Effects of processing methods on nutritional composition of improved soybean varieties for soymilk production

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ABSTRACT

Value addition efforts in respect of using soybean in various food applications are scarce in Ethiopia. The effect of processing methods was investigated on nutritional composition of improved soybean varieties for soymilk production. The experiment was carried out in a factorial design, improved soybean variety as the first factor (Didessa, Katta and Korme) and processing methods as a second factor of three levels (Illinois, Cornel and Traditional method), replicated three times. The Cornel processing method gave the highest ash content (0.32%) from Korme and the lowest (0.27%) from Didessa and Katta varieties. The highest (2.60%) crude protein content was recorded from Didessa and the lowest (2.13%) from Katta, using Cornel processing methods. The highest carbohydrate content (13.21%) was recorded from Didessa and the lowest (6.87%) from Korme. The highest (75.93 kcal/100 g) energy content was recorded from Didessa and the lowest (51.77 kcal/100 g) from Korme, by Cornell processing method. Generally, Cornel processing method was the best of the three processing methods for improved variety of soybean. From the three varieties of improved soybean, Didessa had higher nutritional composition and could be used in different food product development efforts and can contribute in addressing the food security problems of Ethiopia.

Keywords: Improved variety; Processing methods; Soymilk; Nutritional composition; Minerals.
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INTRODUCTION

Soybean (*Glycine max* L. Merrill) belongs to family Fabaceae. It is native to China and is one of the oldest world crops. It is widely grown in tropical and temperate regions of the world (Onuorah *et al*., 2007). The cultivation of

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soybean in Ethiopia dates back to the 1950s (Shurtleff and Aoyagi, 2009). To date, the main attention of many research initiatives was to develop varieties that are high yielding, early maturing and tolerant to disease and drought (EARO, 2001). Soybean has been used in different food applications in the recipe of some infant foods in Ethiopia. One of the evidences could be efforts made by the Faffa Company in Ethiopia which has been working on the production of different soy products as a soy-fortified complementary food since 2003 and has become the first in the country to produce powdered soymilk (Eskedar Kifle, 2012).

In addition to other food products, soybean is known to be among the major legumes that have been used in vegetable milk production. In line with this, efforts were made to use soybean in the processing of soymilk at small-scale farming level by women entrepreneurs in Ethiopia under the support of agricultural research centers. These efforts were aimed at enhancing the use of soybean in the daily food of the households. Soymilk is used as vegetable alternatives to dairy milk in the formulation of infant foods because they have high protein, minerals and vitamins (Tunde-Akintunde and Souly, 2009; Aidoo *et al.,* 2010; Odu *et al*., 2012).

Soymilk resembles cow’s milk in appearance and it is nutritionally comparable with the human and cow’s milk and hence can be comfortably used in place of cow’s milk in some recipes (Khode *et al*., 2015; Ugochi and Chukwuma, 2015). Soymilk is cholesterol-, gluten- and lactose-free, while containing phytochemicals (Nezif Abachebsa *et al*., 2016). Therefore, it is considered as important healthy drink for people who are allergic to cow’s milk proteins or have lactose intolerance and those who have special health or religious diet requirements (Murtaza and Shahid, 2007; Rehman *et al*., 2007; Xu and Chang, 2009; Bansal and Kaur, 2014; Adebayo-Tayo *et al*., 2009). Soymilk is also a rich source of soluble and insoluble dietary fibers, and isoflavones whose presence in everyday diet is very important (Obadina *et al*., 2013).

On the other hand, extensive consumption of soymilk is constrained by a number of factors related to the inherent constituents of soybeans including “beany” taste causing compounds and antinutritional factors that can reduce nutrient bioavailability (Nezif Abachebsa *et al*., 2016). The main factor which hampers utilization of soymilk is the “beany flavor” that results from lipoxygenase-catalyzed reaction of polyunsaturated lipids especially linoleic acid producing products such as aldehydes, ketones and alcohols (Rehman *et al*., 2007). These oxidation products are the main causes of undesirable objectionable flavor of soymilk and they are major hindrances on the acceptability of soymilk (Rehman *et al*., 2007; Kale *et al*., 2012). Other important demerits to the acceptability of soymilk are the astringency (throat catching factor) of soymilk which is related with flavor sensation. This sensation results from the interaction of polyphenolic substances present in soymilk with mucoprotiens in the mouth and throat (Rehman *et al*., 2007). Different methods have been used to overcome the problem of off-flavor in soymilk using herbal additives in different parts of the world including Ethiopia. Proper processing of soybean into soymilk is important to suppress undesirable properties (off-flavor due to the activity of lipoxygenase enzymes with unsaturated fatty acids in soybean) and anti-nutritional factors such as trypsin inhibitors which will hinder nutrient digestibility and absorption (Tunde-Akintunde and Akintunde, 2002; Obadina *et al*., 2013). However, in some conditions thermal processing detrimentally affects nutritional and quality attributes of soymilk and produces strong off-flavors (Lozano *et al*., 2007).

Blanching and soaking of the beans in water are among the remedial actions to overcome the negative effect of inherent components of soybean (Rehman *et al*., 2007; Odu *et al.,* 2012; Obadina *et al*., 2013). Despite the potential of soybean for improving food and nutrition security, and its importance for income generation through sale and employment opportunities in soymilk processing sectors, little information is available in the literature about the types of soybean varieties and processing methods that can produce soymilk with superior nutritional quality. Moreover, soymilk processing and consumption in Ethiopia is not common. Processing at cottage or industrial scale is uncommon in Ethiopia. With this gap of information, this study was conducted to evaluate the effect of soybean varieties and processing methods on nutritional composition and mineral contents of soymilk. The study was, therefore, undertaken to investigate effects of different processing methods on nutritional composition of improved soybean varieties Didessa, Katta and Korme for soymilk production.

MATERIALS AND METHODS

Sample collection and preparation

Three soybean varieties (Didessa, Katta and Korme) grown under similar agronomic practices and management conditions were obtained from Bako Agricultural Research Center, Bako, Ethiopia. The soybean samples were sown and harvested at the same time during 2008/2009. These varieties were selected because of their adaptability to a wide range of agro-ecological locations in the country and their greater importance (MoARD, 2009). About 20 kg of each variety of soybeans was kept in a bag and transported to Wollega University (Shambu Campus), Ethiopia. It was then stored in the Food Science and Nutrition laboratory at room temperature until further processing. Some laboratory analyses were carried out in the Postharvest Technology laboratory, Jimma University, Ethiopia.

Experimental design

The experiment was carried out in 3 × 3 factorial arrangement with three soybean varieties and **three** processing methods in a completely randomized design (CRD) with three replications. The three soybean varieties were (Didessa, Katta and Korme). The statistical model employed is presented below:

$$Y_{ijk} = \mu + t_i + b_j + (tb)_{ij} + e_{ijk}$$

Where Y_{ijk} = the overall observations; μ = overall means; t_i= is the effect of *i*th variety (*i* = 1, 2, 3); b_j = the effect of the *j*th processing method (*j* = 1, 2, 3); $(tb)_{ij}$ = the interaction **effect** of the *i*th variety using *j*th processing methods; e_{ijk} = the error term.

Preparation of soymilk

Three different methods described by Johnson and Snyder (1978) were used in soymilk production. The methods include Illinois, Cornel and Traditional. Soymilk samples were produced from each of variety following the three different methods as detailed below. For each method, 200 g of soybean was used. For the Cornel and Traditional methods, the sample soybean seeds were soaked in two liters of water while for the Illinois process, samples were soaked in 2 litres of 0.5% $NaHCO_3$. All the samples were soaked for 28 h and then decoated and rinsed with tap water.

Illinois method

The three soybean seed varieties were screened and soaked in 0.5% $NaHCO_3$ solution for 28 h, then drained, decoated manually and rinsed with tap water. Then the soybean was blanched at 100 °C in 0.5% $NaHCO_3$ solution for 30 min and ground at 27 to 30 °C using soymilk making machine (SC20COMM Pristine Plant, India). Then it was sieved with 0.04 mm sieve and pasteurized at 68 °C for 30 min and soymilk was obtained.

Cornel method

The three soybean seed varieties were screened and soaked in tap water for 28 h. Then, they were drained and rinsed in hot water at 100 °C for 20 s. Then they were ground using soymilk making machine (SC20COMM Pristine Plant, India) with boiling water and sieved with 0.04 mm sieve, and finally pasteurized at 68 °C for 30 minutes and soymilk was obtained for further analysis.

Traditional method

The three soybean seed varieties were screened and soaked in tap water for 28 h. Then, the water was drained and the soybean seeds were decoated manually and rinsed twice with tap water. The seeds were ground at 27 to 30 °C using soymilk making machine (SC20COMM Pristine Plant, India) and sieved with 0.04 mm sieve. Finally, the extracted soymilk was pasteurized at 68 °C for 30 minutes and kept for further analysis.

Data collection

Determination of proximate composition

The chemical composition of the soymilk produced with different processing methods including moisture, crude fat, crude protein, crude fiber and total ash were determined using AOAC official methods of 925.09, 4.5.01, 979.09 and 923.03, respectively (AOAC, 2000). Total carbohydrate was determined by difference as 100 – (%Moisture + %crude protein + %Crude fat + % Crude fiber + %Ash) (Wangcharoen, 2008). Results were expressed as g/100 g of dry matter. Energy values were calculated using Atwater's conversion factors, where carbohydrates and proteins gave 4 kcal/g while lipids gave 9 kcal /g (Wangcharoen, 2008).

Determination of minerals

Phosphorus content

Phosphorus contents were determined after dry ashing followed by digestion of 1 mg of freeze-dried soymilk powder by measuring the absorbance of the blue color of phosphomolybdate at 822 nm with UV-vis spectrophotometer (T80 UV/VIS Spectrophotometer) (AACC, 2000) method 40-56.01. Phosphorous contents were estimated from a series standard (0.2-10 µg P/ml) calibration curve prepared from K2HPO4.

Iron content

Iron (mg/100 g sample) were determined after dry-ashing followed by digestion of 2.0 g of freeze-dried soymilk powder by measuring the absorbance of Fe^{+2} -1, 10-phenanthrolinered complex color at 248.4 nm using atomic absorption spectrophotometer (Varian, SpectrAA20 plus, Toyama, Japan). Iron content was estimated from a calibration curve (0.5–4 mg Fe/mL) prepared from analytical Fe $(NO_3)_2$. Samples were diluted with deionized water on an air-acetylene flame (model 6, Denmark) as a source of energy for atomization prior to introduction to AAS (AACC, 2000).

Zinc content

Zinc (mg/100 g sample) was determined after digestion of about 2.0 g freeze-dried soymilk powder by Atomic Absorption Spectrophotometer (AAS) at 213.9 nm using air-acetylene as source of energy for atomization (AACC 2000). Zinc level was estimated from a standard calibration curve (0.25–2 mg Zn/mL) prepared from analytical grade Zn $(NO_3)_2$. The methods were validated by simultaneous analysis of the standard reference material (Soya Bean Flour, INCT-SBF-4), with accuracy for Fe and Zn of 96.7 and 94.2%, respectively. Finally, the mineral contents in soymilk samples were expressed in mg/100 g of dry mass.

Calcium

The calcium content was determined following the oxalate precipitation method as described by Kirk and Sawyer (1991). The amount of was calculated using the following formula:

$$\text{Calcium (mg)} = \frac{2V}{W}$$

Where V = volume (mL) of standard $KMnO_4$ solution required to titrate calcium oxalate; W = Weight (mg) of soymilk sample taken to prepare ash.

Statistical analysis

All the data collected were subjected to analysis of the variance (ANOVA) using SAS 9.1 software package (SAS Institute Inc., Cary, NC). The differences between means were compared using Fisher's least significant difference (LSD) at a significance level of 5%.

RESULTS AND DISCUSSION

Effects of soybean processing on proximate composition of soymilk

Cornel method

The moisture content of soymilk produced from different varieties of soybean ranged from 82.3% to 88.6% for Didessa and Korme variety, respectively (Table 1). There was significant difference (*P<0.05*) between the three soybean varieties. The highest value of the moisture content which ranged from 82.3 to 88.6% corresponded with that of Enwere (1998) who reported 92.8% of soymilk was water. The protein composition ranged from 2.13 of Didessa variety to 2.60%of Katta variety. Varieties significantly varied in protein content (*P<0.05*). Similar works reported by Khatib *et al.* (2002) on which the protein content ranged from 2.8 to 4.1%. The values of protein content obtained were lower than the values reported by Afroz *et al*. (2016) in which they found the values between 34.83 to 38.75%.

The highest fat composition was found from Korme (1.64%) and the lowest from Didessa (1.41%). There was no significant difference (*P > 0.05*) in fat content between Didessa and Katta varieties. Korme was significantly different (*P < 0.05*) compared to the two varieties (Didessa and Katta). These figures obtained were comparable to those obtained by Babajide (1985) who stated that soymilk contained 2.12% fat. The value of the fat content was lower than the value reported by Suruga *et al.* (2007) (20.0%) and Rashad *et al*. (2011) (12.0%). But it was higher than the value of 0.8% reported by Muroyama *et al*. (2006).

Table 1. Effects of soybean processing on proximate composition (Cornel method).

Parameters	Variety			CV	SD
	Didessa	Katta	Korme		
Moisture (%)	82.33±0.06c	86.43±0.02b	88.64±0.02a	0.09	0.15
Protein (%)	2.60±0.01a	2.13±0.01c	2.39±0.01b	0.58	0.03
Fat (%)	1.41±0.01b	1.43±0.01b	1.64±0.01a	0.92	0.03
Ash (%)	0.27±0.01b	0.27±0.01b	0.32±0.01a	5.31	0.03
Fiber (%)	0.18±0.01a	0.14±0.01b	0.14±0.01b	6.52	0.02
Carbohydrate (%)	13.21±0.06a	9.59±0.03b	6.87±0.01c	0.69	0.14
Energy (kcal/100 g)	75.93±0.22a	59.78±0.08b	51.77±0.12c	0.42	0.53

ıns within a row with the same letter(s) are not significantly different from each other at α=0.05; CV = Coefficient of Variation, LSD = Least Significance Difference.

The values of crude fiber content ranged from 0.14 to 0.18%. There was no significant difference (*P*> *0.05*) between Katta and Korme, while there was significant difference (*P* < *0.05*) between Korme and the other two varieties. This is in line with the work of Enwere (1998) who reported that soymilk contains no crude fiber or if it occurs it is very small, because of the processing, variety difference (structure) of the soybean and the soil profile. But it was lower than the value (9.2%) reported by Zhu *et al*. (2008) and Fafaungwithayakul *et al*. (2011) with their value (3.52%).

The values of the ash contents ranged from 0.27% for Didessa to 0.32% for Korme and there was no significant difference (*P* > *0.05*) between Didessa and Katta varieties, but there was significant different between Korme and the others. This value is lower than the value reported by Afroz *et al*. (2016) on their work of preparation of soymilk using different methods and they reported the value of 5.10 to 6.54%. This is in line with the work of Nezif Abachebsa *et al*. (2016) in which they reported the value (0.26 to 0.57%) on soymilk from different varieties of soybean.

Carbohydrate content ranged from 6.9 from Korme to 13.2% from Didessa. The carbohydrate contents were significantly different (*P* < *0.05*) among the varieties. The current carbohydrate content was higher as compared to 2.6% of Redondo-Cuenca *et al*. (2010) and 3.8 to 5.3% of Van der Riet *et al*. (1989). But it was lower than the value of Hsieh and Yang (2004) on their carbohydrate content with value of 52.6% and 53.6%, respectively. The energy content was higher (75.93 kcal/100 g) from Didessa variety and lower from Korme variety (51.77 kcal/100 g), which was significant (*P*< *0.05*). USDA nutrient database reports showed 446 kcal/100 g.

The mineral composition of soymilk from different varieties of soybean is shown in Table 2. The phosphorous content ranged from 84.6 to 85.82 mg/100 g in which the highest value was recorded from Korme variety and the lowest, i.e., 84.6 g/100 g, from Didessa variety. Varieties significantly varied in mineral composition (*P* < *0.05*). Nezif Abachebsa *et al*. (2016) reported 0.14 to 0.35% mineral composition and Nwoke and Umelo (2015) 84.55 to 89.63 mg/100 g.

The iron values ranged from 1.06 to 1.11 mg/100 g with the highest value recorded from Katta samples and the least from Didessa sample. No significant difference (*P* > *0.05*) was observed in iron values of the two varieties. Enwere (1998) found 0.44 mg/100 g. The high concentration of Fe in soymilk implies that soymilk can be used as strategic food against the prevalence of anemia in developing countries where resource constrained poor cannot afford to include animal products in their daily diet.

Table 2. Effects of soybean processing on mineral Composition (Cornel Method).

	Mineral composition (mg/100 g)			
Variety	**Phosphorous**	**Iron**	**Zinc**	**Calcium**
Didessa	84.60±0.01[c]	1.06±0.01[c]	0.91±0.01[a]	38.42±0.02[a]
Katta	85.43±0.01[b]	1.11±0.01[a]	0.79±0.01[b]	37.35±0.02[b]
Korme	85.82±0.02[a]	1.07±0.01[b]	0.71±0.01[c]	36.89≤0.01[c]
CV	0.03	0.69	2.34	0.09
LSD	0.06	0.02	0.04	0.07

The zinc values ranged from 0.71 to 0.91 mg/100 g with the highest value recorded from Didessa variety and the lowest recorded from Korme variety. Varieties significantly varied ($P < 0.05$) in Zinc content. The value of zinc content was lower than other values reported before (0.29 mg/100 g) (Mateos *et al*., 2010).

The calcium values ranged from 36.89 to 38.42 mg/100 g with the highest value recorded from Didessa samples (38.42 mg/100 g) and the lowest from Korme samples (36.89 mg/100 g). Differences were significant ($P < 0.05$). These values were higher than previous reports (USDA, 2005; Nezif Abachebsa *et al*., 2016).

Illinois method

The moisture content of soymilk of Didessa samples was 86.4, Katta 90.0, and Korme 92.2%. The values were comparable to 90.5% and 92.5% for traditional and Illinois methods reported before (Wilkens *et al.*, 1967).

The highest (3.12%) protein content was found from Katta variety and the lowest (2.25%) from Korme. Varieties significantly varied in protein content ($P < 0.05$). Nezif Abachebsa *et al*. (2016) reported 2.26 to 3.48% on their work for different variety of soymilk. On the other hand, Nwoke and Umelo (2015) found much higher protein content, i.e., 4.52 to 4.84% on their work of nutrient and sensory quality of soymilk produced from different improved varieties of soybean.

Fat content of Didessa variety was 1.58, Katta 1.83 and Korme 1.33%. Katta sample had the highest fat content (1.83%) and Korme the lowest (1.33%). Varieties significantly varied in fat content ($P < 0.05$). Onuorah *et al.* (2007) reported higher fat content (2.3%) on their work of soymilk production by

Illinois methods. The ash contents of soymilk ranged from 0.27 to 0.34%. Didessa and Katta samples did not vary in ash content but Korme had significantly less ash content than the two. Nwoke and Umelo (2015) reported higher (0.84 to 0.88%) than the current one.

The fiber content of the three varieties of soymilk ranged from 0.18% from Katta to 0.25% from Didessa. Didessa and Korme varieties significantly varied in fiber content but not Katta and Korme. Nezif Abachebsa *et al.* (2016) reported higher fiber content (1.23 to 1.55%) on their work of soymilk production from different soybean varieties. The carbohydrate contents ranged from 3.74 to 8.65% (Table 3). The highest carbohydrate contents were recorded from Didessa (8.65%) and the lowest from Korme (3.74%). The three varieties significantly varied in carbohydrate content ($P < 0.05$). Nwoke and Umelo (2015) reported 1.66 to 2.81%. Didessa variety had more energy content (60.02 kcal/100 g) than Korme (35.94 kcal/100 g). Varieties significantly varied in energy output. On the other hand, USDA nutrient database showed 446 kcal/100 g.

Table 3. Effects of soybean processing on proximate composition of soybean variety (Illinois method).

	Didessa	Katta	Korme	CV	LSD
Moisture (%)	86.39±0.02c	90.01±0.03b	92.21±0.02a	0.04	0.08
Protein (%)	2.79±0.01b	3.12±0.01a	2.25±0.01c	0.51	0.03
Fat (%)	1.58±0.02b	1.83±0.02a	1.33±0.01c	1.78	0.06
Ash (%)	0.34±0.02a	0.34±0.02a	0.27±0.01b	7.11	0.04
Fiber (%)	0.25±0.01a	0.18±0.01b	0.19±0.01b	5.62	0.02
Carbohydrate (%)	8.65±0.06a	4.52±0.02b	3.74±0.02c	1.25	0.14
Energy (kcal/100g)	60.02±0.09a	47.03±0.11b	35.94±0.16c	0.45	0.43

ere; CV = Coefficient of Variation and LSD = Least Significant Difference

The mineral composition of soymilk from different variety of soybean is shown in (Table 4). The phosphorous content ranged from 82.35 in Korme to 84.31 mg/100 g in Didessa. The three varieties significantly varied in mineral composition ($P < 0.05$). Nwoke and Umelo (2015) reported slightly higher mineral content (84.55 to 89.63 mg/100 g) than the current one.

Iron values ranged from 1.01 mg/100 g in Katta to 1.16 mg/100 g in Didessa, which varied significantly between varieties ($P < 0.05$). Enwere (1998) found 1.44 mg/100 g. The variation could have come from the variety of the soybean and the processing conditions. USDA (2005) reported 0.6 mg/100 g, which was lower than the current report.

Table 4. Effects of soybean processing on mineral composition (Illinois method).

	Mineral composition (mg/100 g)			
Variety	Phosphorous	Iron	Zinc	Calcium
Didessa	84.31±0.01^{a}	1.16±0.01^{a}	0.87±0.01^{a}	36.32±0.02^{b}
Katta	83.52±0.02^{b}	1.01±0.01^{c}	0.86±0.02^{a}	37.32±0.02^{a}
Korme	82.35±0.02^{c}	1.08±0.01^{b}	0.75±0.01^{b}	35.83±0.03^{c}
	0.04	0.68	2.93	0.12
LSD	0.06	0.02	0.05	0.08

Where; CV = Coefficient of Variation and LSD = Least Significant Difference

Zinc contents ranged from 0.75 to 0.87 mg/100 g, with the lowest (0.87 mg/100 g) from Didessa and the highest (0.75 mg/100 g) from Korme. Korme and Katta and Korme and Didessa varied significantly in zinc content but not Didessa and Katta. United Soybean Board (USDA, 2005) reported 0.54 mg/100 g. Nezif Abachebsa *et al*. (2016) reported 0.343 mg/100 g for Clark 63K variety and 0.433 mg/100 g Awasa 95 variety by using Illinois processing methods.

Varieties varied significantly in calcium content, which ranged from 35.83 mg/100 g in Korme to 37.32 mg/100 g in Katta. While USDA (2005) reported lower calcium content than the current one, Udeozor (2012) reported higher, i.e., 44.5 mg/100 g. Nezif Abachebsa *et al*. (2016) found very much less calcium, i.e., 0.03 to 0.043 mg/100 g than the current finding.

Traditional methods

The highest moisture content was recorded from Korme (90.33%) and the lowest from Didessa (87.45%). Similar findings were reported on traditional processing of soymilk by Onuorah *et.al.* (2007) in which they found a value of 87.0%.

The highest protein content (2.23%) was recorded from Katta and the lowest from Korme (1.80%). Katta and Didessa varied in protein content but not Didessa and Katta. Nwoke and Umelo (2015) reported higher protein content (4.52 to 4.84%) than the current one. The fat contents ranged from 1.11% in Katta to 1.34% in Didessa. Fat content varied between Didessa and Katta and also Katta and Korme but not between Didessa and Korme. These findings were in line with the work of Nezif Abachebsa *et al*. (2016) in which they reported the value of 1.4 to 1.8% for different processing methods.

The highest ash contents were recorded from Didessa (1.17%) and the lowest from Katta (1.14%). Didessa and Katta and also Didessa and Korme varied in ash content.

These findings were higher than the value (0.4 to 0.45%) reported by Onuorah *et al*. (2007) on their work of comparative physicochemical evaluation of soymilk and soycake produced by three different methods. The fiber ranged from 0.13 to 0.18%. The fiber content recorded was higher as compared to previous reports, but also was lower than the value reported by Nezif Abachebsa *et al*. (2016). This could be due to the soybean variety, growing conditions and processing methods employed to produce soymilk.

Table 5. Effects of soybean processing on proximate composition using Traditional methods.

	Didessa	**Katta**	**Korme**	**CV**	**LSD**
Moisture (%)	87.45±0.04^{c}	89.49±0.02^{b}	90.33±0.02^{a}	0.07	0.12
Protein (%)	2.13±0.01^{a}	2.23±0.08^{a}	1.80±0.01^{b}	4.34	0.18
Fat (%)	1.34±0.02^{a}	1.11±0.01^{b}	1.29±0.01^{a}	1.91	0.05
Ash (%)	0.17±0.01^{a}	0.14±0.01^{b}	0.15±0.01^{b}	4.86	0.02
Fiber (%)	0.13±0.01b	0.18±0.01a	0.13±0.01b	8.73	0.03
Carbohydrate (%)	8.77±0.07^{a}	6.86±0.09^{b}	6.28±0.02^{c}	1.64	0.24
nergy (kcal/100 g)	55.64±0.20^{a}	46.33±0.12^{b}	44.02±0.13^{c}	0.56	0.55

ere CV = Coefficient of Variation and LSD = Least Significant Difference.

The highest carbohydrate was recorded from Didessa (8.77%) and lowest from Korme (6.28%). Varieties significantly varied in carbohydrate content. For example, Nazif Abachebsa *et al*. (2016) reported lower than the current 1.63 to 5.28%.

The highest (55.64 kcal/100 g) energy content was recorded from Didessa variety and the lowest (44.02 kcal/100 g) from Korme. All varieties varied in energy content. This finding was lower than the value of 446 kcal/100 g reported by USDA nutrient database.

The phosphorous content ranged from 77.64 to 78.22 mg/100 g. The highest value was recorded from Didessa and the lowest from Korme. Varieties varied significantly in phosphorus content. The phosphorous content of soymilk was higher (78.99 mg/100 g) as compared to the values of 52 mg/100 g reported by USDA (2005). But it was lower than the value (84.55 to 89.63 mg/100 g) reported by Nwoke and Umelo (2015) in which they conducted on nutrient and sensory quality of soymilk produced from different improved varieties of soybean.

Table 6. Mineral contents of soybean processing by Traditional methods.

	neral composition (mg/100 g)			
Sample code	**osphorous**	**n**	**ıc**	**lcium**
Didessa	22±0.02b	7±0.01a	1±0.01a	31±0.01a
Katta	99±0.05a	8±0.01b	4±0.01b	23±0.01b
Korme	54±0.02c	1±0.01b	3±0.01a	82±0.02c
CV	7	0	6	8
LSD	1	3	4	6

Where; CV = Coefficient of Variation and LSD = Least Significant Difference

The iron values ranged from 0.78 to 0.87 mg/100 g with the highest from Didessa and the lowest from Katta. Didessa and Katta and also Didessa and Korme varied in iron content, but not Katta and Korme. USDA (2005) reported 0.6 mg/100 g, which was lower than the current one. But it was lower than the value of Nwoke and Umelo (2015).

The content of zinc ranged from 0.54 to 0.63 mg/100 g with highest from Korme and the lowest from Katta variety. Varieties Didessa and Katta varied but not Didessa and Korme. Nezif Abachebsa *et al*. (2016) reported similar values (0.343 to 0.70 mg/100 g).

The calcium value ranged from 33.82 to 34.31 mg/100 g with the highest from Didessa and the lowest from Korme. Varieties significantly varied in calcium content. Udeozer (2012) reported similar calcium contents of unfortified soymilk. Nezif Abachebsa *et al*. (2016) reported extremely low contents of calcium, i.e., 0.033 to 0.036 mg/100 g, compared to the current study.

CONCLUSION

The nutritional composition of improved Didessa soybean variety gave better nutritional composition as compared to the improved Katta and Korme by Cornel processing methods. Illinois processing methods also gave better nutritional composition for Didessa soybean variety as compared to Korme and Katta with the same processing methods. Traditional processing methods gave better nutritional composition for Didessa soybean variety. The mineral contents of improved soybean variety of Didessa gave better phosphorous and calcium by Corner processing method as compared to the other processing methods and improved varieties. Cornel and Illinois processing methods for improved variety of Didessa, Katta and Korme gave better nutritional composition and mineral contents as compared to traditional processing methods. Generally, among the three methods of soybean processing, Cornel gave better nutritional composition and mineral contents compared to the other two. Improved Didessa variety contained better nutritional composition and mineral contents compared to improved Korme and Katta soybean varieties. Therefore, Cornel processing methods for soymilk extraction was the best method and Didessa variety contained better nutritional composition.

CONFLICT OF INTEREST

The author declares that there is no conflict of interest

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