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A study on quality parameters and shelf stability of sweetened condensed vegetable milks produced from four varieties of soybeans *(Glycine max)*

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Abstract

This study was aimed at producing sweetened condensed soymilk (SCS) from three improved soybean varieties TGx1740-2F, TGx1987-10F and TGx1987-62F which were obtained from a research institute. SCS was also produced from a local variety and used for comparison with those from improved varieties. The present study was undertaken with the view to improving utilization of the soybeans in developing countries like Nigeria. The SCS samples were canned and stored at room temperature (30°C) for four months, during which certain quality parameters and shelf stability indicators, including proximate properties, amino acid composition and sensory quality were evaluated. The pH values of the samples, during storage period, were within 6.5 to 7.0 while crude fibre (%) varied between 1.34 and 2.14. The highest contents (%) of 2.44 (for TGx1740-2F variety) and 19.82 (for TGx1987-62F) were recorded for ash and protein respectively in the SCS. No significant difference (P>0.05) was observed in the proximate properties during storage. Analysis of amino acid composition indicated that there was presence of essential amino acids such as leucine, isoleucine, threonine and valine at concentrations (g/16 g N) of 11.69, 10.14, 10.57 and 9.58 respectively. Result of sensory evaluation of the SCS showed that they were acceptable in the quality attributes of colour, mouth feel, flavour, taste and viscosity as mean scores of above 5.0 were recoded for each of the attributes. The SCS obtained from TGx1740-2F variety recorded the highest mean score in terms of general acceptability. It was concluded that shelf stable and good quality SCS can be produced from improved and local soybeans varieties. Production of sweetened condensed soymilk from soybeans may therefore promote utilization of the vegetable crop in Nigeria.

Introduction

The soybean *(Glycine max)* is a member of the family leguminosiae, and the vegetable crop has been processed into a great number of palatable foods for centuries (Wang and Carvins, 1989). The most common practice is the hot-water extraction of wet-ground beans to yield a milk-like product known as soymilk. Soymilk is consumed as a beverage, but more often is converted to curd or tofu by the addition of a calcium or magnesium salt. Soymilk, a water extract of whole extract of whole soybean, is rich in water soluble protein, carbohydrate and fat. It is lactose free and this makes it possible for consumption by lactose intolerant individuals, thereby giving it advantage over cow milk (Adebayo-Tayo *et al.*, 2009). Soymilk is non-allergic and can be easily produced with low level technology serving as good nutriment for vegetarian diet; hence, it is referred to as the nature's perfect food as cow milk and human milk (IITA, 1989). Production of soymilk from soybeans has also been reported by other authors (Sowonola *et al*., 2005; Ikya *et al*., 2013; Dauda and Adegoke, 2014).

In addition to the aforementioned products derivable from soybeans, production of other products from a combination of soybeans and cereals or tubers to increase protein content and complement the amino acids profile in the food has been described in Nigeria, including baby foods and breakfast cereals. The vegetable crop has also been utilized for soya cassava foods as well as fortification of ogi (fermented Nigerian cereal gruel) and gari (Fabiyi, 2006). Edema *et al.* (2005) and Olaoye *et al.* (2006) also reported the use of soybean flour as composite of wheat flour in the production of bread. Condensed milk is a convenient product for household use, as a result of its satisfactory keeping quality. It is particularly useful on long journey on board ship and aeroplanes, especially in the tropics. In the household, it is often used for infant feeding and for the preparation of tea, coffee and puddings (Asaduzzaman *et al*., 2007).

Despite many efforts that have been made on

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processing of soybeans into different products, no work has been reported on its processing into sweetened condensed soymilk. Research efforts are therefore necessary in this area so as to enhance utilization of the vegetable crop; this will help foster food security in developing countries like Nigeria. The present study was therefore aimed at processing the vegetable crop into sweetened condensed soymilk and evaluating some quality parameters of the product in terms of physicochemical properties, amino acid composition and sensory quality.

Materials and Methods

Sources of raw materials

Four varieties of soybeans were used in the present study, including TGx1740-2F, TGx1987-10F, TGx1987-62F and a local variety. The first three were improved varieties of soybeans (IITA, 2011) obtained from International Institute of Tropical Agriculture, IITA, Ibadan, Oyo State, Nigeria while the fourth variety was obtained from a local market in Offa, Kwara State, Nigeria. High grade sugar (sucrose) used was also purchased from the latter source; and the lecithin used as stabiliser was obtained from Sigma Aldrich Chemicals, UK.

Production of sweetened condensed soymilk

Evaporated soymilk samples were produced from the soybean varieties using the method described by Jiang *et al.* (2013). The soymilk samples were further processed into sweetened condensed soymilk (SCS) as follows: concentrated sugar solution, CSS (70-80% w/v), was prepared by adding 75 g of sugar to 100 ml boiled water (cooled to 80^{o}C) with continuous stirring until properly dissolved. The resulting solution was sieved using muslin filter cloth (with approx. aperture size 150 µm) to remove any extraneous material that may be present. The SCS was obtained by mixing CSS with evaporated soymilk (~45^{o}C) at ratio 1:1 and stirred properly to ensure uniformity in composition. The SCS was distributed into sterile cans and then canned using a double seamer machine (Metal Box Co., Type R.P.M 820, Serial no X9294/025, England). Canned SCS samples were stored for four months to evaluate their shelf stability.

Determination of proximate properties, pH and total solids of soymilk

The proximate properties (including crude fibre, ash, fat, protein and carbohydrate), pH and total solids of the evaporated and sweetened condensed soymilk samples were determined during storage using the methods of AOAC (1990).

Determination of amino acid compositions

The method of Wang and Cavins (1989) was adopted for determination of amino acids in the soymilk samples, with little modification. Defatted soymilk was dried and then hydrolyzed for 24 h by refluxing in 6N hydrochloric acid, evaporated to dryness, and dissolved in citrate buffer (pH 2.2). A portion of the hydrolysate with norleucine as internal standard was analyzed for amino acids with a Trace GC Ultra gas chromatograph (Thermo Electron Corporation) system which automatically computed the resulting data.

Microbiological analysis

The total viable bacteria (TVB), lactic acid bacteria (LAB), staphylococci, Enterobacteriaceae, yeasts and moulds (Y & M) counts were determined in the evaporated soymilk and SCS samples using the methods described by Olaoye and Dodd (2010). Plate count agar (PCA; SigmaAldrich), deMan Rogossa Sharpe (MRS; Oxoid), sabouraud agar (Oxoid), mannitol salt agar (Oxoid) and violet red bile glucose agar (SigmaAldrich) were used in the enumeration of the respective organisms. Y & M were incubated at 25^{o}C for 72 h and others at 30^{o}C for 24 h. Results were expressed in logarithm of colony forming unit per ml of soymilk (log CFU/ml).

Sensory evaluation of sweetened condensed soymilk

The SCS samples were subjected to sensory evaluation every month during storage, starting from the day of production. Samples were evaluated for the attributes of colour, mouth feel, flavour, taste, viscosity and general acceptability using a 20 member panel. The panellists allocated scores to the samples based on a 9-point hedonic scale, from 1-dislike extremely to 9-like extremely. The data obtained were subjected to statistical analysis.

Statistical analysis

The data obtained, which depended on the soybean varieties and storage periods for the SCS samples, were analyzed using the means of three replicates of each sample. Means were separated and analyzed using the t-test in data analysis functionality of Microsoft Excel 2010 to determine differences. Significant differences between samples were determined at $P<0.05$.

Results and Discussion

The physico-chemical properties and microbial

Table 1. Physico-chemical properties and microbial counts (log CFU/ml) of freshly prepared evaporated soymilk from different varieties of soybeans

	Soymilk samples			
	A	B	C	D
Physicochemical properties				
pH	6.55±0.23^{a}	6.51±0.04^{a}	6.50±0.11^{a}	6.49±0.03^{a}
Crude fibre (%)	0.51±0.03^{a}	0.45±0.03^{b}	0.49±0.10^{a}	0.42±0.02^{b}
Ash (%)	0.54±0.01^{a,b}	0.53±0.01^{a,b}	0.57±0.02^{a}	0.51±0.01^{b}
Fat (%)	2.01±0.13^{a}	2.24±0.11^{a}	2.16±0.14^{a}	2.11±0.12^{a}
Protein (%)	3.70±0.08^{a}	3.26±0.21^{b}	3.58±0.03^{a}	3.66±0.11^{a}
Carbohydrate (%)	2.10±0.03^{a}	1.89±0.01^{b}	1.99±0.08^{b}	2.03±0.28^{a}
Total solids (%)	8.86±0.12^{a}	8.37±0.23^{c}	8.79±1.02^{a}	8.73±0.52^{b}
Microbial counts				
TVB	3.01±0.02^{b}	3.46±0.10^{a}	3.78±0.20^{a}	2.99±0.12^{b}
LAB	1.76±0.21^{b}	2.01±0.20^{a}	1.50±0.02^{b}	1.18±0.02^{c}
Y&M	2.51±0.03^{b}	2.67±0.21^{ab}	2.43±0.02^{b}	2.84±0.05^{a}
Micrococci	3.45±0.01^{a}	2.02±0.29^{c}	3.78±0.02^{a}	2.87±0.16^{b}
Staphylococci	1.28±0.06^{c}	1.34±0.02^{c}	2.01±0.23^{b}	2.49±0.10^{a}
Enterobacteriaceae	1.12±0.02^{c}	ND	1.53±0.02^{b}	1.99±0.08^{a}

Values are means of three replicate samples. Values with different superscript letters across rows are significantly different (P<0.05)
A, Soymilk from soybean variety TGx1740-2F
B, Soymilk from soybean variety TGx1987-10F
C, Soymilk from soybean varietyTGx1987-62F
D, Soymilk from a local soybean variety
TVB, Total Viable Bacteria
LAB, Lactic Acid Bacteria
Y&M, Yeast and Mould
ND, Not Detected

counts of freshly prepared evaporated soymilk samples from the different varieties of soybeans are shown in Table 1. An approximate mean value of 6.5 was recorded as pH for the soymilk samples while crude fibres ranged between 0.42 and 0.51, with soymilk produced from soybean variety TGX1749-2F (sample A) having the highest value. However, no significant difference (P>0.05) was observed between soymilk samples A and C (variety TGX1987-62F) in the crude fibre contents; the two samples were however significantly different (P<0.05) from samples B (variety TGX1749-10F) and D (local variety). With the exception of sample D, no significant difference (P>0.05) was recorded for the evaporated soymilk samples in term of ash contents. The highest fat content was recorded for sample B; the value did not however differ significantly from others (P>0.05). There were higher protein values in samples A, C and D than in B.

The values of protein, carbohydrate and total solids recorded for the soymilk samples were generally similar, and significant differences were recorded among them. The differences could be attributed to environmental and genetic variations among the soybean varieties during their cultivation. Difference in soil types has also been reported to have impact on the composition of vegetable crops (Vollmann *et al*., 2000).

The highest LAB count (log CFU/ml) of 2.01 was recorded for sample B and this differs significantly (P<0.05) from the value (1.18) obtained for sample D. The TVB counts of samples B and C were not significantly different *(P*>0.05). However, the TVB counts of B and C differ significantly from those of samples A and D. Counts of below 2.5 log CFU/ml were recorded for *staphylococci* and *enterobacteriaceae* in the soymilk samples. The low counts could be an indication of good manufacturing practices and personal hygiene that may have been observed during production (Odu and Egbo, 2012). The counts of TVB and LAB recorded in this study were lower than that reported by Nurliyani and Sunarti (2014) in a related finding; this may be attributed to the aforementioned reason or differences in processing techniques used during production.

The soymilk samples were observed to contain essential amino acids such as leucine, isoleucine, threonine and valine (Table 2), suggesting that soybean may be good source of certain amino acids that the body cannot synthesize (Hajirostamloo and Mahastie, 2008). Glutamic and aspartic acids were present in the soymilk samples in higher concentrations than other types of amino acids. A similar observation was reported by Nurliyani and Sunarti (2014) in soymilk

Table 2. Amino acid composition (g/16 g N) of freshly prepared evaporated soymilk from different varieties of soybeans

	Soymilk samples			
Amino acid	A	B	C	D
Arginine	7.32±1.14^{a}	6.87±0.21^{c}	7.01±0.63^{b}	6.97±1.02^{b}
Phenylalanine	5.01±0.01^{b}	5.62±0.02^{a}	4.69±0.32^{c}	5.11±0.23^{b}
Lysine	5.98±0.24^{c}	6.45±0.99^{a}	6.04±0.02^{bc}	6.12±0.91^{b}
Histidine	2.34±0.91^{a}	1.99±0.01^{c}	2.03±0.13^{c}	2.15±0.09^{a}
Aspartic acid	11.02±1.02^{b}	10.21±0.92^{c}	11.54±0.31^{a}	10.99±0.82^{b}
Threonine	3.97±0.83^{b}	4.67±0.55^{a}	4.02±0.21^{b}	4.87±0.72^{a}
Valine	4.71±0.39^{a}	3.99±0.83^{b}	4.13±0.92^{b}	4.83±0.21^{a}
Cystine	0.92±0.22^{b}	0.47±0.02^{c}	1.26±0.21^{a}	1.01±0.10b
Methionine	0.93±0.09^{c}	1.24±0.01^{b}	1.57±0.02^{a}	1.43±0.32^{a}
Isoleucine	5.01±0.92^{a}	4.75±0.21^{c}	4.98±0.01^{a}	4.29±0.21^{d}
Leucine	9.01±1.03^{a}	8.74±0.92^{b}	8.92±0.12^{a}	8.31±0.23^{c}
Tyrosine	3.61±0.64^{b}	3.74±0.02^{b}	4.26±0.28^{a}	3.44±0.20^{c}
Serine	5.01±1.02^{a}	4.51±0.39^{c}	4.79±0.31^{b}	4.53±0.05^{c}
Glutamic acid	15.61±1.21^{c}	16.92±1.20^{a}	16.02±1.04^{b}	15.42±1.35^{c}
Proline	4.21±0.47^{c}	5.75±0.92^{a}	4.98±0.43^{b}	5.00±0.21^{b}
Glycine	3.25±0.03^{b}	3.99±0.27^{a}	4.28±0.29^{a}	4.03±0.05^{a}
Alanine	5.12±0.01^{b}	4.28±0.31^{d}	5.51±0.51^{a}	4.85±0.11^{c}

Values are means of three replicate samples. Values with different superscript letters across rows are significantly different (P<0.05)

A, Soymilk from soybean variety TGx1740-2F

B, Soymilk from soybean variety TGx1987-10F

C, Soymilk from soybean varietyTGx1987-62F

D, Soymilk from a local soybean variety

Table 3. Physico-chemical properties of sweetened condensed soymilk samples during storage

		Physico-chemical properties						
Storage time (Months)	Samples	pH	Crude fibre (%)	Ash (%)	Fat (%)	Protein (%)	Carbohydrate (%)	Total solids (%)
0	A	6.68±0.03	1.86^{a}±0.21	1.89^{b}±0.01	7.82±0.36	17.25^{b}±1.27	9.87^{a}±0.28	38.69^{a}±2.16
	B	6.73±0.02	1.64^{b}±0.04	2.01^{a}±0.01	8.43±0.17	16.02^{b}±0.91	8.72^{b}±1.21	36.82^{a}±3.61
	C	6.61±0.03	1.67^{b}±0.14	1.63^{c}±0.11	7,95±0.18	16.34^{b}±0.99	8.97^{b}±2.01	36.52^{a}±0.97
	D	6.83±0.01	1.34^{c}±0.09	1.92^{b}±0.20	8.25±0.31	16.82^{b}±2.10	9.36^{a}±0.31	37.69^{b,a}±3.91
1	A	7.01±1.02	1.96^{a}±0.20	2.11^{a}±011	8.21±0.67	18.02^{a}±0.22	10.02^{a}±1.32	40.32^{a}±0.12
	B	6.99±0.32	1.69^{b}±0.44	1.99^{b}±0.15	8.23±0.11	16.25^{b}±2.36	9.10^{a}±1.14	37.26^{b,a}±0.36
	C	6.85±0.02	1.76^{a}±0.15	1.72^{b}±0.51	7.88±0.34	16.55^{b}±1.77	9.31^{a}±1.92	37.22^{b,a}±2.73
	D	7.00±0.01	1.44^{c}±0.19	2.02^{a}±0.25	8.22±0.55	17.24^{b}±0.99	9.65^{a}±1.26	38.57^{a}±0.36
2	A	7.03±0.02	2.01^{a}±0.31	1.71^{b}±0.01	7.99±0.22	18.21^{a}±0.23	9.32^{a}±0.93	39.24^{a}±0.02
	B	7.10±0.12	1.78^{a}±0.08	2.01^{a}±0.08	8.11±0.12	16.22^{b}±0.02	10.29^{a}±0.23	38.41^{a}±0.21
	C	6.79±0.21	1.54^{b}±0.11	1.99^{b}±0.07	8.21±1.02	17.21^{b}±0.13	7.98^{b}±1.02	36.93^{b}±0.92
	D	6.99±0.01	1.54^{b}±0.15	1.86^{b}±0.14	8.53±0.06	17.89^{b}±0.32	6.74^{c}±0.01	36.56^{b}±1.26
3	A	7.09±1.02	1.87^{a}±0.76	2.44^{a}±0.08	7.95±0.76	16.73^{b}±1.28	9.02^{a}±1.02	38.01^{a}±3.01
	B	7.02±0.38	1.98^{a}±0.46	1.92^{b}±0.28	7.34±0.28	17.72^{b}±2.11	8.23^{b}±0.15	37.19^{b,a}±2.16
	C	6.98±0.09	2.01^{a}±0.23	2.04^{a}±0.21	8.38±0.27	19.82^{a}±0.09	7.99^{b}±0.31	40.24^{a}±0.83
	D	6.97±0.62	1.76^{a}±0.18	1.72^{b}±0.01	7.96±0.09	18.26^{a}±0.29	10.01^{a}±0.36	39.71^{a}±2.38
4	A	7.01±0.27	2.14^{a}±0.01	1.79^{b}±0.16	8.02±1.22	17.12^{b}±1.72	8.73^{b,a}±1.02	37.85^{b,a}±2.38
	B	6.99±1.03	1.97^{a}±0.13	2.08^{a}±0.07	7.92±0.91	16.89^{b}±0.02	9.10^{a}±0.82	37.96^{b,a}±3.02
	C	7.09±1.14	1.72^{a}±0.08	1.92^{b}±0.18	7.35±2.01	18.20^{a}±2.18	9.72^{a}±0.79	38.91^{a}±0.82
	D	6.95±0.48	1.88^{a}±0.29	1.87^{b}±0.09	8.11±1.02	17.02^{b}±0.63	9.99^{a}±1.11	38.87^{a}±1.97

Values are means of three replicate samples. Values with different superscript letters across columns are significantly different (P<0.05).

A, Concentrated soymilk from soybean variety TGx1740-2F

B, Concentrated soymilk from variety TGx1987-10F

C, Concentrated soymilk from soybean variety TGx1987-62F

D, Concentrated soymilk from a local soybean variety

Table 4. Amino acid composition (g/16 g N) of sweetened condensed soymilk samples during storage

Storage Time (Months)	Samples	Arginine	Phenylalanine	Lysine	Histidine	Aspartic acid	Threonine	Valine	Cystine	Methionine	Isoleucine	Leucine	Tyrosine	Serine	Glutamic acid	Proline
0	A	10.97^{a}	7.80^{b}	8.66^{b}	4.05	19.51	9.35^{a}	8.65	0.16	2.67	8.98^{b}	11.69^{a}	6.50^{a}	10.13^{a}	26.77^{a}	9.80^{b}
	B	9.22^{b}	7.89^{b}	9.50^{b}	4.42	17.86	8.67^{b}	8.72	0.22	2.87	8.35^{b}	10.10^{a}	6.62^{a}	9.10^{a}	24.91^{b}	10.05^{a}
	C	10.45^{a}	10.09^{a}	9.27^{a}	3.99	17.74	9.62^{a}	8.32	0.27	3.22	10.14^{a}	9.19^{b}	7.37^{a}	8.35^{b}	28.37^{a}	11.05^{a}
	D	7.89^{c}	7.05^{b}	9.55^{a}	4.32	19.20	10.57^{a}	7.93	0.18	2.34	7.93^{b}	11.74^{a}	5.76^{b}	9.63^{a}	24.22^{b}	8.71^{b}
1	A	10.56^{a}	7.61^{b}	8.79^{b}	4.21	19.81	10.01^{a}	9.45	0.20	2.91	9.22^{a}	11.51^{a}	6.59^{a}	10.56^{a}	26.91^{a}	9.61^{b}
	B	10.08^{a}	7.49^{b}	9.62^{a}	4.33	18.08	9.49^{a}	8.62	0.24	2.94	9.61^{a}	10.50^{a}	6.93^{a}	9.59^{a}	25.14^{b}	10.40^{a}
	C	10.56^{a}	10.59^{a}	9.54^{a}	4.26	17.38	9.84^{a}	8.54	0.30	3.17	10.09^{a}	9.68^{b}	7.25^{a}	8.67^{b}	27.90^{a}	11.05^{a}
	D	8.36^{b}	7.49^{b}	9.62^{a}	4.42	19.03	10.57^{a}	8.35	0.20	2.65	8.35^{b}	12.21^{a}	5.75^{b}	9.50^{a}	24.52^{b}	9.19^{b}
2	A	10.21^{a}	8.32^{b}	9.11^{a}	4.34	18.76	10.41^{a}	9.58	0.16	3.04	9.58^{a}	10.96^{a}	6.61^{a}	9.62^{a}	26.94^{a}	9.23^{b}
	B	9.67^{a}	8.03^{b}	9.85^{a}	4.46	18.24	9.55^{a}	8.75	0.19	3.03	9.20^{a}	10.05^{a}	6.94^{a}	9.14^{a}	24.91^{b}	10.53^{a}
	C	10.05^{a}	10.57^{a}	9.74^{a}	4.43	18.24	9.62^{a}	8.73	0.24	3.02	9.58^{a}	9.70^{b}	7.47^{a}	8.73^{b}	28.85^{a}	11.01^{a}
	D	8.13^{b}	7.37^{b}	10.09^{a}	3.93	18.67	10.05^{a}	9.11	0.20	2.82	8.79^{b}	11.78^{a}	6.20^{a}	9.19^{a}	24.90^{b}	9.70^{b}
3	A	10.44^{a}	8.79^{b}	9.20^{a}	4.17	18.30	9.66^{a}	8.74	0.16	2.85	9.19^{a}	10.90^{a}	6.55^{a}	9.98^{a}	26.39^{a}	9.20^{b}
	B	10.08^{a}	8.32^{b}	9.92^{a}	3.99	18.68	9.95^{a}	9.19	0.23	3.06	8.67^{b}	10.53^{a}	6.96^{a}	9.11^{a}	25.16^{b}	9.97^{b}
	C	10.49^{a}	9.91^{a}	10.09^{a}	4.34	18.95	10.01^{a}	8.61	0.29	3.03	10.02^{a}	9.57^{b}	7.38^{a}	8.79^{b}	27.99^{a}	10.91^{a}
	D	7.92^{c}	7.48^{b}	9.22a	4.33	18.63	10.55^{a}	7.87	0.22	2.83	8.27^{b}	12.09^{a}	6.24^{a}	9.62^{a}	23.88^{b}	8.74^{b}
4	A	11.00^{a}	9.19^{a}	8.67^{b}	4.28	18.70	9.62^{a}	8.97	0.18	2.82	8.71^{b}	10.85^{a}	6.02^{a}	10.05^{a}	26.43^{a}	9.23^{b}
	B	9.62^{a}	8.09^{b}	9.23^{a}	4.46	18.08	9.11^{a}	9.06	0.29	2.94	8.74^{b}	10.53^{a}	6.51^{a}	9.19^{a}	25.35^{b}	9.98^{b}
	C	10.62^{a}	9.87^{a}	9.53^{a}	4.21	18.24	9.23^{a}	8.67	0.26	3.47	9.97^{a}	9.57^{b}	7.24^{a}	8.69^{b}	28.38^{a}	10.53^{a}
	D	8.35^{b}	7.63^{b}	8.66^{b}	4.33	19.23	10.36^{a}	9.19	0.21	2.60	8.23^{b}	12.21^{a}	5.87^{b}	10.05^{a}	23.86^{b}	9.54^{b}

Values are means of three replicate samples. Values with different superscript letters across columns are significantly different (P<0.05).

A, Concentrated soymilk from soybean variety TGx1740-2F

B, Concentrated soymilk from variety TGx1987-10F

C, Concentrated soymilk from soybean variety TGx1987-62F

D, Concentrated soymilk from a local soybean variety

samples. The different types of amino acids observed in the soymilk samples in the present study may imply that useful proteins that are required by human could be provided by soymilk when incorporated into human diet. Hence, the varieties of soybeans processed into soymilk may help promote food security, especially in terms of protein intake by the majority of the populace in Nigeria who are poor and cannot afford expensive sources of protein. It is worth mentioning that while significant differences (P<0.05) were recorded in soymilk produced from the local soybean variety (sample D) in comparison with the improved varieties, no difference was recorded in many of the amino acids especially phenylalanine (sample A), lysine (sample C) and histidine (sample A). This means that locally available soybeans may be effectively utilised in the production of soymilk containing essential amino acids that may be beneficial for human nutrition.

After evaporated soymilk was processed into SCS, assessment of shelf stability was carried out during four month storage of the product. Results of the physico-chemical properties of SCS samples are shown in Table 3. The crude fibre, ash, fat, protein and carbohydrate contents were higher than those recorded in evaporated soymilk samples; this may obviously be due to loss of water during the process of concentration. Sweetened condensed milk has been reported to contain higher quantity of dry matter (i.e protein, fat, ash and carbohydrate) than their evaporated counterparts and this was attributed to loss of water normally associated with the process concentration of liquid food leading to increased total solids (Hoffman, 2004; Jiao *et al.*, 2004). It is interesting to note that no significant changes were recorded in the contents of crude fibre, ash, fat, protein and carbohydrate during storage, indicating possible shelf stability of the SCS products during storage. The pH values were similarly observed to be insignificant (P>0.05) during the storage period; the values were similar to those of evaporated soymilk samples (Table 1). This indicates that the process of concentration had no significant effect on pH of the soymilk samples.

The amino acid compositions of the SCS samples during storage are presented in Table 4. The amino acid contents were higher in SCS samples compared to their evaporated counterparts (Table 2); this could obviously be due to the effect of water loss during the process of concentration as earlier noted. The result of sensory evaluation of the SCS samples (Table 5) indicates that the sensory properties of colour, mouthfeel, flavour, taste, viscosity and general acceptability were acceptable to consumers and no

Table 5. Result of sensory evaluation of sweetened condensed soymilk samples during storage

Storage time (Months)	Samples	*Sensory attributes*					
		Colour	Mouthfeel	Flavour	Taste	Viscosity	General acceptability
0	A	6.7^{b}	8.6^{a}	5.6^{b}	6.9^{b}	7.1^{a}	8.7^{a}
	B	8.5^{a}	8.3^{a}	7.6^{a}	7.3^{a}	6.8^{b}	8.1^{a}
	C	7.1^{a}	7.3^{a}	6.5^{b}	5.4^{b}	8.2^{a}	7.0^{a}
	D	$5.9^{c,b}$	7.9^{a}	4.3^{c}	5.9^{b}	7.4^{a}	7.2^{a}
1	A	8.5^{a}	8.7^{a}	7.6^{a}	7.8^{a}	8.7^{a}	7.9^{a}
	B	8.2^{a}	8.0^{a}	6.6^{b}	5.5^{b}	6.9^{b}	8.6^{a}
	C	7.0^{b}	7.9^{a}	4.9^{a}	$5,9^{b}$	8.2^{a}	$6.8^{b,a}$
	D	$6.4^{b,c}$	7.3^{a}	5.4^{a}	7.1^{a}	7.0^{a}	6.5^{a}
2	A	7.7^{a}	5.8^{b}	7.7^{a}	8.8^{a}	6.5	8.3^{a}
	B	6.5^{b}	8.0^{a}	8.2^{a}	6.9^{b}	7.6^{a}	7.8^{a}
	C	8.4^{a}	6.5^{b}	5.4^{a}	7.1^{a}	7.1^{a}	6.5^{a}
	D	5.8^{c}	7.6^{a}	7.1^{a}	$6.6^{a,b}$	6.1^{b}	$6.8^{b,a}$
3	A	8.3^{a}	6.9^{b}	8.2^{a}	6.6^{b}	7.2^{a}	8.9^{a}
	B	7.6^{a}	7.0^{a}	7.2^{a}	6.9^{a}	7.7^{a}	8.3^{a}
	C	7.2^{b}	5.7^{b}	6.0^{a}	5.8^{b}	6.4^{b}	7.7^{a}
	D	5.5^{c}	6.5^{b}	5.9^{a}	5.2^{b}	5.4^{b}	7.2^{a}
4	A	8.9^{a}	7.8^{a}	7.9^{a}	7.9^{a}	7.4^{a}	8.3^{a}
	B	7.8^{a}	6.9^{b}	$6.8^{b,a}$	7.4^{a}	$6.9^{b,a}$	7.9^{a}
	C	6.7^{b}	6.5^{b}	7.2^{a}	6.9^{a}	7.0^{a}	7.5^{a}
	D	7.1^{b}	5.9^{b}	5.6^{b}	7.1^{a}	5.8^{b}	$6.9^{b,a}$

Values are means of three replicate samples. Values with different superscript letters across columns are significantly different (P<0.05).
A, Concentrated soymilk from soybean variety TGx1740-2F
B, Concentrated soymilk from variety TGx1987-10F
C, Concentrated soymilk from soybean variety TGx1987-62F
D, Concentrated soymilk from a local soybean variety

significant difference (P>0.05) was observed during storage, except for the attributes of flavour and taste (sample A). The SCS samples therefore appear to be shelf stabile in the sensory attributes tested during the four month storage period.

Generally, it was observed that the SCS samples produced from different soybean varieties had similar physicochemical properties, proximate composition and sensory attributes. This indicates that good and acceptable SCS may be produced from the local soybean variety comparable to similar products the improved varieties of TGx1740-2F, TGx1987-10F and TGx1987-62F.

The results of the microbiological analysis of the SCS samples show that no LAB, Micrococci, Enterobacteriaceae and Staphylococci were detected during storage. Counts of TVB and Y&M were below 1 log CFU/ml throughout the period of storage. This may be attributed to the high concentration of sugar in the product that may act as preservative against microbial growth.

It is worth mentioning that most of the available reports on utilization of soybeans is on production of evaporated soymilk from the vegetable crop (Adeleke *et al.*, 2000; Tunde-Akintunde and Souley, 2009; Sakhale *et al*., 2012; Ikya *et al*., 2013). However, in the present study, sweetened condensed was successfully produced from soybeans. This could promote further utilization of the vegetable crop in developing countries such as Nigeria.

In conclusion, results of this study showed that good quality and shelf stable sweetened condensed soymilk could be produced from soybean varieties. The use of local variety of soybeans in the production of sweetened condensed soymilk may therefore be economically viable in comparison to the improved varieties. It is recommended that further studies be carried out on feeding trials of soymilk trials on rats to ascertain nutritional performance of protein, ash and fat contents of SCS. Analysis of fatty acid contents of the soymilk samples may also be necessary in future work.

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