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MICROBIOLOGICAL AND PHYSICO-CHEMICAL ANALYSIS OF SOYMILK AND SOYFLOUR SOLD IN UYO METROPOLIS, NIGERIA

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ABSTRACT

Ten samples each of unbranded soymilk and soyflour sold in Uyo metropolis were subjected to microbiological and physico-chemical studies. The microorganisms isolated from the milk and flour and their percentage occurrence were *Staphylococcus epidermidis* (14.4%, 11.8%), *Salmonella* sp. (13.2%, 10.5%), *Rhizopus* sp. (13.2%,16.4%) *Staphylococcus aureus* (12.6%, 12.5%), *Aspergillus flavus* (12.0%, 16.4%), *Bacillus* sp (12.0%, 10.5%), *Streptococcus* sp. (11.4%, 10.5%) and *Lactobacillus* sp. (11.4%, 11.2%) respectively. The total microbial counts varied with samples while the statistical analysis showed no significant difference at 1.0% level between the microbial load of the soymilk and that of the soyflour. The result of the physico-chemical analysis also showed variation in percentage composition of crude protein, crude fat, total sugar, ash content, pH and mineral element. The sensory analysis, determined by a 10 point scoring method for judging quality factors in soy products, indicated high beany flavour in both the soymilk and soyflour. The analysis also indicated high sweetness in 60%, and sourness in 40% of the soymilk samples. There was no significant difference in colour intensity of the soymilk obtained from different purchase points. Similarly, the colour of soyflour showed no variation as all the samples were predominantly light brown.

KEY WORDS: Soymilk, Soyflour, Microorganisms, Contamination, Spoilage.

INTRODUCTION

Soybean (*Glycine max L. merril*) is widely consumed in Nigeria either in the form of soymilk, soyflour, soydawadawa or soybean cake. It is a high and cheap source of protein and a good substitute for dairy milk (Uwaegbute, 1992). Soymilk is sometimes recommended by physicians as a substitute for dairy milk for lactose intolerant individuals because it does not contain lactose and is easily digested in the digestive system (Good-enough and Kleyn, 1975).

Soymilk and soyflour marketed in Uyo metropolis are produced locally by small scale industrialists or purchased in bulk from other states and repackaged for retail trade. The production and/or repackaging processes could be carried out under doubtful hygienic environment without strict adherence to aseptic and other quality standards prescribed for foods and similar products. These products may consequently be susceptible to microbial contamination or may act as vehicle for transmission of diseases. Hence, it is necessary to ascertain the microbiological quality and physico-chemical status of soymilk and soyflour marketed in Uyo metropolis.

Whereas studies on nutritional values, chemical composition and sensory evaluation of soybean products in Nigeria have received considerable attention, (Ikenebomeh and Omogbai, 2000; Liener, 1977; Eka, 1978), there seems to be a dearth of information on the microbiological stability and physico-chemical status of soymilk and soyflour similarly produced and marketed. This study is therefore aimed at isolating, characterizing and identifying microorganisms associated with the contamination and possible spoilage of soymilk and soybean flour, and to evaluate the physico-chemical parameters which may enhance or inhibit microbial proliferation in these products.

MATERIALS AND METHODS

Sample collection

In order to have a good representation of Uyo metropolis, triplicate samples each of 10 different unbranded soymilk and soyflour were purchased wholly from hawkers, open markets and three major supermarkets in Uyo municipality. The samples were designated according to the purchase points as follows: Open markets (1-4), hawkers (5-7), and supermarkets (8-10). All the samples were transported in ice-packed containers to the microbiology laboratory, University of Uyo, where microbiological and physio-chemical

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studies were carried out within 4 hours of sample collection.

Preparation of samples for analysis

The soybean flour was prepared for analysis by mixing 5.0 grams of each sample separately in 50.0ml of sterile distilled water and filtered through Whatman No1 filter paper. The filtrate were for analysis. Twenty millilitres each of the soymilk samples were allowed to attain laboratory conditions for 3 hours prior to analysis. All samples were prepared in triplicates.

Microbiological analysis

Microbial load of the soymilk and soyflour was carried out using the pour plate technique as described by Madigan *et al.,* (1997), on serially diluted samples. Viable bacteria were primarily enumerated on nutrient agar (Oxoid). Coliform, staphylococcal, fungal and other fastidious organisms were enumerated using MacConkey (Oxoid), mannitol salt, potato dextrose and Salmonella/Shigella agar respectively. Except for the PDA plates which were incubated at 25^{0}C for 72 hours, other plates were incubated at 37^{0}C for 24 hours. Acceptable plate counts were those that had between 30-300 cfu/ml.

Pure cultures were obtained by repeated subculturing on appropriate media, preserved on agar slants of the same media, and characterized using standard microbiological techniques (Holt *et al.*, 1994; Macfaddin, 1980; Hartman, 1985). The characterization process involved colonial morphology, macroscopic/microscopic appearance, enzyme production and biochemical properties.

PHYSICO-CHEMICAL ANALYSIS

Measurements of pH were taken with portable pH meter with glass combination electrode (Griffin, England) at 4^{0}C. The procedures were as follows: For soyflour, 10.0grams of the samples from each location were mixed with 90.0ml of sterile distilled water in 250 ml conical flasks, shaken and allowed to stand for 1 hour. The temperature of the mixture was then measured with a Digitron thermometer (model 275-k). The pH values were obtained by inserting an electrode of the pH meter after standardizing each of the soyflour-distilled water mixture. Soymilk from different locations were similarly treated, but is this case, 20.0 ml of the sample were used without mixing with sterile-distilled water. The temperature of 4^0 C for soymilk was obtained by putting the samples in the refrigerator for 10minutes. The pH values were read on the meter and recorded. All measurements were done in triplicates and average calculated.

Total solids and moisture content were determined by oven drying at 100^{0}C to constant dry weight as described by Osborne and Voogt (1978). Anthrone method (AOAC 1970) was used for the determination of total sugar. In this method the concentration of total sugar was read off from a standard glucose curve at 620 nm. Crude fat content was determined using a soxhlet extraction method described by AOAC (1970) and crude protein by the micro-Kjeldahl method (AOAC, 1984). The conversion factor (6.33) used was the value recommended for milk product (Davis and McLachlan, 1974).

The ash content was determined by igniting the samples in a muffle furnace at 550^{0}C (Pearson 1976), while the crude fibre was quantified by separate exhaustive extraction technique (AOAC, 1984). The amount of crude fibre was calculated as the difference in subtraction of weight of the ash from the increase of weight on paper due to the insoluble material, (Akpan *et al.,* 1999). Viscosities were measured at 4^{0}C using the Capford viscometer (model 300) with spindle speed of 100rpm. Mineral elements such as calcium and phosphorus were determined according to AOAC (1984), while the titratable acidity was calculated as

$$\frac{\text{Volume of 0.1m NaOH} \times 0.009 \times 100}{\text{Volume or weight of sample used in titration (ml or g).}}$$

SENSORY EVALUATION OF THE SOY PRODUCTS

The sensory attributes determined were colour, flavour and taste. Evaluation was based on the use of a 10 point scoring method for judging quality factors, degree of colour intensity and general acceptability of soy products, adopted from Lamb score card (Amerine *et al.,*1965). According to this method, 10.0 ml each of the soymilk samples were measured into 50 ml glass beakers and served to the panelists, while 5.0 grams each of the soyflour samples were served in sterile glass petri dishes.

The colour, flavour and taste panelists comprised an equal number of males and females within 18-30 years, who regularly took soymilk and soyflour. Samples were presented to the panelists and all attributes for each product were scored on a single score card. All tests were conducted in a well ventilated room with florescent lighting. Attributes with highest mean score were selected and recorded as most acceptable.

STATISTICAL ANALYSIS

Student paired t-test at 1.0% level was

TABLE 1: Incidence of different types of microorganisms isolated from locally produced soymilk.

Sample Code	VIABLE COUNT (cfu/ml) [a]							
	LS	SS	SA	SE	ST	BS	AF	RS
1.	$2.4 \times 10^3 \pm 0.2$	$1.1 \times 10^2 \pm 0.2$	$1.3 \times 10^3 \pm 0.3$	$2.0 \times 10^3 \pm 0.4$	$1.7 \times 10^2 \pm 0.2$	$1.0 \times 10^3 \pm 0.2$	$1.8 \times 10^3 \pm 0.4$	$1.4 \times 10^2 \pm 0.4$
2.	$1.7 \times 10^3 \pm 0.3$	$2.0 \times 10^2 \pm 0.2$	$3.0 \times 10^2 \pm 0.2$	$1.8 \times 10^3 \pm 0.2$	$1.5 \times 10^2 \pm 0.2$	$1.1 \times 10^2 \pm 0.3$	$1.6 \times 10^3 \pm 0.3$	0
3.	$3.0 \times 10^3 \pm 0.4$	$1.8 \times 10^2 \pm 0.3$	$1.1 \times 10^2 \pm 0.3$	$2.5 \times 10^3 \pm 0.2$	$2.6 \times 10^3 \pm 0.1$	$2.4 \times 10^2 \pm 0.2$	$2.0 \times 10^2 \pm 0.2$	$2.6 \times 10^3 \pm 0.2$
4.	$3.4 \times 10^2 \pm 0.1$	$2.2 \times 10^2 \pm 0.3$	$1.6 \times 10^3 \pm 0.7$	$2.7 \times 103 \pm 0.6$	$3.4 \times 10^2 \pm 0.3$	$2.8 \times 10^2 \pm 0.1$	$1.4 \times 10^2 \pm 0.3$	$1.8 \times 10^3 \pm 0.3$
5.	$2.0 \times 10^3 \pm 0.4$	0	$2.5 \times 10^3 \pm 0.4$	$1.4 \times 10^2 \pm 0.2$	$1.8 \times 10^3 \pm 0.5$	$2.1 \times 10^2 \pm 0.2$	0	$1.4 \times 10^3 \pm 0.2$
6.	$1.5 \times 10^3 \pm 0.2$	$2.5 \times 10^2 \pm 0.4$	$2.3 \times 10^2 \pm 0.2$	$2.1 \times 10^3 \pm 0.4$	$2.7 \times 10^2 \pm 0.3$	$2.4 \times 10^2 \pm 0.4$	$1.6 \times 10^3 \pm 0.2$	$2.8 \times 10^2 \pm 0.5$
7.	$2.4 \times 10^2 \pm 0.3$	$0.4 \times 10^3 \pm 0.4$	$1.7 \times 10^3 \pm 0.2$	$2.8 \times 10^2 \pm 0.2$	$2.4 \times 10^3 \pm 0.2$	$2.0 \times 10^3 \pm 0.3$	$2.4 \times 10^3 \pm 0.3$	$3.0 \times 10^2 \pm 0.2$
8.	$3.2 \times 10^3 \pm 0.4$	$1.0 \times 10^2 \pm 0.3$	$3.8 \times 10^2 \pm 0.5$	$3.1 \times 10^2 \pm 0.3$	$1.3 \times 10^3 \pm 0.3$	$2.2 \times 10^3 \pm 0.2$	$1.1 \times 10^3 \pm 0.2$	$2.6 \times 10^3 \pm 0.3$
9.	$3.0 \times 10^3 \pm 0.2$	$1.8 \times 10^2 \pm 0.2$	$2.4 \times 10^3 \pm 0.6$	$3.4 \times 10^2 \pm 0.2$	$3.1 \times 10^3 \pm 0.2$	0	$2.5 \times 10^2 \pm 0.3$	0
10.	$2.8 \times 10^3 \pm 0.3$	$1.7 \times 10^2 \pm 0.2$	$1.4 \times 10^3 \pm 0.4$	$2.5 \times 10^3 \pm 0.3$	$2.6 \times 10^2 \pm 0.4$	$1.6 \times 10^3 \pm 0.4$	0	$1.4 \times 10^3 \pm 0.3$

[a] Values are mean ± standard deviation of three replications

LS: *Lactobacillus*. sp;
SS: *Salmonella*. sp;
SA: *Staphylococcus aureus;*
SE: *Staphylococcus epidermidis;*
ST: *Streptococcus* sp;
BS: *Bacillus* sp;
AF: *Aspergillus flavus;*
RS: *Rhizopus* sp.

employed to determine the significant difference in the frequency of occurrence of the microbial genera in the two products. The mean microbial count for each product was used in this analysis.

RESULTS

Based on cultural morphology, macroscopic/microscopic appearance, biochemical characteristics and with the aid of identification scheme of Holt *et al.*, (1984), the organisms were identified as *Lactobacillus* sp., *Staphylococcus aureus, Staphylococcus epidermidis*, *Streptococcus* sp., *Bacillus* sp., *Aspergillus flavus* and *Rhizopus* sp. The incidence of the different types of microorganisms isolated from the soymilk and soyflour are shown in Tables 1 and 2.

The percentage occurrence of the isolates is presented in Table 3. The result shows specifically that bacteria species occurred more than fungal species in both soymilk and soyflour. The total percentage occurrence of fungi was 25.2% and 32.8% in soymilk and soyflour respectively, while that of bacterial species was 75.0% and 67.0% in soymilk and soyflour respectively. A total of 319 microbial isolates were obtained from both the milk and the flour, with higher incidence of 167 isolates occurring in soymilk and 152 isolates in soyflour.

Tables 4 and 5 show the result of the physico-chemical analysis conducted on the samples. There were variations in the physico-chemical properties amongst samples from different purchase points. The proximate analysis showed that soymilk from supermarkets (points 8-10) had the highest average protein 6.05± 0.02%; titratable acidity 1.06± 0.17%, calcium 41.37 ± 0.31 mg / 100 ml, but least phosphorus 93.08± 0.7 mg / 100 ml. Soymilk from hawkers (points 5-7) had the least crude protein 5.28 ± 0.02% but highest total sugar 1340 mg/100 ml. The average calcium and phosphorus contents were 61.10± 0.4 mg/100 ml and 102.94 ± 0.4 mg/100 ml respectively. The average protein in soymilk from open markets (points 1-4) was 5.93 ± 0.05%;titratable acidity 1.15 ± 0.21% ; total sugar 1198 mg/100 ml; calcium 42.77± 0.5

mg/100 ml, and phosphorus 111.31 ± 0.23 mg/100 ml.

Similarly, average protein in soyflour from supermarkets was the highest 4.95 ± 0.99%; but least calcium and phosphorus contents, 38.9 ± 0.21 mg/100 ml and 100.32 ± 0.41 mg/100 ml respectively. The protein contents in a soyflour from hawkers and open markets were 4.05 ± 1.06 mg/100 ml and 3.95 ± 0.68 mg/100 ml respectively, while phosphorus content was 143.83 ± 0.01mg/100 ml in soyflour from hawkers and 135.34 ± 0.60 mg/100 ml from open markets. The highest calcium content 64.38 ± 0.31mg/100 ml was recorded is soyflour from hawkers while that from open market was 44.61 ± 0.31 mg/100 ml.

Sensory investigations of the soy products indicated beany flavour which was objectionable to many people. The mean panel scores for beaniness in both soymilk and soyflour were higher than the zero mean recommended for soy products. Similarly, there

TABLE 2: Incidence of different types of microorganisms isolated from locally produced soyflour.

Sample Code	VIABLE COUNT (cfu/ml) [a]							
	LS	**SS**	**SA**	**SE**	**ST**	**BS**	**AF**	**RS**
1.	2.0×10^3 ±0.2	0.8×10^2 ±0.2	1.0×10^3 ±0.2	1.6×10^3 ±0.4	1.4×10^2 ±0.2	0	3.0×10^3 ±0.3	2.6×10^3 ±0.2
2.	1.1×10^3 ±0.4	1.4×10^2 ±0.1	2.5×10^2 ±0.4	1.4×10^3 ±0.3	1.0×10^2 ±0.3	2.0×10^3 ±0.3	2.4×10^3 ±0.3	1.0×10^2 ±0.3
3.	2.4×10^3 ±0.3	1.0×10^3 ±0.6	0	2.0×10^3 ±0.2	2.0×10^3 ±0.2	2.0×10^2 ±0.3	2.6×10^2 ±0.2	3.4×10^3 ±0.2
4.	2.0×10^2 ±0.2	2.0×10^3 ±0.4	1.4×10^3 ±0.3	1.8×10^2 ±0.2	2.8×10^2 ±0.4	2.4×10^2 ±0.2	2.8×10^2 ±0.3	2.0×10^3 ±0.3
5.	1.6×10^3 ±0.4	0.4×10^2 ±0.1	1.6×10^3 ±0.3	1.0×10^3 ±0.2	1.0×10^2 ±0.3	1.7×10^2 ±0.4	1.0×10^2 ±0.3	2.5×10^3 ±0.3
6.	1.0×10^3 ±0.2	2.0×10^3 ±0.4	2.0×10^2 ±0.3	1.8×10^3 ±0.3	2.0×10^3 ±0.4	2.0×10^5 ±0.3	2.4×10^3 ±0.3	3.0×10^3 ±0.2
7.	1.8×10^2 ±0.3	2.1×10^3 ±0.3	1.1×10^2 ±0.2	2.0×10^3 ±0.2	2.4×10^2 ±0.2	1.6×10^2 ±0.3	2.0×10^3 ±0.3	4.0×10^2 ±0.2
8.	2.8×10^2 ±0.2	1.0×10^3 ±0.2	3.0×10^2 ±0.5	2.4×10^2 ±0.3	1.8×10^3 ±0.3	1.0×10^3 ±0.4	3.4×10^3 ±0.2	3.0×10^2 ±0.2
9.	1.7×10^3 ±0.3	1.4×10^3 ±0.3	3.4×10^2 ±0.4	3.0×10^2 ±0.2	2.8×10^3 ±0.2	0	3.0×10^2 ±0.2	1.5×10^2 ±0.3
10.	2.1×10^3 ±0.3	2.0×10^3 ±0.3	1.0×10^3 ±0.4	2.0×10^3 ±0.2	2.0×10^3 ±0.3	1.1×10^3 ±0.2	0.8×10^2 ±0.2	2.0×10^2 ±0.3

[a] Values are mean ± standard deviation of three replications

LS: *Lactobacillus.* sp; ST: *Streptococcus* sp;
SS: *Salmonella.* sp; BS: *Bacillus* sp;
SA: *Staphylococcus aureus;* AF: *Aspergillus flavus;*
SE: *Staphylococcus epidermidis;* RS: *Rhizopus* sp.

TABLE 3: Percentage occurrence of microorganisms isolated from soymilk and soyflour

Organism	No. of Isolate		Percentage Occurrence	
	Soymilk	Soyflour	Soymilk	Soyflour
Staphylococcus epidermidis	24.0	18.0	14.4	11.8
Salmonella sp	22.0	16.0	13.2	10.5
Rhizopus sp	22.0	25.0	13.2	16.4
Staphylococcus aureus	21.0	19.0	12.6	12.5
Aspergillus flavus	20.0	25.0	12.0	16.4
Bacillus sp	20.0	16.0	12.0	10.5
Streptococcus sp	19.0	16.0	11.4	10.5
Lactobacillus sp	19.0	17.0	11.4	11.2
TOTAL	**167**	**152**	**100**	**100**

TABLE 4: Physico-chemical properties of locally produced soymilk.

PARAMETERS	SAMPLE CODE									
	1	2	3	4	5	6	7	8	9	10
Colour	C	C	C	C	C	C	C	C	C	C
Flavour	B	B	B	B	B	B	B	B	B	B
Taste	S	SR	SR	S	S	SR	S	S	S	SR
PH	6.5	6.2	5.8	6.0	6.2	6.8	6.5	6.8	6.8	6.2
Viscosity (cp)	340	340	360	340	360	380	360	370	360	360
Moisture content (%)	87.31 ±0.18[a]	86.5 ±0.37	86.9 ±0.41	85.0 ±0.32	87.26 ±0.36	86.4 ±0.34	80.6 ±0.28	84.6 ±0.30	88.42 ±0.24	86.4 ±0.31
Total solid (%)	11.3 ±0.21	12.64 ±0.14	13.40 ±0.24	13.10 ±0.25	11.63 ±0.18	12.58 ±0.17	18.43 ±0.21	11.62 ±0.18	12.62 ±0.14	13.50 ±0.27
Crude protein (%)	7.80 ±0.01	4.00 ±0.00	7.68 ±0.17	4.23 ±0.03	6.53 ±0.01	5.61 ±0.12	6.00 ±0.00	4.26 ±0.02	6.51 ±0.01	5.06 ±0.02
Crude fibre (%)	0.20 ±0.30	0.17 ±0.20	0.20 ±0	0.18 ±0.10	0.22 ±0.30	0.30 ±0.20	0.21 ±0.10	0.20 ±0.00	0.18 ±0.02	0.23 ±0.10
Crude fat (%)	1.41 ±0.00	1.30 ±0.17	0.98 ±0.01	1.00 ±0.00	0.86 ±0.01	1.80 ±0.1	1.48 ±0.20	1.42 ±0.10	1.02 ±0.10	1.38 ±0.01
Carbohydrate (%)	64.1 ±0.20	65.0 ±0.30	63.10 ±0.18	70.0 ±0.00	71.24 ±0.02	68.40 ±0.14	65.10 ±0.11	63.20 ±0.02	68.0 ±0.40	70.20 ±0.30
Ash content (%)	1.38 ±0.20	1.40 ±0.03	1.00 ±0.10	1.24 ±0.02	1.46 ±0.30	1.42 ±0.01	1.32 ±0.02	1.40 ±0.12	1.73 ±0.01	1.56 ±0.02
TotalSugar (mg/100ml)	1200	1100	1240	1250	1140	1460	1420	1265	1220	1420
Titratable acidity %	0.98 ±0.02	1.35 ±0.00	1.36 ±0.00	0.90 ±0.04	1.20 ±0.01	0.92 ±0.00	1.20 ±0.01	1.30 ±0.00	0.98 ±0.00	0.90 ±0.01
Calcium Content (mg/100ml)	16.28 ±0.10	24.00 ±0.00	52.40 ±0.20	78.40 ±0.20	48.60 ±0.10	64.6 ±0.20	70.0 ±0.10	27.45 ±0.20	36.20 ±0.10	60.45 ±0.01
Phosphorus content (mg/100ml)	142.5 ±0.10	130.72 ±0.03	150.00 ±0.10	22.0 ±0.00	120.40 ±0.20	48.00 ±0.10	140.42 ±0.20	70.60 ±0.10	84.65 ±0.10	124.0 ±0.30

[a] Values are mean ± standard deviation of three replications.

C: Creamy; S: Sweet;

B: Beany; SR: Sour.

was a high mean score in the general acceptability of the colour of the soy products. Soymilk samples from 6 purchase points exhibited high sweetness while samples from 4 purchase points were sour. Although the sour taste appeared to have masked to some extent the sweetness in sample from the 4 locations, the sweetness was still slightly perceptible.

DISCUSSION

Food borne diseases are becoming highly prevalent amongst Nigerian population. This may be attributed to the consumption of food products which, may have been grossly contaminated by pathogenic microorganisms or contain lethal microbial toxins liberated into the foods during microbial metabolism (Frazier and Westhoff 1978). In this study, soymilk and soyflour marketed in Uyo metropolis were found to contain high microbial counts of contaminating microorganisms. This may be due to contamination of the products during processing, exposure of the products to unhygienic environment before packaging or the use of contaminated package . The presence of *Staphylococcus aureus* is a source of concern because of the ability of this organism to grow, multiply in foods and produce enterotoxin at room temperature, which may be liberated into the foods (Atanda and Akano, 1997). This organism is also associated with urinary tract infections (Ebie *et al.*,2001). Similarly, the presence of *Aspergillus flavus*, a toxigenic mould, in these soy products poses a great risk to human health because this organism is capable of producing aflatoxin at room temperature which may be liberated into the foods. Some food poisoning outbreaks have been traced to contamination of food products by *Aspergillus flavus* (Uriah and Ugbadu, 1980). The mycotoxigenic potential of this mould has also been reported by Davis (1981).

The presence of coliform bacteria, especially *E. coli* and *Salmonella* species in the

TABLE 5: Physico-chemical properties of locally produced soyflour

PARAMETERS	SAMPLE CODE									
	1	2	3	4	5	6	7	8	9	10
Colour	LB	LB	LB	LB	LB	LB	LB	LB	LB	LB
Flavour	B	B	B	B	B	B	B	B	B	B
Taste	R	R	R	R	R	R	R	R	R	R
PH	5.0	5.0	5.6	5.0	6.2	6.0	5.8	5.6	5.5	5.6
Viscosity (cp)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Moisture content (%)	5.30 ± 0.41[a]	5.80 ± 0.41	6.00 ± 0.00	65.0 ± 0.10	7.00 ± 0.00	5.00 ± 0.00	6.00 ± 0.00	6.50 ± 0.40	6.50 ± 0.01	6.00 ± 0.02
Total solid (%)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Crude protein (%)	4.86 ± 0.17	3.46 ± 0.28	4.32 ± 0.01	3.14 ± 0.00	5.54 ± 0.07	3.21 ± 0.21	3.40 ± 0.24	5.24 ± 0.17	6.00 ± 0.01	3.62 ± 0.01
Crude fat (%)	1.41 ± 0.02	1.31 ± 0.01	0.98 ± 0.01	1.00 ± 0.00	0.14 ± 0.12	0.21 ± 0.02	0.42 ± 0.01	0.58 ± 0.02	0.32 ± 0.03	0.45 ± 0.02
Crude fibre (%)	1.22 ± 0.02	1.48 ± 0.1	0.38 ± 0.02	1.52 ± 0.01	0.25 ± 0.30	1.56 ± 0.06	1.64 ± 0.17	1.70 ± 0.14	1.54 ± 0.10	1.60 ± 0.00
Carbohydrate (%)	60.0 ± 0.00	58.74 ± 0.13	60.23 ± 0.20	66.54 ± 0.17	64.70 ± 0.14	62.50 ± 0.12	65.40 ± 0.18	50.45 ± 0.16	54.23 ± 0.02	60.10 ± 0.20
Ash content (%)	1.82 ± 0.12	2.00 ± 0.00	2.54 ± 0.20	5.63 ± 0.14	3.60 ± 0.20	2.45 ± 0.10	1.74 ± 0.03	2.86 ± 0.02	4.63 ± 0.20	2.40 ± 0.10
TotalSugar (mg/100ml)	325	280	320	420	350	320	400	350	360	460
Titratable acidity %	0.92 ± 0.03	0.74 ± 0.00	0.87 ± 0.02	0.90 ± 0.01	0.98 ± 0.01	1.00 ± 0.00	1.10 ± 0.01	1.30 ± 0.02	0.90 ± 0.01	0.64 ± 0.01
Calcium content (mg/100ml)	40.0 ± 0.00	36.25 ± 0.10	48.20 ± 0.01	54.0 ± 0.20	86.45 ± 0.01	70.45 ± 0.20	36.25 ± 0.10	28.45 ± 0.10	62.0 ± 0.00	26.32 ± 0.02
Phosphorus content (mg/100ml)	96.50 ± 0.10	160.20 ± 0.10	134.0 ± 0.20	150.64 ± 0.20	126.36 ± 0.10	140.14 ± 0.	165.0 ± 0.00	120.0 ± 0.01	86.60 ± 0.20	94.36 ± 0.20

[a] Values are mean ± standard deviation of three replications.

LB: Light Brown; R: Roasty;

B: Beany; ND: Not done.

food is of concern because *E. coli* has been associated with gastroenteritis (Atanda and Akpan, 1999) and urinary tract infections(Omonigho *et al.*,2001), while *Salmonella* species are known to be responsible for certain food born infections including Salmonellosis and Typhoid fever. The presence of *E.coli* in particular is an indicattion of faecal contamination (Edema *et al.*, 2001).

None of the products contained any preservative. This may probably account for the rapid growth and replication of spoilage microorganisms in the products. The level of occurrence of bacterial species which was higher in soymilk, could be due to the higher water activity (^{a}w) value in the milk which would favour bacterial growth and metabolism. The heat treatment given to the bottled soymilk was probably insufficient to kill substantial number of microorganisms in the product or to denature the microbial enzymes which were not desirable in the milk. Also, improper or non-sterilization of the bottles before they were filled with the soymilk could encourage microbial contamination of the product.

The presence of *Staphylococcus epidermidis* and *Streptococcus* species in the products indicate inadequate precautions taken either during processing of raw material or during packaging and subsequent distribution of the finished products.

The carbohydrate content in the soymilk was higher (63.01%) than in soyflour (31.58%). This high level was expected because some soymilk producers add certain carbohydrates such as sugar as sweeteners.

The presence of high counts of food spoilage bacteria and toxigenic mould in soymilk and soyflour strongly suggests high level of contamination by these microorganisms. This poses a serious health risk when such contaminated products are consumed. Producers of soymilk and soyflour should adhere strictly to good manufacturing practice (GMP). Proper handling and storage are also necessary because unhygienic handling and

poor storage methods are known to predispose them to microbial contamination. The National Agency for Food, Drug Administration and Control (NAFDAC) should, as a matter of urgency, set up adequate microbial and physico-chemical standards for these products, and ensure that producers adhere strictly to these regulations.

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