# Chapter I
# Introduction

Following the energy crisis in 1970s, people began to be aware of the importance of non-petroleum energy sources including ethanol. Ethanol is usually used as solvent and chemical feedstock for chemical industries. Furthermore, it is also been considered as a potential alternative for substituting fossil fuel. Ethanol can be used either directly or as additive for gasoline to form a mixture which is more commonly known as gasohol. Fermentation of renewable sources such as agricultural products and wastes is particularly promising because of its huge potential for large scale economic production of ethanol. Although energy content of ethanol is lower than that of gasoline, it offers many advantages such as the possibility of continuous production from renewable materials and lower emission in its application [1].

In general, ethanol production by fermentation can be conducted with various methods. It can be done in batch, fed batch, or continuous mode. Free, flocculated, or immobilized cells can be used as the producers. As compared to other methods, ethanol production using immobilized cell system offers many advantages, especially higher productivity of ethanol. However, some limitations including inadequate mechanical strength and high cost of the carrier have hinder the application of immobilized cell technology in commercial scale. Moreover, as this technology is still in the verge of development, information gained from experiments is considered of great importance. Thus, as new carriers for ethanol production was evaluated in this work, it is expected that this work can provide both an alternative solution and useful information for the development of high performance cell carriers for ethanol production.

## 1.1 Objectives

1. To develop immobilized cell carriers for ethanol fermentation.
2. To gain useful information regarding cell immobilization phenomena in the new carrier based fermentation systems.

## 1.2 Expected benefits

1. Invention of high performance immobilization carrier for large scale commercial ethanol fermentation.
2. Useful information for a better understanding of immobilized cell technology.

## 1.3 Working scopes

In the framework of building an applicable immobilized cell fermentation system for ethanol production, the works carried out in this study is considered as an early step. Therefore, it was considered practical and effective to work in small batch system. The fermentation in this work was carried out in shake flask mode. Based on previous report by Phisalaphong et al. (2006), the optimal sugar concentration of about 200 g/L was used in this study. More scopes are presented in details in the following paragraph.

1. Flocculating yeast strain, *Saccharomyces cereviceae* M30 was used as ethanol producer.
2. The fermentation was carried out in shake flask culture system at shaking frequency of 150 rpm and temperature of 33°C.
3. Loofa sponge, chitosan, and alginate were applied as materials for constructing immobilized cells carriers.
4. Palm sugar and molasses were utilized as carbon and energy source.
5. Immobilization methods evaluated were entrapment and adsorption of cell to carriers/supports.
6. Reusability of the carrier was tested by repeated batch.