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# The Effects of Cooking Time on the Nutritional Parameters of Soya Milk

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## ABSTRACT

In this study, the effect of cooking time on the nutritional quality of soya milk was determined with a view of obtaining the approximate time at which soya milk 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. The soya milk samples were cooked for 15, 30 and 45 min, respectively and there were significant differences in the nutritional composition of soya milk cooked between these time intervals. Soya milk cooked for 15 min was characterized by a moisture content of about 93.45%; ash 4.17%; protein 3.72%; lipids 12.0%; carbohydrates 80.11% and energy value of 443.32 kcal/100 g. On the other hand, the soya milk prepared for 30 min contained moisture content level of 92.29%; lipids 6.48%; energy value of 409.08%, ash 5.83%, crude protein 4.23% and carbohydrates 83.46%. The sample of soya milk prepared for 45 min was characterized by ash content of 6.0%, crude protein 4.74% and lower moisture content 90.36%, lipids 6.17%, carbohydrates 83.09% and energy value of 406.00 kcal/100 g. The minerals investigated gave the following results under treated time of 15, 30 and 45 min, respectively; sodium: 27, 23 and 27 mg/100 mL, potassium: 41, 60 and 62 mg/100 mL, magnesium: 32.2, 31 and 35 ppm and calcium: 109.5, 81 and 90.0 ppm, respectively. It was evident that there were varying degrees of changes that occurred in each of the chemical composition of the soya milk with respect to the different periods of cooking.

**Key words:** Quality, energy, ash, moisture content, calcium

## INTRODUCTION

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 and Smith, 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; in China, Japan and other far Eastern countries, the proportion is greater.

The world produces about 150 million tonnes of 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 *et al*., 1992). Soybean protein is a high quality protein and it is obtained at a cheaper cost compared to other high quality protein sources e.g., meat and fish in the tropics. As a result of this, the potentials of soybean can be used to solve the protein gap problem among the low-income earners in the country (Tunde-Akintunde and Souley, 2009). Soybean is also rich in minerals especially calcium, potassium, magnesium, iron, zinc and copper (FAO, 1971). It is also an excellent source of vitamins, thiamine, riboflavin and niacin (Singh *et al*., 1989). Soya milk if not properly cooked has characteristics flavour (Beany flavour) which limit acceptance by some individuals (Liu, 1997). Tunde-Akintunde and Souley (2009) reported that soymilk is the rich creamy liquid extract of soybean and it is the easiest way of adding soy protein to the Nigerian diet because of the beany taste. Soymilk is a popular nutritious alternative to cow milk and is even cheaper and can be processed in a fairly simple way (Soya-Agrodok, 2005). A new processing method (modern style) for soymilk was developed in the USA in the twentieth century. In this method, grinding and heating are carried out simultaneously. The bean flavor is reduced, thus increasing its popularity (Soya-Agrodok, 2005). Modern-style soymilk gradually spread to north-eastern countries (Northern China, Korea and Japan). There are many soymilk producers in East Asia, just as there are many dairy producers in Western countries. Nowadays, modern style soymilk has become a very popular beverage across the world. Soybean products contain phytoestrogens, such as isoflavones, which may reduce the incidence of estrogen-related cancers and prevalence of climacteric syndrome and osteoporosis. The rate of these diseases is lower in Asian people consuming a diet high in soybean products. Soy products are now spreading across the world as healthy foods and as a low-cost source of nutrients (Soya-Agrodok, 2005). According to Liu (1997), 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 (Soya-Agrodok, 2005). Hence, the effect of cooking time on the nutritional parameters of soya milk is of great importance to analyse. 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. Soya beans (*Glycine max*) have become famous as the plant that will help to solve the world problem of protein deficiency (Soya-Agrodok, 2005). Most soya beans grown in tropical Africa are for oil production and the protein rich-cake is fed to animals (Margaret and Brian, 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% 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 (Ogundipe and Osho, 1990).

The nutritional parameters to be determined include: Crude Protein, Fat (Total Lipid), Ash, Carbohydrates, Energy, Calcium, Magnesium, Potassium and Sodium.

## MATERIALS AND METHODS

**Materials:** The soya beans used as the raw biomaterial for the preparation of the soya milk used for this project work was purchased in July, 2009 at Bosso Market, Minna, Niger State, Nigeria. It was 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, Niger State, Nigeria.

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

**Stage by stage extraction (Netherlands) method:** Five hundred and fifty grams of soya beans was soaked in 1650 mL of excess water for 18 h. This is claimed to remove bitter taste. The soybean was washed with clean water and ground to flour in stages, the soya milk was obtained based on the method suggested by Soya-Agrodok (2005).

**The cooking of the extracted soya milk:**

- A sample (500 mL) 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
- 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
- At 15 min 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 min, bringing the time to 30 min and then another sample, B was collected for preservation. The last sample of the experiment, C was collected after another 15 min of cooking from 30 min; bringing the total time of cooking to 45 min. The samples: control, A, B and C were further processed with other chemicals for proximate analysis and determination of minerals of the soya milk

**Experimental procedures:** AOAC (1998) food analysis procedures was used in the determination of the Nutritional contents; moisture, protein, fat, ash and carbohydrate. The food energy value of the samples was determined according to the method described by Pomeranz and Meloan (1994). The minerals, sodium and potassium were determined according to Ibitoye (2005).

## RESULTS AND DISCUSSION

The proximate composition of soya milk is as presented in Fig. 1-5. The samples (A, B, C) were all produced in triplicates and the data analysed appropriately.

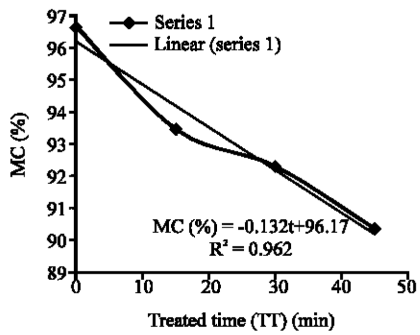


Fig. 1: Graphical representation of %moisture content of soya milk cooked at different time intervals

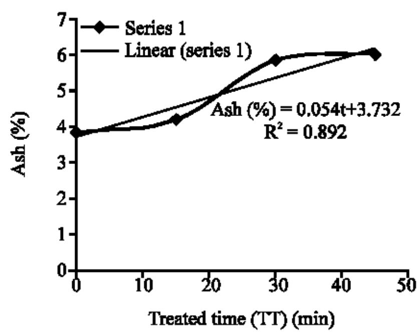


Fig. 2: Graphical representation of %ash in soya milk cooked for different time intervals

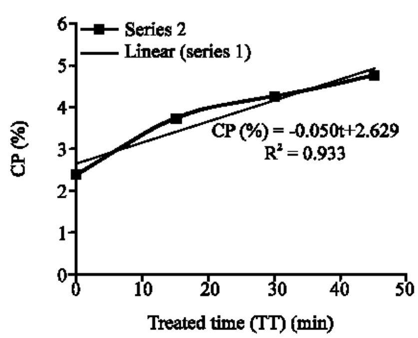


Fig. 3: Graphical representation of %crude protein in soya milk

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. The minerals are sodium, potassium, calcium and magnesium and the results are presented in Fig. 6-9.

**Discussion on the proximate composition of soya milk:** The results shown in Fig. 1 to 5 clearly show the variation that occurred in the nutritional parameters of soya milk as it was prepared over a period of time. The percentage moisture content (%MC) decreased with time; this

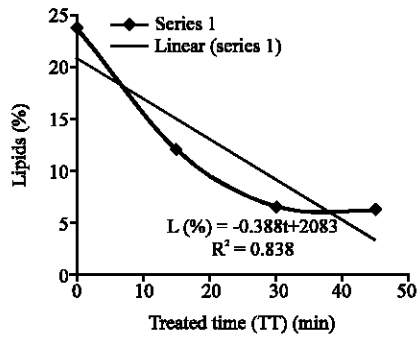


Fig. 4: Graphical representation of %lipids in soya milk cooked for different time intervals

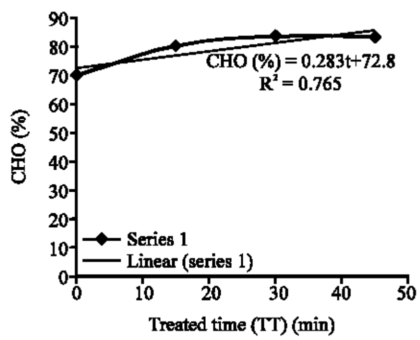


Fig. 5: Graphical representation of %carbohydrates in soya milk cooked for different time intervals

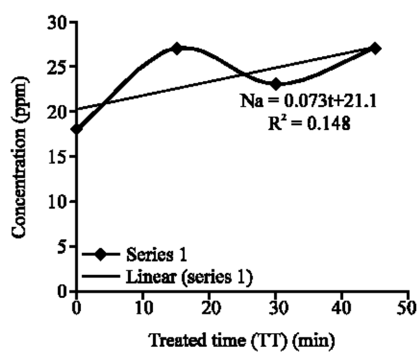


Fig. 6: The graphical representation of the changes in sodium in the soya milk cooked over a period of time

perhaps was due to the evaporation of water as soya milk was cooked. The values varied between 93.45, 92.29 and 90.36% for (A) 15 min, (B) 30 min and (C) 45 min, respectively, these values fall within the range reported by Tunde-Akintunde and Souley (2009).

Figure 1 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 was a decline in the moisture content of soya milk as it was prepared.

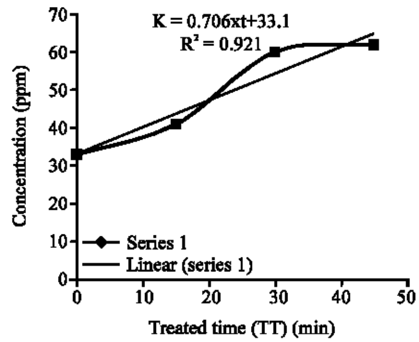


Fig. 7: The graphical representation of the changes in potassium in the soya milk cooked over a period of time

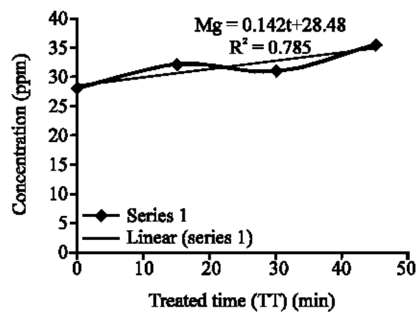


Fig. 8: The graphical representation of the changes in magnesium in the soya milk cooked over a period of time

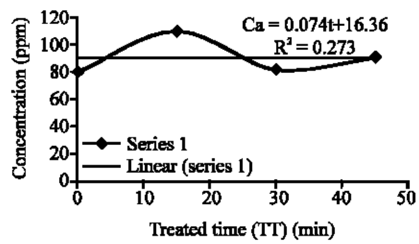


Fig. 9: The graphical representation of the changes in calcium in the soya milk cooked over a period of time

The results obtained for % Ash were as follows: 4.17, 5.83 and 6.0% for soya milk cooked for (A) 15, (B) 30 and (C) 45 min, respectively. It can be observed that there was an increase in %ash in soya milk as it was 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. 2. 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.

Percentage crude protein had the following results for cooking soya milk for (A) 15, (B) 30 and (C) 45 min: 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 could be as a result of decrease in digestibility of soy protein as it was exposed to excessive heat treatment. Soy protein also denatures when exposed to heat treatment which could also explain why there was 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. 3, further illustrates the increase in the protein content in the soya milk cooked over time intervals.

There was a remarkable decrease in %lipid as soya milk was cooked at its boiling temperature (Fig. 4). This decrease was visible from the beginning of cooking to 30 min after the soya milk had started boiling at 100°C. In this research, %lipid content in the soya milk decreased from 12 to 6% between 10 and 30 min of cooking. This could be as a result of the removal of a film which is rich in protein and oil called yuba. Lipids seeped up and were removed as yuba as the soya milk was boiled over the period of time. After 30 min of boiling, the % lipids was considerably constant (Fig. 4).

The %carbohydrates in the soya milk was also affected by the cooking over the period of time (Fig. 5). The values of carbohydrates obtained during the research are as follows: 80.11, 83.46 and 83.09% for 10, 15 and 45 min of cooking, respectively. The gradient of the graph of these values as expressed in Fig. 5 shows a positive increase in carbohydrates at first and then becomes relatively constant.

**Discussion on the mineral content of soya milk:** Sodium showed drastic changes in values from control (0 min) to 30 min (B) of cooking (Fig. 6). There was a positive increase in the values of sodium from the beginning (control) to 15 min (A) and then a decrease in the values is observed from this time to 30 min (B) of cooking. The soya milk sample boiling at 100°C after 15 min (A) of cooking had 27 mg/100 mL sodium present in it. There was a decrease from 27 mg/100 mL for (A) 15 min to 23 mg/100 mL for (B) 30 min of cooking the soya milk. But after cooking the soya milk for another 15 min from 30 min; bringing the total time to (C) 45 min, the soya milk had a value of 27 mg/100 mL. On a general note, there was an increase in the values of sodium in the soya milk as it was illustrated by the linear (series1) representing the line of best fit in the graph.

Potassium and magnesium present in the soya milk both showed positive increase in their values. The values of potassium increased from 41 mg/100 mL (A) to 62 mg/100 mL (C) in the soya milk (Fig. 6), on the other hand, the values of magnesium increased from 32.2 mg/100 mL (A) to 35.5 mg/100 mL (C) in the soya milk as it was cooked at 100°C (Fig. 7). The increase in potassium was more pronounced as the difference in the value for A (15 min) and C (45 min) was 21 mg/100 mL when compared with only 3.3 mg/100 mL of magnesium within the same range of cooking time.

Another mineral considered in this research is calcium. Calcium is particularly important in the body for the building of bones and other skeletal structures. Unlike 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 (Fig. 9). The following values were obtained for A (15 min), B (30 min) and C (45 min): 109.5, 81.5 and 90.0 mg/100 mL, respectively, these were found to be below the amount recommended per day for human beings (WHO/FAO, 2002). Usually soya milk is fortified with Calcium to meet the required intake values recommended for the body.

## CONCLUSIONS

In the course of this study, it was discovered that each of the nutritional parameters varied in various degrees as the soya milk was prepared within the time limit (15-45 min). The results showed that, soya milk cooked for 45 min had the following values: 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 min, respectively. The crude protein increased from 3.72, 4.23 to 4.74% for 15, 30 and

45 min, respectively. In the case of carbohydrates, it increased from 80.11% and ended up at a 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 from 12.0 to 6.17% and the energy value was reduced from 443.32 kcal/100 g at 15 min of cooking to 406.0 kcal/100 g at 45 min.

The minerals were also observed to have undergone some changes as the soymilk was cooked between 15 and 45 min. Calcium decreased in its value from 109.5 to 90.0 ppm 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 41.0 mg/100 mL to 62.0 mg/100 mL and Magnesium increased from 32.2 to 35.5 ppm for 15 and 45 min, respectively.

The approximate time for cooking of soya milk which may be safe and acceptable should be between the range of 20 and 30 min. 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. Furthermore, high price of imported milk and milk products coupled with poor milk production in Nigeria in particular and Africa in general seem to have made consumers more ready to accept milk produced from plant sources hence it is suggested that milk from soybean should be encouraged so as to solve the problem of protein-calorie malnutrition in Africa.

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