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Effects of Soaking Time and Temperature on the Nutritional Content and Sensory Quality of Soybean Flour and Milk

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Abstract- Soybean plays a great role to reducing protein-energy malnutrition. However, the major problems in raw soybeans are off-flavor. Processing also affect nutritional value unless optimum processing methods were used. Thus, this investigation was carried out to evaluate the effect of soaking temperature and time on proximate composition and sensory properties of soy products made from soybean variety AFGAT (Glycine max). Two soaking temperatures hot water (40°C) and ambient temperature (25°C) and three soaking times (8, 12 and 16 hrs) were considered in the experiment. The study revealed that soaking time and the temperature had significantly ($p<0.05$) affected proximate composition of soybean products. Flour protein content was significantly affected by soaking time and temperature. A higher value (44.26%) was observed at 16 hrs soaking time with 40°C soaking temperature. The result was slightly greater than the raw soy flour (44%). Flour fat content was 21.98% for soybean soaked for 8 hrs at 40°C. This result was found to be higher than the raw (20.80%). Significantly higher flour fiber content (3.77%) was obtained at 16 hrs soaking time with 40°C. The fiber content appeared to increase with increasing soaking time at 40°C. Soy milk proximate composition was significantly affected by soaking time and the temperature.

Keywords: soaking time and temperature, proximate composition, soybean, soybean flour, soy milk.

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Abstract- Soybean plays a great role to reducing protein-energy malnutrition. However, the major problems in raw soybeans are off-flavor. Processing also affect nutritional value unless optimum processing methods were used. Thus, this investigation was carried out to evaluate the effect of soaking temperature and time on proximate composition and sensory properties of soy products made from soybean variety AFGAT (Glycine max). Two soaking temperatures hot water (40°C) and ambient temperature (25°C) and three soaking times (8, 12 and 16 hrs) were considered in the experiment. The study revealed that soaking time and the temperature had significantly ($p<0.05$) affected proximate composition of soybean products. Flour protein content was significantly affected by soaking time and temperature. A higher value (44.26%) was observed at 16 hrs soaking time with 40°C soaking temperature. The result was slightly greater than the raw soy flour (44%). Flour fat content was 21.98% for soybean soaked for 8 hrs at 40°C. This result was found to be higher than the raw (20.80%). Significantly higher flour fiber content (3.77%) was obtained at 16 hrs soaking time with 40°C. The fiber content appeared to increase with increasing soaking time at 40°C. Soy milk proximate composition was significantly affected by soaking time and the temperature. Soy milk protein content was 52.35% for soybean soaked for 16 hrs at 25°C. Protein were increased as the soaking time increasing at a temperature 25°C. Soy milk fat content was 23.98% for soybean soaked for 16 hrs at 25°C. The processing methods showed that the most acceptable product was obtained for soybean soaked for 8 hrs at 40°C which resulted in good color, flavor, odor and overall acceptance of soy milk with an average sensory score of 7.00, 6.68, 6.96 and 7.00, respectively on 7- point hedonic scale. Whereas, soybean soaked for16 hrs at 25°C were found to have less sensory acceptance. In conclusion, the proximate composition of soybean flour and milk and sensory quality of soybean milk were influenced by soaking time and temperature. The result suggests that good quality soybean flour and soybean milk were obtained from soybean soaked for 8 hrs at 40◦C.

Keywords: soaking time and temperature, proximate composition, soybean, soybean flour, soy milk.

I. Introduction

The soybean (*Glycine max (L) Merrill,* family Leguminosae) originated in Eastern Asia, have been grown as a food crop for thousands of years in China. Nowadays, soybeans are widely grown and consumed as a source of plant protein in the diets of millions of people throughout the world (Varma, and Mehta, 1988 and Millward, 2004). In the year 2004/05, the world had produced approximately 229 million metric tons of soybean, enough to give each man, woman, and child 35 kg of soybeans for each, or the equivalent of nearly 300 liters of soybean milk for a year (Riaz, 2006). The United States, the overall soybean foods industry has grown dramatically since the mid-1990s, from $1.2 billion in 1996 to an estimated $4.0 billion in 2004. 2001/02 Ethiopia had produced only 42,881.47 quintals of soybeans from 4,922.38 hectares of land (Riaz, 2006).

Soybean is important sources of high quality, inexpensive protein than other legumes and about 35 - 38 % of its calories are derived from its protein as compared to 20 –30% in most other beans. Protein rich source of other legume is high in cholesterol and saturated fat whereas, soybean foods provide high quality protein, cholesterol free and low in saturated fat, equivalent to animal protein in its protein quality and higher than other plant proteins (FAO, 1990). Among soybean products, soy flour is made from whole or dehulled soybeans. Soy flour had protein content between 35 and 40% and a fat level between 15 and 20%. It is extremely nutritious and high in fiber and contains all of the vitamins, minerals, and phytochemicals of soybeans. Soy milk is an emulsive liquid extracted from soybean and it is recognized as milk from vegetable due to its high protein and fat content and the homogeneous form in texture resembling animal milk. The protein and fat content ranges from 39 to 46% and 16 to 18%, respectively, based on variety.

Soy milk is cholesterol free and low fat produced from soaked soybean. The nutritional value can be compared with that of cow's milk. It contains higher protein than cow's milk (Hurrell *et al.,* 1992). Soy milk containing good quality protein, fat, isoflavones, vitamins, minerals and carbohydrate has attracted a great deal of public attention as a healthy food and a good choice for people who are lactose intolerant, in which 75% of the world population have no ability to digest lactose that causes stomach cramp, flatulence and diarrhea (Riaz, 2006). Also it is a good alternative to those who are allergic to the proteins of cow's milk, however, there are some problems in using soy milk

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because it has unpalatable taste such as greasy smelling and disagreeable stimulating taste, odor and flavor due to minor components of soybean (Muller Harvey and Allan 1992). This probably because of lipoxygenase enzyme found on the intact seed that catalyzes lipid oxidation leading to the production of unacceptable flavor. To control this reaction, soybeans are blanched before soaking (Hurrell *et al.,* 1992). Therefore, search for suitable soy milk and soy flour processing methods that can be locally adapted, improve the nutritional quality through suppressing the lipo-oxiginase enzyme and off flavor nature coupled with better nutrient extraction are required for proper utilization of soybean flour and milk in Ethiopia.

General Objective

To investigate the effects of soaking time and temperature on soybean flour and soybean milk quality

Specific Objectives

1. To study the effects of soaking time and temperature on the proximate nutritional value of soybean flour and soybean milk
2. To study the effects of soaking time and temperature on sensory quality of soybean milk

II. Materials and Methods

This experiment was conducted at Haramaya university in 2010. Improved soybean variety named AFGAT [TGX-1892-10F], was used. This variety was selected due to its relatively lower price, good productivity and high nutritional composition. For ensuring the quality, the breeder seed was used. The experiment comprised two factors (soaking times and temperatures) arranged in CRD with three replications. Soaking time had three levels (8, 12 and 16 hrs) and two soaking temperatures, 25 and 40ºC.

The clean seed samples was immersed into a thermostatically controlled hot water bath for 10 seconds at a temperature 91°C with a ratio of soybean grain to water, 1:3 to suppress the soybean lipoxygenase enzyme activity (Brown *et al*., 1982). As soon as the blanching was completed, the samples were withdrawn and immediately cooled down in cold water at ambient temperature for 15 seconds. The blanched samples were soaked in tap water for 8 hrs,12 hrs and 16 hrs at ambient temperature (25°C) and hot water (40°C) using a thermostatically controlled water bath. The soaked samples were dried in direct sunlight. The seed coats and germs were then removed manually using stone grinder. The dehulled beans were milled for further analyses.

The untreated sample (control) which was used for comparison was cleaned manually to remove physical impurities such as foreign matters, immature and damaged seeds. The cleaned soybean was milled using Professional Burr mill and the flour was sifted to pass through 710 micron test sieve. The sample was sealed in moisture proof a plastic bag and stored at room temperature until laboratory analysis were conducted (Nwabueze, 2007). The grain flour was analyzed for Proximate Composition to compare with the treated samples.

Treated soy flour preparation: Soybean was cleaned from physical impurities and thoroughly washed with soft water, then it was blanched. One kg blanched soybean was soaked in 2 litters hot water (40°C) and 25°C in each a plastic container for 8, 12, and 16 hours. After pouring off the water, the soybean was rinsed with water (Hymowitz and Polmer 2004). Part of each soaked soybean were dried in direct sun light and dehulled manually using stone grinder. The dehulled beans were manually separated from the hull and milled to flour using laboratory mill.

Soy milk preparation: Soy milk was prepared from soaked soybean and Japanese method was used for main soy milk maker (Soy wonder Soymilk Machine, Model MJ 720) for each grinding time (10 min) to produce a slurry. The slurry was heated near boiling temperature and the soluble soy milk emulsion was readily separated from the insoluble residue (okara) by passing a slurry through a fine filter cloth (cheese cloth). The filter cloth was folded four times to reduce entrance of unwanted materials to the extracted soy milk (Nwabueze, 2007). The soy milk was boiled at 90°C for 18 minutes to reduce trypsin inhibitor and to retain nutritive value of the product (Camire, 2001). Soy milk was analyzed for its nutrient composition.

The soymilk sample were dried in two stage drying in an oven (Incubators Circulation air natural, Binder GMBH) at a temperature of 70°C and 100°C for 16 hrs and 1 hrs, respectively.

The soybean milk powders were sealed in moisture-proof plastic bag and analyzed for nutritional composition.

a) Raw Material Proximate Composition

i. Determination of moisture content

The moisture content was determined by the gravimetric method as described in the AOAC (1990), Method No 935.30. Weigh a clean dried and covered flat aluminum dish, and flour about 2g was dried in an air forced drought oven at 103°C for 6 hrs by placing the cover on the sample dish half-open. Then it was cooled in a desiccator (Nalgene Model 5317-0120) and re-weighed. The mass loss on drying, determined as % moisture was used:

$$Moisture(\%) = \frac{m_{initial} - m_{dried}}{m_{initial}} \times 100$$

Where $m_{initial}$ = weight of the sample before drying

m_{dried} = weight of the sample after drying

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ii. *Determination of crude protein*

Total nitrogen content was determined by micro-Kjeldahl method, according to AOAC (1990) method (No. 925-09) using Automatic digestion and distillation systems (Model UDK-142, Europe). For a control urea was used.

$$Nitrogen(\%) = \frac{VHCl\,in L \times NHCl(ca.0.1) \times 14.00}{Sample\,weight\,on\,dry\,materbasis} \times 100$$

Where:

V is a volume of HCL in L consumed to the end point of the titration, N is the normality of HCl (used often is 0.1 N), and 14.00 is the molecular weight of nitrogen. The percent of nitrogen was converted to % of protein by using conversion factor (% protein = 6.25 ×% N for soy flour).

iii. *Determination of crude fat*

The fat content of flour was determined, according to AOAC (1995) Method No 923-09. Flour (2g) was extracted with 150 ml di-ethyl ether for a minimum period of 8 hrs in the soxhlet extractor. The solvent was then evaporated by heating on a steam bath. The flask containing the extracted fat was dried in an oven to a constant mass for 1 hr.

$$Crude\ fat,\ percent\ by\ weight = \frac{W_2 - W_1}{W} \times 100$$

Where: W_1 =Weight of the extraction flask (g)

W_2 = Weight of the extraction flask plus the dried crude fat (g)

W = Weight of sample flour (g)

iv. *Determination of ash content*

Ash content of flour was determined according to AOAC (1995) Method No 923-09. Clean porcelain dish, dried at 120°C in an oven was ignited at about 550°C in a muffle furnace for 3 hours was cooled in a desiccator and weighed (m1). Then 3 g of flour sample was put into the porcelain dish and weighed (m2). This sample was dried at 120°C for 1 hour and carbonized over to hot plate until contents turn black. The dish with its contents was transferred to a muffle furnace and ignited at about 550°C until ashing was complete. The residue was weighed (m3). The total ash was expressed as percentages on a dry matter basis as follows:

$$\text{Total Ash (\%)} = \left(\frac{M_3 - M_1}{M_2 - M_1}\right) \times 100$$

Where: (M_2-M_1) is sample mass in g on dry base and (M_3-M_1) mass of ash in g.

v. *Determination of crude fiber*

A 3 g sample was transferred to 600 ml beaker. After digestion with 1.25% sulfuric acid, washed with distilled water and digested by sodium hydroxide (1.25%), it was then filtered in 76 μm coarse porosity crucible in apparatus at a vacuum of about 25 mm. The residue left after refluxing was again washed with 1.25% sulfuric acid near boiling point. This residue was then dried at 110°C overnight, cooled in desiccator and weighed (M1). After ashing at 550°C, it was cooled in a desiccator and weighed again to get mass of ash (M2). The total crude fiber was expressed in percentage as:

$$\text{Total Crude fiber} = \left(\frac{M_1 - M_2}{M_3}\right) \times 100$$

Where; M_1 = mass of ash + fiber,

M_2 = mass of ash

M_3 = mass of sample on the dry matter basis

v. *Determination of carbohydrate*

Carbohydrate content was determined by the difference.

$$\%C = 100 - [\%M + \%P + \%F + \%Fb + \%A]$$

Where: C-Carbohydrate content, M-Moisture content, P-Protein content, F-Fat content, Fb- Fiber content and A-Ash content.

vi. *pH Value Determination*

For soy milk pH determination, pH meter was used (model HI 9017 microprocessor pH meter, USA). Glass electrode attached to digital electronic pH meter was used, after calibrating using standard buffer solutions of pH 4 and pH 7. pH was measured by inserting the glass electrode into the sample in a beaker and reading was taken when the displayed value is steady at room temperature.

vii. *Sensory Evaluation*

Sensory panelists were selected from Awassa Agricultural Research center food science staffs that have already been trained in sensory analysis. A total of 50 male and female panelists were involved in the sensory evaluation to assess the sensory quality of soymilk (Dadzie, 1998). The evaluation were includes sensory attributes such as color, flavor, odor and over all acceptability of the product, using 7-point hedonic scale rating consisting of 1 (dislike very much), 2 (dislike moderately), 3 (dislike slightly), 4 (neither like nor dislike), 5 (like slightly), 6 (like moderately) and 7 (Like very much) was used.

After cooling for 5 min, the soy milk was kept in a refrigerator for short time until it was tasteful for subjective analysis. Product sample was arranged and each panelist was instructed on the procedure of sensory evaluation. Soymilk was given in a glass for each evaluator and the number of samples was 6 at a time. Panelists were instructed to make their own

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individual assessments according to their best feel after tasting the product. Total samples were presented for each panelist throughout the evaluation period to evaluate the sample on the bases of taste, color and flavor and over all acceptability.

b) Statistical Analysis

All data were analyzed using two factors analysis of variance (ANOVA). Duncan's multiple- range test was used to establish multiple comparisons of mean values. Mean values were considered at 5% significance level ($p < 0.05$). The statistical analysis of the data were conducted using the SAS statistical software package.

III. Results and Discussions

a) Proximate Composition of Raw Soybean Flour

i. *Proximate composition*

The proximate compositions analyzed for raw soybean flour (control) were given in Table 3. The flour moisture was 5.33%. This result was similar to Olasoju and Ajav (2007) result (5.38%). But lower than 7.75% reported by Yimer and Admassu, (2008) and 7.4 % reported by Abdet *et al*., (2009). This difference was probably due to the variety and environmental factors (Famurewa and Raji, 2005). Lower moisture content hinders microbial growth and enzymatic activity; and reduces rancidity during storage. This may contribute to keeping the product in good quality and better shelf life.

The crude protein content of raw soy flour was 44.00%. The result obtained was in close agreement with those of an earlier report (43.4%) by Fasoyiro *et al*. (2006). Also the present value was in the range of 40% to 45% reported by Liener, (1989). The crude fat content of raw soy flour obtained in the present study was 20.80%. This value was in the range (15 to 20%) reported by Famurewa and Raji, (2005). But it was higher than 18.5% (Abdet *et al*., 2009). The ash content of raw soy flour was 4.98% (Table 3). This result was similar with that reported (4.86%) by Fasoyiro *et al*., (2006). However, these values were higher compared to processed (treated) flour. This could probably be due to the presence of hull in raw soybean and were lower than 5.6%, reported by Yanez, *et.al* (1982) and 6%, Stuffer (2008), 5.73% and 5.88% reported for Awassa and Belesa varieties, respectively (Yimer and Admassu, 2008). But the present value was in the range of 3.09% to 5.04% obtained by Vasconcelos *et al*. (1997).

The crude fiber was 5.83% (Table3). The result obtained was in agreement with Fasoyiro *et al*. (2006). Who reported that, the fiber content of soy flour was 5.05%. This value was lower than (6.89% and 7.27%) the two varieties, namely, Awassa and Belessa (Yimer and Admassu, 2008). Similarly, higher fiber content was measured from raw soy flour due to the presence of hull compared to processed (blanched, soaked, and dehulled). The total carbohydrate of soy flour was 20.00%. The result obtained was less than the value reported by Famurewa, Raji (2005) (24.92%) and Stauffer (2008) (22%). This might be due to varietal differences. Variety, environmental factors and management in pre and post-harvest conditions could affect the proximate composition (Fasoyiro *et al*., 2006).

Table 3: Proximate composition of raw soybean flour

Moisture (%)	Crude protein (%)	Crude fat (%)	Crude fiber (%)	Ash (%)	Carbohydrate (%)
5.33±0.71	44±0.24	20.80±1.01	5.83±0.92	4.98±0.52	20.0±1.23

b) The Effect of Soaking Temperature and Time on Proximate Composition of Soybean Flour

Moisture content: The proximate compositions of soy flour were presented in Table 4a. Effect of soaking temperature was significant ($p<0.05$) on soy flour moisture content. The moisture content was 4.73% at 25oC and 4.55% for those soaked at 40°C. This result is somewhat higher than the findings of Orhevba, (2010) who reported that moisture content of soy flour was lower (4.6%) at a higher temperature. However, the result showed lower value as compared to 6.6% reported by Abdet *et al.,* (2009). The moisture content decreased with increasing temperature. This was perhaps due to the evaporation of water. This could be explained by the fact that the size of the soybean increase due to expansion of tissue which led to the loss of moisture as soaking temperature increased. Lower moisture content helps the product to retain its quality without deterioration for a long period because the mold and microbial growth can be potentially inhibited.

Soybean soaking time did not significantly affect the moisture content of the flour. This might be due to uniform sun drying after soaking. Interaction effects of soaking time and temperature was significantly ($p<0.05$) affected the soy flour moisture content (Table 4a). Accordingly, flour moisture content was significantly lower (4.22%) than other treatments for soybean soaked for 12 hrs at 40°C. This value was also lower than the raw (5.33%). The results in this study were in agreement with earlier investigator Orhevba (2010), who reported that moisture content of soy flour as (4.8%).

Crude protein: Soaking temperature exhibited no significant effect ($p>0.05$) on the protein content of the flour as both flours produced after soaking at 25°C and 40°C had 43.4% and 43.7% protein content, respectively

(Table 4a). This finding was in agreement with those of Yanez, et al. (1982) who reported no significant effect of soaking temperature at 45oC the protein content of peanut flour.

The effect of soaking time on the protein content of soy flour was significant ($p<0.05$). The flour protein content was 43.17% for soybean soaked for 8 hrs and 43.96% for soybean soaked for 16 hrs (Table 4a). No difference was observed as a result of the 12 hrs soaking time as compared to either value. But the trend was increasing, as the soaking time increased from 8 to 16 hrs. This showed that soaking soybean for a longer time gave more protein content compared to soaking for a short time. Although the increase in protein was more significant in 16 hrs soaked soybean than 12 hrs, the value remained higher as compared to 8 hrs. Alonso *et al*., (1998) observed a significant increase in protein levels in kidney beans after soaking (3%) and after dehulling (6%). Mubarak (2005) also reported a 9% increase in protein content in mungbean flour, but Njitang *et al*., (2001) observed an average decrease in protein content in dehulled bean flour due to germination. The result in the present investigation was in agreement with the earlier investigation of Orhevba, (2010) who studied processing of soybean and found out that the protein content of soaked soybean ranged from 43 to 46%.

Crude protein content of soy flour was not significantly ($p>0.05$) influenced by the interaction effects of time and temperature. At soaking time of 16 hrs at 40°C, higher protein content (44.26%) was obtained compared to 8 hr soaking at 25°C, 8 hr soaking at 40°C and 12 hr soaking at 25oC (Table 4a). Furthermore the values exhibited a consistent increasing trend in protein content as the soaking time increased for both temperatures. At soaking temperature of 25°C and 8, 12, and 16 hrs of soaking time, the crude protein was 43.21, 43.42, and 43.65% respectively. At soaking temperature of 40°C, and 8, 12, and 16 hrs of soaking time, 43.13, 43.72, and 44.26%, respectively protein content of soy flour were observed. This value is slightly higher than the raw soy flour due to both soaking and dehulling. According to Mubarak (2005) after soaking, dehullinhg with the combination of germination, the protein value was higher compared to the raw flour.

Fat content: The fat contents of soy flour showed significant difference ($p<0.05$) with the soaking temperature. The soybean subjected to 25°C soaking temperature had lower (19.86%) fat content than obtained from soybean soaked at 40°C (21.22%) (Table 4a). The value exhibited increasing trend as the soaking temperature increased. High value in which the soybean seeds are soaked in hot water because the preheating treatment reduces viscosity of the oil and allows for easy breakdown of cells and release of oil. This can be explained by the fact that due to expansion of the tissue of soaked soybean facilitate better extraction of fat. This value obtained were closer to the value (26% to 19.90%) reported by Raji and Famurewa, (2008).

The fat content of the flour appeared to be decreased with increase in the soaking time. The shortest soaking time, i.e. 8 hrs, gave flour with the highest (21.47%) fat content which was significantly different ($p<0.05$) from those of 20.21 and 19.95% for the flour obtained after 12 and 16 hrs of soaking time, respectively. This could be due to leaking of fat as soaking time increased. This result was in agreement with the findings of (Suberbie *et al.,* 1981) who reported that dehulled beans contained 18% to 22% oil. This value was also higher than the raw soy flour (20.80%). Suberbie *et al.,* (1981) also reported that nutrient distribution after dehulling and soaking may explain higher in fat content of bean compared to raw seed flour.

Soaking temperature and time interaction exhibited no significant effect ($p>0.05$) on the fat content of the flour as flours produced after soaking at 12 hrs with 25°C, 16 hrs with 25°C, and 40°C (Table 4a). The fat content 21.98% was obtained from soybean soaked for 8 hrs at 40°C but not significantly different from 20.96% and 21.38% soybean soaked at 8 hrs at 25°C and 12 hrs at 40°C, respectively.

Crude fiber: The crude fiber content of the soy flour soaked at 40°C had showed significantly higher (2.66%) value than the flour produced after soaking the soybean at 25°C. The value increased with increasing in soaking temperature attaining the highest value at the highest soaking temperature. This could be explained by the fact that the size of the soaked soybean increased with temperature due to expansion of the tissue particles allowed to give higher fiber at higher temperature. The result obtained was in close agreement with those of earlier reported (2.3%) by Yanez, *et al.* (1982). Results in this study also agreed with the findings of (Dubois and Hoover, 1981) of 2.1%. The result obtained in the present study was lower than the raw soy flour (5.83%). This might be due to the lower or absence of hull compared to raw soy flour.

The fiber contents of the flours obtained from the soybean subjected to the three soaking periods exhibited significant ($p<0.05$) difference from each other (Table 4a). The flour of the soybean with the longest (16 hrs) soaking time had the highest (3.22%) fiber content while that of the shortest (8hrs) soaking time showed the lowest (1.47%). The 12 hrs soaking time resulted in flour with 2.08%, which was significantly different ($p<0.05$) from either of the two (Table 4a). As the soybean soaking time increased from 8 to 16 hrs the score of crude fiber content of the soybean flour also increased from (1.47%, 2.08%, and 3.22%), respectively. This could be due to longer soaking time that facilitated to separate fiber from the cell during processing.

Interaction effect of soaking time and temperature significantly affected crude fiber content ($p<0.05$) (Table 4a). Accordingly, higher value (3.77%) was obtained for soybean soaked at 16 hrs and 40°C. The lower value was observed for soybean soaked for 12 hrs at 25°C and 8 hrs soaked at 40°C (Table 5a). These values were lower than the raw (5.83%) soy flour fiber due to soaking and dehulling. The values showed a consistent increase in fiber content as the soaking time increased at 40°C (1.27, 2.95, and 3.77%). This might be due to higher temperature combined with longer soaking time which facilitated better separation of fiber.

Table 4a: Effect of soaking temperature and time on proximate composition (moisture, protein, fat and crude fiber) of soybean flour and soybean milk

Variables		Soy flour				Soy milk			
		Moisture (%)	Protein (%)	Fat (%)	Crude fiber (%)	Moisture (%)	Protein (%)	Fat (%)	Crude fiber (%)
Time	Temp.	Main effect of soaking temperature (25 and 40°C) and soaking time (8, 12 and 16 hrs)							
	25	4.73±0.17a	43.43±0.33a	19.86±1.09b	1.85±0.65b	10.54±1.40b	50.76± .82a	21.38±1.97a	0.05±0.01a
	40	4.55±0.30b	43.70±0.57a	21.22±1.03a	2.66±1.11a	11.20±1.26a	49.16±1.31b	21.41±1.18a	0.04±0.03a
8		4.63±0.15a	43.17±0.25b	21.47±0.66a	1.47±0.22c	11.81±0.75a	48.91±0.66c	20.37±0.29c	0.03±0.01b
12		4.56±0.39a	43.57±0.37ab	20.21±1.53b	2.08±0.95b	10.69±1.21b	50.98±0.66a	21.45±1.61b	0.04±0.02b
16		4.73±0.15a	43.96± 0.44a	19.95±0.93b	3.22±0.62a	10.10±1.49c	49.98±2.62b	22.35±1.85a	0.06±0.01a
Interaction effect (soaking time and temperature)									
8	25	4.58±0.09b	43.21±0.17b	20.96±0.13abc	1.67±0.02d	11.15±0.19b	48.42±0.41e	20.14±0.08c	0.04±0.01bc
8	40	4.66±0.21ab	43.13±0.36b	21.98±0.56a	1.27±0.04e	12.47±0.24a	49.41±0.43d	20.61±0.20c	0.03±0.01cd
12	25	4.90±0.14a	43.42±0.26b	19.03±0.32d	1.22± 0.19e	11.72±0.55b	51.49±0.27b	20.01±0.31c	0.05±0.01b
12	40	4.22±0.10c	43.72±0.40ab	21.38±1.27ab	2.95±0.11b	9.66±0.38c	50.46±0.47c	22.88±0.47b	0.03±0.01cd
16	25	4.68±0.07ab	43.65±0.44ab	19.61±1.31cd	2.67±0.15d	8.75± 0.21d	52.35±0.30a	23.98±0.51a	0.05±0.01b
16	40	4.78±0.21ab	44.26±0.17a	20.29±0.31cbd	3.77± 0.19a	11.45±0.23b	47.61±0.46f	20.73±0.65c	0.08±0.01a
Mean		4.64	43.56	20.54	2.26	10.86	49.96	21.39	0.04
CV		3.25	0.76	3.91	6.06	3.00	0.80	1.97	16.84

CV=coefficient of variance, Values followed by different letters indicate a significant difference ($p<0.05$), Mean ± SD; Number of observation with in treatment = 3

Table 4b: Effect of soaking temperature and time on ash, carbohydrate and pH of soybean flour and soybean milk

Variables		Soy flour		Soy milk		
		Ash (%)	Carbohydrate (%)	Ash (%)	Carbohydrate (%)	pH
Time(hrs)	Temp.	Main effect of soaking temperature (25 and 40°C) and soaking time (8, 12 and 16 hrs)				
	25	4.41±0.18a	25.30±2.19a	6.62±0.54b	10.65±2.47a	6.66±0.06a
	40	4.54±0.21a	23.38±1.49b	8.30±1.44a	9.87±0.45b	6.68±0.04a
8		4.43±0.22a	24.72±0.66ab	6.89±0.53b	11.96±2.12a	6.71±0.03a
12		4.52±0.15a	25.33±2.42a	7.36±0.72b	9.47±0.27b	6.67±0.05ab
16		4.46±0.25a	23.00±2.15b	8.13±2.15a	9.36±0.94b	6.64±0.05b
Interaction effect (soaking time and temperature)						
8	25	4.44±0.26a	25.12±0.07ab	6.43±0.20cd	13.81±0.88a	6.72±0.04a
8	40	4.42±0.22a	24.32±0.77ab	7.36±0.15b	10.11±0.44b	6.69±0.02ab
12	25	4.44±0.19a	27.12±0.43a	7.25±0.37bc	9.45±0.33bc	6.66±0.07ab
12	40	4.59±0.05a	23.53±2.21b	7.47±1.06b	9.49±0.26bc	6.68±0.03ab
16	25	4.34±0.08a	23.65±3.15b	6.17±0.18d	8.69±0.82c	6.62±0.04b
16	40	4.59±0.32a	22.29±0.55b	10.08±0.17a	10.03±0.47b	6.66±0.06ab
Mean		4.47	24.34	7.46	10.26	6.67
CV		4.75	6.69	6.47	5.68	0.71

Note: CV=coefficient of variance, Values followed by different letters indicate a significant difference ($p<0.05$), Mean ± SD; Number of observation with in treatment = 3

Ash: The effect of soaking temperature was not significant on the ash content of the two flours (Table 4b) (4.41% ash for 25°C soaking and 4.54% for 40°C soaking). These findings were in agreed with the previous studies Salim *et al*., (2007) who reported ash content from 4.57 to 5%. Soaking time exhibited no significant effect on the ash content of soy flour processed at 8, 12, and 16 hours had 4.43, 4.52, and 4.46%, respectively. These results were not agreed with those of Orhevba, (2010) who reported that soaking time significantly increased from 4.17, 5.83, and 6.0% for ash content of soy flour but some difference was observed because he was used 2, 3, and 4 hrs soaking time, respectively.

The interaction effects of soaking time and temperature were not significantly affected ash content of soy flour (Table 4a). Ash content indicates milling performance by indirectly revealing the amount of bran contamination in flour. Ash in flour can affect color, imparting a darker color to finished products. The ash content was also an indicator of flour yield; hence the flour possessing lower ash content may have more endosperm and ultimately good flour yield (William *et al*., 1986).

Total carbohydrate: Soy flour produced from soybean at 25°C had significantly ($p<0.05$) higher total carbohydrate (25.30%) than hot water at a temperature of 40°C (23.38%) (Table 4b). This indicated that temperature affected the total carbohydrate content of processed soy flour. As soaking temperature increased from 25 to 40°C, the carbohydrate content was decreased. This was probably due to leaching of water soluble nutrients to the soaking water. The total carbohydrate content obtained was in agreement with Stauffer (2008). But it was lower than the value (30%) reported by Famurewa and Raji, (2005). The total carbohydrate content of soy flour was not significantly affected ($p<0.05$) by the soaking time. The total carbohydrate of 24.72%, 25.33%, and 23.00% were observed at soybean subjected to 8 hrs, 12, hrs and 16 hrs soaking time, respectively. However, these results were greater than the raw soy flour (20.0%).

The interaction effects of time and temperature were not significant on the total carbohydrate content of soy flour (Table 4b). At 12 hr soaking with 25°C, higher total carbohydrate content (27.12%) was obtained compared to12 hrs soaking at 40°C, 16 hrs soaking at 25°C, and 16 hrs soaking at 40°C. However, the result was not significantly different ($p>0.05$) compared to 8 hrs soaking at 25°C, and 8 hrs soaking at 40°C. The result of the present investigation was agreed with the earlier investigation of Salim *et al*., (2007) reported that the total carbohydrate content of processed soy flour ranges between 18 to 29.2%. Salim *et al*., (2007) also reported, higher total carbohydrate content in the processed soy flour than raw soy flour.

c) *The Effect of Soaking Temperature and Time on Proximate Composition of Soybean Milk*

Moisture content: Temperature was significant ($p<0.05$) on moisture content of soy milk (Table 4a). The moisture content of soy milk was 11.20% for sample soaked at 40°C and 10.54% for sample soaked at 25°C. Increase in moisture content might be due to hot water which affected the water absorption capacity of protein and starch. This is supported by the finding of (Akinyele 1989; Saikia *et al.*, 1998) who reported that heat increased the water absorption of protein. In the present study, increased in moisture content probably had a dilution effect on other nutrient in the soaked soybean. The result obtained for soy milk moisture was in close agreement with those reported earlier (11.4% and 10.40%) by Salunkhe and Kadam, (1989).

The three different soaking times produced a significant difference ($p<0.05$) in the moisture content of the soy milk (Table 4a). The increase in soaking time from 8 hrs to 16 hrs resulted in decreased moisture content. There was an inverse relationship between moisture and soaking time. Moisture content was significantly higher value occurred at 8 hrs soaking time and the lower moisture content obtained at 16 hrs soaking time. It showed 11.81% for 8 hrs soaking, 10.69% for 12 hrs soaking and 10.10% for 16 hrs soaking.

The combined effect of soaking time and temperature on the moisture content of soy milk was presented in Table 4a. The interaction effects of soaking time and temperature was significant ($p<0.05$) on moisture content of soy milk. Moisture was significantly higher (12.47%) for soaking time 8 hrs at 40°C whereas the lower moisture value (8.75%) was for soaking time of 16 hrs at 25°C. These result agreed with the findings of Orhevba, (2010) who reported the moisture content of 9.2% but some difference was observed because of higher soaking time and temperature combination i.e. 18 hrs with 50°C.

Crude protein: The protein content of soy milk obtained from soybean soaked at 25°C was significantly ($p<0.05$) higher (50.76%) than that of the soy milk produced from soybean soaked at 40°C (49.16%) (Table 4a). The high protein value for 25°C is probably due to the fact that soaking had increased the breaking down of the secondary bonds holding down the molecules of the amino acid thus making the protein more soluble and hence increasing availability of the amino acid. NRC (1993) showed that excessive heat treatment reduces the availability of heat sensitive amino acids and in particular that of lysine. Salunkhe and Kadam, (1989) indicated that heat treatment followed by grinding could affect nutritional composition. Wilkens and Hackler, (1969) stated that the effect of water temperature on soy milk composition were an increase in lipid but a decrease in carbohydrate and protein was relatively unaffected but some difference observed because of higher temperature i.e.25°C to 60°C.

Table 4a shows that soaking time had influenced soy milk protein content. The highest (50.98%) protein content was that of milk produced after 12 hrs of soybean soaking. The 16 hrs soaking period resulted in milk of 49.98% protein content whereas the 8 hrs soaking time gave 48.91% milk protein (Table 4a). All three values of protein contents were statistically different ($p<0.05$) from each other eventhough no trend was shown relative to the soaking times. These value were different when compared to the protein range of soybean (35 to 40 %) reported by Famurewa and Raji, (2005) and most legumes (17% to 48.30%) reported by Reddy *et al*. (1984) and 39 to 46% observed by Bhumiratana (1978). The result reported in this study was probably due to high protein composition of AFGAT variety. Trongpanich, *et.al* (1988) reported that high protein in soybean usually gives high protein in soy milk.

Soy milk crude protein was significantly ($p<0.05$) influenced by interaction effects of soybean soaking time and temperature. For 16 hrs soaking at 25°C, highest (52.35%) crude protein was obtained. The least result was for16 hrs soaking at 40°C (Table 4a). Furthermore, the value exhibited increasing trend in protein content as the soaking time increased from 8 to 16 hrs at 25°C (48.42, 51.49 and 52.35%). The high protein value for 25°C was probably due to the fact that longer soaking time had increased the breaking down of the secondary bonds holding down the molecules of the amino acid thus making the protein more soluble and hence increasing availability of the amino acids. Soaking probably helped to increase the solubility of the denatured protein such that the protein content of the soymilk produced was high. Tunde and Souley (2009) reported that soaking as well as blanching gave a higher protein content of soymilk because soaking gives a tender product, which results in a finer slurry and thus more filtrate which will filter through the filter cloth thereby increasing yield and subsequently the protein content of soymilk. Wilkens and Hackler, (1969) reported that the effect of soaking temperature (25 to 60°C) on soy milk protein were relatively unaffected but protein recovery was known to decrease slightly at 70°C and higher.

Fat content: The fat content of soy milk obtained after treating the soybean with the two soaking temperature (25 °C and 40 °C) exhibited no significant difference (21.38 and 21.41% respectively). The fat content of the milk had significantly ($p<0.05$) increased with increasing in soaking time. The 8, 12 and 16 hrs soaking periods resulted in 20.37%, 21.45% and 22.35%, respectively, fat content of the soybean milk (Table 4a). This could be due to longer soaking time weaken the structure of the tissues or wall of the cells that facilitated their rapture and thereby the released of the fat globules during the milk processing. The present study was in agreement with Wilkens and Hackler, (1969) who reported that the major effect of soaking increased fat content with increasing soaking time.

The interaction effect of soaking time and temperature was significant ($p<0.05$) on the fat content of soy milk. The highest fat value (23.98%) occurred in soybean milk prepared at 16 hrs soaking at 25°C (Table 4a). No significant differences were observed among 8 hrs soaking at 25°C and 40°C, 12 hrs soaking at 25°C and 16 hrs soaking at 40oC. These results were in line with Milligan *et al*., (1981) who reported that 22.89%. Different investigators reported that, the overall effect of soaking was enrichment of the crude protein and fat content of the soy milk. Soaking at higher temperature was known to drastically reduce the yield of soy milk.

Crude fiber: The soaking temperature showed no significance difference on the crude fiber content of soymilks which were obtained from 25°C and 40°C soaking temperature (0.05 and 0.04%, respectively) (Table 4a). These value was very low as compared to Bahareh Hajirostamloo, (2009) who reported (0.2% to 0.31%) for soy milk. This could be probably due to processing difference or different soy milk extracting equipment (blender). Balogun and Fetuga, (1986) revealed that, the low crude fiber is nutritionally appreciated because it traps less proteins and carbohydrates and improves their bioavailability.

The longest soybean soaking time (16 hrs) had resulted in soybean milk with significantly ($p<0.05$) higher crude fiber (0.06%) content than the other two soaking periods. The two soaking periods (12 and 8 hrs) values (0.04% and 0.03%) were not significantly different ($p<0.05$). When the soaking time increased, the fiber content of the soy milk also increased. This could be due to longer soaking time which allowed separating fiber from the tissue.

The interaction effects of time and temperature had significantly ($p<0.05$) affected the fiber content of soy milk (Table 4a). The highest value (0.08%) was observed at soaking time of 16 hrs at 40oC. The values in the present study were lower than the result of Bahareh Hajirostamloo, (2009) who observed the fiber content of soy milk in which ranged from 0.2 to 0.31%. In the current study, the crude fiber was closer to (0.0). This might be due to method of extraction and soy milk extracting equipment (blender). The blender sieve size was denser (<100 μm) and with lower amount of pore space it accommodated suspended particles inside the extracting material. The denser and the less pore size distribution of the blander that can reduce or blocked the probability of entrance of fiber in to the milk resulted in less fiber content due to less pressure within the pores during soy milk extraction. Balogun and Fetuga, (1986) revealed that the low crude fiber is nutritionally appreciated because it traps less proteins and carbohydrates.

Ash content: The ash content of soy milk produced from soybean soaked at 40°C was significantly ($p<0.05$) higher (8.30%) than that of the milk produced after soaking the soybean at 25°C (6.62%) (Table 4b). The value increased with increasing in soaking temperature attaining the highest value at the highest soaking temperature due to expansion of the tissue. This value was higher than 4.83% and 5.02% observed by Adebayo, *et al*., (2008). The difference was probably due to processing and variety difference (Saikia *et al*., 1998).

Soybean subjected to 16 hrs soaking had significantly ($p<0.05$) higher ash value (8.13 %) than other two soaking times in soymilk. Whereas the remaining two soaking times (8 and 12 hrs) had not showed significant differences between each other. The result showed the ash content of soymilk was increased with increasing the soaking time. This might be due to prolonged exposure of the soybean to soaking which increased degradation of tissues.

Soymilk ash content was significantly ($p<0.05$) influenced by soybean soaking time and temperature (Table 4b). Accordingly, higher ash value (10.08%) was measured for soaking time of 16 hrs at 40°C. This result agreed with the findings of (Orhevba, 2010) who reported the ash content of soy milk from 4.5 to 10.5%. Ash contents in this study also agreed with the findings of Liu, (1997) that found 6 to 9.2% but some difference observed because of the higher temperature i.e. (50oC) used during soaking. The presence of ash in the soymilk produced, gave an indication of the presence of inorganic minerals in it. But among other treatments of 8 hrs soaking at 40°C, 12 hrs soaking at 25°C and 12 hrs soaking at 40°C, ash content of soy milk were not significantly varied.

Total carbohydrate: The total carbohydrate of soy milk was significantly affected ($p<0.05$) by temperature. The highest total carbohydrate content (10.65%) was observed in the soy milk sample extracted from soybean soaked at 25°C and the lowest (9.87%) was for soy milk sample extracted from soybean soaked at 40°C (Table 4b). This value was higher as compared to 9.22% observed by Bhumiratana, (1978). The present result was lower than 11.3% reported by Salunkhe and Kadam (1989). This report indicated that processing will affect the total carbohydrate content of soy milk. The result obtained in the present study had agreed with Wilkens and Hackler, (1969) in which a reduced carbohydrate content and increase in lipid content was reported with soaking effect. The longer soaking at higher temperature had reduced solid yield. In other work (Bhumiratana, 1978) soaking temperature above 45°C with longer soaking time had resulted in a large decrease in the total solids and carbohydrate. The effect of short

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duration of soaking was also predominantly because of leaching of water soluble carbohydrate. Processing has different effect on different food products. In soymilk, crude protein, ash and fat were increased whereas the total carbohydrate and crude fiber were decreased from the original value.

Soymilk that obtained from soybean soaked for 8 hrs resulted in significantly ($p<0.05$) higher value of total carbohydrate (11.96%) than those treated with 12 and 16 hrs soaking time (Table 4b). The later value was not significantly different between each other. It showed that when the soaking time increased, a decrease in the total carbohydrate content. This result in agreement with Bhumiratana, (1978) reported that the major effect of soaking on composition was to reduce total carbohydrate and increase lipid content. Longer soak reduce solid yield.

Soymilk carbohydrate was significantly ($p<0.05$) affected by interaction effects of time and temperature. Accordingly, carbohydrate content (13.81%) was higher for soybean soaked for 8 hrs at 25oC (Table 4b). However, there was no significant difference between 12 and 16 hrs soaking at both temperatures. The result showed a decreasing trend as soaking time increased. This result was supported by Wilkens and Hackler, (1969) who reported that the total solids decreased with both increasing soaking time and temperatures for dehulled beans. The effect of short duration soaking was predominantly leaching of water soluble carbohydrate. On the average, carbohydrate accounted 60% of the solids contained in the soaking water.

pH: Soy milk pH was not affected by temperature. The value was 6.67 (Table 4b). This was similar to 6.74 reported by Bahareh (2009). The present value was in the range reported by Trongpanich, *et.al* (1988) who stated that the proper range of pH of soymilk was (6.6 to 6.8). The same author reported that lowering the pH (<6.6) would result into protein precipitation and an increase in the pH (>6.8) would affect the milk flavor. Similarly, the time was not significant on the pH of soy milk as soy milk produced after soaking 8, 12 and 16 hrs had 6.71, 6.67 and 6.64 pH of soymilk, respectively.

As shown in Table 5b the pH of the soy milk not significantly influenced by interaction of soaking time and temperature. Generally the pH was reduced as soaking time extended from 8 to 16 hrs although some irregularity was observed.

d) The Effect of Soaking Temperature and Time on Sensory Attributes of Soybean Milk

i. Color

Temperature was significantly different ($p<0.05$) on color acceptability of soy milk (Table 6). At 40°C soaking temperature soy milk color was found to have significantly higher score (6.71) than at 25°C. The product obtained at 40°C was more accepted by consumer panelists. The colors of the soybean milk that obtained from the two soaking temperatures were above average based on the scale used on the evaluation sheet. Heat treatment (blanching and hot water soaking) were known to reduce lipoxygenase enzyme which deteriorated color and thereby keeping the natural color of the soy milk. According to Cauvain and Young (2001) soybean contained lipoxygenase enzyme, which oxidized carotenoid and chlorophyll pigments. Muller, (1988) also reported that soybean lipoxygenase inactivated by blanching. Since soybean was blanched prior to soaking, this might be blocked the activation of enzyme or color oxidation.

Soy milk color was significantly affected by soybean soaking time (Table 6). The soymilk prepared by soaking for 8 hrs was found to have significantly ($p<0.05$) higher (6.82) than 12 and 16 hrs soaking time. Between the products obtained at 12 hrs and 16 hrs significant differences was not observed. The former soy milk color was perceived as more accepted by consumer panelists as compared to the later. Soy milk color acceptance had increased when soaking time decreases from 16 hrs soaking to 8 hrs soaking. Longer soaking time is shown to have slightly reducing the color acceptance of the soy milk; it becomes yellowish color with increasing soaking time.

The interaction effect of soaking time and temperature on sensory quality of soy milk color is presented in Table 6. Soy milk which was made from soaked soybean at 40°C soaking temperature with 8 hrs soaking time resulted in highest sensory score (7.00) of color than other treatments, there was no significant difference among others. But color acceptance was close to "like moderately" based on the scale and this indicated that panelists had accepted the color of all soymilk. The product was more acceptable in color at lower soaking time with higher soaking temperature. According to evaluator perception, color was major parameter in sensory attribute of soymilk. The highest sensory score of milk color might be due to optimum soaking temperature and time in combination with proper blanching that prevented from oxidation of color pigments and which gave the product more acceptability.

Table 6: Effect of soaking temperature and time on sensory quality attributes of soybean milk

Variables		Color	Flavor	Odor	Overall acc.
Time	Temperature				
		Main effect of soaking temperature (25 and 40^{O}C) and time (8, 12 and 16 h)			
	25	6.55±0.62b	6.31±0.64a	6.37±0.75a	6.50±0.50b
	40	6.71±0.46a	6.37±0.55a	6.44±0.64a	6.67±0.50a
8		6.82±0.39a	6.61±0.49a	6.84±0.66a	6.90±0.30a
12		6.55±0.67b	6.53±0.50a	6.57±0.50b	6.70±0.46b
16		6.52±0.50b	5.88±0.52b	5.80±0.45c	6.16±0.42c
		Interaction effect (soaking time and temperature)			
8	25	6.64 ± 0.48b	6.54±0.50ab	6.72 ± 0.90b	6.80 ± 0.40b
8	40	7.00 ± 0.00a	6.68 ±0.47a	6.96 ± 0.20a	7.00 ± 0.00a
12	25	6.48 ± 0.81b	6.64 ± 0.48a	6.96 ± 0.20a	6.66 ± 0.47b
12	40	6.62 ± 0.49b	6.42 ± 0.50b	6.58 ± 0.50b	6.74 ± 0.44b

CV=coefficient of variance, Values followed by different letters indicate a significant difference (p<0.05), Mean ± SD; Number of panelist = 50.

The attractive color could be probably due to modern extraction material (blender) which was protected entrance of unwanted material into the milk and allowed the okara to remain on the sieve; this may keep the natural color of the milk. According to Trongpanich, et al. (1988) in the traditional way of soy milk production, the slurry was cooked since it was well recognized technique for improving the flavor. However, even slight over cooking resulted in strong sulfur and burnt smell as well as dark color in the appearance of soymilk.

ii. *Flavor*

There was no significant difference between the two soaking temperatures on flavor acceptance of soy milk (Table 6). All products had good flavors and this might be due to optimum blanching which stopped the enzymatic activity that helped to produce acceptable flavor. The result indicated that blanching and soaking were examined the composition of soy milk extracted with hot water prevent development of rancid flavor. Guy (2001) reported that unprocessed soybeans have off-flavor. Off-flavors are often generated through enzymatic lipid oxidation. The enzymes involved in lipid oxidation are lipoxygenases. Hymowitz and Polmer (2004) also described that during soymilk production; distinctive flavors were developed that were variously described as beany, rancid, and bitter. The flavor was due to the action of native soybean enzyme.

The effect of soaking time on flavor is presented in Table 6. The soy milk prepared from soybean soaked for 16 hrs had significantly (p<0.05) lower score (5.88) than others. However, there was no significant difference between 8 hrs and 12 hrs soaking time. Generally, as the soaking time increased from 8 to 16 hrs the flavor acceptance score decreased. Optimum soaking time avoided most off-flavor compounds resulting in good flavor acceptance. Longer soaking time gave slight bitterness to the product. According to Perkins, (1989) during heat treatment, time was critical to obtain optimum results with the least protein denaturation.

Interaction effect of soaking time and temperature was significantly affected the soy milk flavor (Table 6). Soy milk flavor was significantly lower (5.74) which were obtained from soaked soybean for16 hrs at 25oC than other treatments (8 hrs soaking at 40oC, 12 hrs at 25oC, and 8 hrs at 25oC soaking). The entire flavor acceptance score were above “moderately like” except few, which are very close to “moderately like” indicating that all the products had acceptable flavor by the panelists.

The result showed that the beany flavor of soy milk was reduced to greater extent by blanching and soaking. According to Taylor, (1996) flavor was considered as a combination of aroma, taste and trigeminal perceptions from stimulation of the mouth and nasal area. Wilkens *et al.* (1967) had reported that heat treatment could reduce the off flavor in soy milk. Wilkens and Hackler, (1969) also reported that range of processing conditions were known to influence the composition and yield of soybean milk and among these blanching and soaking of soybean seed were known to prevent the formation of rancid flavor.

iii. *Odor*

Soy milk odor was not affected by soaking temperature. Unlike temperature, soaking time had significant influence (p<0.05) on soymilk odor (Table 6). Significantly higher score (6.84) was observed at 8 hrs soaking time. The result showed that as the soaking time extended from 8 hrs to16 hrs, the odor acceptability of soymilk was reduced. Based on the scale (seven point hedonic scale) considered in this study for sensory evaluation, longer soaking time were not required for acceptable soy milk odor.

The combined effect of soaking time and temperature was significant ($p<0.05$) on odor of soy milk (Table 6). Soybean subjected to 40°C and 25°C soaking temperature for 8 hrs and 12 hrs, respectively, resulted in more acceptable odor with value of 6.96 compared to soymilk odor obtained from soybean that was treated at 25°C and 40°C soaking temperatures for 16 hrs. The result showed that the former soymilk was better accepted based on the scale used in the evaluation sheet.

iv. *Overall acceptability*

The overall acceptability of soy milk was influenced by soaking temperature which expressed as the cumulative effects of the selected parameters (Table 6). More accepted product was obtained from soybean treated at 40°C. Soy milk made from soaked soybean at 25°C was found to have lower acceptance. This showed that soaking temperature significantly affected the overall acceptability of soy milk. The score of overall acceptability tended to decrease with decreasing soaking temperature due to the occurrence of some off flavoring compounds.

Over all acceptability of soy milk was significantly ($p<0.05$) reduced with increasing soaking time. Soybean treated for 8, 12, and 16 hrs soaking period scored 6.90, 6.70, and 6.16, respectively, (Table 6) The decreased in overall acceptability occurred when the product soaked for longer time the compounds leached into the water and reabsorbed by the grain. The highest acceptability soy milk produced from 8 hrs soaking. Moreover, the overall acceptability were above moderate indicating higher level of the overall quality of the milk.

The interaction effects of soaking time and temperature on sensory evaluation of soy milk regarding the overall acceptance is presented in Table 6. Soy milk prepared from soybean soaked for 8 hrs at 40°C were found to have significantly ($p<0.05$) higher (7.00) overall acceptance than others. Soymilk prepared from soybean soaked at 25°C for 16 hrs was found to be the least acceptable. The overall acceptability was based on consumer panelist experience as a personal appraisal. Hot water soaking is extremely important for the overall acceptability because it changed properties of soybean. Soaking for relatively hot water with shorter soaking time gives good acceptance to the soy milk than lower temperature and longer soaking time.

IV. Summary and Conclusions

a) Summary

The present study was conducted to investigate the effects of soaking time and temperature on proximate composition and sensory quality of soy milk. The experiment was comprised two soaking temperature (25°C and 40°C) and three soaking times (8, 12, and 16 hrs), total six treatments for each (soy flour and milk) and laid in CRD with three replications. Sensory evaluations were conducted on soy milk to evaluate color, flavor, odor and overall acceptability. A total of 50 male and female consumer panelists were involved in the evaluation.

Soaking time and temperature were found to have significant effects on the proximate composition. Flour protein, fat and total carbohydrate were significantly ($p<0.05$) higher (44.26%,21.98%,27.12%) for soybean soaking time of 16 hrs at 40°C, 8 hrs at 40°C and 12 hrs at 25°C as compared to raw soybean flour 44%,20.80% and 20.0%, respectively. However, crude fiber (3.77%) and ash (4.47%) were less in soybean flour. Soy milk protein, fat and total carbohydrate were significantly ($p<0.05$) higher (52.35%, 23.98%, and 13.81%) for soybean soaking time 16 hrs at 25°C,16 hrs at 25°C, and 8 hrs at 25°C, respectively. Compared to other treatment crude fiber value were low (0.03%) at 8 and 12 hrs soaking time with 40°C soaking temperature.

Soaking temperature and time had significant effect on soy milk quality. The soybean milk quality was evaluated by sensory panelists for color, flavor, odor and overall acceptability. The most accepted milk was obtained from soy bean soaked for 8 hrs at 40°C in all parameters. The sensory mean score for color, flavor, odor and overall acceptability were 7.00, 6.68, 6.96 and 7.00, respectively on seven point hedonic scale.

b) Conclusion

The current study revealed that soaking time and temperature had increased protein, fat and total carbohydrate whereas crude fiber and ash were lower than raw soybean flour. In soy milk, protein, fat and ash were increased while total carbohydrate and crude fiber were reduced. It was concluded that the two products needed different processing conditions to improve their protein properties. Optimum processing time and temperature was important for increasing nutrient content. Processing included soaking and dehulling. The most accepted soybean flour and milk was produced from soy bean soaked at 8 hrs with 40°C in all parameters.

c) Recommendations

In this experiment to recommend optimum processing methods for soy flour and soy milk, two important points were considered: treatments which increased or maintained the proximate composition and sensory quality. Accordingly, soaking of soybean for 8 hrs at 40°C is recommended for soy flour production. Based on the result, at this time and temperature the nutritional compositions were positively affected. Although proximate composition was relatively not high for soaking of 8 hrs at 40°C as compared to other treatments, this optimum processing time and temperature is recommended for soy milk due to sensory quality.

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