1. INTRODUCTION

1.1 Introduction to the Project

1.1.1 Food drying
Drying is the oldest method of preserving food. The sun, the wind, and smoky fire have been used to remove water from fruits, vegetables, meats and herbs for many years. Preserving food requires the control of enzymes and microorganisms. Microorganisms which grow rapidly on raw or fresh food products can be controlled by drying because drying is the process of removing water from food. Lack of water limits the growth of microorganisms and preserves food. Other than preservation drying minimizes space required for storage of dried products. Lightweight of final products, easiness of handling, low consumption of energy to the process and simplicity of the process compared to other processes can be listed as other advantages. Presently several drying methods are practiced in common; sun drying, solar drying, air drying, oven drying, microwave drying, drying with etc.

Drying can also be done to concentrate some compounds present in a material or it can be done to prepare the material to another process. The main purpose of copra drying is to concentrate the oil content which eventually facilitates coconut oil extraction process.

1.1.2 Introduction to copra
Coconut tree has bound with Sri Lankan life style since thousands years ago. Many historical stories can be found about the history of coconut tree in Sri Lankan folklore. These folklore even dates back to king Dutugamunu era with stories on using toddy obtained from the coconut tree (An introduction about coconut industry 1997). Spanning from those days people has been using almost all parts of the coconut tree for different kind of purposes. Therefore, Sri Lankans used to call it as “Kap Ruka” (the tree which provides all the necessities of life). The development of coconut cultivation which was started in king’s era continued to even in the colonial era. Later, the Sri Lankan governments contributed towards coconut cultivation by many ways. At present, three institutions have been established for developing
coconut industry namely Coconut Cultivation Board, Coconut Research Institute and Coconut Development Authority.

Few industries have been developed in relation to the coconut tree which can be categorized into four main types namely products related to fruit, products related to coconut flower, products related to coconut trunk and the products related to coconut leaves. Products related to fruit come with three main sources namely coconut kernel, coconut husk and coconut shell (An introduction about coconut industry 1997). Copra is a primary product which is produced by drying of coconut kernel. The name copra has been derived from the Malayalam word kopra for dried coconut. The drying operation reduces the moisture content in the kernels from around 50% to 6%. The final moisture content of copra should be reduced to at least 7% for producing good quality coconut oil. Copra can be mainly considered as an intermediate product of the coconut oil manufacturing process because major portion of world’s copra production is utilized for coconut oil production. The copra made for coconut oil production is called as “Milling copra”. According to the quality of milling copra they are again classified into six types in Sri Lanka namely MS1, MS2, MS3, MO1, MO2 and MO3 (Copra industry in Sri Lanka 1997). Copra is also produced as “Edible copra” to fulfill the demand of consuming directly as food but the quantity is much lower than milling copra. In general, edible copra is again categorized into two types as cup copra and ball copra.

Several methods have been developed for copra making throughout the world. Among them, kiln drying is the widely used method while sun drying and hot air drying are also practiced. In 1923, an indirectly heated air dryer called “Chula Dryer” was introduced in Sri Lanka for manufacturing copra. “Ceylon Copra Kiln” which was designed by Coconut Research Institute was introduced in 1960s. This dryer was a direct air heated dryer and was more economical than the previous dryer (Rodrigo, M. C. P., 1996). Therefore, Ceylon copra kiln has been using vastly not only in large scale commercial copra manufacturing mills but also some small scale copra manufactures since 1960 with several developments in time to time. In addition to this sun drying of copra can still be seen in rural areas at domestic level. Most of the copra mills are situated in coconut triangle area and in the coastal area from
Negombo to Tangalle (An introduction about coconut industry 1997). The total copra production of Sri Lanka during past years is given in Table A1 in appendix A.

1.1.3. Introduction to coconut oil

Coconut oil is the oil contained in the coconut kernel. It has been consumed in tropical countries including Sri Lanka since many centuries mainly as edible oil. Historical reports indicate that Captain Boid has carried coconut oil which was extracted using “Chekku” to England in 1820. In those days, there was equipment called “Paha” in Sri Lanka which was used to extract oil in small scale. In 1835 the British Ceylon Corporation (BCC) was established to manufacture coconut oil in large scale (Coconut oil production 1997). However, even today coconut oil industry is still running as a small scale industry in Sri Lanka.

Two main oil extraction processes are used in industrial scale operations which are categorized as dry process and wet process according to the form of kernel. Dry process is the traditional oil extraction process which uses copra. In the wet process, oil is extracted using fresh kernel (Fereidoon Shahidi, 2005). In Sri Lanka, dry process is the most popular method and at present more than 250 oil mills are registered with CDA (Coconut Development Authority). Many of these oil mills are also situated within the coconut triangle while few are in coastal area from Negombo to Tangalle. In some mills, production of both copra and coconut oil is done at the same place. The size of the kiln depends on the capacity of the mill. Table A1 in Appendix A shows the coconut oil production in Sri Lanka in recent years.

Coconut oil is used heavily in the food industry. In Sri Lanka it has been extensively used as cooking oil from the day of its origin. It also has some applications in medical and pharmaceutical industries. A very common application of coconut oil is soap and detergent industry in the other applications include glycerol manufacturing, cosmetic industry, plastic industry, rubber industry, etc. At present it is being tested for using as bio fuel.
1.2 Objectives

1. Determination of drying characteristic of copra and its effect on quality of copra and coconut oil
2. Evaluation of single bed drying and multi bed drying for copra drying

1.3 Justification

In Sri Lanka, the copra drying kilns are made by owners themselves since the design is not much complicated. In some places, small scale copra manufacturers have their own designs but these designs are not considerably different to the standard Ceylon Copra Kiln. Coconut shells are used as the main fuel in all the mills.

Few drawbacks can be identified in the kiln drying process of copra. A major drawback is the deposition of polycyclic aromatic hydrocarbons (PAH) on the kernel of copra. In kiln dryers copra is stored in a rack directly over the fire. Therefore PAH which are produced during the combustion process of coconut shells, contact with coconut kernels with the smoke and deposits on the kernels. These PAH are transferred to the coconut oil in the oil extraction process (Roberto, C. Guoarte, et al, 1996). Therefore, the deposition of PAH has been a major concern in kiln drying since some of the PAH are highly carcinogenic. Furthermore, direct contact of smoke in kiln dryers seriously affect the color of copra which turns to brown. Therefore, there is no possibility of making good quality white copra in kiln drying. Brown colored copra has a low value in the market than white copra. Also brown copra yield more brownish coconut oil than white copra which again considered as low quality oil than light color coconut oil.

Few other drawbacks can also be seen in copra industry due to poor operating practices and also due to inaccurate designing of kilns (Rodrigo, M. C. P., et al, 1996). The Standard Ceylon Copra Kiln has been designed to achieve efficient and effective heat distribution within the chambers of the kiln which allows producing good quality copra within shorter drying time. But in some commercial kilns, the height between the copra platform and the fire pit was less than the recommended height. This was done by the copra producers intentionally, to catch more heat from combustion. But, this can cause scorched and dark brown copra unless the burning
rate adjusted according to the height. On the other hand, copra producers use wider platforms to lay copra against the recommended area to increase the capacity of the copra kiln. To compensate this, they use additional number of rows of shells in the fire pit instead of recommended single row firing. This again results in producing dark brown copra and also due to poor heat distribution, uneven drying of copra. Furthermore, the final moisture content of copra of many commercial kilns is not reduced to the recommended level. This is again done by the producers intentionally to reduce their drying time and to have higher weight of copra. The high moisture content provides an ideal medium for bacteria and fungi. This leads to formation of Aflatoxin which is a cancer-poisonous substance (Krishna Raghavan, 2010).

The bad quality copra always results in bad quality coconut oil. Higher moisture content of copra causes higher free fatty acid levels in the oil and these free fatty acids cause rancidity in oil with bad odour. The presence of PAH and Aflatoxin in the copra can easily be transferred to the coconut oil. The brown color copra always provides brown colored oil which can be easily adulterated with other low quality oils. Further, bad quality coconut oil needs to be processed further to meet quality requirements. Therefore, the cost of final product becomes higher than typical coconut oil. As a result, the consumers lose confidence and shift to other oils such as palm oil. The domestic consumption of other oils has been increased significantly during the recent past in Sri Lanka (Peiris, T. S. G., n.d.). The variations in oil consumption are shown in Table A2 in appendix A.

These problems can be overcome by designing indirect heated hot air dryers with good heat distribution. Use of hybrid dryer which consists of a solar collector and a biomass stove heater is a good alternative for drying copra since utilization of solar heat reduces the consumption of other energies. Few studies have been carried out for copra drying with new dryers but still need further analysis on effectiveness of multi bed drying compared to single drying on final product quality.

1.4 Outline of the Thesis

This thesis is consisted with five chapters. In the first chapter, the research project is introduced and the research objectives are given with justification. A literature review on copra, coconut oil and available drying methods of copra and other food
has been presented in the second chapter. In the third chapter all the materials used to conduct the study and the methodology followed to fulfill the research objectives are described. The results obtained during the current study are presented and discussed in the fourth chapter. The last and fifth chapter summarizes the conclusions of the study and future recommendations.