THE EFFECTS OF COOKING TIME ON THE NUTRITIONAL PARAMETERS OF SOYA MILK

BY

AHAR PAUL ZUNGWE

MATRIC NO. 2004/18344EA

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CERTIFICATION

This project entitled "The Effect of Cooking Time on the Nutritional Parameters of Soya Milk" by Ahaz Paul Zungwe, meets the regulations governing the award of the degree of Bachelor of Engineering (B. ENG.) of the Federal University of Technology, Minna, and it is approved for its contribution to scientific knowledge and literary presentation.

Mrs. B. Orhebva Supervisor	17/02/2010 Date
Engr. Dr. A.A Balami HOD, Agricultural and Bioresources Engineering.	27/02/10 Date
External Examiner	10/2/2010 Date

DECLARATION

I hereby declare that this project work is a record of a research work that was undertaken and written by me. It has not been presented before for any degree or diploma or certificate at any university or institution. Information derived from personal communications, published and unpublished work were duly referenced in the text.

18/02/10

Ahar Paul Zungwe

Date

2004/18344EA

DEDICATION

This project is dedicated to my Late father, Mr. Ahar J. Galu, who was visionary enough to enroll every of his children in school while he was alive. It is also dedicated to my immediate elder brother, Ahar Kôr who is late and was not privileged to go to school. The last but not the least person who this project is dedicated to is Miss Iwuerse Msugh Ahar, a child my heart went to but the Lord God loved more and is now in His Bosom. Your memories lives on in my mind; you were truly loved and cherished in my heart!

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ABSTRACT

In this research work, the effect of cooking time on the Nutritional Values of Soyamilk was determined with a view of obtaining the approximate time at which soyamilk should be cooked to have its optimum benefit for man. Standard Laboratory conditions, Methods and instruments were used to obtain the results of the experiments. There are important differences in the chemical composition of soyamilk cooked between the time intervals of 15 minutes and 45 minutes. Soyamilk cooked for 15 minutes is characterized by a Moisture content of about 93.45%; ash is 4.17%; protein 3.72%; lipids 12.0%; carbohydrates 80.11% and energy value of 443.32 kcal/100g. On the other hand, the soyamilk prepared for 30 minutes contains a little lower moisture content level of 92.29%; lipids 6.48%; and energy value of 409.08%. The same soyamilk sample cooked for 30 minutes recorded changes which are slightly higher than the values cooked for 15 minutes; these include: ash 5.83%, crude protein 4.23% and carbohydrates 83.46%. The sample of soyamilk prepared for 45 minutes is characterized by higher ash 6.0%, crude protein4.74%, and lower moisture content 90.36%, lipids 6.17%3%, carbohydrates 83.09% and energy value 406.00kcar/100g. For the minerals considered under this research, Sodium has the following results: 27mg/100ml, 23 mg/100ml and 27mg/100ml for 15, 30 and 45 minutes of treated time respectively. The changes noticed in Potassium from 41mg/100ml, 60mg/100ml and 62mg/100ml for 15, 30 and 45 minutes of cooking were relatively higher than that observed in Sodium. On the other hand magnesium's changes in the composition in the soyamilk from 31ppm to 35ppm for 15 minutes and 45 minutes treated time respectively is small compared to Potassium. The last but not the least of the minerals considered under this project has the following values over the time of cooking: 109.0ppm after 15 minutes, 81ppm and 90.0ppm after 30 minutes and 45 minutes of cooking accordingly. It is evident that there are varying degrees of changes that occurred in each of the chemical composition of the soymilk.

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CHAPTER ONE

1.0 INTRODUCTION

1.1 Background to the study.

Although grain crops contribute almost half of the total protein of the world food supply, these grain protein are deficient in varying degree in several of the essential amino-acids, namely lysine, methionine, threonine and tryptophan. In countries lacking adequate animal protein sources, these amino-acid imbalances fortunately can be appreciably improved by mutual supplementations with properly processed oil seeds pulse and other legumes and nuts (Circle & Smith, 2005 citing Liener, 1972). Soya beans now supply more proteins than any other crops except Wheat, Maize and Rice. However, most of the soya beans crops are processed by solvent extraction to yield edible oil, with the meal primarily directed to animal feeding; only a minor percentage of the meal is processed for human consumption. Thus, in the United States only about 1.5% of the defatted soya meal is used directly in the human food supply (Circle and Smith, 2005); in China, Japan and other far Eastern countries the proportion is greater. For several years the United States soya beans crop has amounted to about three-quarters of the world soya beans production. The US together with China and Brazil accounted for 93.5% of the world soya beans crop in 1972. Table 1.1(USDA, 1974) and Table 1.2(USSA 1999); summarizes world soya beans production by individual countries for the years 1967-72 and 1997-98.

Table 1.1. *Soya beans: Production in specified countries and the world*

Continent and country	1967	1968	1969	1970	1971	1972	1973
	Production (tonnes x 10^3)						
North America							
United States	26575	30127	30839	30675	32006	34916	42634
Canada	220	246	209	283	280	375	397
Mexico	121	270	300	240	250	375	510
South America							
Argentina	20	22	32	27	59	78	272
Brazil	716	654	1057	1609	2100	3340	5000
Colombia	80	87	100	95	100	115	97
Paraguay	18	14	45	52	75	115	122
Europe							
Romania	41	47	51	91	165	186	244
Yugoslavia	9	3	5	5	4	6	5
USSR							
Africa							
Nigeria	16	7	34	11	1	4	1
Tanzania	4	4	4	4	4	4	4
South Africa	4	5	7	4	2	3	5
Asia							
Iran	2	2	4	6	7	9	20
Turkey	6	8	11	12	13	13	13
China							
Mainland	6950	6480	6300	6900	6700	6300	6700
Taiwan	75	73	67	65	61	60	60
Cambodia (Khmer, Republic of)	4	4	4	4	4	4	4
Indonesia	416	420	389	488	475	518	539
Japan	190	168	136	126	122	127	118
Korea, South	201	245	229	232	222	225	246
Philipines	1	1	1	1	1	1	2
Thailand	53	45	61	70	74	83	95
Australia	1	2	2	6	11	26	38
Other countries	273	278	282	296	309	332	351
Total excluding Romania, USSR, Bulgaria, Hungary Mainland, China, North Korea and North Vietnam	28752	32424	33557	33961	35905	40456	50285

Source: USDA (1974), Foreign Agriculture Service

Table 1.2 *Global coverage of soya beans (1997-98)*

SI. No.	Country	Area (million ha)	Yield (t/ha)	Production (million t)
1.	United States	27.97	2.62	73.18
2.	Brazil	13.00	2.42	31.50
3.	China	8.35	1.76	14.73
4.	Argentina	6.95	2.76	19.20
5.	India	5.86	1.15	6.72
6.	European union	0.46	3.44	1.57
7.	Paraguay	1.20	2.49	2.99
8.	Others	5.22	1.31	6.84
9.	Total	69.01	2.27	156.73

Source: Oilseeds: World Market and Trade, USDA, (1999).

The world produces about 150 million tonnes soya beans of which less than 10% is used as human food. Much of the soya meal is used for animal feed. The efficiency of converting soya beans protein to animal protein is only 25% (Salunke, 1992).

1.2 Statement of the Problem

Soya milk if not properly cooked has characteristics flavour (Beany flavour) which limit acceptance by some individuals. Several references (Circle and Smith, 2005) indicate that lipoxidase and perhaps other enzymes in the soya beans may be responsible for much of this 'off flavour'; the activities can be diminished by grinding the beans initially in hot water at 80-100°C (with or without chemical additives in the water). As stated above soya bean requires proper heat treatment in order to get rid of the flavour in processed soya milk or soybean products. Soya milk which is one the products of soya beans also has its nutritional parameters and these may also be affected by heat treatment with time.

Cooking time is a salient property of food processing which in most cases is not adhered to. Heat which is applied during cooking does not have an instant impact or influence on the food being cooked; it takes time for heat to make the desired effect that is required of it on food generally. In general, heat has its adverse effect on food. The following are some of the effect on the nutritional values of food: Protein denatures, lipids coagulates, starch which is the source of carbohydrates breakdown into simpler components when cooked for a period of time. To this end, time is indeed a very important factor to be considered when processing food and indeed soya milk to obtain its optimum benefit for man. Hence, the effect of cooking time on the nutritional parameters of soya milk is of great importance to analyse.

1.3 Objectives of the Study

a) To ascertain the proximate composition of soya milk;

b) To determine the changes in nutritional parameters of soya milk cooked over a period of time and;

c) To determine the approximate time for cooking soya milk at which its nutritional parameters are optimum for human consumption.

1.4 Justification of the Project

The quest to find out the solution to the world's increasing demand for protein and other nutritional values in the right quality which is hardly met by the animal sources in recent times, due to the increasing world population is a motivating factor for this research. It is hoped that this work will go a long way to contribute its little quota to sciencetific knowledge and to the already vast research work done on soya beans and perhaps soya milk in particular by the Academia.

Soya beans, (*Glycine Max*) has become famous as the plant that will help to solve the world problem of protein deficiency. Most soya beans grown in tropical Africa are for oil production and the protein rich-cake is fed to animals (Margaret et al, 1994). This crop is grown in Ethiopia, Nigeria, Uganda, and Tanzania with Nigeria and Tanzania exporting small quantities of soya products.

Dry soya beans contains 30-50 per cent protein and they can be ground into a highly nutritious flour, which is rich in Calcium, Iron, and the B vitamins as well as soya milk, which is an excellent source of protein for babies, especially those weaned from breast feeding.

Soya milk as mentioned above is one of soya beans products which is also an excellent source of high quality protein and B-vitamins. Soya milk naturally contains isoflavones, plant chemicals that help lower LDL ("bad" cholesterol) if taken as part of a "heart healthy" eating plan (www.sova.be, citing The American Journal of Clinical Nutrition, 2000).

In heat treatment of Biological materials, time and temperature are equally important if viability nutrients and quality of the material are to be preserved. Heating or treating soya milk with boiled water for just two (2) minutes will destroy enzymes which are responsible for the development of beany flavour in it, which of cause will extent to affect the other nutrients in soya milk.

1.5 Scope of the Project.

The scope of this project is limited to the effect of cooking time on the following nutritional values of soya milk carried out in the Food Science Laboratory of the Federal University of Technology, Minna-Niger State. These nutritional parameters include: Crude Protein, Fat (Total Lipid), Ash, Carboh ydrates, En ergy, Calcium, Magnesium, Potassium and Sodium.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Historical Evolution of Soya beans

Soya bean originated in China; its origin probably dates back to 2800 B.C. Its first domestication occurred in eastern half of North China around 11^{th} century B.C. (Wang, 1981). The eastern half of China was believed to be the primary centre and Manchuria, the secondary centre of origin of soya beans. Recently, Chang Ruzben (1989) discussed different hypotheses on the centre of origin. It is now largely accepted that Lower and Middle Yellow River Valley in China is the main centre of origin of soya beans.

Soya bean, (*Glycine max*) was first introduced in Nigeria in 1908 and the total area cultivated was 401,000 hectares while the yield recently was put at about 1270 Kg/ha (Dashiell, 1993, Agure, 1997). Its seed has a close protein content and fairly close amino-acids content with cow milk. The beans can be utilized in the liquid, powdery and curd forms for human consumption. The oil could be converted to margarine and salad oil. The meal is used as animal feed (Cowan, 1973). Soya bean was used to fortify maize custard while soft cheese and yoghurt could be prepared from soya beans. Recently, Belewu *et al.,* 2005 documented the combination of soya milk (50%) and coconut milk (50%) in the preparation of soya-coconut yoghurt.

2.2 Agronomy and Propagation.

The soya beans, *glycine max* (L) Merrill, is a member of the family *Leguminosae,* subfamily *Papilionaseae* (Bernard, 1998).

It is an erect legume 60-100cm tall. The leaves have three leaflets which they shed at maturity. Small white or purple flowers grow in branches from the leaf axis. Pods are short hairy and brown. Seeds are of different colours and sizes (Bhatia, 1993). It is grown from seeds.

Soya bean is indigenous to the warm temperate or sub-tropical regions but is now grown from the tropics to about 52^{o} latitude north or south. Heat resistant and less photo-sensitive varieties are grown in humid tropics. In equatorial regions maturations occurs in about 90-days. Soya beans grow best on rich sandy loams, (Margaret, 1994).

2.3 Processing and Products of Soya beans.

Igwe, (1998) reviewed the nutritional value of soya beans protein in the whole bean and as it occurs in the various processed fractions, including immature green and mature beans, sprouts, meal and flour (full-fat and defatted), protein concentrates, protein isolates, tofu curd, soy fermentation products, soya milk and textured meat analogs. Based on the ratio of total essential amino acids to total nutrients, soya flour ranks last below the animal proteins (egg, milk, meat and fish) and above the other oil seeds (sesame, cotton seed and peanuts). Soya protein isolates is somewhat lower in nutritional value than the protein in soya flour, due to the separation of soya "whey" proteins in processing.

The limiting amino acids on the bases of chemical score are sulphur containing methionine assisting; however, one of the most valuable attributes of soya protein lies in the fact that it contains more lysine than most plant proteins (Kho, 1988). The principal non-fermented soy foods processed traditionally include: soya milk, *tofu* (soya curd), *Yuba*, *kinako* and soya beans sprout (Smith & Circle, 2005).

2.3.1 Soya beans as a Table Vegetable.

It is regrettable that the use of soya beans as a table vegetable is relatively neglected, considering that this mode of use requires the least processing. Bates (1977) investigated a number of vegetable type soya beans and compared the cooked beans for flavour, colour, texture and other qualities.

Breaded, deep-fat fried vegetable soya beans made from beans harvested in green stage were recommended as a potential high protein snack item (BSM, 1995).

2.3.2 Soya milk.

In the far east, soya beans is traditionally prepared by soaking the beans in water over night, draining the water, grinding the beans in hot water (approximately 10 parts water to 1 part beans to give the desired solids content in the final product), then cooking the wet mash for 10-15 minutes at 100°C, and filtering through coarse cloth to recover the product (Carison, 1979). The water-beans ratio specified above extract about 50% of the protein and oil.

When supplemented with vitamin, minerals, methionine, oil and sugar, soya beans is nutritionally equivalent to cow's milk (Cowan, 1973). In Japan spray dried soya beans milk is made commercially (Watanabe, 1984). Soya beans may be used to 'tone' or supplement Buffalo milk or cow milk (Kolar, 1979).

2.3.3 *Tofu* (Soya beans Curd).

Tofu, which is a good source of protein and oil is the most important of the non-fermented foods. The first step to prepare soya milk as described above. While stirring the hot milk, the tofu is precipitated by adding calcium sulphate to form a gelatinous curd which is separated and drained free of whey and then soaked in fresh water for an hour or more; it is then ready for he market (Smith & Circle, 2005).

The yield of *tofu* is variable depending on the variety of the beans as well as other factors. Smith *et al.* (2005) reported that 1.8kg of soya beans (12% moisture) yielded 5.55kg of tofu (88% water). On a dry basis this is 42% of the bean weight. Dry *tofu* contains 55% protein and 28% oil. *Tofu* curd (wet) is frequently served in soup, and may also be used in the dry form called *kori-tofu* (Watanabe, 1984).

2.3.4 *Yuba*

When soya milk is cooked at or near its boiling temperature, a film composed of protein and oil (with a composition similar to *tofu*) forms on the surface. This film when removed and dried is a nutritious food known as *Yuba*. It is used in soups or fried in fat for table use (Watanabe, 1984; Smith & Circle, 2005).

2.3.5 *Kinako*.

A product made in Japan known as *Kinako* is similar to full-fat soya flour except that it may contain the seed coat (Watanabe, 1984). *Kinako* is prepared from clean whole soya beans which are first roasted in oven at about 100°C for 30 minutes to diminish the beany flavour and improve the nutritional value and then ground into a fine powder. This product is sprinkled on rice or rice cakes and used as a protein supplement.

2.4.6 Salted Soya beans.

A product resembling salted peanuts is prepared by soaking clean whole beans in 10% salt solution over night then boiling in water for about 30 minutes. The beans are removed from the water and dry roasted to a light brown colour (Circle & Smith, 2005).

2.3.7 Soya beans Sprouts.

When properly prepared, soya beans sprouts do not have the beany flavour so frequently associated with soya beans foods. Bates, (1977) have described some of the common procedures for their preparation. Clean whole beans are soaked in water over night and sprouted in grass fruit, flower pots or between wet clothes supported by a wire screen. They are maintained in the dark during the sprouting period and washed several times a day with water containing one teaspoon calcium hypochlorite per 13 litres of water to discourage the growth of micro-organisms. Excessive moisture is unfavourable to rapid sprouting; the recommended amount is about 55% of the weight of the wet beans at a temperature of about 30°C. The sprout should be about 5cm long in 4-5 days.

The sprout may be prepared for the table by pan frying with a small amount of fat, and seasoning with salt. For use in a salad they are boiled in water for a few minutes, drained and chilled. The sprouted beans are rich in protein and oil and during sprouting there is a rapid increase in ascorbic acid as well as other vitamins.

2.4 The Effect of Cooking on Soya beans Products.

Thermal processing involves heating food, either in a sealed container or by passing it through a heat exchanger. It is important to ensure that the food is adequately heat treated and to reduce post-processing contamination (ppc) (Lewis, 1990). Heat or energy (J) is transferred from a high to a low temperature, the rate of heat transfer being proportional to the temperature difference. The heating medium is usually saturated steam or hot water. For temperatures above 100°C, steam and hot water are above atmospheric pressure (Bjork, 2006).

Thermisation is a mild process which is designed to increase the keeping quality of raw milk. It is used mainly when it is known that it may not be possible to use raw milk immediately for conversion to other products, such as cheese or milk powder. The aim is to reduce psychrotropic bacteria, which can release heat resistant protease and lipase enzymes into the milk. These enzymes are not inactivated during pasteurisation and may give rise to off flavours if the milk is used for cheese or milk powders. Temperatures used are 58–68°C for 15 s. Raw milk thus treated can be stored at a maximum of 8°C for up to 3 days (Carison, 1979).

2.4.1 Reasons for Heating Food.

Foods are heated for a number of reasons, the main one being to inactivate pathogenic or spoilage microorganisms. It may also be important to inactivate enzymes.

The process of heating food also induces physical changes and chemical reactions, such as starch gelatinization, protein denaturation or browning, which in turn affects the sensory characteristics, such as colour, flavour and texture, either advantageously or adversely. For example, heating pretreatments are used in the production of evaporated milk to prevent gelation and age-thickening and for yoghurt manufacture to achieve the required final texture in the product. Heating processes may also change the nutritional value of the food (Lewis 1990).

Thermal processes vary considerably in their intensity, ranging from mild processes such as thermisation and pasteurisation through to more severe processes such as in-container sterilisation. The severity of the process affects both the shelf life and other quality characteristics.

Foods which are heat-treated can be either solid or liquid, so the mechanisms of conduction and convection may be involved. Solid foods are poor conductors of heat, having a low thermal conductivity, and convection is inherently a much quicker process than conduction.

All thermal processes involve three distinct periods: a heating period, holding period and cooling period. By far the easiest to deal with is the holding period, as this takes place at constant temperature (Lewis, 1990).

2.5 Soya beans Composition.

Soya beans varieties vary in colour, shape, size and composition of their seed. This subject has been reviewed in detail by Lewis (1990), including reference to seed parts, protein and non-protein, amino-acid composition, oil composition, mineral constituents and carbohydrates. The protein contents of a whole seed, approximately 40% (%N x 6.25) of the seed weight are the highest of any commercially important crop. The non-protein calculated as a percentage of total N ranges from a low of 2.9% to a high of 7.8%. The seed coat weight is approximately 8% of the seed weight, but varies with the size of the seed. The N content of the seed coat is about 1.5%.

Soya bean seeds have an ideal chemical constitution (Wilson, 1999) as given in Table 2.1 on the next page.

Table 2.1 Chemical composition of soybean seeds.

Constituent	% Content
Protein	30-40%
Lipid	16-20%
Moisture	13%
Ash	4-5%
Carbohydrate	31%
Sugars	2.5-8.2%
Oligosaccharides	0.15-5%
Raffinose	1-2%
Stachyose	1.4-4.1%
Starch and Fibre	Less than 1%
Other Constituents Phospholipids, trypsin inhibitors, phytactic acid, isoflavones, vitamins, saponions, other trace compounds	Negligible %

Source: Wilson, 1999.

2.6 Factors Affecting the Composition of Soya beans.

Soya bean is classified under the least storable group. Its seed is highly sensitive to mechanical and temperature injury. Bold seeds are more prone to loose longevity fast (Bhatia *ea al*, 1993).

Besides deterioration in seed germinability or longevity during storage, there may be reduction in seed viability due to field weathering (Bhatia *et al*, 1993). Small seeded genotypes are generally resistant to field weathering (Bhatia *et al*, 1993).

Soybeans seeds are sensitive to damage in threshing and other post-harvest operations. The seed should be well-dried after threshing with specific soya beans threshers which run at low cylinder speed. Seeds should be stored in moisture-prove bags (Bhatia et al, 1993).

2.7 Origin of Soya milk.

The oldest evidence of soya milk production is from China where a kitchen scene proving use of soya milk is incised on a stone slab dated around A.D. 25-220. It also appeared in a chapter called Four Taboos (Szu-Hui) in the A.D. 82 book called Lunheng by Wang Chong, possibly the first written record of soya milk. Evidence of soymilk is rare, prior to the 20th century and widespread usage before then is unlikely.

According to popular tradition in China, soya milk was developed by Liu An for medicinal purposes, although there is no historical evidence for this legend. This legend appeared in the late 15th century in Bencao Gangmu, where Li was attributed to the development of tofu with no mention of soya milk. Later writers in Asia and the West additionally attributed development of soya milk development to Liu An, assuming that he could not have made tofu without making soya milk.

The earliest European reference to soya milk was in 1665 by Domingo Fernandez de Navarrete and in 1790 by Juan de Loureiro, a Portuguese missionary who lived in Vietnam (Bernard, 1998). All these early references to soya milk only mentioned soya milk as part of the process for making tofu. Only 1866, Frenchman Paul Champion, who had traveled in China, mentioned that the Chinese drank hot soya milk for breakfast.

Soya milk was first referred to in the United States by Henry Trimble in 1896 in the American Journal of Pharmacy. In 1910, Li Yu-ying, a Chinese living in Paris founded the world's first soya milk factory. In 1917, the first commercial soya milk in the US was produced J.A. Chard Soya Products in New York.

The first calcium fortified soya milk was produced in 1931 by Madison Foods, Tennessee. This Madison Foods company was run by the faculty of the Madison College. In 1939 Miller started to produce canned liquid soya milk, which was called Soya La, because the dairy industries prevented Miller from calling the product "soya milk" (www.Soya.be, 2009).

2.8 Nutritional Benefits of Soya milk.

Soya beans is of major importance as a source of oil and relatively high quality protein for human and livestock feeding; it contains all the essential amino-acids required by man. The seed contain 16-74 percent of oil and 30 percent crude oil protein (Salunke, 1992).

As the taste of commercial soya milk improves more and more people are drinking it as enjoyment. But many people drink soya milk for the added health benefits (Fukushima, 1991).

2.8.1 Soya milk contains only Vegetables Proteins.

Vegetable proteins have the advantage in that they cause less loss of calcium through the kidneys. It is known that a diet rich in animal (and dairy protein) creates a higher risk for osteoporosis (www.soya.be, 2009).

2.8.2 Soya milk contains no Lactose.

About 75 percent of the world population cannot tolerate lactose. Some ethnic groups are more affected than others. For example 75 percent of Africans and 90 percent of Asians have lactose intolerance. As an additional benefit, soya milk contains the prebiotic sugars; stachyose and raffinose. These prebiotic sugars boost immunity and help decrease toxic substances in the body. (www.soya.be, 2009).

2.8.3 Fewer People are Allergic to Soya milk.

Only 0.5 percent of the children are allergic to soya milk, whereas 2.5 percent is allergic to cow's milk. (www.soya.be, 2009).

2.8.4: Soya milk Reduces Cholesterol.

The saturated fats in cow's milk are unhealthy and increase one's cholesterol. The protein in cow's milk has no benefits for the cholesterol. Soya protein can decrease cholesterol levels. The FDA (Food and Drug Administration of US) confirms that soya protein, as part of a diet, low in saturated fat and cholesterol may significantly reduce the risk of coronary heart. The FDA recommends to incorporate 25 grams of soya protein in all daily meals (www.soya.be, 2009)

2.8.5: Soya milk contains no Hormones.

Cow's milk contains natural hormones (from the cow) but also synthetic hormones, which can influence the good working of the body. The synthetic hormone rBGH (recombinant bovine growth hormone) increases milk production by as much as 20 percent. (www.soya.be, 2009).

2.8.6 Soya milk does not cause Insulin Dependent Diabetes

Although no general consensus exists among scientists, some studies have shown an association between drinking cow's milk in early life and the development of insulin dependent diabetes. This association does not exist with soya milk (www.soya.be, citing The American Journal of Clinical Nutrition, 2000).

2.8.7 Soymilk is Rich in Isoflavones.

The presence of isoflavones is the most important and unique benefit of soya milk. Each cup of soy milk contains about 20 mg isoflavones (mainly genistein and daidzein). Cow's milk does not contain isoflavones. Isoflavones have many health benefits including: reduction of cholesterol, easing of menopause symptoms, prevention of osteoporosis (studies have shown that a higher intake of milk and calcium from milk is associated with a higher risk of osteoporosis (www.soya.be, citing The American Journal of Clinical Nutrition, 2000)), and reduction of risk for certain cancers (prostate cancer and breast cancer). Incidents of these cancers are very low in countries with high intake of soya products, including soya milk. Isoflavones are also antioxidants which protect our cells and DNA against oxidation.

CHAPTER THREE

3.0 Materials and Methods

3.1 Materials

The soya beans used as the raw biomaterial for the preparation of the soya milk used for this project work was purchased at Bosso Market and transferred under ambient temperature in a polythene bag. The preparation of the soya milk and subsequent determination of the nutritional values was carried out in Food Science Laboratory in Federal University of Technology, Minna.

The Stage by Stage Extraction (Netherlands) Method was adopted for the extraction of soya milk. The quantity of soya beans weighing up to 550g of the purchased biomaterials was weighed and soaked for 18 hours in order to prepare soya milk.

3.1.1 Stage by Stage Extraction (Netherlands) Method

550g of soya beans was soaked in 1650ml of excess water for 18 hours. This is claimed to remove bitter taste. The soybean was washed with clean water and ground to flour in stages (Soya-Agrodok, 1986):

(i) Grind coarsely without adding water.

Repeat the grinding with 1100ml clean water. The mixture of the ground soya beans was well-stirred and sieved using muslin cloth. The cloth is used to squeeze or press out the milk much as possible.

(ii) The residue (solid remaining matter) was then finely ground, again with 1100ml clean water. The mass was stirred well and further separated and added to the first collection.

(iii) The resulting residue was ground to fineness again. First dry and then with the addition of 1100ml clean water. The mixture was stirred, sieved and milk recovered as usual. Recovered milk was added to rest. The total recovered was assumed to be 3300ml, with dry matter content. Milk was then subjected boiling at different time intervals to determine its effects on the nutritional parameters. Usually the milk is supposed to be boiled for 5 to15 min before being consumed in order to inactivate trypsin inhibitor (Churella, 1976).

3.1.2 The Cooking of the Extracted soya milk.

1) A sample (500ml) of the extracted soya milk was boiled in a beaker to determine the temperature at which soya milk boils. With the use of a thermometer, the boiling point (bp) of the soya milk was measured once it began to boil. It was discovered that soya milk boils at 100°C at ambient atmospheric conditions.
2) The remaining quantity of the extracted soya milk apart from the control sample was put in an Aluminum pot and cooked until it began to boil. The boiling point (bp) was verified to be at 100°C with the use of a thermometer. As soon as this was established, the timing of the cooking began.
3) At 15 minutes from the time the soya milk began to boil, a sample A was collected from the boiling soya milk and reserved in a plastic bottle. The boiling soya milk was allowed to cook for another 15 minutes, bringing the time to 30 minutes and then another sample, B was collected for preservation. The last sample of the experiment, C was collected after another 15 minutes of cooking from 30 minutes; bringing the total time of cooking to 45 minutes. The samples:

Control, A, B and C were further processed with other chemicals for proximate analysis and determination of minerals of the soya milk as shown below.

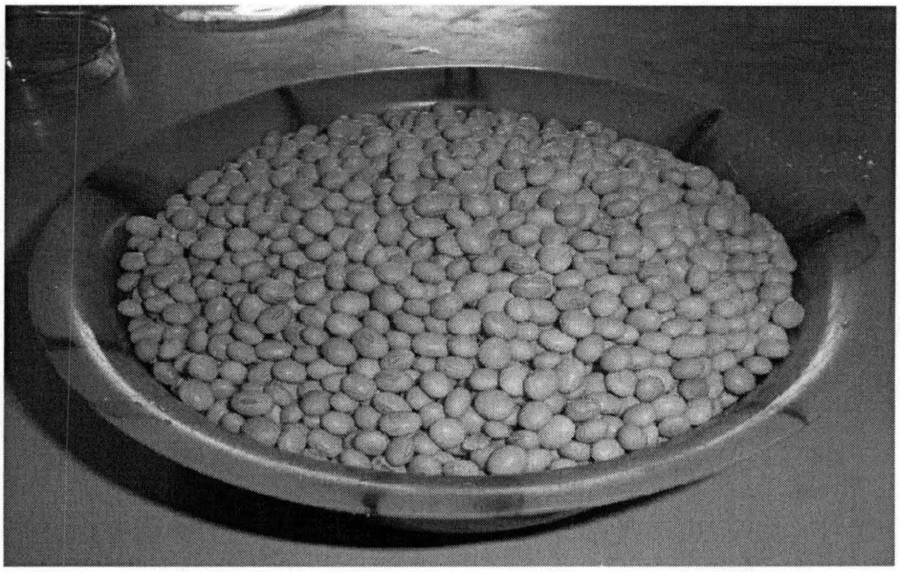

Plate 1-Unsoaked Soya beans

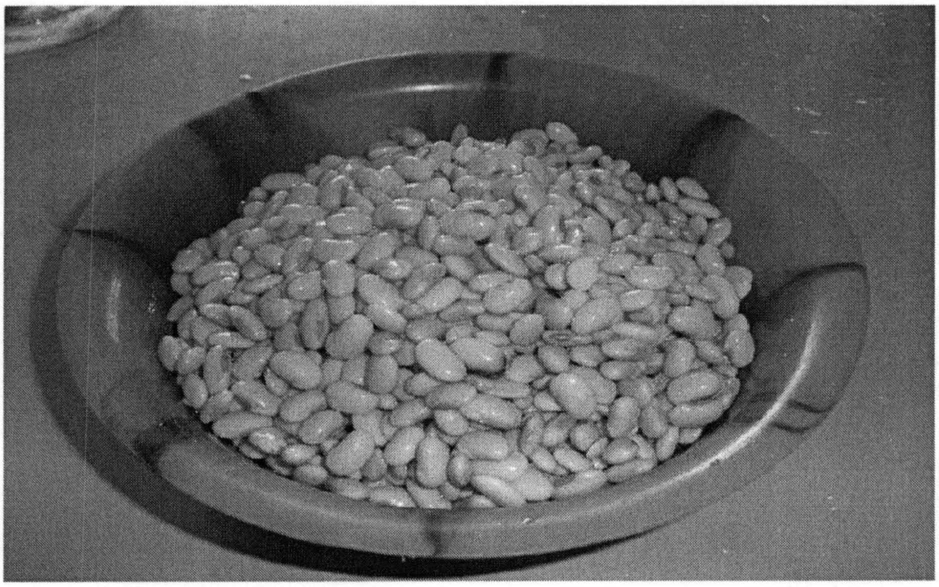

Plate 2-Soaked Soya beans

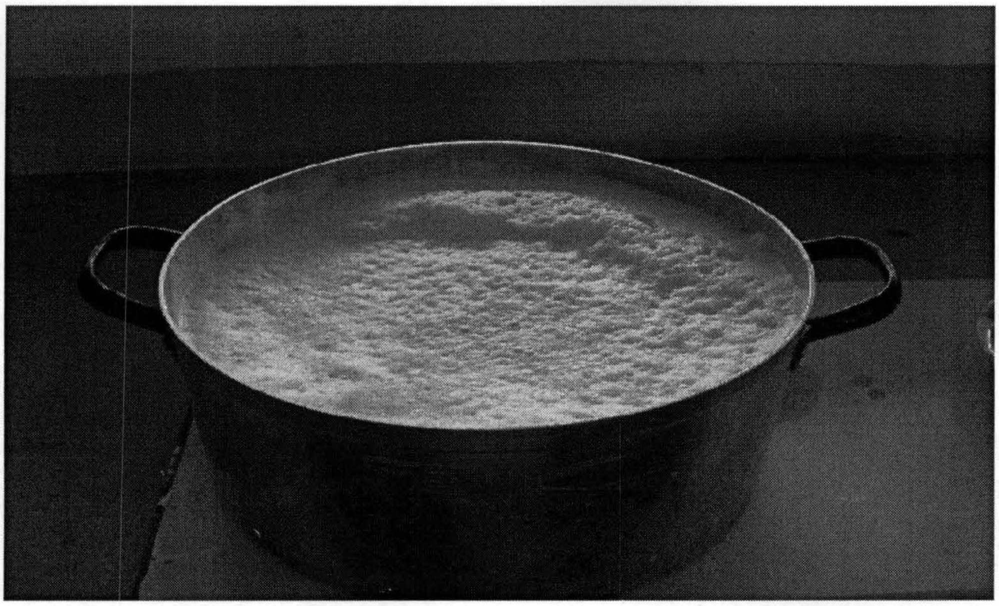

Plate 3-Extracted soya milk

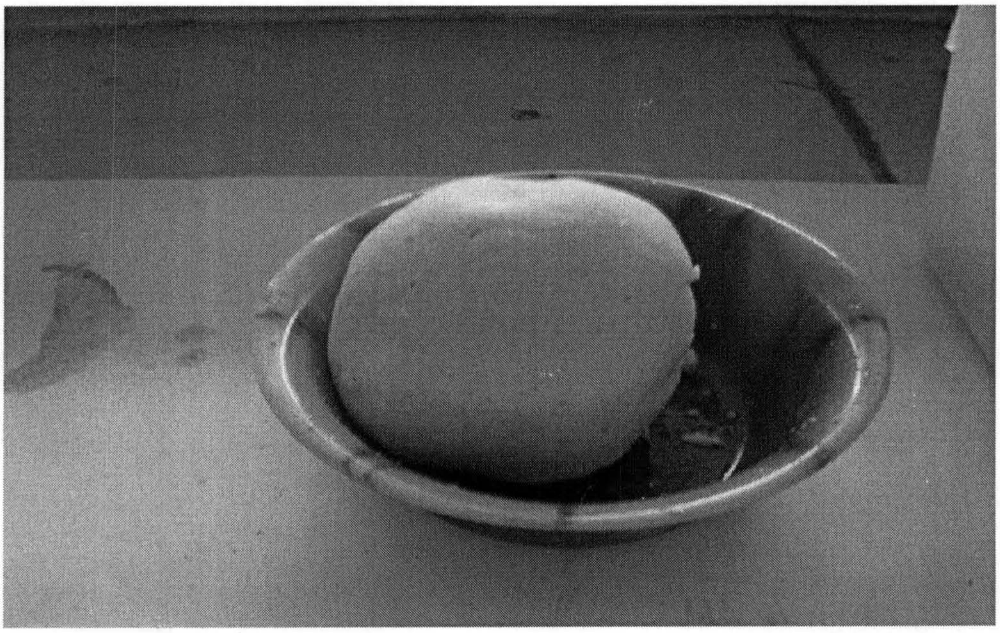

Plate 4-Okara (chaff after the extraction of soya milk)

3.2 Reagents and Instruments

3.2.1 Reagents

Tetraoxosulphate (iv) acid (H_2SO_4)

Sodium Hydroxide ($NaOH$)

Calcium Chloride ($CaCl_2$)

Calcium Hydroxide ($Ca(OH)_2$

Ammonium Chloride Solution (NH_4Cl)

Petroleum ether

Copper Sulphate ($CuSO_4$)

Mixul indicator (Methyl Orange and Bromo cresolgrean)

Boric Acid

Hydrogen Chloride (HCl)

3.2.2 Instruments/Apparatuses

Crucibles

Furnace

Filter Papers

Water bath

Petri dishes

Desiccators

Weigh balance (with sensitivity of 300µg)

Bunsen burner

Oven

Thimbles

Pipette

Conical flasks

Muffle furnace

Soxhlet Apparatus

Heating Mantle

Thong

Spatula

Markhamp Apparatus (Nitrogen Distillation Unit)

Kjeldatherm Unit (digestion block)

3.3 Methods (Analysis of Chemical Properties of Soymilk)

3.3.1 Determination of Moisture

Moisture content was determined by an air-oven method as describe in the AOAC (1995). Quantities of the test samples enough to fill the petri dishes were weighed in triplicate into already weighed and cooled petri dishes. These were transfered into an oven at 105±2^{0}C for 3 hours. The samples were covered in the oven, transferred into the desiccators and allowed to cool for 15 minutes before weighing. The dishes were returned to the oven to reweigh until constant weights were obtained. The loss in weight was regarded as moisture content.

$$\text{Percentage Moisture} = \frac{\text{Weight loss}}{\text{weight of sample}} \times 100$$

3.3.2 Determination of Protein

The micro Kjeldahl method as described by AOAC (1995) was used. Two grammes (2ml ≡ 2g) of samples were weighed into 500ml Kjeldahl flask and two tablets of selenium were added. To this 20ml concentrated sulphuric acid was added down the side of the flask, stoppered and swirled. The flask and its content heated gently in a fume cupboard in an inclined position, and swirl occasionally until the liquid was clear and free from black or brown colour. They were allowed to cool and diluted with distilled water to make it 100ml. Twenty five milliliters (25ml) of boric acid was put into 250ml collection flask and placed under the collection spigot of the distillation apparatus. The digested samples (10ml) was dissolved with 10ml of 40% sodium hydroxide solution and placed under the stoppered portion of the condenser. The solution was allowed to distill for about 7 minutes or when the volume of ammonia solution collected in boric acid in the receiver flask was 50ml and when the purple solution had turned green an indication of an alkaline gas. The distillate was titrated against 0.1N hydrochloric acid to a grayish blue colour.

A blank titration was carried out. Percentage protein was calculated as:

$$\text{Percentage Nitrogen} = \frac{T.V \times M.A \times 0.014 \times 10}{W} \times \frac{100}{1}$$

Where, *T.V*= Titre value

M.A=Molar Acid

W=Weight of sample

Percentage Protein = (N × 6.25)

3.3.3 Determination of Fat

The soxhlet solvent extraction method outlined in AOAC (1995) was used in determining fat content of samples. Two grammes (2g) of the samples were weighed and the weight of the flat bottom flask was taken with the extractor mounted on it. The thimble was held half way into the extractor and the weighed sample was carefully transferred into the thimble. Extraction was carried out using petroleum ether (boiling point 40-60°C), the thimble was plugged with cotton wool was fully dropped into the extractor and the extraction was continuously for 8 hours.

At the completion of extraction, the solvent was removed by evaporation on the water bath and the remaining part in the flask dried to 80°C for 30 minutes in the air oven to dry the solvent and cooled in a desiccators. The flask was reweighed and percentage fat calculated as:

$$\text{Percentage Fat} = \frac{Weight\ of\ Extracted\ Fat}{Weight\ of\ Sample} \times 100$$

3.3.4 Determination of Ash

The procedure outlined in AOAC (1995) was used in determining the ash content of samples. The weight of the crucible dish was taken. Two grammes (2g) of samples were added to each of the crucible.

The dish and content was placed on the furnace rack and the furnace temperature was set to 500°C for 16 hours until the sample was completely ashed. The ash in the crucible dishes was removed and kept in desiccators to cool. The cooled ash were reweighed and percentage ash was calculated as:

$$\text{Percentage Ash} = \frac{\text{Total Weight of extracted Ash}}{Weight\ of\ Sample} \times 100$$

3.3.5 Determination of Carbohydrate

The procedure outlined in the AOAC (1995) was used in determining the carbohydrate content. This was calculated by difference: Fat, Protein and Ash contents were subtracted from 100 as;

Carbohydrate Content = $100 - (\%Protein + \%Fat + \%Ash)$.

3.3.6 Determination of Energy Value

The food energy value of the samples were determined according to the method described by Osbone and Voogt (1978).

The energy value(kcal/100g) = $(4 \times Protein) + (9 \times Fat) + (4 \times Carbohydrates)$.

3.4 Determination of Mineral Element

The mineral or inorganic salts regulate the metabolism of the body and are essential constituents of many vital substances within the body. The dietary minerals can be classified into macro and micro minerals. The macro minerals are minerals required in sufficient quantity – calcium, chloride, magnesium, phosphorus, potassium, sodium and surphur.

The micro or trace minerals are required in a little quantity - aluminium, arsenic, cobalt, chromium, copper, fluorine, iodine, iron, manganese, molybdenium, nickel, selenium, silicon, tin, vanadium and zinc.

3.4.1 Determination of Potassium and Sodium using Flame Photometer

Potassium and Sodium are usually determined using flame photometer. This instrument is an atomic emission spectrophotometer. It is an analytical device which utilizes the basic principle of atomic spectrometry for qualitative determination.

3.4.1.1 Preparation of working Standards

$$1000mg/l = \frac{KCl}{K} g \text{ or } \frac{NaCl}{Na} g$$

$$= \frac{74.5}{39} g \text{ or } \frac{58.5}{23} g$$

= 1.910g/l K or 2.543g/l Na

The calculated masses were dissolved in separate flask and made up to one litre to give 100mg/ml stock solution of Sodium and Potassium. The solutions were further diluted 100mg/ml by pipetting 10ml stock solution and made it up to 100ml with distilled water. The working standards of 0, 20, 40, 60 80 and 100mg/ml were prepared for Na from 100mg/ml and the working standard of 0, 10, 20 and 50mg/ml were prepared for K from 100mg/ml.

3.4.1.2 Method of dilution

$$C_1V_1 = C_2V_2$$

Where:

C_1 = Concentration where dilution is required

V_1 = Volume required to make new concentration

C_2 = the new concentration required

V_2 = the new volume required.

The dilution ratio is a general application (Ibitoye, 1998).

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1Data Presentation and Analysis

4.1.1 Discussion of the Proximate Composition of Soya milk

The proximate composition of soya milk is as presented in table 4.1. The samples (A, B, C) were all produced in triplicates and the data analysed appropriately.

Name of Sample	Treated Time (TT) Min	Moisture Content (MC), %	Ash %	Crude Protein (CP) %	Lipids %	Carbohydrate (CHO)%	Energy Value kcal/100 g
Control	0	96.62	3.83	2.38	23.75	70.04	502.91
A	15	93.45	4.17	3.72	12.00	80.11	443.32
B	30	92.29	5.83	4.23	6.48	83.46	409.08
C	45	90.36	6.00	4.74	6.17	83.09	406.00

Table 4.1 The composition of soya milk as determined at different intervals of time.

The results shown in Table 4.1 above clearly shows the variation that occurs in the nutritional parameters of soya milk as it is prepared over a period time. The percentage moisture content (%MC) decreased with time; this perhaps is due to the evaporation of water as soya milk is cooked. The values vary between 93.45%, 92.29% and 90.36% for 15 minutes (A), 30 minutes (B) and 45 minutes (C) respectively. The moisture content was determined by air-oven method.

Figure 4.1 below shows a graphical representation of the variation of percentage moisture content (% MC) in soya milk as it was cooked over a time period. As can be observed, the slope of the graph is negative which shows that there is a decline in the moisture content of soya milk as it is prepared.

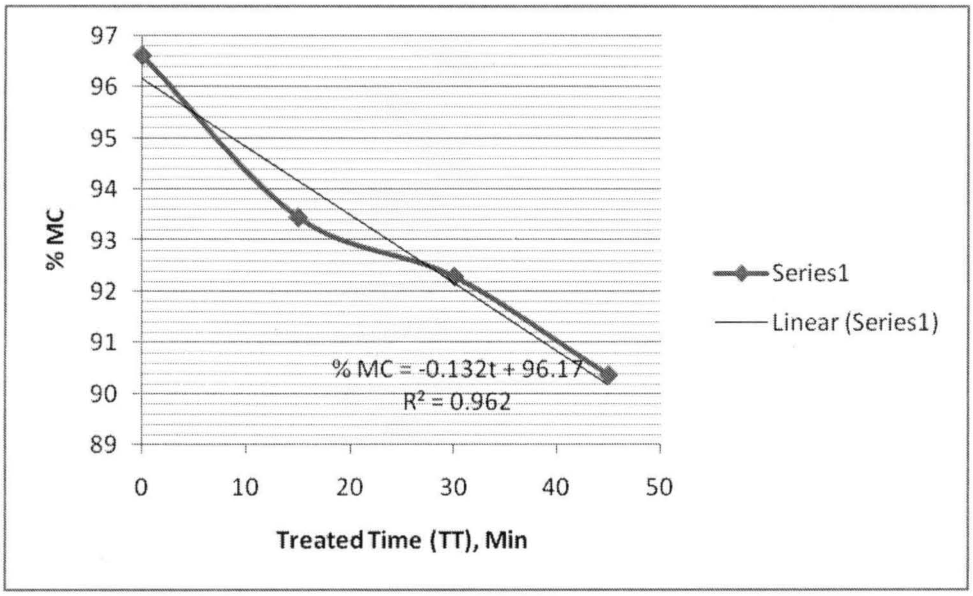

Fig 4.1: Graphical representation of %Moisture Content of soya milk cooked for different time intervals.

The results obtained for %Ash as shown in Table 4.1, in the cause of this research include: 4.17, 5.83, and 6.0% for soya milk cooked for 15 min (A), 30 min (B), 45 min (C) respectively. It can be observed that there is an increase in %Ash in soya milk as it is prepared within the time limit. This increase in the %Ash of the soya milk is more visible as expressed in the graphical representation in Fig. 4.2 below. It can be observed from the graph that after 30 min of cooking the amount of %Ash became constant in the milk samples. The presence of ash in soya milk indicates that minerals are available in it.

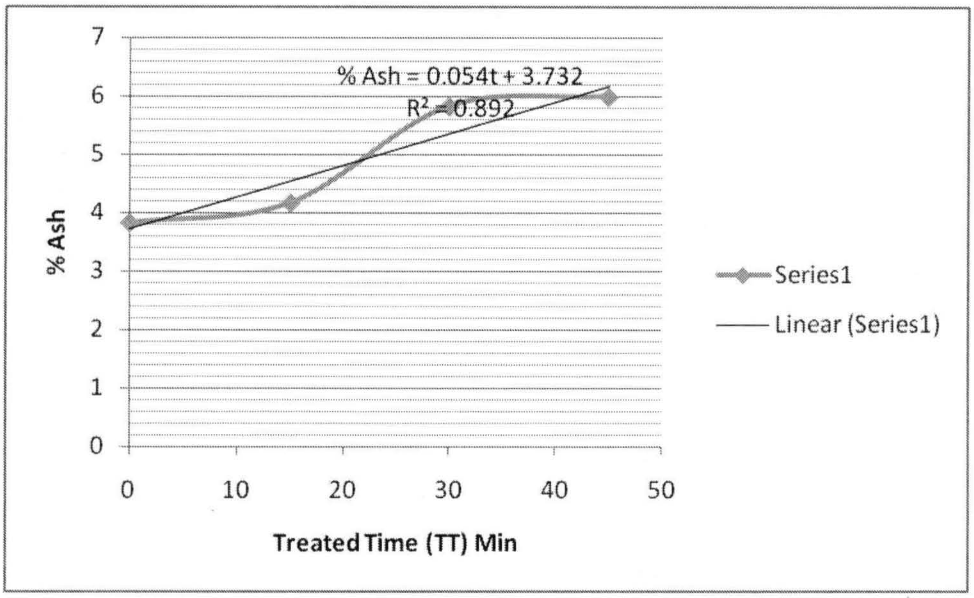

Fig 4.2: Graphical representation of %Ash in soya milk cooked for different time intervals.

Percentage Crude Protein has the following results for cooking soya milk for 15 min (A), 30 min (B) and 45 min (C): 3.72, 4.23 and 4.74% respectively. These results show an increase in % Crude Protein as it was cooked for the time under consideration. The increase in the % Crude Protein is as result of decrease in digestibility of soy protein as it is exposed to excessive heat treatment. Soy protein also denatures when exposed to heat treatment which explains why there is an increase in the Crude Protein in the soya milk samples prepared over different period of time.

The graphical representation of % Crude Protein as shown in Fig. 4.3, further illustrate the increase in the protein content in the soya milk cooked over time intervals.

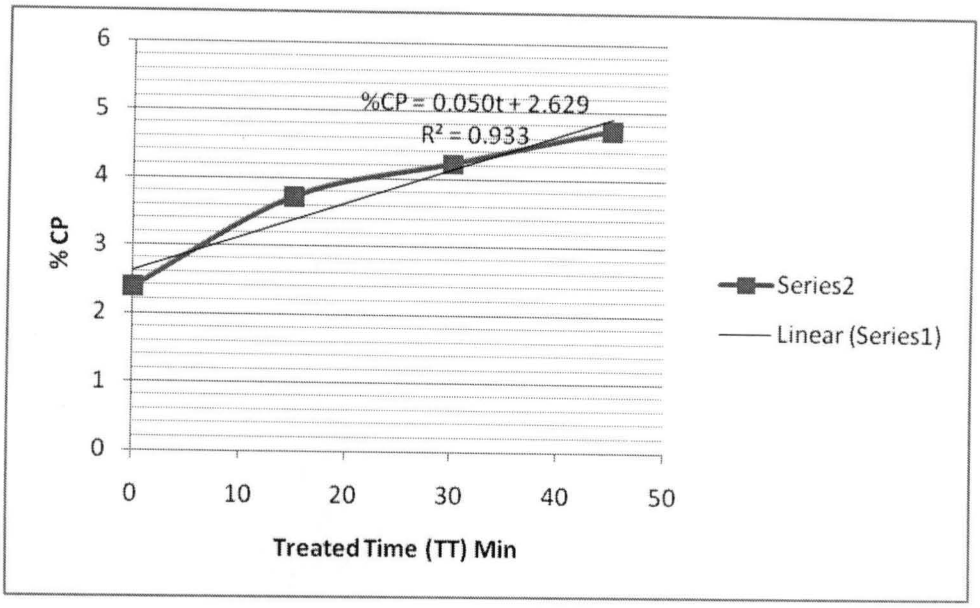

Fig 4.3: Graphical representation of % Crude Protein in soya milk.

There is a remarkable decrease in % lipid as soya milk is cooked at its boiling temperature. This decrease is visible from the beginning of cooking to 30 min after the soya milk has started boiling at 100°C. In this research, % lipid content in the soya milk decreased from 12% to 6% between 10 min and 30 min of cooking. This is as a result of the removal of a film which is rich in protein and oil called *yuba*. Lipids seep up and it is removed as *yuba* as the soya milk is boiled over the period of time. After 30 min of boiling, the % Lipids is considerably constant as it is further illustrated in the graphical representation in Fig.4.4 below.

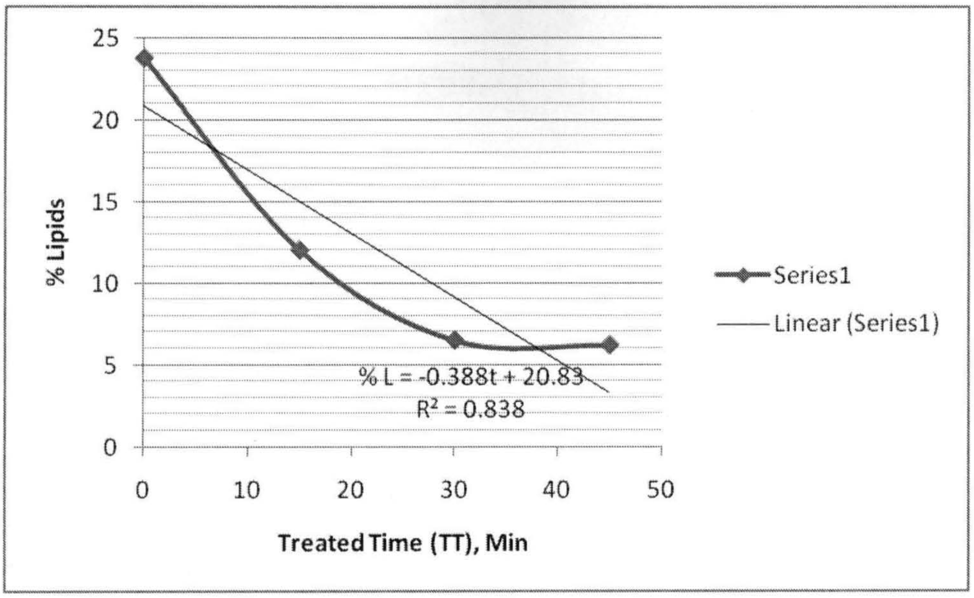

Fig 4.4: Graphical representation of % Lipids in soya milk cooked for different time intervals.

The %Carbohydrates in the soya milk was also affected by the cooking over the period of time. The values of carbohydrates (Table 4.1) obtained during the research are as follows: 80.11, 83.46 and 83.09% for 10 minutes, 15 minutes and 45 minutes of cooking respectively. The gradient of the graph of these values as expressed in Fig 4.5 shows a positive increase in carbohydrates at first and then becomes relatively constant.

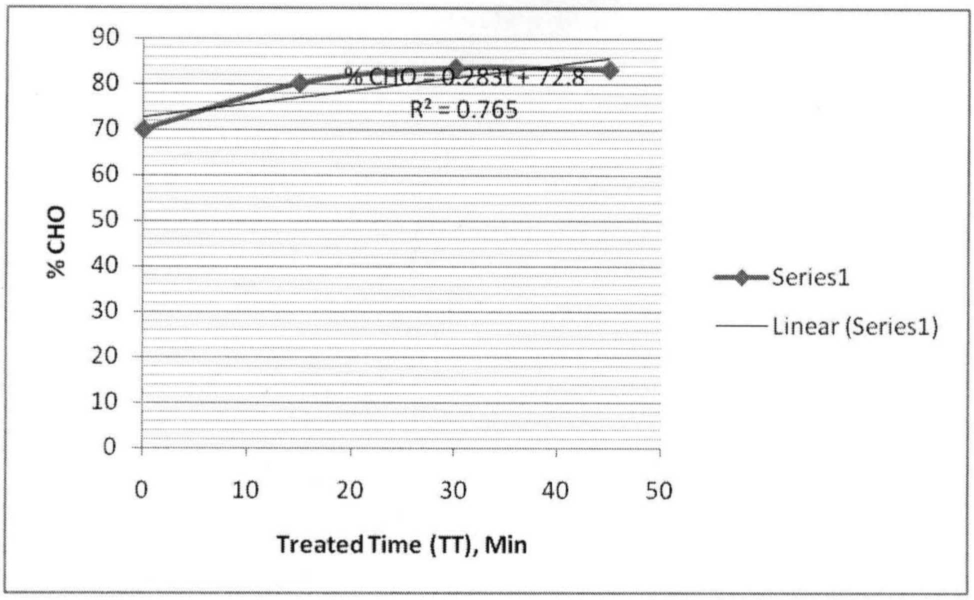

Fig 4.5: Graphical representation of %Carbohydrates in soya milk cooked for different time intervals.

4.1.2 Discussion of the Mineral Contents of Soya milk

The presence of ash in the soya milk produced gives an indication of the presence of inorganic minerals in it. Some of the minerals present in soya milk were also determined and analysed to consider the effect of cooking time on them. These minerals considered in the research are presented in a tabular form in Table 4.2 below.

Name of Sample	Treated Time (TT) Min	Sodium, Na(ppm)	Potassium,K(ppm)	Calcium, Ca(ppm)	Magnesium Mg(ppm)
Control	0	18.0	33.0	79.5	28.0
A	15	27.0	41.0	109.5	32.2
B	30	23.0	60.0	81.5	31.0
C	45	27.0	62.0	90.0	35.5

Table 4.2 Some minerals present in Soya milk prepared over a period of time.

Sodium present in the soya milk (Table 4.2) shows drastic changes in values from control (0 min) to 30 minutes (B) of cooking. There is a positive increase in the values of sodium from the beginning (Control) to 15 minutes (A) and then a decrease in the values is observed from this time to 30 minutes (B) of cooking. The soya milk sample boiling at 100°C after 15 minutes (A) of cooking has 27mg/100ml Sodium present in it. There is a decrease from 27mg/100ml (ppm) for 15 min (A) to 23mg/100ml for 30 minutes (B) of cooking the soya milk. But after cooking the soya milk for another 15 min from 30 minutes; bringing the total time to 45 minutes (C), the soya milk shows 27mg/100ml of Sodium again. These results are expressed in a graphical method as shown in Fig.4.6 below. On a general note, there is an increase in the values of Sodium in the soya milk as it is illustrated by the linear (series1) representing the line of best fit in the graph.

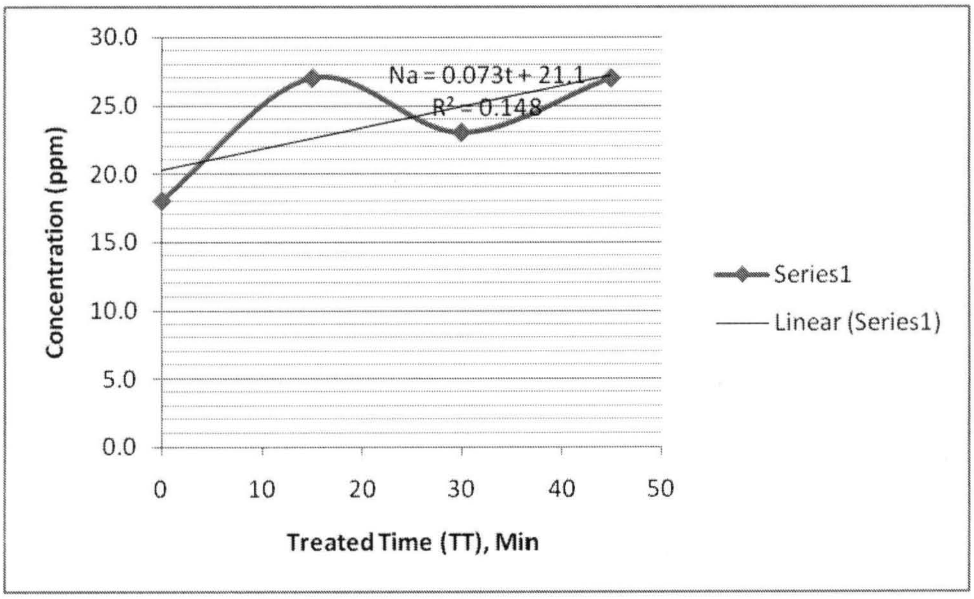

Fig 4.6: The graphical representation of the changes in Sodium in the soya milk cooked over a period of time.

The Potassium and Magnesium present in the soya milk both shows (Table 4.2) positive increase in there values. The values of Potassium increased from 41 mg/100ml (A) to 62 mg/100ml (C) in the soya milk, while on the other hand, the values of Magnesium increased from 32.2 mg/100ml (A) to 35.5 mg/100ml (C) in the soya milk as it was cooked at 100°C. The increase in Potassium was more pronounced as the difference in the value for A (15 min) and C (45 min) is 21 mg/100ml when compared with only 3.3 mg/100ml of Magnesium within the same range of cooking time. The graphical representation of the increase in both Potassium and Magnesium in the soya milk samples are shown in Fig. 4.7 and Fig. 4.8 respectively.

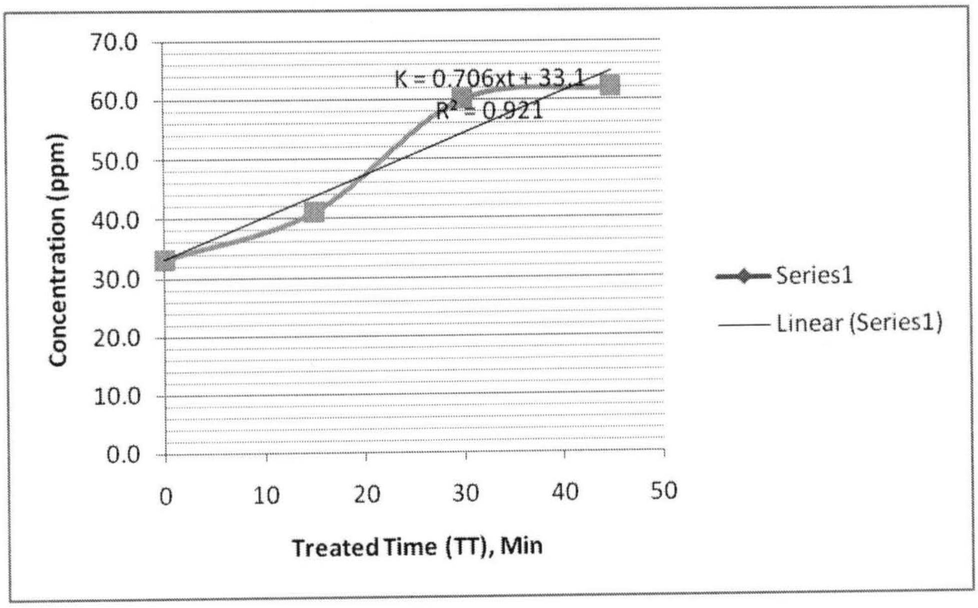

Fig 4.7: The graphical representation of the changes in Potassium in the soya milk cooked over a period of time.

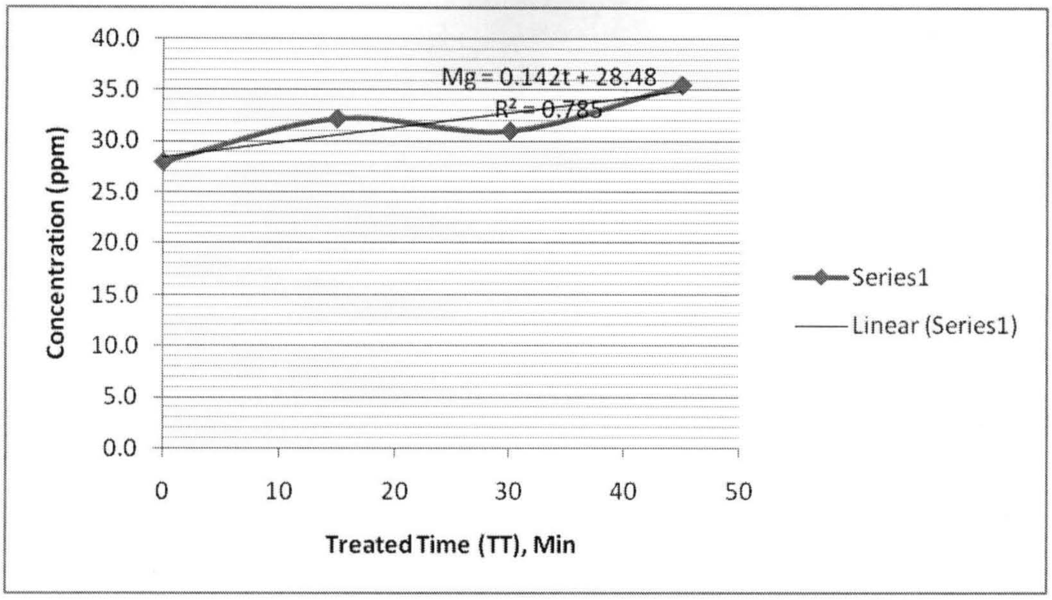

Fig 4.8: The graphical representation of the changes in Magnesium in the soya milk cooked over a period of time.

The last but not the least of the minerals considered in this research is Calcium. Calcium is particularly important in the body for the building of bones and other skeletal structures. On like Potassium and Magnesium, Calcium showed a decrease and then an increase in the values as it was cooked from the time soya milk started to boil at 100°C. The following values were obtained for A (15 min), B (30 min) and C (45 min): 109.5, 81.5 and 90.0 mg/100ml respectively. Usually soya milk is fortified with Calcium to meet the required intake values recommended for the body. Below (Fig. 4.9) is the graphical representation of the changes that occurred in the Calcium Content in the soya milk.

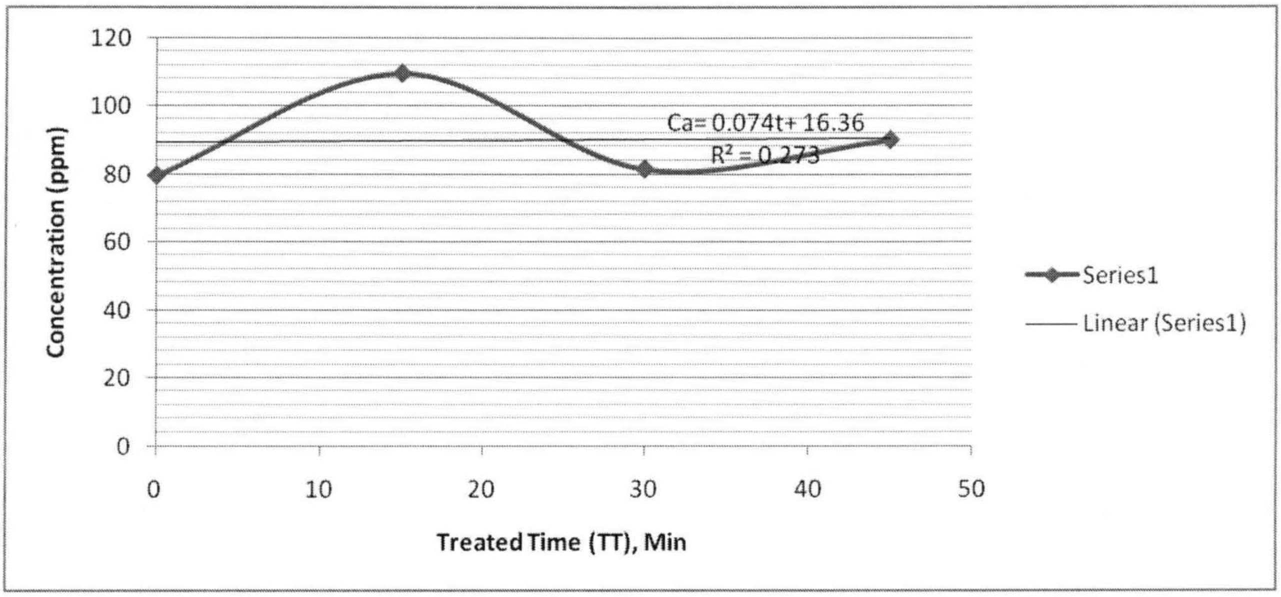

Figure 4.9: The graphical representation of the changes in calcium in the soya milk cooked over a period of time.

CHAPTER FIVE

5.0 CONCLUSON AND RECOMMENDATIONS

5.1Conclusion

In the course of this research, it was discovered that each of the nutritional parameters treated varied in various degree as the soya milk was prepared within the time limit (15-45 minutes).

The result (Table 4.1) shows that, soya milk cooked for 45 minutes has higher percentage of ash 6.0%, crude protein 4.74% and carbohydrates 83.09%. The ash increased during cooking from 4.17%, 5.83% to 6.0% for 15, 30 and 45 minutes respectively. The crude protein increased from 3.72%, 4.23% to 4.74% for 15, 30 and 45 minutes respectively. In the case of carbohydrates, it increased from 80.11% and ended up at value of 83.09% for the time under consideration.

The reverse was the case for percentage lipids and the energy values of the soya milk. The lipids reduced from12.0% to 6.17% and the energy value was reduced from 443.32 kcal/100g at 15 minutes of cooking to 406.0 kcal/100g at 45 minutes.

The minerals were also observed to have some changes as the soymilk was cooked between 15 minutes and 45 minutes. Calcium decreased in its value from 109.5ppm to 90.0ppm while sodium had a relatively constant value but with a fluctuation. The remaining minerals under consideration were observed to increase in value in the following order: Potassium increased from 41.0mg/100ml to 62.0 mg/100ml and Magnesium increased from 32.2ppm to 35.5ppm for 15minutes and 45 minutes respectively.

Soya milk cooked for 30 minutes have relative values that are on average when compared with the order values for the other time under consideration. The approximate time for cooking of soya milk which may be safe and acceptable should be between the range of 20 minutes and 30 minutes. This will be safe for both infants who need much protein for their growth and adults who do not need much fat in their diet.

5.2 Recommendations

Based on the research work done during this project, the following recommendations are made.

1. High price of imported milk and milk products coupled with poor milk production in Nigeria have made consumers more ready to accept milk prepared from soya beans and other plant sources hence it is suggested that milk from other sources should be encouraged so as to solve the problem of protein-calorie malnutrition in Nigeria.
2. Sensory evaluation of Soya milk should be carried out to ascertain its acceptability for making various confectionaries.
3. It is recommended that awareness should be made concerning the effects of cooking time on the nutritional parameters of soya milk so as to prevent adverse effect on these nutrients which are most needed in the body.

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Appendix I

Determination of Moisture Content (%MC)

Controls (Before Boiling)	Wt of Empty Pd W1 (g)	Wt of Pd + Wet Sample W2(g)	Wt of Pd + Dry sample W3 (g)	% Moisture Content	Average % moisture Content
1	29.93	86.59	31.76	96.77	
2	31.76	88.57	33.61	96.74	96.62
3	30.05	85.12	32.05	96.37	

A (15 min)	Wt of Empty Pd W1 (g)	Wt of Pd + Wet Sample W2(g)	Wt of Pd + Dry sample W3 (g)	% Moisture Content	Average % moisture Content
1	31.86	82.22	35.12	93.33	
2	26.31	76.27	29.41	93.80	93.45
3	29.82	80.63	33.25	93.21	

B (30 min)	Wt of Empty Pd W1 (g)	Wt of Pd + Wet Sample W2(g)	Wt of Pd + Dry sample W3 (g)	% Moisture Content	Average % moisture Content
1	41.47	100.78	45.98	92.40	
2	32.86	92.06	36.76	92.34	92.29
3	21.76	81.51	26.46	92.29	

C (45 min)	Wt of Empty Pd W1 (g)	Wt of Pd + Wet Sample W2(g)	Wt of Pd + Dry sample W3 (g)	% Moisture Content	Average % moisture Content
1	29.91	88.09	35.46	90.46	
2	33.63	91.59	39.30	90.23	90.36
3	21.37	79.93	27.00	90.39	

Appendix II

Determination of Percentage Lipids (% L)

Control (before boiling)	Wt of Empty Filter Paper (Fp) W1	Wt of Fp + Sample W2(g)	Wt of Fp +Extraction W3(g)	Percentage Lipids (%)	Average (%) Lipids
1	0.68	2.28	1.90	23.75	
2	0.72	2.72	2.26	23.00	23.75
3	0.53	2.53	2.04	24.50	

A (15 min)	Wt of Empty Filter Paper (Fp) W1	Wt of Fp + Sample W2(g)	Wt of Fp +Extraction W3(g)	Percentage Lipids (%)	Average (%) Lipids
1	0.71	2.71	2.47	12.00	
2	0.61	2.61	2.36	12.50	12.00
3	0.70	2.70	2.47	11.50	

B (30 min)	Wt of Empty Filter Paper (Fp) W1	Wt of Fp + Sample W2(g)	Wt of Fp +Extraction W3(g)	Percentage Lipids (%)	Average (%) Lipids
1	0.70	2.70	2.580	6.00	
2	0.63	2.63	2.480	7.50	6.48
3	0.59	2.59	2.471	6.95	

C (45 min)	Wt of Empty Filter Paper (Fp) W1	Wt of Fp + Sample W2(g)	Wt of Fp +Extraction W3(g)	Percentage Lipids (%)	Average (%) Lipids
1	0.69	2.69	2.57	6.00	
2	0.73	2.73	2.60	6.50	6.17
3	0.66	2.66	2.54	6.00	

Appendix III

Determination of Percentage Crude Protein (% CP)

Control (Before Boiling)	Sample Weight (g)	1st Titre Value (ml)	2nd Titre Value (ml)	Average Titre Value (ml)	% Nitrogen	% Crude Protein	Average % Protien
1	2.00	0.56	0.54	0.55	0.385	2.41	
2	2.00	0.53	0.54	0.54	0.378	2.36	2.38
3	2.00	0.56	0.52	0.54	0.378	2.36	

A (15 min)	Sample Weight (g)	1st Titre Value (ml)	2nd Titre Value (ml)	Average Titre Value (ml)	% Nitrogen	% Crude Protein	Average % Protien
1	2.00	0.90	0.80	0.85	0.595	3.72	
2	2.00	0.80	0.80	0.80	0.600	3.50	3.72
3	2.00	0.90	0.90	0.90	0.630	3.94	

B (30 min)	Sample Weight (g)	1st Titre Value (ml)	2nd Titre Value (ml)	Average Titre Value (ml)	% Nitrogen	% Crude Protein	Average % Protien
1	2.00	1.00	0.90	0.95	0.665	4.16	
2	2.00	0.90	1.00	0.95	0.665	4.16	4.23
3	2.00	1.00	1.00	1.00	0.700	4.38	

C (45 min)	Sample Weight (g)	1st Titre Value (ml)	2nd Titre Value (ml)	Average Titre Value (ml)	% Nitrogen	% Crude Protein	Average % Protien
1	2.00	1.10	1.10	1.10	0.77	4.81	
2	2.00	1.00	1.10	1.05	0.735	4.59	4.74
3	2.00	1.10	1.10	1.10	0.77	4.81	

Appendix IV

Determination of Percentage Ash (%Ash)

Control (Before Boiling)	Wt of empty Crucible, W1(g)	Wt of Crucible + Sample before Ashing, W2(g)	Wt of Crucible + sample after Ashing, W3(g)	% Ash Content, %	Average % Ash Content, %
1	32.39	34.39	32.47	4.00	
2	29.41	31.39	29.48	3.5	3.83
3	30.62	32.62	30.70	4.00	

A (15 min)	Wt of empty Crucible, W1(g)	Wt of Crucible + Sample before Ashing, W2(g)	Wt of Crucible + sample after Ashing, W3(g)	% Ash Content, %	Average % Ash Content, %
1	31.29	33.29	31.37	4.00	
2	21.63	23.63	21.71	4.00	4.17
3	29.71	31.71	29.80	4.50	

C (45 min)	Wt of empty Crucible, W1(g)	Wt of Crucible + Sample before Ashing, W2(g)	Wt of Crucible + sample after Ashing, W3(g)	% Ash Content, %	Average % Ash Content, %
1	27.45	29.45	27.57	6.00	
2	34.31	36.31	34.42	5.50	6.00
3	31.43	33.43	31.56	6.50	

Appendix V

Determination of Percentage Carbohydrates (% CHO)

Control (Before Boiling)	% Protein	% Lipids	% Ash	% Carbohydrate
	2.38	23.75	3.83	70.04

A (15 min)	% Protein	% Lipids	% Ash	% Carbohydrate
	3.72	12.00	4.17	80.11

B (30 min)	% Protein	% Lipids	% Ash	% Carbohydrate
	4.23	6.48	5.83	83.46

C (45 min)	% Protein	% Lipids	% Ash	% Carbohydrate
	4.74	6.17	6.00	83.09

Appendix VI

List of plates for determining the Nutritional parameters of Soyamilk

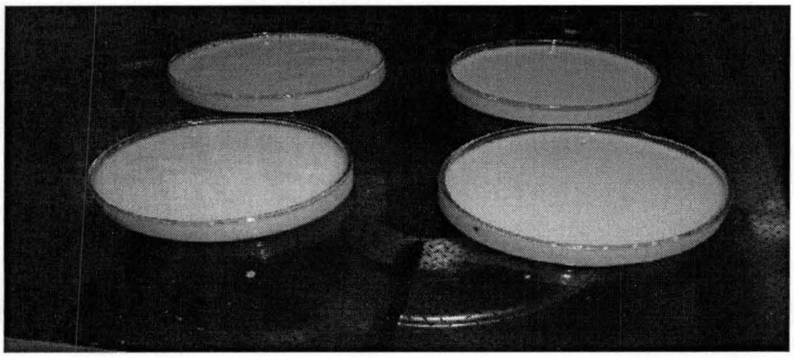

Plate 5- Soyamilk samples for determination Moisture Content

Plate 6- Soymilk samples in Air-Oven for drying

Plate 7-Dried soymilk for moisture Content determination

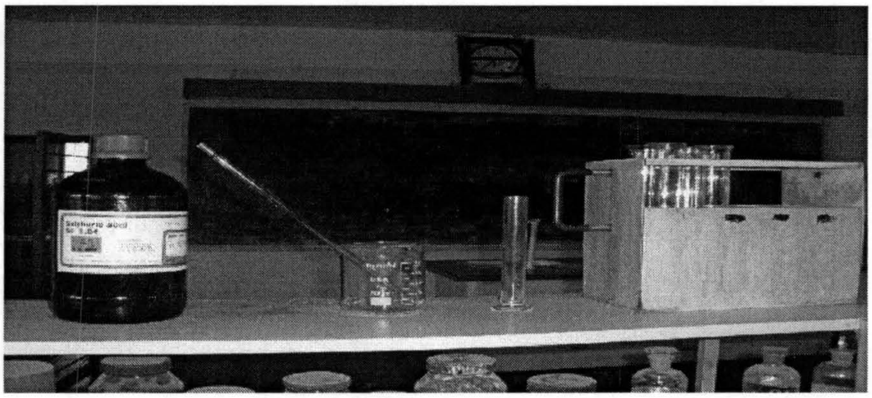

Plate 8-Soymilk samples prepared for Crude Protein with some apparatus and reagent used for the experiment.

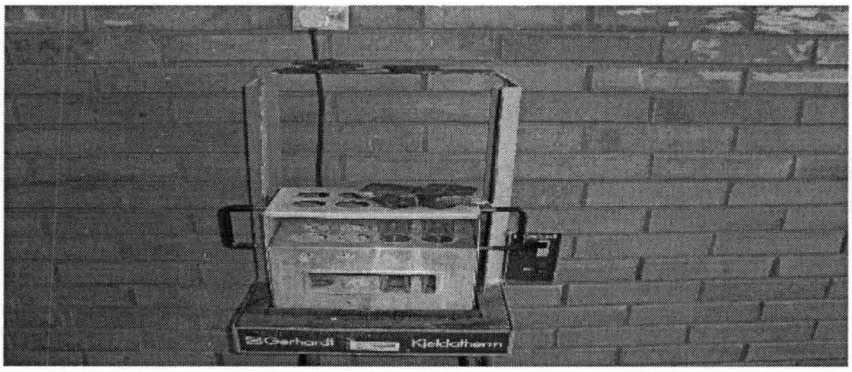

Plate 9- Digestion of samples for determination of Protein

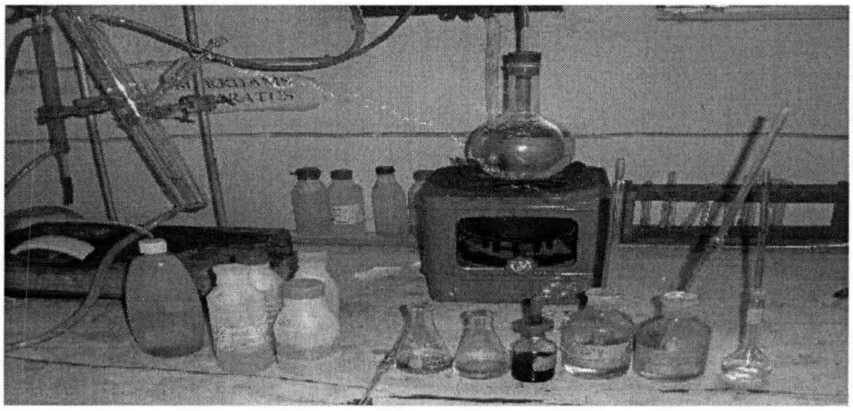

Plate 10-Titration of samples for determination of protein

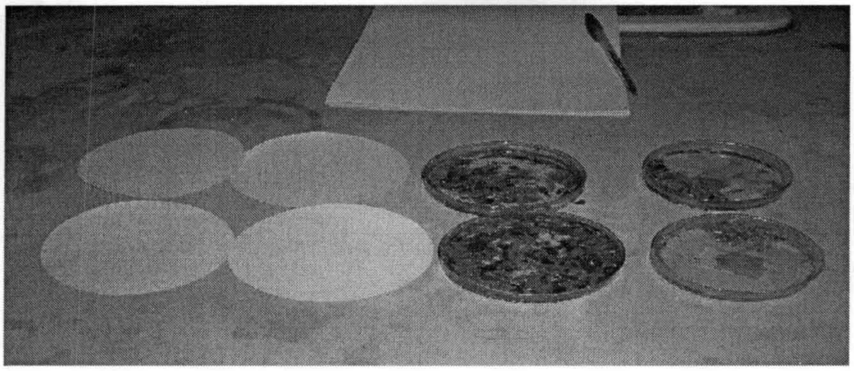

Plate 11- Dry samples of Soyamilk ready for use in the extraction of Lipid.

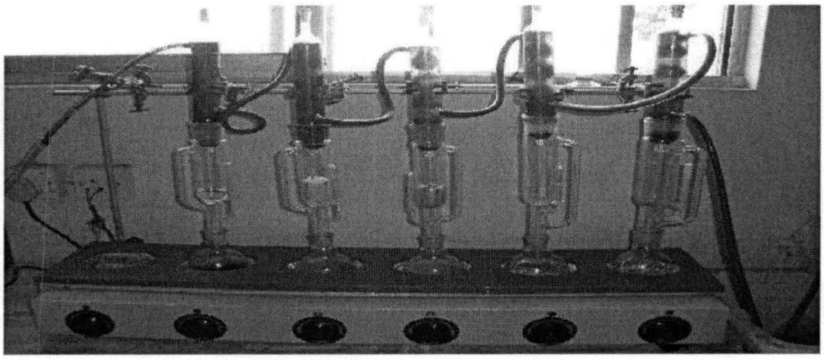

Plate 12-Extraction of Lipid from soyamilk using the Soxhlet Extractor

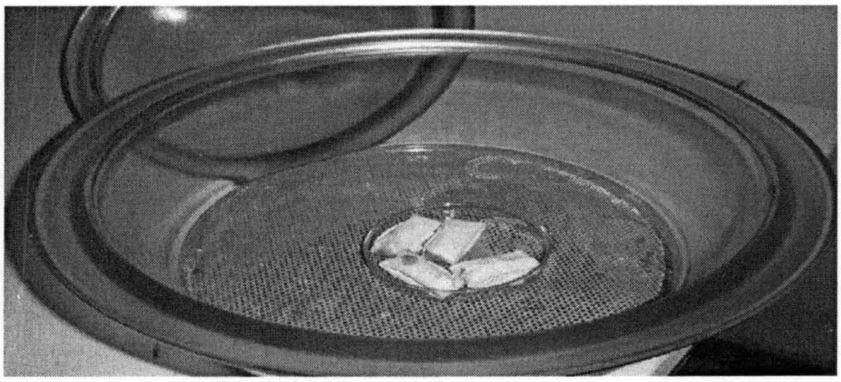

Plate 13-Extracted samples of soyamilk in desiccators

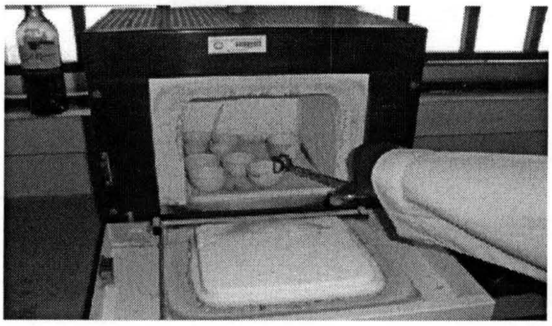

Plate 14- Samples of soyamilk in furnace for Ashing

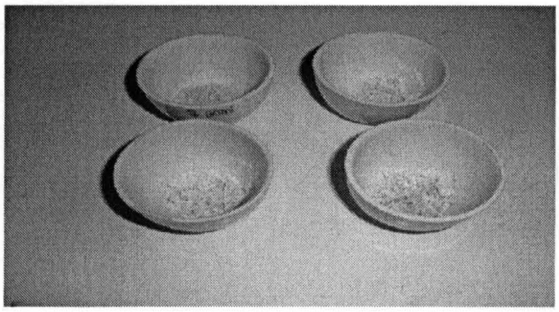

Plate 15- Ashed soyamilk samples in crucibles

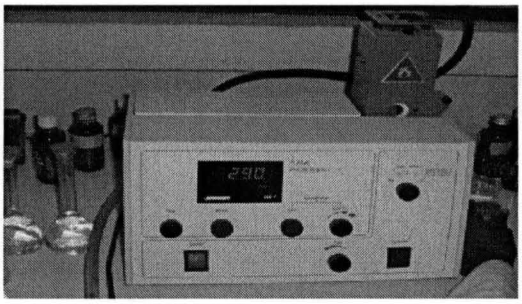

Plate 16- Flame Photometer for determination of Sodium and Potassium

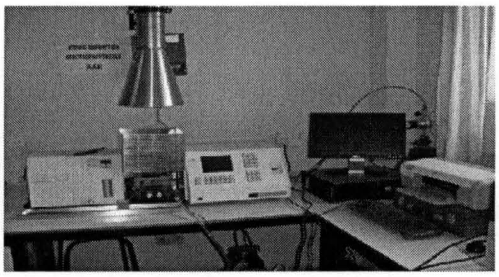

Plate 17- Atomic Absorption Spectrophotometer for determination of Minerals (Calcium and Magnesium).

Appendix VII

Calculations of Soyamilk Nutritional Parameters

Percentage Moisture Content (%MC)

1. % Moisture content = $\frac{86.59-31.76}{86.59-29.93} \text{x} 100$

$= \frac{54.83}{56.66} \text{x} 100$

= 96.77%

2. $= \frac{88.57-33.61}{88.57-31.76} \text{x} 100$

$= \frac{54.96}{56.81} \text{x} 100$

= 96.74%

3. $= \frac{85.12-32.05}{85.12-30.05} \text{x} 100$

$= \frac{53.07}{55.07} \text{x} 100$

= 96.37%

%MC for A

$= \frac{82.22-35.12}{82.22-31.86} \text{x} 100$

$= \frac{47.10}{50.36} \text{x} 100$

= 93.33%

2. $= \frac{76.27-29.41}{76.27-26.31} \text{x} 100$

$= \frac{46.86}{49.96} \text{x} 100$

= 93.80%

3. $= \frac{80.63 - 33.25}{80.63 - 29.82} \text{x} 100$

$= \frac{47.38}{50.83} \text{x} 100$

= 93.21%

Average = $\frac{93.33 + 93.80 + 93.21}{3}$

$= \frac{280.34}{3} = 93.45$

% MC for B

1. % Moisture content = $\frac{100.78 - 45.98}{100.78 - 41.47} \text{x} 100$

$= \frac{54.80}{59.31} \text{x} 100$

= 92.40%

2. % moisture= $\frac{92.06 - 36.76}{92.06 - 32.86} \text{x} 100$

$= \frac{55.30}{59.89} \text{x} 100$

= 92.34%

3. % Moisture = $\frac{81.51 - 26.46}{81.51 - 21.76} \text{x} 100$

$= \frac{55.05}{59.75} \text{x} 100$

= 92.13%

$$\text{Average} = \frac{92.40 + 92.34 + 92.13}{3}$$

$$= \frac{276.87}{3} = 92.29\%$$

%MC for C

1. % Moisture content = $\frac{88.09 - 35.46}{88.09 - 29.91} \text{ x } 100$

$$= \frac{52.63}{58.18} \text{ x } 100$$

= 90.46%

2. % moisture= $\frac{91.59 - 39.30}{91.59 - 33.63} \text{ x } 100$

$$= \frac{52.29}{57.96} \text{ x } 100$$

= 90.23%

3. % Moisture = $\frac{79.93 - 27.00}{79.93 - 21.37} \text{ x } 100$

$$= \frac{52.93}{58.56} \text{ x } 100$$

= 90.39%

$$\text{Average} = \frac{90.46 + 90.23 + 90.39}{3}$$

$$= \frac{271.08}{3} = 90.36\%$$

% Lipid of Control

1. % Lipid = $\frac{2.28-1.90}{2.28-0.68}\text{ x }100$

$= \frac{0.38}{1.6}\text{ x }100$

= 23.75%

2. % Lipid = $\frac{2.72 - 2.26}{2.72 - 0.72}\text{ x }100$

$= \frac{0.46}{2}\text{ x }100$

= 23.00%

3. % Lipid = $\frac{2.53-2.04}{2.53-0.53}\text{ x }100$

$= \frac{0.49}{2}\text{ x }100$

= 24.50%

Average = $\frac{23.75+23.00+24.50}{3}$

$= \frac{71.25}{3} = 23.75\%$

% Lipid for A

1. % Lipid = $\frac{2.71-2.47}{2.71-0.71}\text{ x }100$

$= \frac{0.24}{2}\text{ x }100$

= 12%

2. % Lipid = $\frac{2.61 - 2.36}{2.61 - 0.61}\text{ x }100$

$$= \frac{0.25}{2} \times 100$$

= 12.5%

3. % Lipid = $\frac{2.70 - 2.47}{2.70 - 0.70} \times 100$

$$= \frac{0.23}{2} \times 100$$

= 11.5%

Average = $\frac{12. + 12.50 + 11.50}{3}$

$$= \frac{36}{3} = 12\%$$

% Lipid for B

1. % Lipid = $\frac{2.70 - 2.58}{2.70 - 0.70} \times 100$

$$= \frac{0.12}{2} \times 100$$

= 6%

2. % Lipid = $\frac{2.63 - 2.48}{2.63 - 0.63} \times 100$

$$= \frac{0.15}{2} \times 100$$

= 7.5%

3. % Lipid = $\frac{2.59 - 2.471}{2.59 - 0.59} \times 100$

$$= \frac{0.119}{2} \times 100$$

= 5.95%

Average = $\frac{6.+7.50+5.95}{3}$

$=\frac{19.45}{3}=6.5\%$

% Lipid for C

1. % Lipid = $\frac{2.69-2.57}{2.69-0.69}$ x 100

$= \frac{0.12}{2}$ x 100

= 6%

2. % Lipid = $\frac{2.73 - 2.60}{2.73 - 0.73}$ x 100

$= \frac{0.13}{2}$ x 100

= 6.5%

3. % Lipid = $\frac{2.66-2.54}{2.66-0.66}$ x 100

$= \frac{0.12}{2}$ x 100

=6%

Average = $\frac{6.+6.50+6}{3}$

$=\frac{18.5}{3}=6.17\%$

DETERMINATION OF ASH CONTENT (%)

% Ash Control

1. % Ash = $\frac{32.47-32.39}{34.39-32.39} \text{x} 100$

$= \frac{0.08}{2} \text{x} 100$

= 4%

2. % Ash = $\frac{29.48 - 29.41}{31.39 - 29.41} \text{x} 100$

$= \frac{0.07}{2} \text{x} 100$

= 3.5%

3. % Lipid = $\frac{30.70-30.62}{32.62-30.62} \text{x} 100$

$= \frac{0.08}{2} \text{x} 100$

= 4%

Average = $\frac{4+3.50+4}{3}$

$= \frac{11.5}{3} = 3.8\%$

% Ash A

1. % Ash = $\frac{31.37-31.29}{33.29-31.29} \text{x} 100$

$= \frac{0.08}{2} \text{x} 100$

= 4%

2. % Ash = $\frac{21.71 - 21.63}{23.63 - 21.63} \text{ x } 100$

= $\frac{0.08}{2} \text{ x } 100$

= 4%

3. % Lipid = $\frac{29.80 - 29.71}{31.71 - 29.71} \text{ x } 100$

= $\frac{0.09}{2} \text{ x } 100$

= 4.5%

Average = $\frac{4 + 4 + 4.5}{3}$

$= \frac{12.5}{3} = 4.17\%$

% Ash B

1. % Ash = $\frac{28.07 - 27.95}{29.95 - 27.95} \text{ x } 100$

= $\frac{0.12}{2} \text{ x } 100$

= 6%

2. % Ash = $\frac{33.37 - 33.26}{33.26 - 33.26} \text{ x } 100$

= $\frac{0.11}{2} \text{ x } 100$

= 5.5%

3. % Lipid = $\frac{21.46 - 21.34}{23.34 - 21.34} \text{ x } 100$

$$= \frac{0.12}{2} \text{ x } 100$$

= 6%

$$\text{Average} = \frac{6 + 5.50 + 6}{3}$$

$$= \frac{17.5}{3} = 5.83\%$$

% Ash C

1. % Ash = $\frac{27.57 - 27.45}{29.45 - 27.45} \text{ x } 100$

$$= \frac{0.12}{2} \text{ x } 100$$

= 6%

2. % Ash = $\frac{34.42 - 34.31}{36.31 - 34.31} \text{ x } 100$

$$= \frac{0.11}{2} \text{ x } 100$$

= 5.5%

3. % Lipid = $\frac{31.56 - 31.43}{33.43 - 31.43} \text{ x } 100$

$$= \frac{0.13}{2} \text{ x } 100$$

= 6.5%

$$\text{Average} = \frac{6 + 5.50 + 6.5}{3}$$

$$= \frac{18}{3} = 6\%$$

% NITROGEN FOR CONTROL

$$\%N = \frac{T.VxM.Ax0.014x10}{Wt\ of\ sample\ (g)} x\ 100$$

Where:

T.V = Titre Value

M. A. = Molar acid

% N for Control

1. $\% N = \dfrac{0.55x0.1x0.014x10x100}{2}$

$$= \frac{0.77}{2} = 0.385\%$$

% Protein = %N x 6.25

= 0.385 x 6.25

= 2.406%

2. $\% N = \dfrac{0.54x0.1x0.014x10x100}{2}$

$$= \frac{0.756}{2} = 0.378\%$$

% protein = %N x 6.25

=0.378 x 6.25 = 2.36

3. $\% N = \dfrac{0.54x0.1x0.014x10x100}{2}$

$$= \frac{0.756}{2} = 0.378\%$$

% Protein = %N x 6.25

= 0.378 x 6.25

$= 2.36\%$

$$\text{Average} = \frac{2.41 + 2.36 + 2.36}{3}$$

$$= \frac{7.13}{3} = 2.38\%$$

% Nitrogen for A

1. $$\%N = \frac{T.VxM.Ax0.014x10}{\text{Wt of sample (g)}} x\,100$$

$$= \frac{0.85x0.1x0.014x10x100}{2}$$

$$= \frac{1.19}{2} = 0.595\%$$

% Protein = %N x 6.25

= 0.595 x 6.25

= 3.72%

2. $$\%\ N = \frac{0.80x0.1x0.014x10x100}{2}$$

$$= \frac{1.12}{2} = 0.560\%$$

% protein = %N x 6.25

=0.560x 6.25 = 3.50%

3. $$\%\ N = \frac{0.90x0.1x0.014x10x100}{2}$$

$$= \frac{1.26}{2} = 0.63\%$$

% Protein = %N x 6.25

= 0.63 x 6.25 = 3.94%

Average = $\frac{3.72+3.50+3.94}{3}$

$$=\frac{11.10}{3}=3.72\%$$

% Nitrogen for B

1. %N = $\frac{\text{T.VxM.Ax0.014x10}}{\text{Wt of sample (g)}}\text{x 100}$

$$= \frac{0.95x0.1x0.014x10x100}{2}$$

$$=\frac{1.33}{2}=0.655\%$$

% Protein = %N x 6.25

= 0.665 x 6.25

= 4.16%

2. % N = $\frac{0.95x0.1x0.014x10x100}{2}$

$$=\frac{1.13}{2}=0.665\%$$

% protein = %N x 6.25

=0.665x 6.25 = 4.16%

3. % N = $\frac{1x0.1x0.014x10x100}{2}$

$$=\frac{1.4}{2}=0.700\%$$

% Protein = %N x 6.25

= 0.700 x 6.25 = 4.38%

$$\text{Average} = \frac{4.16 + 4.16 + 4.38}{3}$$

$$= \frac{12.7}{3} = 4.23\%$$

% Nitrogen for C

1. $$\%N = \frac{\text{T.VxM.Ax0.014x10}}{\text{Wt of sample (g)}} \text{x } 100$$

$$= \frac{1.10x0.1x0.014x10x100}{2}$$

$$= \frac{1.54}{2} = 0.77\%$$

% Protein = %N x 6.25

= 0.77 x 6.25

= 4.81%

2. $$\%\ N = \frac{1.05x0.1x0.014x10x100}{2}$$

$$= \frac{1.47}{2} = 0.735\%$$

% protein = %N x 6.25

=0.735x 6.25 = 4.59%

3. $$\%\ N = \frac{1.10x0.1x0.014x10x100}{2}$$

$$= \frac{1.54}{2} = 0.770\%$$

% Protein = %N x 6.25

= 0.77 x 6.25 = 4.81%

$$\text{Average} = \frac{4.81 + 4.59 + 4.81}{3}$$

$$= \frac{14.21}{3} = 4.74\%$$

Percentage Carbohdrate (CHO)

Percentage carbohydrate = 100 – (P + L + A)

Where:

P = % Protein

L = % lipid

A = % Ash

% CHO for Control

% CHO = 100 – (2.38 + 23.75 + 3.83)

= 100 – 29.96 = 70.04%

% CHO for A

% CHO = 100 – (3.72 + 12.00 + 4.17)

= 100 – 19.89 = 80.11%

% CHO for B

% CHO = 100 – (4.23 + 6.48 + 5.83)

= 100 – 16.54 = 83.46%

% CHO for C

% CHO = 100 – (4.74 + 6.17 + 6.00)

= 100 – 16.91 = 83.09%