CHAPTER 1

INTRODUCTION

The increasing demand for gasoline by the world population has resulted in higher global petroleum prices. Many countries have been trying to explore new energy sources. One such example of this would be biodiesel which is a form of alternative energy derived from animal and plant lipids. It is degradable and considered to be less toxic than petroleum fuel (Petchmala *et al*., 2008). Algae, especially microalgae which are cultivated for food supplement or component of animal feed (Peerapornpisal, 2003), have the potential for use as biodiesel production material because they grow rapidly and accumulated high lipid in cells. These lipids are similar to those found in higher plants (Banerjee *et al*., 2002). Some species have up to 50% lipid content per gram dry weight, such as *Botryococcus braunii* (25-75% hydrocarbon per gram dry weight), *Chlorella* sp. (28-57.9% lipid per gram dry weight), *Nannochloropsis* sp. (31-68 % lipid per gram dry weight). Therefore, many countries have realized the benefit of microalgal cultivation for biodiesel production (Chisti, 2007).

However, most of the studies were done in temperate zones, where the ambient temperature is typically around 25 ℃ (Chini Zittelli *et al*., 1999; Attilio *et al*., 2009). Thailand lies in the tropical zone. Thus the lipid producing strains and their cultivated conditions the temperate countries may not be suitable for Thailand or other tropical countries. Moreover, they have been very few studies conducted on

the production of microalgal oil in tropical countries, especially Thailand. This is due to the fact that many commercial microalgal farms only have cultivated microalgae for food supplements and animal feed in Thailand (Peerapornpisal, 2003).

In addition, the total cost of biodiesel production from microalgae is still comparatively higher than the cost of fossil fuels due to the high capital of construction materials and the operating costs of photobioreactor, including, equipments, labor and nutrients (Richardson *et al.*, 2012). Furthermore, the productivity of total extracted lipid from biomass is still low. Therefore, it results in high-cost of microalgal biodiesel when produced on the large scale. Oil – productivity depends on the algal growth rate and the oil content of biomass. The optimal cultivation condition could promote biomass production and lipid accumulation. Furthermore, the process of lipid extraction could also increase lipid productivity.

It is therefore interesting to study some of the green microalgae in Thailand for possible biodiesel production. These native strains were cultivated under ordinary climate condition of Thailand without regulating control, as compared with the foreign strain, *Nannochloropsis limnetica* SAG 18.99. The promising strain with fast growth rate and high lipid content, was selected to look for the optimal condition for increasing the lipid productivity by decreasing or increasing some nutrients in medium using response surface methodology (RSM). Moreover, utilization of inexpensive medium (CMU03) and cultivation in the open system (100 L) were investigated for reduction of cultivation cost. In addition, ultrasonic device has been developed to increase the capability of lipid extraction. The effects of cavitation from ultrasound have been found to encourage the damage of cell walls. It requires less

time for extraction comparing to the conventional method according to the method of Folch *et al.* (1957) and Bligh and Dyer (1959).

Objectives

1. To compare the growth and lipid productivity of local microalgal strains i.e. *Chlorella* sp. AARL G008, *Scenedesmus* sp. AARL G022, *Monoraphidium* sp. AARL G044, *Carteria* sp. AARL G045 and *Carteria* sp. AARL G046 with the foreign strain, *Nannochloropsis limnetica* SAG 18.99.

2. To analyze the effects of nutrients on the growth and lipid production in *Carteria* sp. AARL G045 by using Plackett - Burman Design (PBD) and optimized the suitable significant factors using Box - Behnken design (BBD).

3. To reduce partial budget by using inexpensive media and cultivating in an open system.

4. To develop a lipid extraction technique for enhancing the lipid recovery using low power ultrasonic assisted solvent extraction (UASE) and analyze fatty acid composition in the extracted lipid.