EFFECT OF DIFFERENT PROCESSING METHODS ON THE QUALITY, YIELD AND STORAGE STABILITY OF SOYMILK (*Glycine max. L*)

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Abstract

This work aimed at producing and evaluating the quality of soymilk obtained from soybeans processed by different methods (boiling, steeping, and roasting). The beans were processed, wet milled and sieved to obtain soymilk. The milks were subjected to proximate, microbial and sensory analyses using standard methods. Results for proximate composition of the samples showed crude protein content to range from 30.66% - 42.49% with sample RSM (roasted soymilk flour) having the least value while sample SSM (steeped soymilk flour) had the highest, fat content ranged from 22.33% - 23.67% with sample SSM having the least value while RSM had the highest value. RSM had the least milk yield while sample SSM had the highest. Sample BSM (boiled soymilk flour) had the least microbial count of all. Sensory evaluation showed that soymilk produced from roasted soybean was the most acceptable and differs significantly ($P \leq 0.05$) from other samples.

Keywords: Food processing, Soymilk, Sensory evaluation, Cooking

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Introduction

Soybean is an excellent source of protein both in quality and quantity. According to Ayo *et al.*, (2011) soybean contributes approximately 20% protein to diet of animals and humans. Soybean contains 35 – 40% protein with all the indispensable amino acids (Serrem *et al.,* 2011). For thousands of years, the Chinese and people in the neighboring countries consumed soybean in various forms including Tofu, Soy sauce, Miso among others. Like soymilk, soy foods are becoming some of the fastest growing categories in the food industry. Despite the benefits derived from soy proteins, proper processing of soybeans in various products is important to remove trypsin inhibitors and lipoxygenase enzyme. The greatest setback to the general acceptability of soymilk from soybean is the beany off flavor (Oloye, 2014) and the concept is to minimize the beany off flavor based on specific principles.

Soymilk, a dairy milk substitute, easily prepared from mature dry beans is fast becoming a household food in developing countries including Nigeria because of its diet improving capabilities (Obiegbuna *et al.*, 2014). Like animal milk, soymilk is used in the manufacture of other food products due to its functional properties and nutritive value. Despite its intrinsic beany flavor, it has gained wild acceptances.

Soybeans are rich in vitamins, minerals and acids. Meanwhile Africa's serious malnutrition problem is essentially acute in terms of protein deficiency. Livestock constitute the major source of protein for human body, but a combination of factors including the recent persistent drought and the poor performance of indigenous animals have led to the situation where the prices of such conventional livestock product such as meat, eggs, and milk have risen beyond the reach of ordinary man. In view of this problem an alternative source of high-quality cheap protein was sought for and soybean was found to have the potential to meet part of this need.

Materials and Methods

Soybean (yellow variety) was purchased from Ikole Market, Ekiti state and was taken to the department of Food Science and Technology, Federal University, Oye Ekiti for further processing. Thereafter it was pasteurized for $75^oC - 80^oC$ and the soymilk was obtained.

Reconstitution Index

This is a property that gives an idea of how easily a product can be mixed in water before consumption. It was determined according to the method described by Banigo and Akpapunam (1987). About 50grams of each sample was dissolved in 300ml of distilled water, 15grams of sugar was also added and mixed for 30 minutes.

Proximate Composition

The moisture content, crude fibre, crude fat, crude protein and ash content were determined using the method of AOAC (2005) while carbohydrate content of the samples was determined in accordance with the method described by Ihekeronye and Ngoddy (1985).

Yield determination

Yield was determined by the method of AOAC (2000).
% of Yield = Weight of soil milk extracted x 100
Weight of sample collected 1

Sensory evaluation

The sensory evaluation was performed for seven days on the samples by (20) semi-trained panelists. Colour, mouthfeel, flavor, taste and general acceptability were estimated using a nine-point Hedonic scale with 9 and 1 representing 'Liked Extremely' and 'Disliked Extremely' respectively (Iwe, 2007)

Total plate count

The method of Adegoke (2004) was adopted in determining the total plate counts.

Calcium and Iron determination

Calcium and iron were determined by method of AOAC (2000).

Calcium= Weight of the sample (in a 10ml aliquot of the sample) = mg calcium oxide 0.7147

Statistical analysis

Data were reported as mean ± SD. Statistical significance was established using One-Way Analysis of Variance (ANOVA) at 5% level of confidence as described by Steel *et al.* (1997). The mean separation for parameters found to be significantly different was carried out using Duncan's Multiple Range Test (Ihekoronye and Ngoddy, 1985).

Results and Discussion

Proximate Composition

The results of proximate analysis of soy milk samples from different processing methods are presented in Table 1. The moisture content ranged from 4.50 % to 4.67% with sample RSM having the lowest value while sample SSM had the highest value. The moisture had no significant difference ($p<0.05$) between boiled and steeped samples respectively. However, roasted soymilk flour was significantly different with a value 3.17%. Agume *et al.* (2016) reported the same effect, stating that the low level of moisture in roasted soybean flours probably results from the high temperature (which eliminates water more quickly), and the intermolecular cross-linking that might occur. The higher moisture content in steeped sample may be due to partial coagulation of protein leaning to expulsion of water (Udeozor, 2012).

The protein content ranged from 30.66% to 42.49% with sample RSM having the lowest value while sample SSM had the highest value. The protein composition of soybeans has been generally reported to be between 20 and 48% (USSEC, 2015). This is in accordance with was reported by Aurelie *et al.* (2017) who stated in their work that roasted and unroasted soybean had a protein content of 35.5 and 46.0 g/100g (dry weight basis) respectively.

The carbohydrate content ranged from 25.25% to 40.09% with sample SSM having the lowest value while sample BSM had the highest value. All samples were significantly different ($p<0.05$) from each other.

The fat content ranged from 22.33% to 23.67% with sample SSM having the lowest value while sample RSM had the highest value. The fat of the three sample had no significant difference ($p<0.05$) between them. These figures obtained were compared to those obtained by Babajide (1985) This result shows that fat content of soymilk is not affected by the different processing methods. Fat is important in the diets of infants and young children, as it provides high energy density and facilitates the absorption of fat-soluble vitamins. It also provides essential fatty acids such as omega-3 and omega-6 polyunsaturated fatty acids (PUFAs) needed for proper neural development in infants and young children (Igyor *et al.*, 2011).

The ash content ranged from 3.33% to 4.50% with sample BSM having the lowest value while sample SSM had the highest value. The ash of the three samples had no significant difference ($p<0.05$) between them. The ash content of the three samples shows that they have relatively low values. This is also similar to what was reported by Akubor and Onimawo (2003), Aurelie *et al.* (2017) where values of 3.48-6.00% has been reported. This reduced ash content was attributed to be as a result of solubilisation of minerals in the cases of steeping and boiling, or the difference in variety and agro-ecological zone of cultivation.

The fiber content ranged from 0.55% to 0.76% with sample RSM having the lowest value while sample SSM had the highest value. The fiber content of soymilk is trace as seen from the result. This agrees with the work done by Enwere (1998) that soymilk contains no crude fiber in minute quantity, reason could be as a result of processing.

Table 1: Proximate composition of soy milk flour Sample

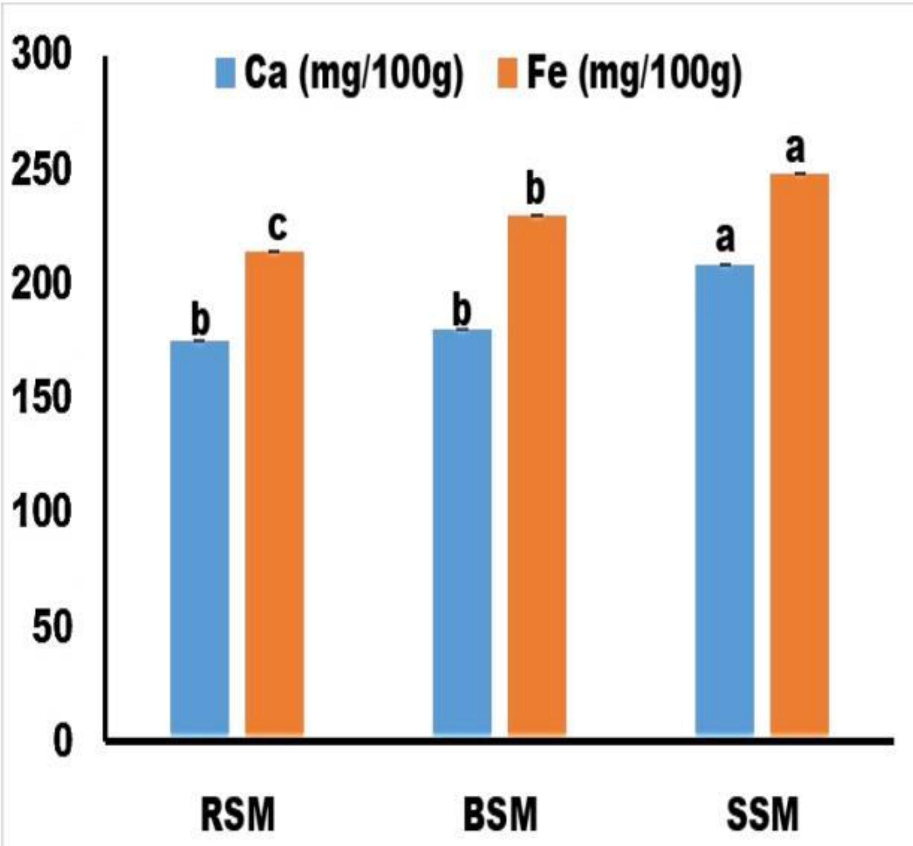
Sample	Protein (%)	Fat (%)	Ash (%)	Moisture (%)	Crude fibre (%)	Carbohydrate (%)
RSM	$30.66^{c} \pm 0.01$	$23.67^{a} \pm 4.60$	$4.00^{a} \pm 0.87$	$3.17^{ab} \pm 1.04$	$0.55^{a} \pm 0.01$	$37.95^{b} \pm 0.36$
BSM	$31.52^{b} \pm 0.01$	$23.00^{a} \pm 0.01$	$3.33^{a} \pm 0.58$	$4.50^{a} \pm 1.00$	$0.56^{a} \pm 0.01$	$40.09^{c} \pm 0.65$
SSM	$42.49^{a} \pm 0.02$	$22.33^{a} \pm 1.53$	$4.50^{a} \pm 0.50$	$4.67^{a} \pm 2.08$	$0.76^{a} \pm 0.01$	$25.25^{a} \pm 0.82$

RSM: Roasted soy milk flour, BSM: Boiled soy milk flour, SSM: Steeped soy milk flour
Values with the same superscript in the same column are not significantly different

Mineral composition

The mineral composition of different methods (Boiling, Steeping and Roasting) employed in the processing of soy milk is presented in Figure 1. The calcium content ranged from 175.11 mg/100g to 208.25 mg/100g with sample RSM having the lowest value while sample SSM had the highest value. Calcium content varies significantly ($p<0.05$) across the three samples. This shows that the application of heat has an impact on the level of micronutrients in the soy milk.

The iron content ranged from 214.01 mg/100g to 248.25 mg/100g with sample RSM having the lowest value while sample SSM had the highest value. Iron content varies significantly ($p<0.05$) across the three samples. The values obtained is close to the value reported by Enwere (1998).



RSM: Roasted soy milk flour, BSM: Boiled soy milk flour, SSM: Steeped soy milk flour

Figure 1: Mineral composition of soymilk flour using different processing methods

Microbial count of Soymilk

The microbial quality of soy milk flour is reported in Table 2. The microbial analysis was done to ascertain the safety of the soy milk flour samples for human consumption. These counts ranged from 2.10-1.52 ×1010 coliform unit. Boiled (BSM) and Roasted (RSM) samples had considerably lower bacterial counts (2.00 ×109 and 2.10 ×109 cfu/ml) when compared to that of the steeped sample having a bacterial count of 1.52 ×1010 cfu/ml.

Table 2: Coliform count of soy milk flour samples using different processing methods

Sample	CFU/ml in original sample
BSM	2.00 ×109
SSM	1.52 ×1010
RSM	2.10 ×109

Dilution factor: 10-8
RSM: Roasted soy milk flour, BSM: Boiled soy milk flour, SSM: Steeped soy milk flour

Yield determination
The results of soy milk produced from different processing methods are presented in Table 3. The yield of the soymilk samples ranged from 64 - 81 with sample RSM having the lowest value while SSM had the highest value. Soymilk yield were significantly different (p <0.05).

Table 3: Effect of different processing methods on the % yield of soy milk

Sample	Yield
BSM	72
SSM	82
RSM	64

RSM: Roasted soy milk flour - BSM: Boiled soy milk flour - SSM: Steeped soy milk flour

Sensory Evaluation
Table 4 presents the result of the organoleptic evaluation of different processing methods on soy milk flour over a 7-day period. The colour of samples is expressed as the level of sensation of product provided to the eye by the rays of light (Udensi *et al.*, 2010). The mean scores for colour ranged between 7.03-8.05 for the three samples (SSM, RSM, BSM) respectively with no appreciable decline in colour. The taste of the soymilk samples ranged from 5.33 -7.85, significant difference (p<0.05) exists between the heat-treated samples (BSM and RSM) and non-heated sample (SSM). Flavor is regarded as the expression of the aroma of a product, based on the sensory evaluation, it ranged between 5.34 and 7.55.

The heat-treated sample also had a better preference than the steeped sample. Although, the three samples had almost similar preference after the fourth day. This was described by the sensory panelists as having a reduced flavour compared to the first 2-days. A similar trend was observed for the mouthfeel mean scores of the soy milk, where significant difference (p<0.05) was observed between the soy milk samples. The values observed ranged from 5.01-8.00, representing moderately like to like very much based on a 9-point hedonic scale. In addition, a viscous texture was reported after the fourth day, this was also reported Achouri *et al.* (2008) who found similar trends after a storage period of four days. For the overall preference, the roasted sample (RSM) recorded the highest preference compared to the other two samples. Although, the boiled sample (BSM) was reported to have better sensory properties than the steeped soymilk (SSM). The lower preference by the panelists for sample SSM may be due to the beany flavour associated with the sample.

Table 4: Effect of different processing methods on the sensory properties of soy milk Sample

Samples	**No of Day(s)**	**Colour**	**Taste**	**Flavour**	**Mouth feel**	**Overall Acceptability**	**Ranking**
SSM	1	7.80a ± 2.01	7.25b ± 1.07	7.55a ± 0.76	7.25b ± 1.25	7.60ab ± 0.94	2.10a ± 0.85
BSM		8.05a ± 1.15	7.85a ± 0.88	6.85b ± 1.34	7.45ab ± 1.10	7.35c ± 1.04	2.15a ± 0.75
RSM		7.85a ± 1.70	7.85a ± 0.68	7.20a ± 0.95	8.00a ± 0.86	8.00a ± 0.92	1.70b ± 0.80
SSM	2	7.80a ± 1.10	7.21b ± 0.25	7.48a ± 0.80	7.18b ± 0.97	7.83b ± 0.84	2.09a ± 0.74
BSM		8.01a ± 2.15	7.83a ± 0.52	6.78b ± 1.09	7.38ab ± 0.98	7.44b ± 0.93	2.12a ± 0.51
RSM		7.82a ± 1.20	7.82a ± 0.98	7.14a ± 0.89	7.90a ± 0.69	8.30a ± 0.82	1.68b ± 0.03
SSM	3	7.68a ± 1.10	6.41b ± 1.30	7.48a ± 0.93	7.08b ± 0.89	7.33ab ± 0.82	2.01a ± 0.05
BSM		8.04a ± 2.15	7.63a ± 0.78	6.78b ± 1.04	7.02ab ± 0.76	7.24b ± 1.42	2.07a ± 0.92
RSM		8.81a ± 1.21	7.19a ± 0.38	7.14a ± 0.32	7.26a ± 0.76	7.30a ± 0.99	1.64b ± 0.75
SSM	4	8.53a ± 1.30	6.04b ± 0.30	7.49a ± 0.90	7.00b ± 0.90	7.33a ± 0.82	2.84c ± 0.55
BSM		7.32a ± 1.55	7.51a ± 0.98	7.78b ± 1.34	6.72ab ± 0.31	5.24b ± 1.42	2.01b ± 0.42
RSM		7.62a ± 0.21	6.69a ± 0.91	7.01a ± 0.94	5.26a ± 0.02	6.30a ± 0.99	1.61a ± 0.61
SSM	5	8.03a ± 1.02	5.73b ± 0.59	6.31ab ±0.90	7.00b ± 0.90	6.33a ± 0.08	2.20c ± 0.32
BSM		7.22a ± 1.06	6.31a ± 1.08	6.90a ± 1.34	6.72ab ± 0.31	5.24b ± 1.40	1.96b ± 0.22
RSM		8.02b ± 0.76	5.89c ± 1.91	5.91b ± 0.94	5.26a ± 0.02	6.20a ± 0.90	1.51a ± 0.40
SSM	6	7.43b ± 0.82	5.63b ± 0.92	5.83a ± 0.65	6.00ab ± 0.77	6.13a ± 0.38	2.22c ± 0.29
BSM		7.86a ± 0.36	5.83a ± 0.80	5.90a ± 0.34	6.17a ± 0.34	5.94ab ± 0.29	1.64b ± 0.31
RSM		7.92a ± 0.62	5.65b ± 0.94	5.75b ± 0.45	5.26b ± 0.32	5.23b ± 0.83	1.51a ± 0.61
SSM	7	7.03b ± 0.23	5.33b ± 0.92	5.34b ± 0.52	5.01a ± 0.47	5.13b ± 0.49	2.12c ± 0.51
BSM		7.86a ± 0.56	5.83a ± 0.80	5.80a ± 0.24	5.11a ± 0.31	5.24b ± 0.29	1.24a ± 0.18
RSM		7.42b ± 0.23	5.64b ± 0.94	5.56b ± 0.85	5.04a ± 0.27	5.30a ± 0.52	1.41b ± 0.31

RSM: Roasted soy milk flour, BSM: Boiled soy milk flour, SSM: Steeped soy milk flour
Values with the same superscript in the same column are not significantly different

Conclusions

The study shows that it is possible to produce rich and nutritious soymilk from different processing methods. There is significant difference between the samples with respect to proximate analysis and mineral analysis. Processing by steeping methods produced the highest yield and roasted method produced the lowest yield.

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