COMPARISON THE NUTRIENTS CONTENTS IN SOYBEAN PRODUCTS BETWEEN PRIMARY ANALYSIS AND NIR ANALYSIS

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CHAPTER ONE

INTRODUCTION

1.1 Background of Study

The soybean *Glycine max (L.) Merrill, family Leguminosae, subfamily Papilionoidae* originated in Eastern Asia, probably in north and central China. Soybeans have been grown as a food crop for thousands of years in China and other countries of East and South East Asia and constitute to this day, an important component of the traditional popular diet in these regions. Nowadays, soybean foods have become increasingly popular since the Food and Drug Administration approved the soy protein health claim in 1999 (Food Labeling, 1999). It also proved that world production of soybeans has increased in the last half century to reach its present level of over 100 million metric tons per year. The leading producers are the U.S.A. (45%), Brazil (20%) and China (12%) (FAO and Agriculture Organization of the United Nations, 1987).

Figure 1.1 Soybeans

For this research, it will focus on soybean milk, tauhu, and bean curd. These products will be analyzed using NIR method and conventional method analysis. These entire products from soybean products are outstanding nutrition, along with their health benefits. They provide balanced nutrition which a healthy balance of high-quality protein and carbohydrates, low in fat with no cholesterol and very low in saturated fat. The nutrients contents in soybean products will refer in Table 1 and Table 2.

Soybean products are containing rich protein, fat, carbohydrate, and other mineral elements. High-quality soy protein is considered equal to that of poultry and milk. For example, the soybean milk and bean curd contain the highest concentration of protein among all the legumes about 40% protein by volume compared to 20% for other beans. According to U.S. Food and Drug Administration granted this health claim for soy with 25 grams of soy protein a day, as part of a diet low in saturated fat and cholesterol, may reduce the risk of heart disease. Besides that, they said one serving of soy milk is about 1 cup or 240 mL, for instance, contains 6 or 7 grams of soy protein (Ben O. de Lumen 1995).

In order to meet the demand of the market throughout the year in all areas, we need to control the quality of products of soybean especially the protein contains. The protein is very important in our body to avoid serious disease. In the last decades, soybean foods have generated a lot of interest as a result of evidence that its consumption may alleviate menopausal symptoms (Messina, 2000) and reduce the risk of osteoporosis and some chronic diseases, most notably coronary heart disease and cancer (McCue and Shetty, 2004).

The quality of the food also refers to its nutrient contents. Customers today are well educated and knowledgeable. They are concern with the nutrients contents in the food that they take. For this reason, it is important to develop new nutritional food, maximize their nutrient content in both processing and storage and extend the shelf-life, thus to meet the requirement of the market. In this regard, the information on nutrient change in processing and storage will be of great importance.

Table 1.1 Nutritional Values of Soybean Milk (per 100g)

Nutrients	Nutritional Value
Water	8.5 g
Energy	416 kcal
Protein	36.5 g
Fat (total lipid)	19.9 g
Fatty acids, saturated	2.9 g
Fatty acids, mono-unsaturated	4.4 g
Fatty acids, poly-unsaturated	11.3 g
Carbohydrates	30.2 g
Fiber	9.3g
Ash	4.9g
Isoflavones	200 mg
Calcium	277 mg
Iron	15.7 mg
Magnesium	280 mg
Phosphorus	704 mg
Potassium	1797 mg
Sodium	2.0 mg
Zinc	4.9 mg
Copper	1.7 mg
Manganese	2.52 mg
Selenium	17.8 µg
Vitamin C (ascorbic acid)	6.0 mg
Thiamin (vitamin B1)	0.874 mg
Riboflavin (vitamin B2)	0.87 mg
Niacin (vitamin B3)	1.62 mg
Panthotenic acid (vitamin B5)	0.79 mg
Vitamin B6	0.38 mg
Folic acid	375 µg

Source: USDA Nutrient Database for Standard Reference

Table 1.2 Nutritional Values of Soybean Tauhu (per 100g)

Nutrients	Nutritional Value
Water	84.55 g
Energy	76 kcal
Energy	318 kJ
Protein	8.08 g
Total lipid (fat)	4.78 g
Ash	0.72 g
Carbohydrate, by difference	1.88 g
Fiber,	0.3 g
Calcium, Ca	350 mg
Iron, Fe	5.36 mg
Magnesium, Mg	30 mg
Phosphorus, P	97 mg
Potassium, K	121 mg
Sodium, Na	7 mg
Zinc, Zn	0.80 mg
Copper, Cu	0.193 mg
Manganese, Mn	0.605 mg
Selenium, Se	8.9 mcg
Tryptophan	0.126 g
Threonine	0.330 g
Isoleucine	0.400 g
Leucine	0.614 g
Lysine	0.532 g
Methionine	0.103 g
Cystine	0.112 g
Phenylalanine	0.393 g
Tyrosine	0.270 g
Thiamin	0.081 mg
Riboflavin	0.052 mg

Source: USDA Nutrient Database for Standard Reference

1.2 Problem Statements

Even though the soybean products are very popular in Malaysia since it can give a lot of nutrients, but most of the soybean products are made traditionally by small scale industry. Small scale industry normally lack of good production because of the less technologies and experiences. Therefore, there is no specific data about nutrient contents in soybean foods that attached to the food packaging. As a result, the customers do not know the exactly nutrients containing in the soybean foods. Nowadays the customers are very concern about their health and diet. So the nutritional labeling is very important to them because it can give the information about balance diet.

For determination of nutrients contents in soybean products, the method use is physical method which is by using Near-Infrared (NIR) and conventional method. By using NIR, it can analysis and determine the pattern of nutrient content in soybean products like soybean milk, tauhu, and bean curd and compare the nutrient contents between NIR analysis and conventional method analysis. The NIR analysis and primary method analysis will discuss in Chapter 3.

1.3 Objectives

1. To determine the nutrient contents in soybean products using NIR.
2. To compare the nutrient contents between NIR analysis and conventional method analysis.

1.4 Scope of study

To achieve these objectives, scopes have been identified in this research. These scopes are listed below:

1. Focus in traditional producer with small scale productions.
2. To check on the nutrient contents of soybean productions by NIR analysis and conventional method analysis.
3. To study 4 elements of nutrients :
    a. Protein
    b. Fat
    c. Fiber
    d. Ash

1.5 Significance of study

With the presence of modern technologies, this research gives many advantages and benefits to food industry, the customers and also for the producers. For food industry, it can be established the specific data of soybean based products for small scale industry. For the customers they deserved to get more information about nutrient contents in soybean products since they are very concern about it. For the producer, it will help to increase the productivity and quality.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

Soybean (*Glycine max* L. Merrill) is a legume that is consumed worldwide. Recently, soybean foods have generated interest because of their reported beneficial effects on nutrition and health. In Asia, soybean products can be divided into two large groups which are non-fermented soy foods consisting of fresh soybeans, soybean soymilk and bean curd, and fermented soy foods, including items such as natto, soy sauce, Kochujang and temphe (Kwak et al., 2007). Studies have shown that Asian populations habitually consuming soybean products have a lower risk of osteoporosis and some chronic diseases, most notably heart disease and cancer (McCue & Shetty, 2004). Also, epidemiological studies suggest that the consumption of soybean products is inversely correlated with cancer and cardiovascular diseases (Adlercreutz, Goldin, & Gorbach, 1995).

According to Food and Agriculture Organization of the United Nations, the composition of soybean it has been possible to obtain protein levels between 40% and 45%, and lipid levels between 18 and 20%. Usually, an increase of 1% in protein content is accompanied by a decrease of 0.5% in oil (Pedro A. Alvareza et al., 2008).

Soybean is a good source of protein because it contains a significant amount of essential amino acids. Soy protein is the most inexpensive source of high nutritional quality protein and therefore is the predominant commercially available vegetable in the world. Soybean is a complex food matrix containing low or no starch, about 20% oil and 40% high-quality protein (Liu, 1997), in addition to several important bioactive

compounds for examples lunasin, trypsin inhibitors, isoflavones, and saponins. Soybeans are unique foods because of their rich nutrient content. They contain complex carbohydrates, protein, dietary fiber, oligosaccharides, phytochemicals especially the isoflavones in soy and minerals (Refstie, Storebakken, & Roem, 1998).

Because of its quality, soybean protein can replace animal protein without a significant decrease in nutritive value (Tripathi and Misra, 2005). In fact, soy protein has an advantage over animal protein as it does not raise the serum cholesterol values (Fukushima, 2001) and hence, is useful for people suffering from cardiovascular disorder (De Kleijn et al., 2002). Table 3 shows there comparisons about nutrients facts between soy bean milk and cow's milk. The reason why demand of soy bean milk because it rich with protein content which 3.6 g compare with cow's milk which is around 3.5 g only.

Table 2.1 Comparisons about nutrients facts between soy bean milk and cow's milk

Nutritional value per 100 g	**Cow's Milk**		**Soymilk**
	Whole	**Semi-skimmed**	
Protein	3.4 g	3.5 g	3.6 g
Fat	3.5 g	1.5 g	2.3 g
Carbohydrate	4.6 g	5.4 g	3.4 g
kJ	269	208	204
Kcal	64	49	49
Cholesterol	10 mg	5 mg	0
Lactose	4.6 g	5.4 g	0
Fatty acid composition			
Saturated	63.5%	63.5%	14.0%
Poly-unsaturated	3.0%	3.0%	63.5 %
Mono-unsaturated	33.5%	33.5%	21.6%

Carbohydrates are the second largest component in soybeans. Their complex carbohydrates and dietary fibre contents contribute to their low glycemic index, which benefits diabetic individuals (Jenkins, Wolever, & Taylor, 1981) and reduces the risk of developing diabetes (Salmeron et al., 1997). Besides that, the high-fat diets are reported to increase oxidative stress in a variety of tissues, which may result in many degenerative diseases (Chen et al., 2008). There have been several reports describing the biological activities of soybean oligosaccharides such as antioxidant, blood pressure lowering and antidiabetic activities (Huang et al., 2006) and (Zhao and Yang, 2007). Research concerning soybean isoflavones has revealed their protective effect in health associated with menopause, cancer and cardiovascular disease. Some other health benefits are under investigation (McCue & Shetty, 2004).

According to Mrinal Pednekar et al., 2009, it can see that the percentage of nutrients contents in soybean in general, Table 2.2. These nutrients contents will be determine by experiment by using NIR. Near-infrared is one of the most useful, rapid, nondestructive, cost-effective and reliable multi-trait technique in food analysis (Wang and Paliwal, 2007). It can analyze, large number of samples in small quantity in the form of whole grains, minimizing sampling error. NIR was used for the first time to measure moisture concentration in soybean and since then has been used to measure moisture, protein, oil and starch concentration in forage, legume and cereal crops, as well as other food commodities. It has also been applied for fatty acid profiling in oilseeds like and soybean (Kovalenko et al., 2006).

Table 2.2 Nutrients contents of soybean in general (Mrinal Pednekar et al., 2009)

Nutrients in soybeans	Percentage (%)
Protein	36.5357 ± 1.04
Ash	0.7877 ± 0.033
Lipid	22.7007 ± 0.582
Moisture	7.3557 ± 0.077

Most researchers agree that there is a need for more research to exploit the possibilities of the soybean protein as a functionality-enhancing ingredient. One venue of interest in soy research is the study of soybean protein denatured (A.Achouri et al., 2007). In some conditions, thermal processing, detrimentally affects nutritional and quality attributes of soymilk. Hence, it will limit the production of soybean foods that are appealing to consumers and negatively impacts the use of heat-treated soymilk as an ingredient (N. Kitabatake et al., 1990). According to N. Kitabatake, the heat treatment can cause denaturizing and aggregation of previous soy proteins (Hauman, B.F., 1984).

Storage is very important aspect to maintain the quality of the products besides to enhance the productivity and to increase shelf life of food. For good storage stability and good viability as a seed, soybeans should have a moisture content of about 12% to 13%. Above this level, serious danger of mould attack exists, especially in hot weather. Below 12%, the beans tend to crack and split extensively in the course of handling (Zeki Berk, 1992)

2.2 Soybean Products

2.2.1. Soybean Milk

A patent for soybean milk production was issued in 1910, to Li Yu Ying, a Chinese living in France. Strictly speaking, soybean milk is a water extract of whole soybeans. It is an off-white emulsion or suspension containing the water soluble proteins and carbohydrates, and most of the oil of the soybeans.

Figure 2.1 Soybean milk

Soymilk is one of the most acceptable and well known soy products among the oriental countries. From home-made freshly prepared milk and sold daily in fresh market, it was researched and developed to meet more customer's preferences, human nutritional requirements and industrial practice from which the soymilk industries developed.

Table 2.3 show that the summary of nutrients contents inside the soybean milk (Kulvadee, 1999, Baherah Hajirostamloo, 2009, Pracha Boonyasirikool et al., 2001).

Table 2.3: Nutrient contents in soybean milk (Pracha Boonyasirikool et al., 2001)

Nutrient in soybean milk	Percentage (%)
Protein	39 – 46
Fat	4.67
Fiber	6.89
Ash	0.66

2.2.2 Processing of Soybean Milk

This is the method by which soymilk is made for daily consumption. Soybean seeds (100 g) were soaked for 16 h in 300 mL water. Excess water was decanted off and 80 mL fresh water was added and seeds were pressure cooked for 10 min after first pressure release. The cooked seeds were blended in the grinder by adding 300 mL of water. Further this homogenate was filtered through muslin cloth, while filtering 600 mL of water was added. The filtrate was heated in a boiling water bath for 15 minutes. Heating at or near the boiling point is continued for a period of time, 15-20 minutes, followed by the removal of an insoluble residue by filtration (Zeki Berk, 1992).

2.2.2.1 Tauhu and bean curd

Tauhu and bean curd are the most popular type of traditional soy protein products. It has been prepared and consumed in China for thousands of years and a written record of its preparation dates from the second century B.C (Escueta et al., 1986).

Figure 2.2: Bean curd and tauhu

Both of products have been made in the U.S.A since the beginning of the century, as an ethnic food. Its consumption in the West increased rapidly since the 1970s, mainly as a vegetarian alternative to meat and cheese or as a novel food by itself (Hongkang Zhang et al., 2004). There are many different varieties of it, including fresh tauhu and tauhu that has been processed in some way.

Table 6 show that the summary of nutrients contents in bean curd and tauhu (FAO, Expert Consultation, Energy and Protein Requirements, 1985, H.LWang and J.F.Cavins, 1989, Synder, HE, Kwon, 1987)

Table 2.4 Nutrients Contents in bean curd and tauhu (H.LWang and J.F.Cavins, 1989)

Nutrient in bean curd and tauhu	Percentage (%)
Protein	20-35
Fat	15.4-19.6
Fiber	15
Ash	3.9-4.24

2.2.2.2 Processing of Tauhu and Bean Curd

Both of it have a similar processing. But it has a little bit differences which in depending on methods preparation, textural properties and moisture content. It was prepared by a modified method of Nong Sun and Breene (1991). Calcium sulfate (0.2 M) was added to warm soy milk in 1:10 ratio and was heated at 70 °C for 10 min for coagulation to occur. The coagulated curd was separated using cheese cloth.

Next step is straining the curds and pressing. When large white curds can be seen floating in a clear yellow liquid, called whey, the soymilk is completely curdled and ready to be filtered through a clean cloth into a suitable mould. The same method is used here as used in straining the soymilk. To form a block of tauhu, cover the top of the tauhu with the filter cloth and place a weight on top. Apply constant pressure for about 20 minutes to squeeze out the excess water. The water content will reduce by approximately 60%. The pressed tauhu can be sliced and fried or eaten plain with salt.

The coagulant itself has no perceivable taste. Use of this coagulant also makes both of it that is rich in calcium, an important mineral for treating and preventing osteoporosis. As such, many tauhu manufacturers choose to use this coagulant to be able to market their tauhu as a good source of calcium (Henkel, John, 2000). Coagulation of soymilk is the most important step in the tauhu and bean curd making process. Coagulation occurs due to the cross linking of protein molecules in soymilk with the divalent cations (Saio, Koyama & Watanabe 1967).

Hot Soybean Milk 	Coagulant just added 	Soymilk curdling 
Transfer to tofu box 	Put a weight on it 	Bean Curd 

Figure 2.3 Step in processing bean or tauhu

2.3 Nutrient Contents in soybean products

2.3.1 Protein

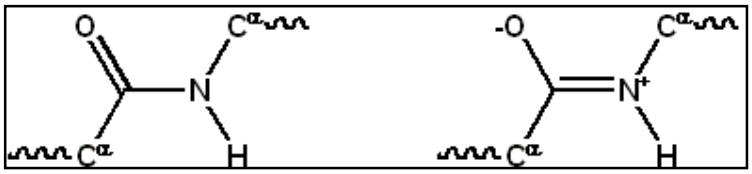

Figure 2.4 Chain of peptide to form protein

Interest in introducing soybean and soy products to the Western diet has grown rapidly in recent years due to the health promoting effects of soy protein and isoflavones. Protein is very important nutrient in our body. Soy and its constituent protein and isoflavones have been associated with reduced risk of cardiovascular disease (Rimbach et al., 2008), prostate (Nagata et al., 2007), breast (Steiner et al., 2007) and colon (MacDonald et al., 2005) cancers, and improved bone health (Barnes, 2003).

The World Health Organization has established that soy protein contains enough of all the essential amino acid to meet human requirements when consumed at the recommended level of protein intake and is considered equivalent to animal proteins in quality. Soybeans are high in protein containing 38% by weight and have a favorable amino acid profile. The World Health Organization has established that soy protein contains enough of all the essential amino acid to meet human requirements when consumed at the recommended level of protein intake and is considered equivalent to animal proteins in quality.

2.3.2 Fat

The soybean oil contains approximately 110 g kg^{-1} palmitic, 40 g kg^{-1} stearic, 240 g kg^{-1} oleic, 540 g kg^{-1} linoleic, and 70 g kg^{-1} linolenic acid (Schnebly & Fehr, 1993). Improvement of nutritional and functional properties of soybean oil by modification of fatty acid composition has been a major objective of plant breeders. Reduction in polyunsaturated (linoleic and linolenic acids) and increase in monounsaturated (oleic acid) fatty acids content improves nutritional quality and shelf life of soybean oil (Lui and White, 1992). Actually, the soybean cultivar has high content of saturated fatty acids for example palmitic acid and stearic acids can be important for production of margarine and solid fats (List et al., 1996).

The lipids of soybeans consist typically of 96% triglycerides, 2% phospholipids, 1.6% unsaponifiables, 0.5% free fatty acids and minute amounts of carotenoid pigments. The phospholipids are surface-active substances located on the surface of the oil bodies. The relatively high content of phospholipids in soybean oil which are two to three times higher than other common vegetable oils is explained by the small size of the oil bodies, resulting in a larger surface per unit weight of lipids.

2.3.3 Ash

Ash refers to the organics residue remaining after either ignition or complete oxidation of organic matter in food stuff. Ash represents the total mineral content in foods. Determining the ash content may be important for several reasons. It is a part of the proximate analysis for nutritional evaluation.

When soybeans are processed, most of the mineral constituents go with the meal and few with the oil. The major mineral constituents are potassium, calcium and magnesium. The minor constituents comprise trace elements of nutritional importance, such as iron, zinc and copper. The biological availability of minerals may be impaired somewhat as a result of the presence of phytates in soybeans and soybean products. The mineral composition of soybeans is affected by the composition of the soil. Thus, the contamination of soils with undesirable elements such as heavy metals, as a result of irrigation with poorly treated waste water, may be reflected in the composition of the soybeans

2.3.4 Fiber

Fiber sometimes called roughage is the indigestible portion of plant foods that pushes food through the digestive system, absorbing water and easing defecation. Dietary fiber is found in plants. While all plants contain some fiber, plants with high fiber concentrations are generally the most practical source. The American Dietetic Association (ADA) recommends consuming a variety of fiber rich foods. Some soluble fiber is found in varying quantities in all plant foods, including in soy bean base. According the data Nutritional Values of Soybeans the fiber content is 9.3g per 100g of the soybean products (S. Suzanue. Nielein, 2003).

Eating fiber has many benefits for our health. The consumption of soluble fiber has been shown to protect you from developing heart disease by reducing your cholesterol levels. The consumption of insoluble fiber reduces your risk of developing constipation, colitis, colon cancer, and hemorrhoids.

2.4 Near Infrared (NIR)

Near infrared spectroscopy (NIR) is a spectroscopic method which uses the near infrared region of the electromagnetic spectrum from about 730 nm to 2500 nm. NIR spectroscopy is the study of the absorption of near infrared which is energy by molecules. The technique has found its widest use in the grain, cereal products, and others foods. NIR technique using reflectance measurements from ground or powdered samples have been adopted as approved method of analysis by the American Association of Cereal Chemist for measurements nutrients contents in foods.

This research will use the NIR to determine the nutrients contents of soybean products. Then, will do the comparison the data between NIR analysis and conventional method analysis. The conventional method analysis will based on experiments in a lab by determined protein, fat, fiber, ash and moisture contents inside the samples. These methods will be discussed in chapter 3.

2.4.1 Principle Of NIR

Near infrared light is defined as the wavelength region from 730 to 2500 nm, lying between the visible light with shorter wavelengths and the infrared light with longer wavelengths. Mid infrared radiation (2500-5000 nm) provides energy quanta causing changes in the vibration energy states of the molecules. When a sample is irradiated, light is absorbed selectively according to the specific vibration frequencies of the molecules present and gives rise to a spectrum. Mid infrared spectra of foods may consist of sharp absorption bands, from which organic compounds may be identified, but are less suited for quantitative analysis because of the low signal to noise ratio of the instruments.

Table 2.5 Division of the infrared region (Osbome & Feam, 1986)

Region	Characteristic	Wavelength range (nm)
Near Infrared	Overtones/Combination	730 - 2500
Middle Infrared	Fundamental vibrations	2500 – 5000
Far Infrared	Rotations	5000 - 10^6

The NIR can be classified as physical analysis since this instruments made by FOSS use a tungsten halogen lamp as the energy source. The light from the lamp is dispersed into individual wavelength by a holographic gravity. The dispersed light energy is then focused on the samples which are soybean milk, tauhu and bean curd where it interacts with the sample molecules. Some of the light energy is absorbed by the sample molecules. **(Figure 2.5)**

When radiation strikes a sample, part of the radiation is reflected from the sample surface. This mirror like reflectance is called specular reflectance, and gives little useful information about the sample. Most of the specular reflected radiation is directed back toward the energy source. Another portion of the radiation will penetrate through the surface of the sample and be reflected off several sample particles before its exits the sample. This is referred to as diffuse reflectance and this diffusely reflected radiation emerges from the surface at random angles through $180^{o.}$ Each time the radiation interacts with the sample particle the chemical constituents in the sample can absorb a portion of the radiation.

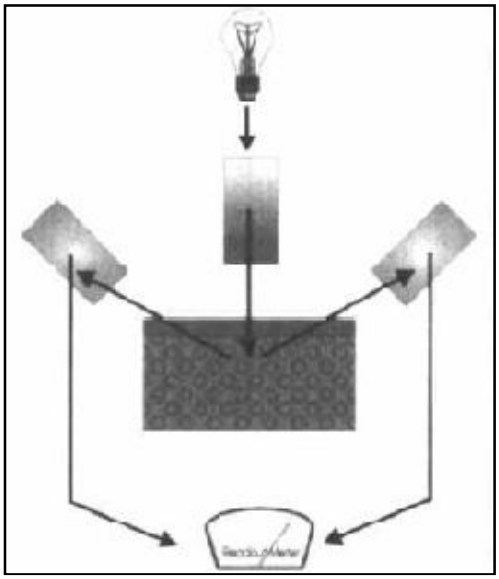

Figure 2.5 NIR analyze the samples

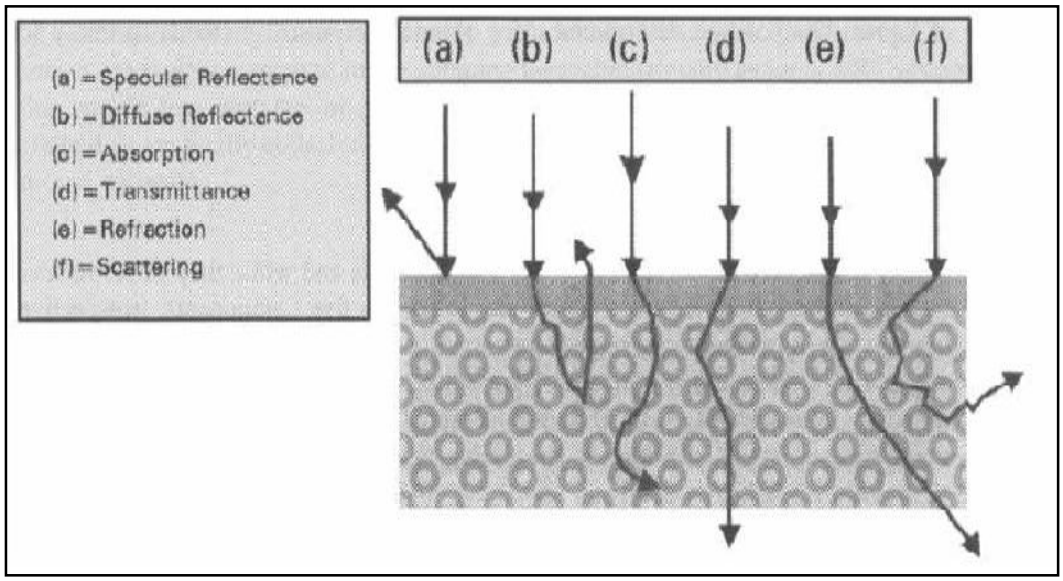

Figure 2.6 Interaction of near infrared radiation with the samples

CHAPTER THREE

METHODOLOGY

3.0 Introduction

In this chapter we will discuss on the preparation and process involved in order for the research to be conducted. The overall methodology involves all the steps in this experiment. The whole study is divided into three major sections:

1) Prepare of sample:
    (a) Soybean milk
    (b) Tauhu
    (c) Bean curd

2) Preparation of standard analysis to set up library and primary method analysis:
    (a) Protein
    (b) Fat
    (c) Ash
    (d) Fiber

3) Near-Infrared (NIR) method analysis

3.1 Standard Analysis

For prepare standard analysis, need 14 samples from different soybean products. Besides that, it needs to take different places from soybean milk productions, to-fu productions and bean curd productions.

3.2 Standard Analysis for Crude Protein *Kjeldahl Method*

3.2.1 Reagents

i. Sulphuric acid (98%)
ii. Kjeldahl tablet (5 g each)
iii. Sodium Hyrixide (8%)
iv. Bromothymol Blue
v. Ethanol (95%)
vi. Disttilled water
vii. Activated charcoal
viii. Boric Acid (4%)

3.2.2 Material and equipment

i. Kjeldahl digestion and distillation apparatus
ii. 500 ml Kjeldahl flasks
iii. pH indicator
iv. volumetric flask

3.2.3 Srubber

i. To prepare 5 L of sodium hydroxide (8%), dissolve 400g NaOH in 5 L distilled water.
ii. Add pH indicator (eg Dissolve 0.5 g Bromothylmol Blue in 500 ml ethanol (95%) and add 500 ml distilled water to the solution)
iii. Add activated charcoal (granular).

3.2.4 Distillation

i. To prepare 1 L of boric acid (4%), dissolve 40 g boric acid in 800 ml distilled water. Adjust to pH 4.65 using NaOH (10%). Fill up to 1 L with distilled water.
ii. To prepare 1 L sulphuric acid (0.25%), add 13.3 ml sulphuric acid (98%) into volumetric flask and make up to 1 L with disttiled water.
iii. To prepare 500 ml NaOH (10%), dissolve 50 g NaOH in 500 ml distilled water.

Table 3.1 Standard setting on the equipment

Water	50 mL
NaOH (32%)	90 mL
Reaction time	5 s
Distillation time	240 s
Steam power	100%
Stirrer speed	5^5

3.2.5 Titration

i. Titrate the distilled sample from KjelFlex with sulphuric acid (0.25M) and stop once it reaches slight purple or pH 4.65.

ii. Record the volume of titrant used.

3.3.6 Calculations

$$\% \text{ Nitrogen} = \frac{(Vs_{ample} - V_{blank}) \text{ ml} \times 0.05 \times 14.0067}{\text{Weight of sample in g}}$$

$$\% \text{ Protein} = \% \text{ Nitrogen} \times \text{Emprical protein factor}$$

Table 3.2 Empirical protein factors for the Kjeldahl method

Food	Factor
General	**6.25**
Animal origin	
Eggs and eggs product	6.25
Gelatine	5.55
Meat and meat products	6.25
Fish, sea animals	6.25
Milk, milk products, cheese, whey	6.38
Grains & Cereals	
Barley, oats, rye	5.83
Corn	6.25
Rize	5.95
Wheat	5.70
Full grain products	5.83
Bran	6.31
Fruits	
Fruits and fruits products	6.25
Legumes	
Vegetables and products made of vegetables (except soy)	6.25
Beans	6.25
Soy and soy products	5.71
Nuts	
Nuts (treenut, coconut, chestnut)	5.30
Peanuts	5.46
Almonds	5.18
Seeds	
Oilseed (except of peanuts)	5.30

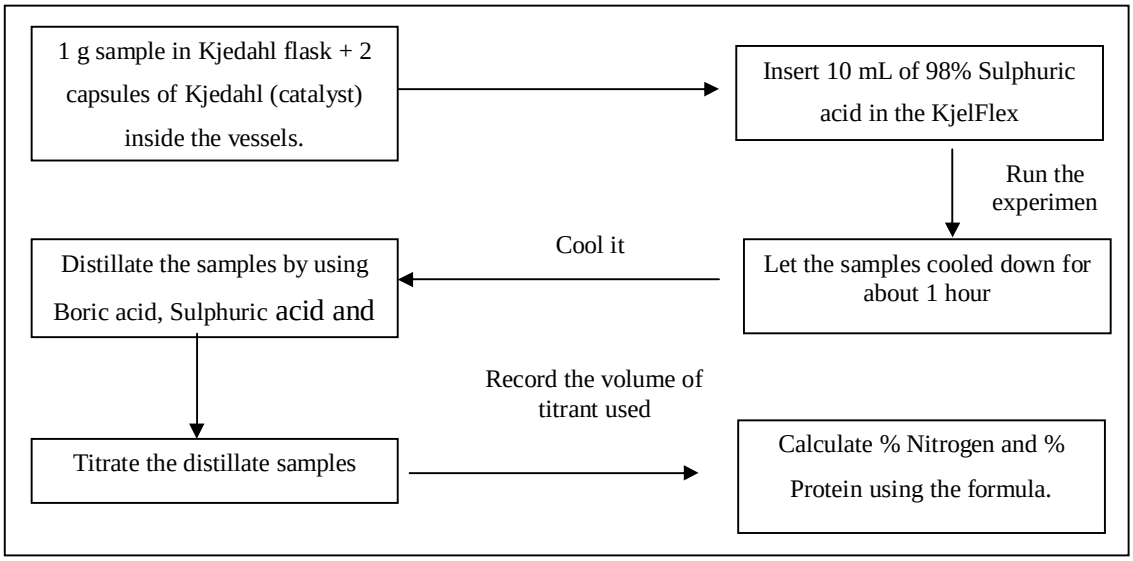

Figure 3.1 Determination of protein content

3.3 Standard Analysis for Ash

This method is used to determine ash content in feedstuffs by calcination. Ash is considered as the total mineral or inorganic content of the sample.

3.3.1 Materials and equipment

i. Porcelain crucibles
ii. Crucible furnace
iii. Dryer
iv. Desiccators

3.3.2 Method

i. Place 2.5 to 5 g of dry sample in a crucible previously calcined and brought to constant weight.
ii. Place the crucible in a furnace and heat at 130°C for 1 hours; leave to cool and transfer to a dryer.
iii. Carefully weigh the crucible again with the ash.

3.3.3 Calculations

$$\% \text{ Ash} = \frac{A-B}{C} \text{ X } 100 \%$$

Where:

A = weight of crucible with sample (g)

B = weight of crucible with ash (g)

C = weight of sample (g)

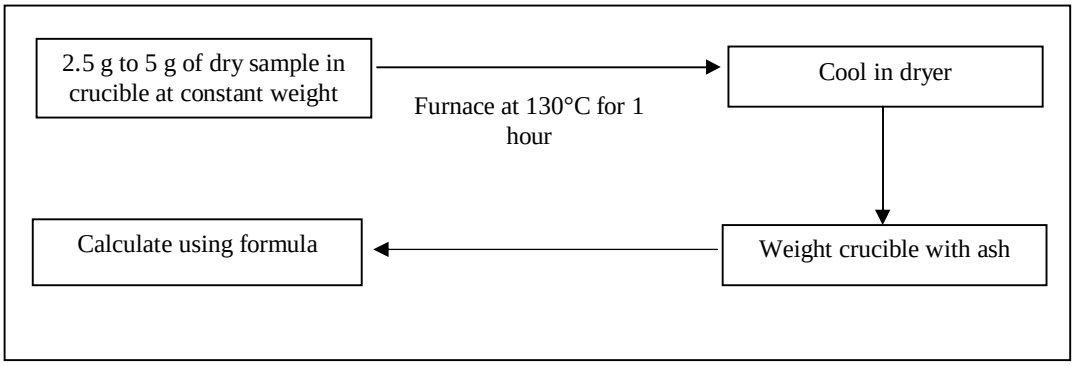

Figure 3.2 Determination of ash content in feed ingredients

3.4 Standard Analysis for Crude Fat *Soxhlet Method*

In this method, the fats are extracted from the sample with petroleum ether and evaluated as a percentage of the weight before the solvent is evaporated.

3.4.1 Materials and equipment

i. Petroleum ether, boiling point 60–80°C.
ii. Soxhlet extraction apparatus.
iii. Heating mantle
iv. Dryer
v. Extraction thimbles
vi. Round bottom flask 150 ml

3.4.2 Method

i. Weight 2 g sample (S) into the timble and place cotton wool in the top of the timble.
ii. Insert the timble in a soxhlet extractor.
iii. Accurately weight a clean, dry 150 ml round bottom flask with antibumping (W1) and put about 90 ml of petroleum ether into the flask.
iv. Assemble the extraction unit over the heating mantle.
v. Heat the solvent in the flask until it boils. Adjust the heat source so that solvent drips from the condenser into the sample chamber at the rate of about 6 drops per seconds.
vi. Continue the extraction for 8 hours.
vii. Remove the extraction unit from the heat source and detach the extractor and condenser. Replace the flask on the heat source and evaporate off the solvent.

viii. Place the flask in an oven at 120°C and dry the content until a constant weight is reached about 1-2 hours.

ix. Cool the flask in a desiccators and weight the flask and content (W2)

3.4.3 Calculations

$$\text{Crude fat content (\%)} = \frac{(W2-W1)}{S} \times 100\ \%$$

Where:

W1 = weight of round bottom flask with antibumping

W2 = weight of round bottom flask after dry

S = Weight of sample

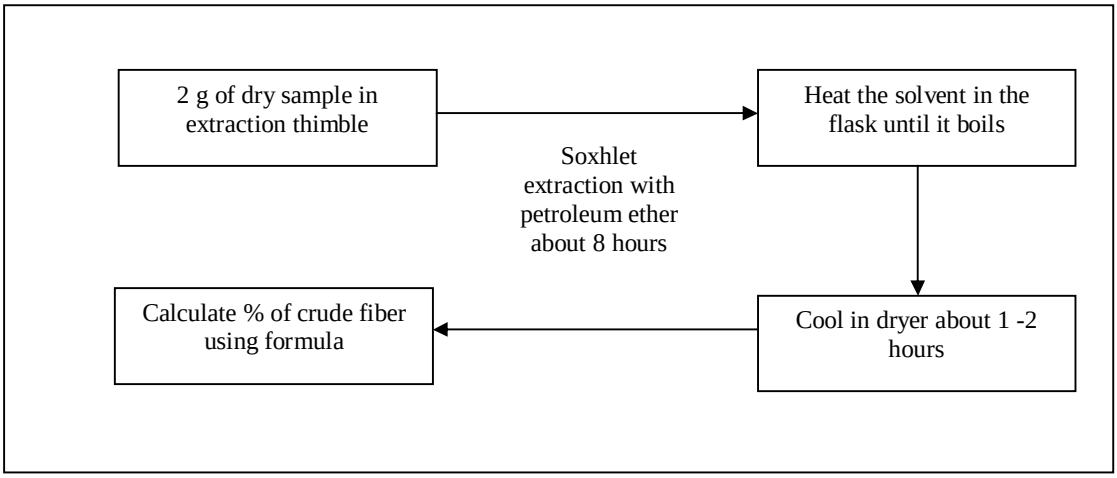

Figure 3.3 Determination of lipids by Soxhlet's method

3.5 Standard Analysis for Fiber (Filter Bag Technique, ANKOM ^{2000})

This method determine crude fiber which is the organic residue remaining after digesting with 0.255N H_2SO_4 and 0.313N NaOH. The compounds removed are predominantly protein, sugar, starch, lipids and portions of both the structural carbohydrates and lignin. This method is applicable for all feed materials such as grains, meals, pet food, mixed feeds, forages and the following oilseeds: corn and soybeans.

3.5.1 Reagent

i. Sulphuric acid solution 0.255N
ii. Sodium hydroxide solution 0.313N

3.5.2 Materials and equipment

i. Analytical balance
ii. Oven
iii. Electric muffle furnace
iv. Filter bag
v. Heat sealer
vi. Desiccators pouch
vii. Digestion instrument
viii. Crucible and cap

3.5.3 Method

i. Use a solvent and acid resistant marker to label the filter bag. Weight filter bag (W1) and zero balance.
ii. Weight about 1 g of sample (W2) and put inside the filter bag. Using a heat sealer, completely seal the upper edge of the filter bag.

iii. Weight one blank bag include in run to determine blank bag filter bag correction.(C1)

iv. Extract fat from sample by placing all bags into a 250 ml container. Add enough petroleum ether to cover bags and soak for 10 minutes. Pour off solvent and allow bags to air-dry.

v. Place a maximum of 24 filter bag into the Bag Suspender. All nine trays are used regardless of the number of bags being processed. Place three bags per tray and then stack trays on center post with each level rotated 120 degrees. Insert the Bag Suspender with bags into the fiber analyzer vessels and place the Bag Suspender weight on top of the empty 9^{th} tray to keep it submerged.

vi. Set the temperature until 70°C and start the machine.

vii. When the crude fiber extraction and rinsing process is complete, open the lid and remove the samples. Gently press out excess water from bags. Place bags in 250 ml beaker and add enough acetone to cover bags and soak for 3-5 minutes.

viii. Remove the bags from acetone and dry it. Completely dry in oven at 102°C within 2-4 hours.

ix. Remove the bags from the oven and cool it in desiccators for a while

x. Ash the entire bags in crucible for 2 hours at 600°C, cool it in desiccators and calculate the crude fiber by using the formula.

3.5.4 Calculations

$$\text{Crude fiber content (\%)} = \frac{(W3-(W1-C1))}{W2} \text{ X } 100\,\%$$

Where:

W1 = Bag tare weight

W2 = Sample of weight

W3 = Weight of organic matter

C1 = Ash corrected blank bag factor

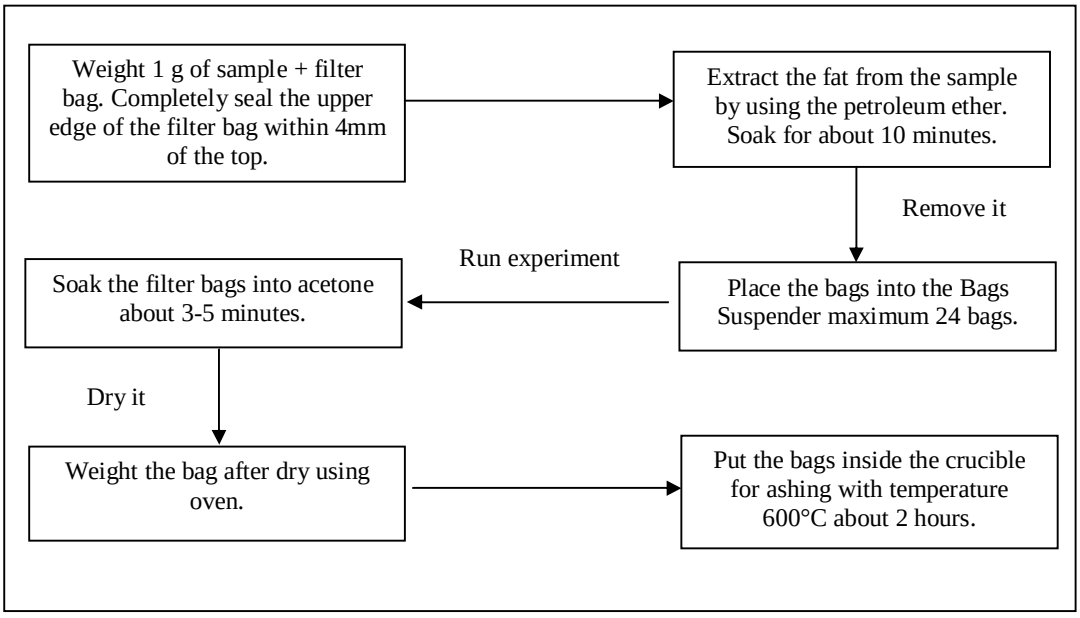

Figure 3.4 Determination of crude fiber

3.6 Near Infrared (NIR) method analysis

The entire sample will analyze by using Near Infrared to determine the nutrient contents in soybean products.

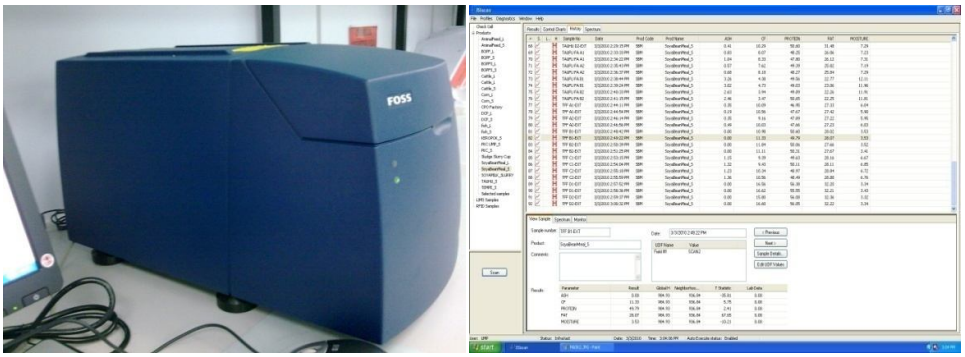

Figure 3.5 NIR analysis

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.1 Introduction

This experiment was conducted to determine the nutrients contents in soybean products; soybean milk, bean curd and tauhu. These analyses were based on NIR method and primary method. The results will divide into 2 parts; result from primary method analysis and result from NIR analysis based on 4 parameters which are protein, fat, fiber and ash.

4.2 Result Analysis for Soybean Milk from primary method

Table 4.1 Analysis of Soybean Milk by primary method

Samples	Analysis (%)			
	Protein	**Fat**	**Fiber**	**Ash**
SOYBEAN A1	46.67	2.30	17.29	3.74
SOYBEAN A2	44.78	2.56	22.42	3.68
SOYBEAN B1	49.97	3.16	15.11	2.39
SOYBEAN B2	47.81	3.22	19.22	2.10

4.3 Result Analysis for Tauhu from primary method

Table 4.2 Analysis of Tauhu by primary method

Samples	Analysis (%)			
	Protein	**Fat**	**Fiber**	**Ash**
TAUHU A1	43.03	25.11	25.53	8.03
TAUHU A2	43.24	25.46	27.51	8.19
TAUHU B1	45.71	25.13	13.39	5.14
TAUHU B2	43.70	26.44	12.12	5.13

4.4 Result Analysis for Bean Curd from primary method

Table 4.3 Analysis of Bean Curd by primary method

Samples	Analysis (%)			
	Protein	**Fat**	**Fiber**	**Ash**
BEAN CURD A1	50.77	27.17	34.53	4.29
BEAN CURD A2	50.70	26.51	27.21	4.25
BEAN CURD B1	42.69	28.84	12.58	3.35
BEAN CURD B2	45.69	28.77	11.50	4.24

4.5 Result Analysis for Soybean Milk from NIR method

Table 4.4 Analysis of Soybean Milk using NIR

Samples	Analysis (%)			
	Protein	**Fat**	**Fiber**	**Ash**
SOYBEAN A1	43.30	2.36	20.60	3.38
	43.31	2.37	20.68	3.38
SOYBEAN A2	43.76	2.39	20.42	3.44
	43.80	2.40	20.69	3.44
SOYBEAN B1	45.46	2.83	23.10	3.09
	45.42	2.84	23.26	3.09
SOYBEAN B2	45.24	2.78	21.91	3.01
	45.28	2.76	22.06	3.06
SOYBEAN C1	44.14	2.51	21.82	3.39
	44.15	2.51	22.00	3.41
SOYBEAN C2	44.23	2.54	21.68	3.36
	44.26	2.55	21.83	3.37
SOYBEAN D1	44.69	2.35	20.02	3.78
	44.71	2.35	20.09	3.79
SOYBEAN D2	44.06	2.43	21.61	3.66
	44.02	2.44	21.89	3.67
SOYBEAN E1	44.07	2.37	19.22	3.50
	44.07	2.40	19.40	3.50
SOYBEAN E2	43.94	2.40	19.38	3.47
	43.90	2.41	19.85	3.48

4.6 Result Analysis for Bean Curd from NIR method

Table 4.5 Analysis of Bean Curd using NIR

Samples	Analysis (%)			
	Protein	**Fat**	**Fiber**	**Ash**
BEAN CURD A1	51.12	26.67	29.97	3.35
	51.18	26.71	29.86	3.42
BEAN CURD A2	50.91	26.90	31.53	3.50
	50.93	26.94	31.09	3.44
BEAN CURD B1	44.78	29.22	17.06	4.90
	44.82	29.26	16.87	4.97
BEAN CURD B2	44.45	28.93	10.19	3.08
	44.47	28.97	10.14	3.07
BEAN CURD C1	50.91	30.64	20.67	2.51
	50.93	30.70	20.87	2.51
BEAN CURD C2	50.77	30.76	21.87	2.89
	50.80	30.81	22.11	3.02
BEAN CURD D1	46.08	34.41	51.71	2.86
	46.12	34.18	51.78	2.96
BEAN CURD D2	46.40	33.57	43.70	2.54
	46.43	33.62	44.22	2.71
BEAN CURD E1	44.90	29.08	14.98	4.24
	44.93	29.14	15.01	4.23
BEAN CURD E2	44.49	28.87	12.89	3.55
	44.53	28.91	12.87	3.61
BEAN CURD F1	51.27	29.85	15.29	3.34
	51.30	29.90	15.63	3.39
BEAN CURD F2	51.03	30.55	20.42	2.77
	51.06	30.62	20.96	2.83

4.7 Result Analysis for Tauhu from NIR method

Table 4.6 Analysis of Tauhu using NIR

Samples	Analysis (%)			
	Protein	**Fat**	**Fiber**	**Ash**
TAUHU A1	42.47	26.40	28.65	8.31
	42.61	26.35	28.90	8.31
TAUHU A2	42.77	26.75	30.38	8.46
	42.92	26.72	31.06	8.46
TAUHU B1	39.61	28.06	15.29	6.35
	39.71	28.05	15.57	6.36
TAUHU B2	40.22	27.82	16.15	6.42
	40.32	27.79	16.57	6.42
TAUHU C1	44.15	23.37	36.30	10.66
	44.25	23.35	36.54	10.67
TAUHU C2	44.22	23.32	36.21	10.67
	44.27	23.30	36.36	10.68
TAUHU D1	46.99	23.37	35.22	8.96
	47.08	23.70	35.40	8.97
TAUHU D2	47.11	23.75	35.88	9.02
	47.21	23.72	36.09	9.03
TAUHU E1	38.57	26.43	23.40	8.83
	38.68	26.41	23.59	8.84
TAUHU E2	38.50	26.70	23.96	8.90
	38.55	26.67	24.05	8.89

4.8 Discussion

4.8.1 Analysis of Soybean Milk

Soybean milk is an emulsive liquid extracted from soybean. It is recognized as milk from vegetable due to its high protein and other potential nutrients. For this research, has 5 samples of soybean milk will analyze using NIR analysis and each of these samples will be duplicate; Sample A, Sample B, Sample C, Sample D and Sample E. These samples came from different places of productions. For primary analysis only 2 samples of soybean milk will analyze.

Table below show the nutrients contents in soybean milk between NIR analysis and primary analysis. Both of these methods using the same samples which are sample A1, sample A2, sample B1 and sample B2 to get more accurate result.

Table 4.7 The nutrients contents in soybean milk between NIR analysis and primary analysis (%)

Samples	Protein		Fat		Fiber		Ash	
	Primary Analysis	NIR Analysis	Primary Analysis	NIR Analysis	Primary Analysis	NIR Analysis	Primary Analysis	NIR Analysis
A1	46.67	43.30	2.30	2.36	17.29	20.60	3.74	3.38
A2	44.78	43.80	2.56	2.39	22.42	20.42	3.68	3.44
B1	49.97	45.46	3.16	2.83	15.11	23.10	2.39	3.09
B2	47.81	45..24	3.22	2.79	19.22	21.91	2.10	3.01

From the primary analysis, most of the soybean milk contains about 44% until 49% of protein and for NIR analysis most of soybean milk contains about 43% until 45% of protein based on the dry basis of soybean. Based on journal Kulvadee, 1999, it can compare with his results where it stated that most of soybean milk contains around 39% until 46% of protein. Besides, from USDA Nutrient Database for Standard Reference stated that the protein contain in soybean milk in 100 g is about 36.5%. It can conclude that, the soybean milk is a low cost source of protein and become the most acceptable products among the customers.

From the figure 4.1, it can see that the results of protein between primary analysis and NIR analysis. The results are slightly different between two methods but overall the primary method is the best method to determine the nutrient contents in soybean milk.

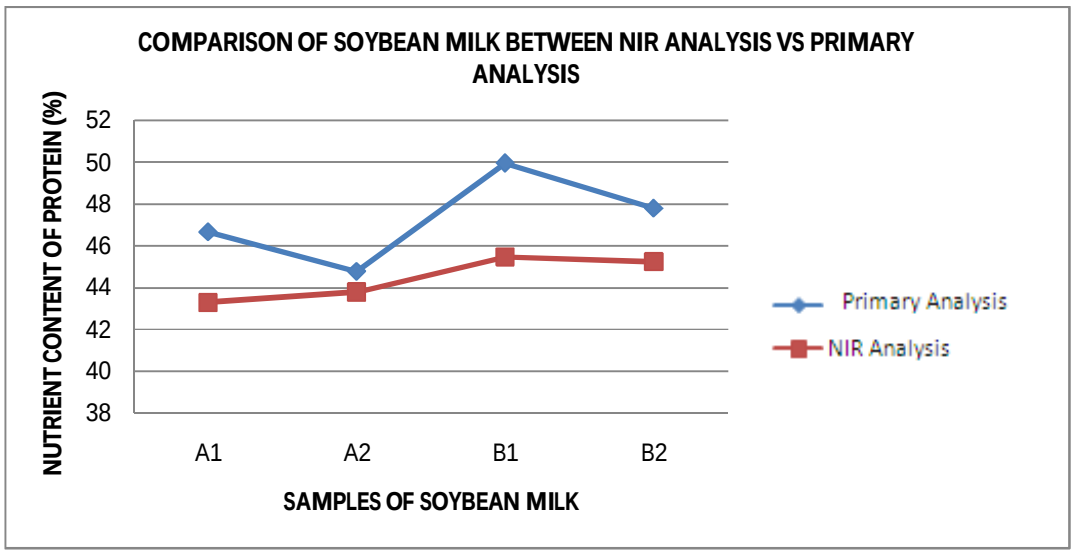

Figure 4.1 Comparison protein content of soybean milk between NIR analysis and primary analysis.

Second nutrient will be discuss is fat content. From the primary analysis, most of the soybean milk contains about 2% until 3% of fat and for NIR analysis is around 2.3% until 2.5%. By referring the journal Kulvadee, 1999, the soybean milk contains about 5.6% of fat. In addition, according to Bahereh Hajirostamloo, 2009 stated that the fat contain in soybean milk is around 4.67%. And from USDA Nutrient Database for Standard Reference stated that the protein contain in soybean milk in 100 g is about 2.9%. Based from the results, it can see that there are different and these different will based on several factor such as quality of soybean milk, storage condition, soaking time, the amount of food addictive, cooking of the slurry when making soybean milk and dilution water in soybean milk production. (Kulvadee, 1999)

From figure 4.2, it can see that the result between two analyses had been done. Both of these analyses give quite similar result. Overall it can see that primary is the best method to determine the nutrient contents in soybean milk and NIR analysis is the faster route to determine the nutrient contents.

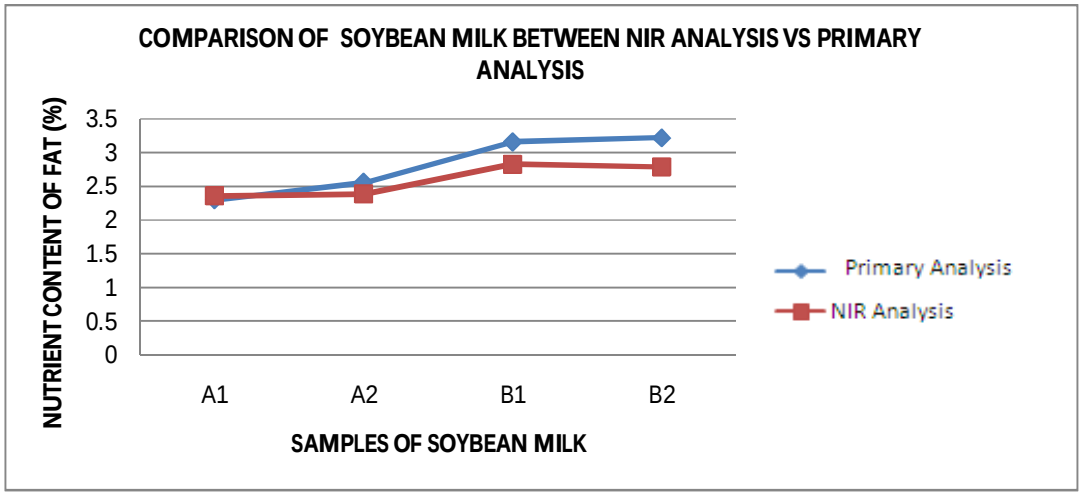

Figure 4.2 Comparison fat content of soybean milk between NIR analysis and primary analysis.

Third nutrient will be discuss is fiber content. From the primary method, the fiber contain is around 15%-22% and from NIR analysis the fiber contain in soybean milk is around 19% until 23%. From USDA Nutrient Database for Standard Reference stated that the fiber contain in soybean milk in 100 g is about 9.3%. Based on journal Pracha Boonyasirikool1 et al., 2001, the fiber contain in soybean milk based on dry basis is around 6.89%.

The reason why there are different between two methods because there are some errors during runs the experiment. During experiment, it noticed that the weight of filter bag decreases and some of the sample spill out from the filter bag. As a result, the some error during calculation and also during creates an equation for Near Infrared.

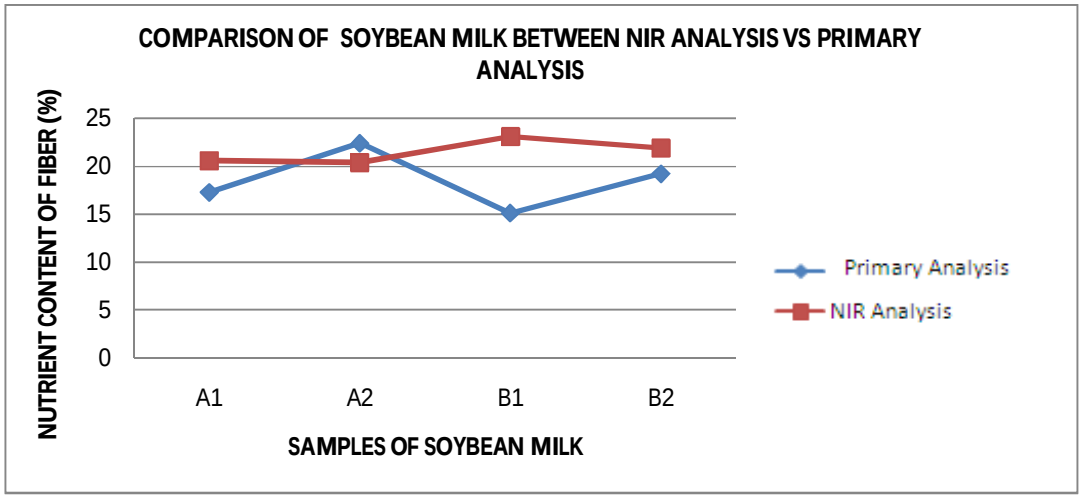

Figure 4.3 Comparison fiber content of soybean milk between NIR analysis and primary analysis.

Fourth nutrient will be discuss is ash content. From the primary method, the ash contain is around 2.10% until 3.74% and from NIR analysis the ash contain in soybean milk is around 3% until 3.44%. From USDA Nutrient Database for Standard Reference stated that the ash contain in soybean milk in 100 g is about 4.9%. Based on journal Pracha Boonyasirikool1 et al., 2001, the fiber contain in soybean milk based on dry basis is around 0.66%.

From figure 4.4, it can see that there is slightly different between two analyses. For sample A1 and A2, the primary analysis is the best method but for sample B1 and B2, NIR analysis is the best method to determine the ash content in soybean milk. Overall the analysis it still can be accepted since the results are quite similar with journal's results.

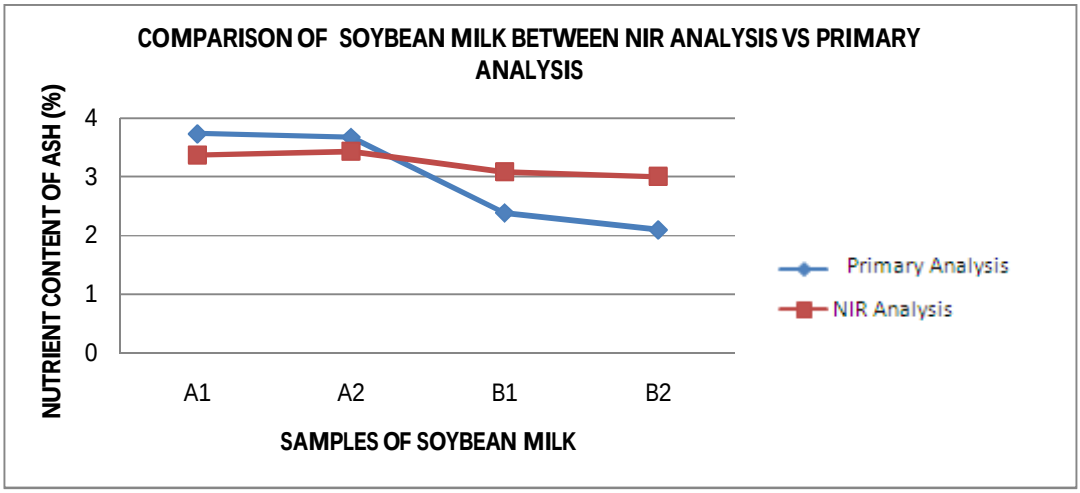

Figure 4.4 Comparison ash content of soybean milk between NIR analysis and primary analysis.

4.8.2 Analysis of Tauhu and Bean Curd

Bean curd and tauhu are know as soybean curd, is a soft cheese like food made by curding fresh soybean milk with a coagulant. For this research, has 6 samples of bean curd and 5 samples of tauhu that will analyze using NIR and each of these samples will be duplicate to give more accurate data. For primary method only 2 samples of tauhu and bean curd will analyze. These samples came from different places of productions to get more variety of data. For this part, both tauhu and bean curd will discuss together since there have quite same characteristic and nutrients contents.

Table below show the nutrients contents in tauhu and bean curd between NIR analysis and primary analysis. Both of these methods using the same samples which are sample A1, sample A2, sample B1 and sample B2 to get more accurate result.

Table 4.8 The nutrients contents in tauhu between NIR analysis and primary analysis (%)

Samples	Protein		Fat		Fiber		Ash	
	Primary Analysis	NIR Analysis	Primary Analysis	NIR Analysis	Primary Analysis	NIR Analysis	Primary Analysis	NIR Analysis
A1	43.03	42.47	25.11	26.40	25.53	28.65	8.03	8.31
A2	43.24	42.77	25.46	26.75	27.51	30.38	8.19	8.46
B1	45.71	39.61	25.13	28.06	13.39	15.29	5.14	6.35
B2	43.70	40.22	26.44	27.82	12.12	16.15	5.13	6.42

Table 4.9 The nutrients contents in bean curd between NIR analysis and primary analysis (%)

Samples	Protein		Fat		Fiber		Ash	
	Primary Analysis	NIR Analysis	Primary Analysis	NIR Analysis	Primary Analysis	NIR Analysis	Primary Analysis	NIR Analysis
A1	50.77	51.12	27.17	26.67	34.53	29.97	4.29	3.35
A2	50.70	50.93	26.51	26.90	27.21	31.53	4.25	3.50
B1	42.69	44.78	28.84	29.22	12.58	17.06	3.35	4.90
B2	45.69	44.45	28.77	28.93	11.50	10.19	4.24	3.08

For primary analysis, normally the protein contain in tauhu is around 43% and for NIR analysis the protein content is around 39% until 40%. For bean curd, the result from primary analysis stated that the protein contents is around 42% until 50% and NIR analysis is around 44% until 51%. Based on FAO, Expert Consultation, Energy and Protein Requirements, 1985, the protein contains in bean curd and tauhu has an average of 20% until 35%. In addition, according to H.L.Wang and J.F.Cavins, 1989 stated that the protein content in bean curd and tauhu is an average 53.9% on a dry weight basis.

The protein content varies with the protein content in bean, but it is also affected by water content. The water content of bean curd and tauhu can vary significant with the type and quality of coagulant used, coagulant conditions and the method used. (Wang and Hesseltine, 1982). There is why there are different data between sample A and sample B since it come from differences area of productions.

Figure 4.5 and 4.6 show that the comparison between NIR analysis and primary analysis. It can see that the two sample; Sample A1, Sample A2 and Sample B1, Sample B2 have different value of protein contents. It is because two samples are come from different place of production. Overall, the result between two method analyses is slightly same and small errors.

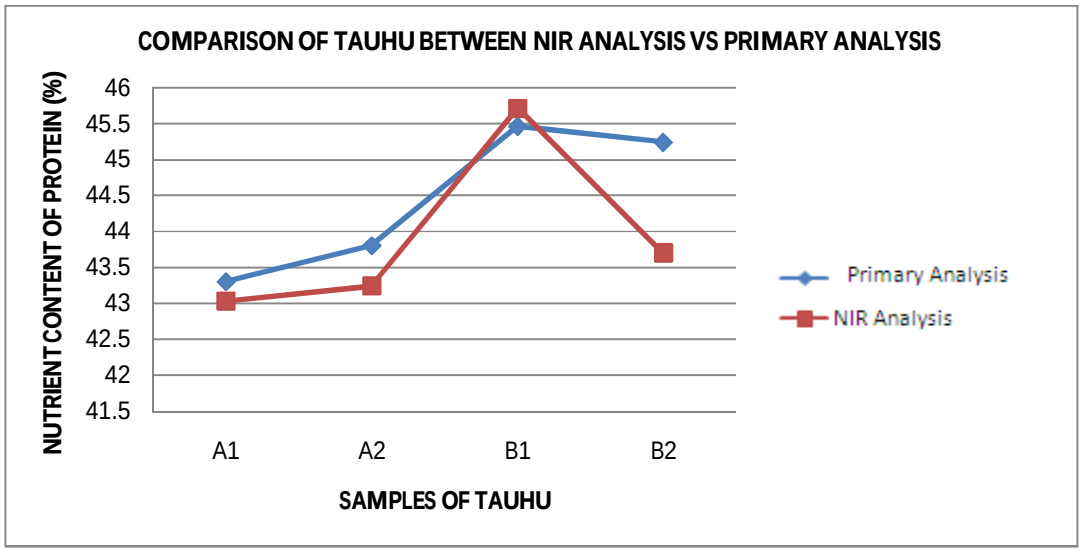

Figure 4.5 Comparison protein content of tauhu between NIR analysis and primary analysis.

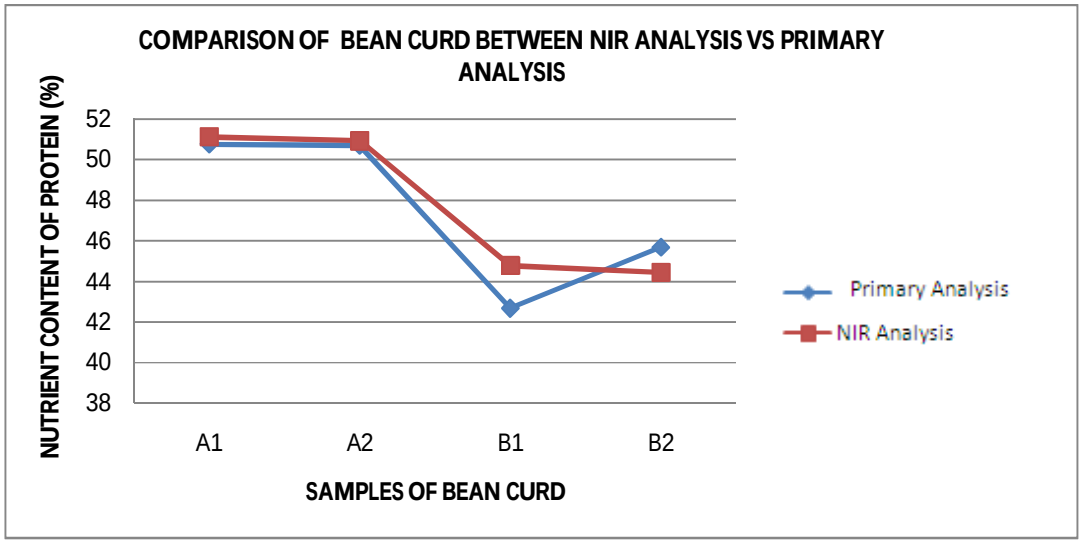

Figure 4.6 Comparison protein content of bean curd between NIR analysis and primary analysis.

Second nutrient will be discuss is fat content. For primary analysis, normally the fat contain in tauhu is around 25% until 26% and for NIR analysis the fat content is around 26% until 28%. For bean curd, the result from primary analysis stated that the fat contents are around 26% until 28% and NIR analysis is around 26% until 29%. According to journal from H.L.Wang and J.F.Cavins, 1989, they stated that the composition fat inside the bean curd and tauhu in between 15.4% until 19.6%. In addition, according to Mrinal Pednekar et al., 2009 the fraction of fat in bean curd and tauhu is around 22.7%.

So, it can see the different results between experiment and the standard. The reason is because the soybean products have very high in essential fats likes linoleic and linoleic acid. (Synder, HE,Kwon, 1987) Besides that, the qualities of products and storage time also give the impact of nutrients contents. As result, it can see the variety value of fat contents.

From figure 4.7 show that the comparison of fat content in tauhu between NIR analysis and primary analysis. From figure it can see that NIR analysis is more dominant compare to primary analysis. But overall the different between two methods of analysis is still quite the same.

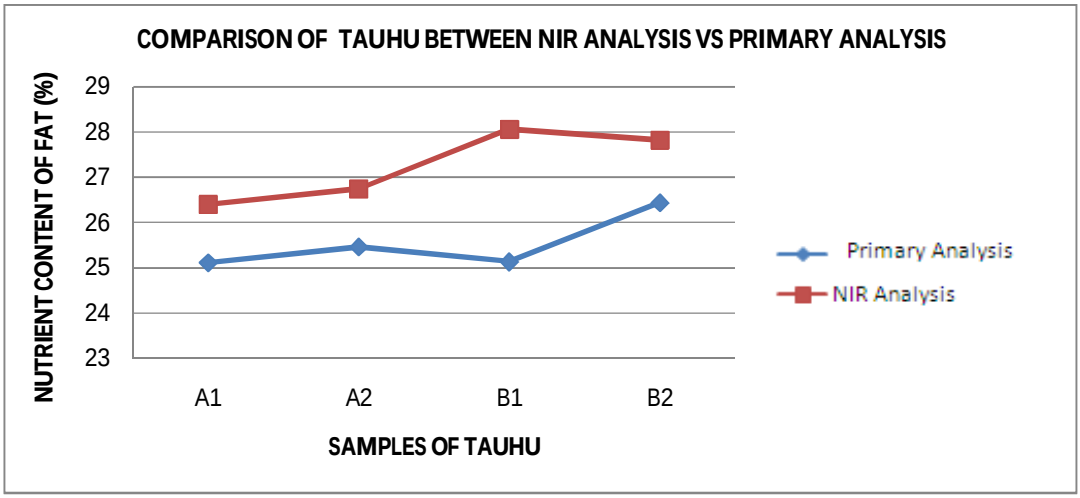

Figure 4.7 Comparison fat content of tauhu between NIR analysis and primary analysis.

In figure 4.8, the comparison of fat content in bean curd between NIR analysis and primary analysis. Overall here it can see that the results from NIR analysis and primary analysis have similarity. But the nutrient content between sample A and sample B have quite different since it come form different place of productions.

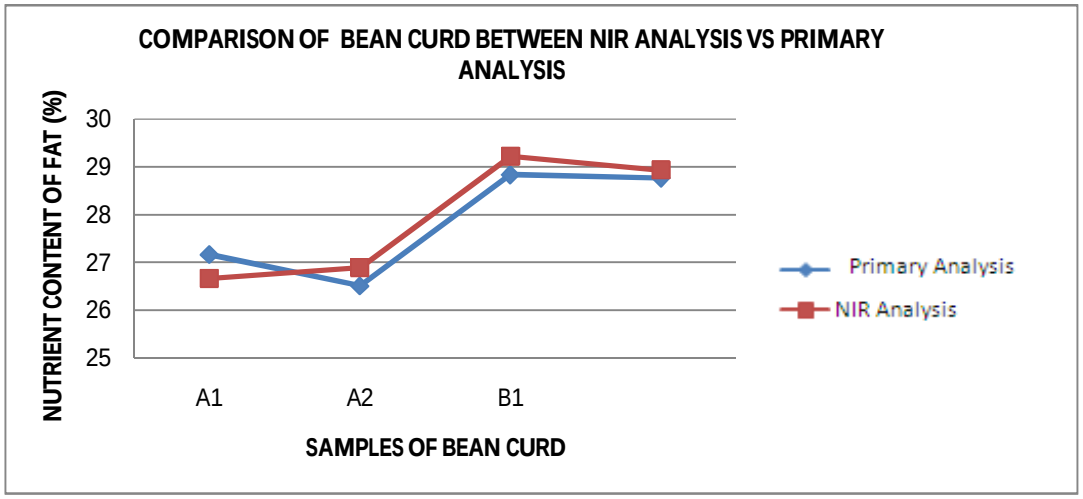

Figure 4.8 Comparison fat content of bean curd between NIR analysis and primary analysis.

Third nutrient will be discuss is fiber content. From primary analysis, the fiber content in tauhu is around 12% until 27% and for NIR analysis is around 15% until 30% of fiber content. For bean curd, normally for primary analysis the fiber content is around 11% until 34% and NIR analysis is around 10% until 31% of fiber content. From the USDA Nutrient Database for Standard Reference stated that the fiber contain in soybean milk in 100 g is only 0.3%. According to Synder, HE,Kwon, 1987, the fiber content is around 15%.

In information, soy products are an excellence source of fiber. The fiber is often separated out in the process of creating various soy foods. It is then used as an additive to enhance the fiber content of other food. There are the different value between experiment's result and journal's result because during the experiment there are some errors. During experiment, it noticed that the weight of filter bag decreases and some of the sample spill out from the filter bag. As a result, the some error during calculation and also during creates an equation for Near Infrared.

From figure 4.9 shows that the comparison of fiber content in tauhu between NIR analysis and primary analysis. From the figure it can see that NIR analysis is more dominant compare primary analysis. Overall, the results between two methods of analysis are quite similar.

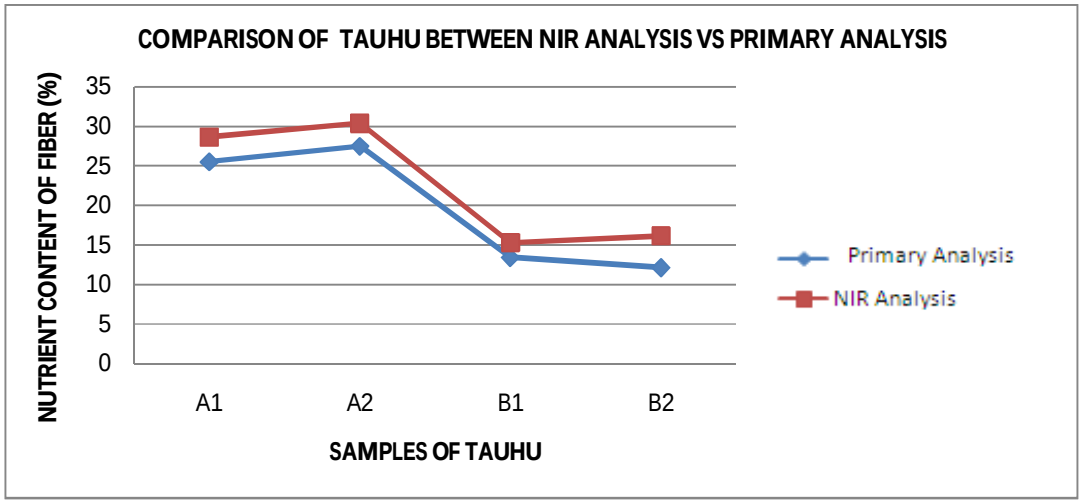

Figure 4.9 Comparison fiber content of tauhu between NIR analysis and primary analysis.

From figure 4.10 shows that the comparison of fiber content in bean curd between NIR analysis and primary analysis. From the figure, it can see that there is quite similar between two methods of analysis.

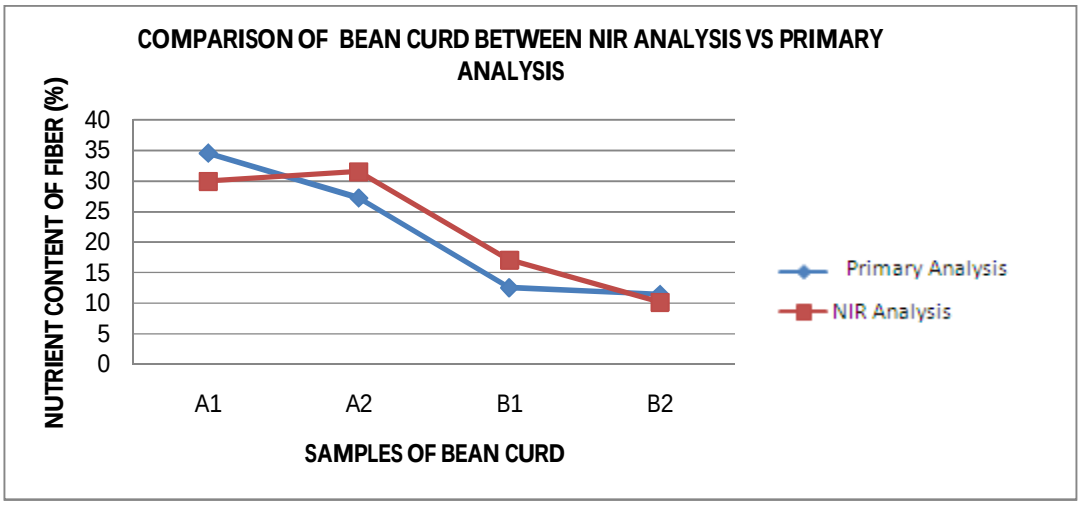

Figure 4.10 Comparison fiber content of bean curd between NIR analysis and primary analysis.

Fourth nutrient will be discuss is ash content. From the primary method, the ash contain is around 5% until 8% and from NIR analysis the ash contain in soybean milk is around 6% until 8%. For bean curd, normally the ash content in primary analysis is around 3%-4% and for NIR analysis is around 3% until 5% of ash content. From USDA Nutrient Database for Standard Reference stated that the ash contain in soybean milk in 100 g is about 0.72%. Based on journal Pracha Boonyasirikool1 e.t, 2001, the fiber contain in soybean milk based on dry basis is around 3.9% until 4.24%.

From figure 4.11, there are comparisons of ash content in tauhu between NIR analysis and primary analysis. It can see that NIR analysis more dominant compare to primary analysis. Overall both results from two methods of analysis can be accepted since there are small errors between NIR analysis and primary analysis.

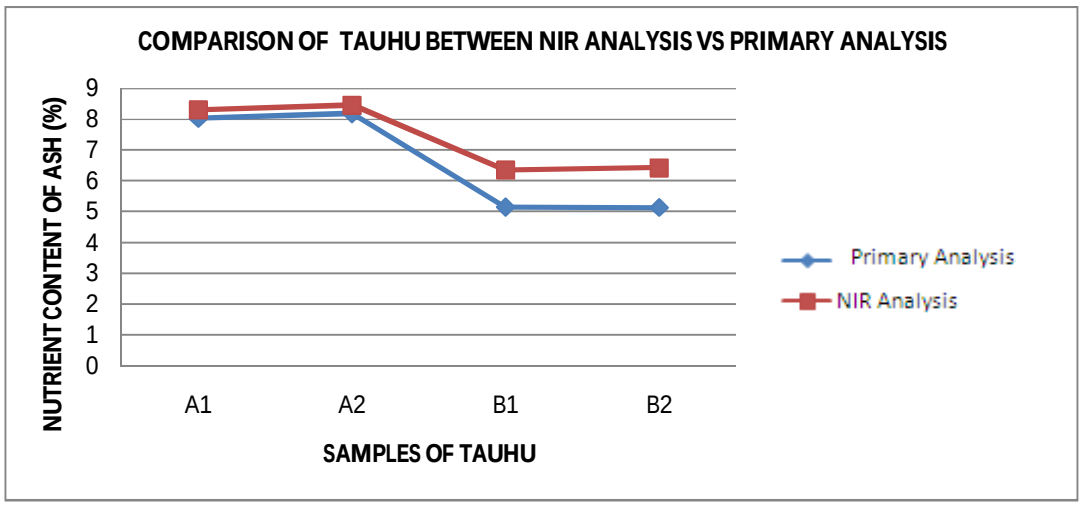

Figure 4.11 Comparison ash content of tauhu between NIR analysis and primary analysis.

In figure 4.12, there are comparisons of ash content in bean curd between NIR analysis and primary analysis. According to this figure, the primary analysis is more dominant compare to NIR analysis.

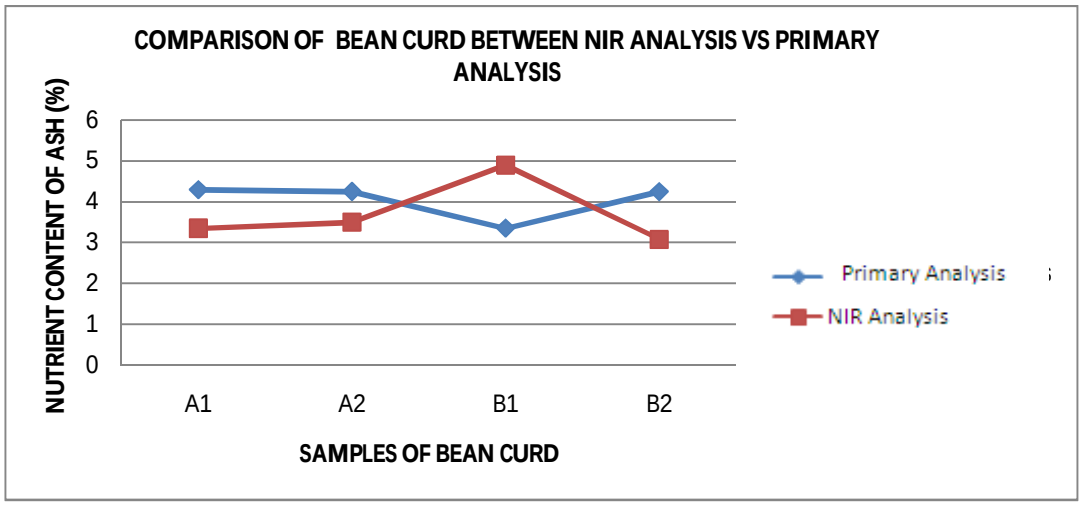

Figure 4.12 Comparison ash content of bean curd between NIR analysis and primary analysis.

Since NIR is a physical analysis which is use wavelength to penetrate the samples and get the result, actually it very sensitive with several factors. Size particle of samples also give some effect during analysis by using NIR. NIR extracts usable information from the absorption spectral characteristics of sample irradiated by light in the NIR region. The NIR region is between 730 until 2500 nm. According to journal by Melchor C.Pasikatan et at., 2001 stated that it has been long recognized that NIR reflectance is sensitive to the particle of size, shape and distribution of powder or granular samples.

A sensor that has sensitivity to two measureable quantities is said to exhibit cross-sensitivity. For these sensors, calibration involves maximizing the wanted and minimizing the unwanted signal. For NIR reflectance applications, determining chemical compound in granular or powder samples, particles size effects on the spectra is considered the unwanted signal. Besides that, factors such as mean particle size, particles distribution, particle shape, packing density and surface texture presented to the instrument influence the penetration of radiation into the samples and thus the diffuse reflectance from the samples. Since the diffusely reflected light is the sum of the random reflection at the surface and within the sample, the particle size is an integral part of the NIR absorbance values at all wavelengths.(M.F.Devaux et al,1995) Here it can see that the size particle give an effect to calibration curve during analysis the samples. That is why there still the different between each sample.

Since this research only focus on small scale industry, they lack of experience, lack of new technology and lack of new equipments. It can see based on the nutrient contents after analyze using NIR. There are the different between each samples and this different come from several factor, for example nutrient lost during processing and storage, quality of products, and other factors

CHAPTER FIVE

CONCLUSION & RECOMEMENDATIONS

5.1 Conclusion

In conclusion, to analyze the nutrients contents in soybean products, it has two methods of analysis which are primary analysis and NIR analysis. For primary analysis, the results are based on lab experiment and it more accurate. For NIR analyses is the faster route and help us to get to analyze the nutrients contents faster. Soybean products are extremely versatile and are made into an astounding variety of food. Soybeans have healthful nutrient profile. The availability of nutrients varies with the form of soy food. Soybeans are used in a variety of foods can be easily incorporated into the diet.

Overall from the experiments, most of the soybean products have higher protein content, based on primary method the soybean milk is around 44% until 49%, tauhu is around 43% and bean curd is around 42% until 50%. For fat content, the soybean milk is around 2% until 3%, tauhu is around 25% until 26% and bean curd is around 26% until 28%. For fiber content, the soybean milk is around 15% until

UNIVERSITI MALAYSIA PAHANG

BORANG PENGESAHAN STATUS TESIS♦

JUDUL: **COMPARISON THE NUTRIENTS CONTENTS IN SOYBEAN PRODUCTS BETWEEN PRIMARY ANALYSIS AND NIR ANALYSIS**

SESI PENGAJIAN: **2006/2007**

Saya **MASKHAIRIAH BINTI ISMAIL (870310-05-5226)**
(HURUF BESAR)

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APPENDIX A

Figure A1: Procedure in moisture

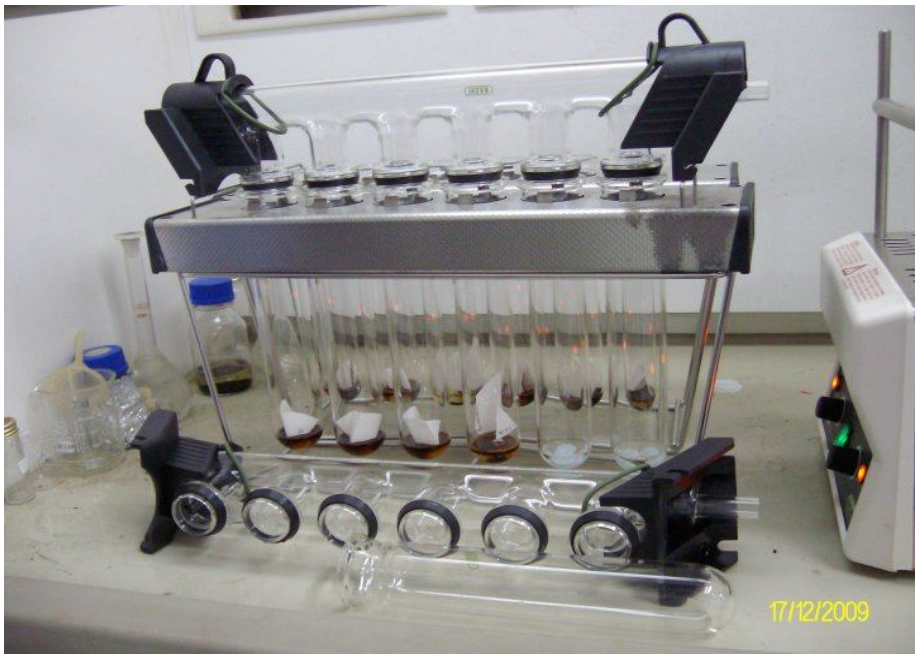

Figure A2: Procedure during Kjedahl Method

Figure A3: Procedure during Kjedahl Method

Figure A.4: Procedure during Kjedahl Method

Figure A.5: Procedure during Fat Soxhlet Method

Figure A.6: Procedure during Fiber Method

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COMPARISON THE NUTRIENTS CONTENTS IN SOYBEAN PRODUCTS BETWEEN PRIMARY ANALYSIS AND NIR ANALYSIS

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A report submitted in partial fulfillment of the
requirements for the award of the degree of
Bachelor of Chemical Engineering

Faculty of Chemical and Natural Resources Engineering
Universiti Malaysia Pahang

APRIL, 2010

"I hereby acknowledge that the scope and quality of this thesis is qualified for the award of the Bachelor Degree of Chemical Engineering"

Signature : _____

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Date : 30 APRIL 2010

Signature : _____

Author : MASKHAIRIAH BINTI ISMAIL

Date : 30 APRIL 2010

Special Dedication to my beloved family members,
My friends, my fellow colleague,
who have guided and inspired me throughout
my journey of education.

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ABSTRACT

The objective on this research is to determine the nutrients contents in soybean products using 2 method analysis which are primary analysis and NIR analysis. The scope of study are focus on small scale production of soybean products. Small scale industry normally lack of good production because of the less technologies and experiences. Therefore, there is no specific data about nutrient contents in soybean foods that attached to the food packaging The primary analysis are bases on the conventional method; Kjedahl's method to determine the protein contents, Soxhlet's method to determine the fat contents, fiber method to determined the fiber contents and ash method to determine the ash content in soybean products. By using NIR, it cans analysis and determines the pattern of nutrient content in soybean products and compares the nutrient contents between NIR analysis and primary method analysis. From the experiment, the results between primary analysis and NIR analysis have small error and it almost similar as it discuss in chapter 4. Most of the nutrients contents; protein, fat, fiber and ash have small errors. NIR is a clone from primary analysis since all the data was determined from primary methods; Kjedahl Method, Soxhlet Method, Fiber Method and Ash Method. NIR is an instrument that will help to determined nutrients contents in faster route but somehow it is not too accurate since NIR consider with size, shape and distribution of particles of samples. The primary analysis is the best method to determine the nutrients contents since it more accurate compare than NIR analysis

ABTRAK

Objektif kajian ini adalah untuk mengkaji nutrisi di dalam produk kacang soya dengan menggunkan 2 kaedah analisis iaitu *Primary* analisis dan NIR analisis. Kajian ini focus kepada pengeluaran produk kacang soya dalam skop yang kecil kerana ianya terhad dari segi teknolgi, alatan dan pengalaman. Hasilnya produk-produk ini tidak mempunyai label nutrisi makanan yang lengkap. *Primary* analisis terbahagi kepada beberapa bahagian; Kaedah *Kjedahl* iaitu mengkaji kandungan protein, Kaedah *Soxhlet* iaitu mengkaji kandungan lemak, Kaedah Fiber iaitu mengkaji kandungan fiber dan Keadah *Ash* iaitu mengkaji kandungan ash di dalam produk kacang soya. Dengan menggunkan NIR iaiya dapat menganalisa dan mengkaji kandungan nutrisi di dalam makanan kacang soya dan data-data ini akan di banding antara satu sama lain. Hasil dari eksperimen ini, keputusan data antra *primary* analisi dan NIR analisis mempunyai perbezaan yang kecil dan hampir sama. NIR merupakan klon daripada *primary* analisis kerana kesemua data-data adalah berasal dari Keadah *Kjedahl*, Kaedah *Soxhlet*, Kaedah Fiber dan Keadah *Ash*. NIR juga merupakan instrument yang membantu untuk mengkaji kandungan nutrisi dengan kadar cepat akan tetapi ianya tidak tidak kerana bergantung kepada saiz, bentuk dan taburan sampel. *Primary* analisis merupakan kaedah yang terbaik kerana mampu mengkaji kandungan nutrisi dengan tepat.

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LIST OF SYMBOLS/ABBREVIATIONS

NIR	-	Near-Infrared
mL	-	Milliliter
g	-	Gram
mg	-	Milligram
µg	-	Microgram
%	-	Percentage
ºC	-	Degree celcius
M	-	Molar
kg	-	Kilogram
nm	-	Nanometer
NaOH	-	Sodium Hydroxide
H_2SO_4	-	Sulfuric acid

LIST OF APPENDICES

22%, tauhu is around 12% until 27% and bean curd is around 15% until 30%. For ash content, the soybean milk is around 2.10% until 3.74%, tauhu is around 5% until 8% and bean curd is around 3% until 4%.

Based on NIR analysis, most of the soybean products have higher protein content, the soybean milk contains about 43% until 45% of protein based on the dry basis of soybean, tauhu is around 39% until 40% and bean curd is around 44% until 51%. For fat content, the soybean milk is around around 2.3% until 2.5%, tauhu is around is around 26% until 28% and bean curd is around 26% until 29%. For fiber content, the soybean milk is around 19% until 23%, tauhu is around 15% until 30% of fiber content and bean curd is around 10% until 31%. For ash content, the soybean milk is around 3% until 3.44%, tauhu is around 6% until 8% and bean curd is around 3% until 5% of ash contents.

From the experiment, the results between primary analysis and NIR analysis have small error and it almost similar as it discuss in chapter 4. Most of the nutrients contents; protein, fat, fiber and ash have small errors. NIR is a clone from primary analysis since all the data was determined from primary methods; Kjedahl Method, Soxhlet Method, Fiber Method and Ash Method. NIR is an instrument that will help to determined nutrients contents in faster route but somehow it is not too accurate since NIR consider with size, shape and distribution of particles of samples. The primary analysis is the best method to determine the nutrients contents since it more accurate compare than NIR analysis.

5.2 Recommendations

In order to improve this research, there are several things should be stress out. Firstly, for further study, it needs to determine nutrients contents during processing of soybean products. Besides, to determine the nutrients contents lost during the processing and propose the best method on how to maintain the nutrients contents in soy foods.