CHAPTER 1

INTRODUCTION

1.1. Introduction

Sweet soy sauce is one of the essential condiments in Indonesian diet. It has brown-black color along with complex flavor and unique taste as its production occurs in the presence of diverse microflora, such as yeast and lactic acid bacteria (Atmoko, 2015). In Indonesia, soy sauce consumption is progressively growing, which is shown in per capita average consumption is 0.66 kg per person per year and increasing to 0.7 kg in 2017 (*Sekretariat Jenderal Pertanian*, 2019). Nowadays, with the development of food technology, many food ingredients are provided in the form of powder to facilitate easier processing and handling. As most sweet soy sauce in Indonesia is only available in liquid form, the conversion of liquid soy sauce into powder form will increase product variability. The development of soy sauce powder has great benefits in improving product functionality and reducing cost and space needed for storage and distribution (Wang, Jiang, & Zhou, 2013). Soy sauce powder has gained popularity in Japan and has been extensively used to enhance the flavor in soup base, sauce, gravy mix, processed meat, and frozen food (Wang & Zhou, 2012; Wang & Zhou, 2015).

Spray drying is a widely used method to convert liquid products into powder. However, there are some difficulties in handling and drying the product with high sugar and viscosity, particularly sweet soy sauce, due to sticking problems (Selvamuthukumaran, 2019). Thick and sticky sweet soy sauce can be difficult to pump and atomize in the spray dryer. Sweet soy sauce composition is dominated by 43-45% sugar, majorly sucrose and slight glucose and fructose (Atmoko, 2015; Syifaa *et al.*, 2016). Also, sucrose, fructose, and glucose have low molecular weight and low glass transition temperature (T_g) at 62^oC, 31^oC, and 5^oC, respectively (Selvamuthukumaran, 2019). When the spray drying passes these temperatures, the feed turns into a viscous liquid, caramelized, and attached to the drying chamber (Lee, Taip & Abdulah, 2018). To achieve the best stability, outlet air temperature should not reach above 5-20^oC of T_g of powder (Zhang *et al.*, 2018). However, it is not possible since spray drying uses inlet temperatures around 150-220^{o}C with high outlet temperature ranging from 60-100^{o}C (Fang & Bhandari, 2012; Gharsallaoui, 2007).

The common approach to solve the stickiness problem is by controlling the inlet temperature and addition of carrier agents, a group of high molecular weight compounds with high T_g, which could improve the spray drying performance (Selvamuthukumaran, 2019). Maltodextrin is a carrier agent which mostly used in spray drying because of high glass transition temperature and solubility, low cost, and neutral flavor (Lee, Taip & Abdulah, 2018). However, as reported by Wang & Zhou (2012), the stickiness problem of soy sauce powder cannot be improved with maltodextrin alone. Apart from carbohydrate, protein has been widely applied in spray drying of food ingredients. Protein can migrate to the surface of the feed material, creating a film, and reducing the stickiness of the powders during spray drying (Wang, Jiang, & Zhou, 2013; Lee, Taip & Abdulah, 2018). Hence, the combination of carbohydrate (maltodextrin) with protein potentially optimize the properties of resulting powder.

Currently, the research regarding sweet soy sauce powder production is still limited. Nurlita *et al.* (2019) has done the vacuum drying of sweet soy sauce using different concentrations of maltodextrin. Increasing maltodextrin concentration exhibits powder with higher moisture content, dissolution time, L* value, and recovery with a decrease in hygroscopicity. In the previous study, Wang, Jiang, & Zhou (2013) has successfully done the spray drying of salty soy sauce using a mixture of 5-15% WPI and maltodextrin. On the other hand, Shi, Fang, Bhandari (2013) successfully produced high yield (>50%) spray-dried honey, a product with similar characteristics to sweet soy sauce, using 0.5-30% WPI and maltodextrin. It shows that small additions of protein (0.5%) significantly increased yield to 57.4%. However, both Wang, Jiang, & Zhou (2013) and Shi, Fang, & Bhandari (2013) reported further increase of WPI gave no significant difference in yield, moisture content, and water activity between powders with different amounts of WPI. This literature shows that the characteristics of powder highly depend on spray drying parameters and the addition of carriers. Therefore, these factors should be controlled to optimize the production of powder in this study.

1.2. Objectives

This research was conducted to evaluate the effect of whey protein isolate (WPI) and maltodextrin (MD) as carrier agents and inlet temperature on the physical properties of spray-dried sweet soy sauce powder.

1.3. Problem Formulation

a. What is the effect of spray drying inlet temperature on the physical properties of sweet soy sauce powder?
b. What is the effect of carrier composition (whey protein isolate and maltodextrin) on the physical properties of sweet soy sauce powder?

1.4. Scope of Research

The scope of this research includes the manufacturing of sweet soy sauce powder using spray drying and powder analysis. This experiment will focus on evaluating the effect of carrier agents and inlet temperature. The powder analyses done are yield, moisture content (Sarabandi *et al.*, 2018), water activity, hygroscopicity (Lasekan, 2014), tapped and bulk density (Tze et *al.*, 2012), dissolution rate (Goula & Adamopoulos, 2010), solubility (Wang & Zhou, 2015) and color. The effect of other factors like glass transition temperature, particle size, and other spray drying parameters, which are known to affect powder quality, are not studied and instead will be discussed.