

CHAPTER I

INTRODUCTION

1.1 Background

Tofu is a kind of soybean protein foods that contain vegetable protein and various other nutrient elements in a well-balanced form and has become popular in recent years as healthy vegetable foods. Unlike most other protein foods especially meat-derived foods, tofu is entirely free of cholesterol and low in fat, particularly saturated fat. The quality of tofu protein is as high as that found in chicken. Thus, tofu can serve as an ideal protein backbone of the diet for health-minded, cost-conscious people who love fine food (Shurtleff and Aoyagi, 2001).

According to Sanjayet *al* (2008), the quality of tofu is significantly influenced by types of coagulants. It has been recognized that addition of a coagulant at the proper level is the most important step in the preparation of tofu. For the production of tofu, usually magnesium chloride, calcium sulfate, or calcium chloride are used as the coagulant for soybean milk. However, those inorganic additives often involve impurities such as heavy metals in the production process at industrial level although in a trace amount. According to Shurtleff and Aoyagi (2001), calcium chloride, magnesium chloride, and lactone (glucono delta-lactone) are not on the GRAS list of direct food additives. Moreover, those chemical coagulants sometimes are not readily available for use in the household and not easily available in the rural areas. Hence, an attempt to find some natural coagulants for making tofu is warranted. From previous research conducted by Sanjayet *al*. (2008), the natural coagulants used were

obtained from plant sources (*Citrus limon*, *Garcinia indica*, *Tamarindus indica*, *Averrhoa carambola*, *Averrhoa bilimbi*, *Phyllanthus distichus*, *Tamarindus indica* flower extract, *Hibiscus cannabinus*, and *Passiflora edulis*). Nonetheless, there are some samples such as *Averrhoa carambola* and *Averrhoa bilimbi* that contain high oxalic acid.

According to Rassam and Laing (2005), oxalate is present in plants in soluble form (oxalic acid) and insoluble forms (largely as calcium oxalate crystals). It is known that oxalate has adverse nutritional effects i.e. binding Ca^{2+} , Mg^{2+} , and Fe^{2+} and lowering their bioavailability in the diet by decreasing their absorption. High levels of oxalate in the body, resulting from the ingestion of a high-oxalate diet and from endogenous metabolism may result in calcium oxalate crystallization and kidney stone formation. Dallas (2006) stated that a long-term consumption of food high in oxalic acid could lead to nutrient deficiencies. For those with kidney disorders, gout, or rheumatoid arthritis, or having family history of experiencing such health problems should avoid foods high in oxalic acid. Anonymous (2006^a) stated that some food that are high in oxalic acid are spinach, rhubarb, buckwheat, blackberries, star fruit, lemon peel, among others.

Therefore, this present research was conducted to find good sources of natural coagulants for making firm tofu i.e. *Averrhoa carambola*, *Averrhoa bilimbi*, and peel of *Citrus limon* by carrying out pretreatment to reduce the oxalic acid content first in the samples.

1.2 Research Problem

The usage of *Averrhoa carambola*, *Averrhoa bilimbi*, and the peel of *Citrus limon* as natural coagulants in making tofu has several benefits, such as cheap, easily accessible, and rich in vitamins, carotenoids, and bioactive compounds. But, those samples naturally contain high amount of oxalic acid. Thus, a pretreatment has to be done in order to reduce the oxalic acid content in the samples. Beside that, according to Liu (1999), the temperature of soymilk at the time of adding a coagulant affects the coagulation rate as well as tofu quality.

So, this research studied the effect of different temperature of soymilk when the coagulant was added and types of coagulants used. Moreover, further investigations were done to assess the physical, chemical, and sensory characteristics of the tofu coagulated by oxalic acid-reduced extracts of *Averrhoa carambola*, *Averrhoa bilimbi*, and the peel of *Citrus limon*.

1.3 Objectives

1.3.1 General Objective

The general objective of this research was to investigate the best source among natural coagulants for making tofu i.e. fruits of *Averrhoa carambola*, *Averrhoa bilimbi*, and the peel of *Citrus limon* in terms of physical, chemical, and sensory characteristics.

1.3.2 Specific Objective

The specific objectives of this research were

1. To determine the optimal concentrations of calcium propionate to precipitate the oxalic acid in the filtered juices of *Averrhoa carambola*, *Averrhoa bilimbi*, and the peel of *Citrus limon*.
2. To investigate the effect of different temperature of soymilk when the coagulant is added.
3. To evaluate the physical and chemical characteristics of tofu coagulated by *Averrhoa carambola*, *Averrhoa bilimbi*, and the peel of *Citrus limon*.
4. To evaluate the sensory characteristics of tofu coagulated by *Averrhoa carambola*, *Averrhoa bilimbi*, and the peel of *Citrus limon*.
5. To select the best coagulant for making tofu i.e. *Averrhoa carambola*, *Averrhoa bilimbi*, and the peel of *Citrus limon* based on physical, chemical, and sensory characteristics.

