CHAPTER I

INTRODUCTION

1.1 Background

Calcium is one of the primary nutrients that contribute to the development and preservation of bone mass. In adolescence, calcium is important to support the yearly increase of skeleton mass of up to 409 g for male and 325 g for female and in elderly, it is important to maintain bone density due to yearly calcium loss of 15 g. On average, a bone contains about 30-35% calcium, therefore, inadequate intake of calcium especially in adolescents and young adults can hinder the development of bone and deficiency in adults may cause problems with bone mass retention which could lead to osteoporosis and bone fractures (Balk *et al.*, 2017). A problem with fulfilling the recommended daily intake of calcium is because calcium is heat sensitive. Based on the research done by Hayat *et al*., 2019 on fennel seeds, the calcium content of fennel seeds significantly decreased as the heating time increases when heated at the same temperature.

Cow milk is widely recognized as a complete food due to its nutritional composition which consists of both macro and micronutrients. Furthermore, it is one of the main sources of calcium in the diet, however, milk allergy is common among infants although it is not as common in adults. Cow milk is also rich in lactose, making it unsuitable for people with lactose intolerance due to the absence or deficiency of lactase (Paul *et al.*, 2019; Vanga and Raghavan, 2017). Plant-based milk is developed as an alternative to cater to this group as well as people who due to belief or diet should not consume animal-based products. In appearance, plant-

based milk and cow milk are similar but from the nutritional content, cow milk is superior especially in calcium. Plant-based milk can be divided into cereal-based, legume-based, nut-based, seed-based, and pseudo-cereal-based (Chalupa-Krebzdak *et al.*, 2018; Sethi *et al.*, 2016). Rice milk is a cereal-based milk that is considered one of the best hypoallergenic milks and is recommended for people who are allergic to legumes or nuts. It is mostly composed of carbohydrates with small amounts of protein and fat. Rice milk is also sweeter compared to other plant-based milk. However, it is low in calcium compared to cow milk and other plant based milk such as almond milk, soy milk, and coconut milk (Abou-Dobara *et al.*, 2016; Vanga and Raghavan 2017). Moreover, as rice milk is susceptible to separation after homogenization, a thickening agent such as CMC is needed to increase the viscosity and stability of rice milk (Octaviani *et al.*, 2020).

Moringa leaves (*Moringa oleifera* Lam.) are widely utilized in food products to increase their nutritional content. In the research conducted by Khanifah *et al.* (2017), moringa leaf powder was used as a source of calcium in soy milk. The calcium content of soy milk that is fortified with 32 mg/100 ml moringa leaf powder is 119.48 ppm compared to unfortified soy milk which is 83.72 ppm and is well accepted by toddler panellists. Katmawanti *et al.* (2021) conducted research using moringa leaf flour to improve the nutritional content of instant porridge baby food. The porridge added with 5 g moringa leaf flour has fulfilled 96% of the calcium RDA for infants aged 6-12 months compared to commercial porridge at 35% RDA. Both research reported that although the formulations containing higher amounts of moringa leaves provides higher amount of calcium, it is not preferred by the panellists due to its bitter taste. In addition, Katmawanti *et al.* (2021) also reported

that higher amounts of moringa leaves in the formulation causes the product to have unpleasant aroma as well as grainy mouthfeel. Other limitation in the utilization of moringa leaves in food products is the presence of phytic acid which will reduce the calcium bioavailability (Dai *et al.*, 2020).

Dates and its derived products are commonly used as a sweetener in food products such as bakery products, confectionery, drinks, and desserts. In the research done by Manickavasagan *et al.* (2013) on using dates as a sugar substitute in *idli*, a traditional food in India and Sri Lanka, the addition of chopped dates increases the sweetness, aroma, and overall acceptance of *idli* when compared to *idli* that is sweetened with sugar. Furthermore, Alhamdan *et al.* (2021) researched about the effect of fortification of date syrup in *laban*, a fermented milk drink, towards the sensory quality attributes and concluded that the increasing amount of date syrup increases the sensory quality attributes for overall acceptance, taste, and flavor of the products containing to the products without the addition of date syrup.

As rice milk is low in calcium, it could not be consumed as a cow milk substitute for people with dietary restrictions to achieve their daily calcium intake. Therefore, rice milk should be fortified with other foods that contains high amount of calcium such as moringa leaves, however, despite the high calcium content, the addition of moringa leaves in food products also introduced unpleasant sensory attributes which limits its utilization (Katmawanti *et al.*, 2021; Khanifah *et al.*, 2017). Therefore, date syrup is used to increase the acceptability of moringa rice milk by improving its sensory characteristics.

1.2 Research Problem

In the general population, the average calcium intake in Indonesia is 254 mg/day which is lower than the 1000-1200 mg/day recommended amount issued by the government (Bardosono *et al.*, 2020; Mentri Kesehatan Republik Indonesia, 2019). The addition of moringa leaf flour can significantly increase the calcium content of food products, however, its acceptance is limited due to its bitter taste, unpleasant aroma, and grainy texture (Katmawanti *et al.*, 2021; Khanifah *et al.*, 2017). The presence of phytic acid in moringa leaves will also reduce the bioavailability of calcium (Dai *et al.* 2020). Therefore, in this research, date syrup is used to increase the acceptance of moringa rice milk by improving the taste, aroma, and texture sensory parameters. Moreover, phytic acid in moringa leaves will be reduced to ≤0.3% as recommended by Nissar *et al.* (2017) to minimize its effect towards the bioavailability of calcium.

1.3 Objectives

1.3.1 General Objectives

The general objective of this research was to utilize moringa leaf (*Moringa oleifera* Lam.) to increase the calcium content of rice milk and increase the acceptance of the product by using date syrup.

1.3.2 Specific Objectives

The specific objectives of this research are:

1. To reduce the amount of phytic acid in moringa leaves to ≤0.3%.

2. To determine the best drying time for moringa leaf flour based on the yield, moisture, ash, and calcium content.
3. To determine the most preferred combination of moringa leaf flour and date syrup in rice milk based on insoluble solids, viscosity, total soluble solids, calcium content, and sensory evaluation.