregation is irreversible.

According to Wang *et al.* (2014), application of heat treatment resulted in higher surface hydrophobicity. Surface hydrophobicity was mainly caused by unfolding of proteins as thermal response, which were followed by agglomeration of proteins through disulfide bonds. Higher surface hydrophobicity resulted in lower surface tension at air-water interface which resulted in improved foaming properties of protein.

According to Lee *et al.* (2019), application of heat treatment causes protein unfolding that uncover internal non-polar amino groups that resulted to protein insolubility that increases protein-protein interactions. The increase in protein interactions is caused by the production of reactive thiol groups. However, excessive amount of heat causes extensive protein denaturation that resulted in droplet flocculation and coalescence.

Several studies have been conducted on developing aquafaba (Alsaman *et al.* 2020, Stantiall *et al.* 2020, Alsaman and Ramasmewy 2021, He *et al.* 2021). However, the treatment of aquafaba have been focused on the amount of soaking time, the ratio between legumes and cooking water, pH alteration, and the application of pressure into aquafaba. According to Alsaman *et al.* (2020), functional properties of aquafaba was determined from cooking time and legume type used as raw materials. Therefore, the present study aimed to observe and compare the physical characteristics and chemical composition to functional properties of aquafaba derived from whole green lentils, whole brown lentils, and chickpea based on different time of cooking.

1.3 Objectives

1.3.1 General Objectives

The general objective of this research was to prepare aquafaba from brown lentils and green lentils and to determine its foaming properties.

1.3.2 Specific objectives

The specific objectives of this research were:

1. To determine the effect of cooking time and types of legumes toward the physical characteristics and chemical compositions of aquafaba.
2. To determine the optimum cooking time towards different types of legumes based on the foaming capacity and foaming stability of the aquafaba.