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Surveillance of the Microbial Quality of Soybean Products Sold within Markets in Port Harcourt Metropolis, Rivers State, Nigeria

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Abstract Considerable public health burden and challenge has been caused by foodborne pathogens. They cause illnesses to children, elderly and immune-compromised persons and this poses a great health risk. The microbial quality of locally and industrially soybean products sold within in Port Harcourt Metropolis, Nigeria was investigated. The results show significant higher bacteria and fungi counts [$p < 0.05$] in locally prepared samples compared to industrially prepared samples. Occurrences of the bacteria isolated from industrial samples include: *Pseudomonas* sp. [37.5%], *Bacillus* sp., *Staphylococcus* sp. [25% each] and *Streptococcus* sp. [12%], while *Pseudomonas* sp. and *Staphylococcus* sp. were the most frequent bacteria in locally processed samples [25% each]. Fungi isolated from industrially processed samples include: *Rhizopus* sp., *Aspergillus* sp. and *Saccharomyces* sp. [33.3% each]. The most frequent fungus in locally produced samples is *Rhizopus* sp. [40%] followed by *Saccharomyces* sp. and *Aspergillus* sp. [30% each]. 50% of the isolates were resistant to ampicillin and ofloxacin, while about 70% were sensitive to erythromycin and augmentin. The results revealed that locally made soy products would most likely cause food-borne illnesses, stressing the need for local vendors to be enlightened on the practice of good hygiene and observing Hazard analysis and critical control points during processing and packaging of these products for consumption. Most of the isolates are spoilage microorganisms but several of them invaded the product through poor handling and processing routes employed.

Keywords Antibiotic Sensitivity, Port Harcourt Metropolis, Public Health, Soybean beverages, Soy milk

1. Introduction

In recent years, legumes have been identified as sources of high nutritional value which could aid in addressing related dietary issues worldwide. Soybean [*Glycine max*] is recognized as one of these legumes with a huge protein potential [Kolapo and Oladimeji, 2008]. Its edible products including; soymilk, soy bean flour and other soy based products. They are food items consumed on purchase from vendor, hawkers and consumed immediately without any further preparation. Some of them are snacks which are also vended along highways linking several geographical areas in the country [Oranusi and Braide, 2012]. But most of them are found in public places including markets, motor parks, and streets, outside schools, hospitals and even express way [Izah *et al.,* 2015].

Soymilk is rich in protein, carbohydrate and oil, made by soaking the soybeans in water before grinding and straining, the milk produced resembles cow milk in both appearance and constituency. They could be used as a potential substitute to cow milk in terms of quality and nutritive properties [Soya.be, 2006; Adebayo-Tayo *et al.,* 2008].

Soy flour is normally manufactured with different fat levels: raw soy flour doesn't require the roasting step; defatted soy flour is obtained from- solvent- extracted- flakes, and contains less than 1% oil and natural or full-fat soy flour made from un-extracted, de-hulled beans with about 18% - 20% oil. The quality of the flour and storage condition after milling is very important in the shelf life and hygienic quality of the flour. Although flour is generally regarded as a safe product due to its low water activity, it has been reported that a variety of pathogenic and non-pathogenic microorganisms can contaminate it during processing [Berghofer *et al.,* 2003]. Low-moisture foods and ingredients have not been discussed traditionally in terms of food safety, primarily because these products do not offer welcoming environments for microorganism growth [Akissoe *et al.,* 2001]. Food borne outbreaks has been sometimes associated with consumption of flour, although most flour-based products reportedly undergo a validated kill step at the point of production (e.g. baking or cooking), other products may be at risk [Ndife

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et al., 2011]. Emphasis on the improvements of microbiological safety of foods have been attributed to response to disease outbreaks; with these improvements been implemented by international standards and legislation, considered to have had an impact on diarrheal incidence as reflected in trends reported worldwide [Nawal *et al.,* 2013].

Health benefits of soybean and related products include low lactose and cholesterol, reduced bone loss, prevention and reduction of heart diseases [Adebayo-Tayo *et al.,* 2008]. However, in developed countries, the quality of soymilk is limited by factors including biological and storage factors [Kolapo and Oladimeji, 2008]. Despite these arrays of benefits derivable from soybean products, previous studies have reported that it can easily be a route for transmitting food borne illnesses. Bacterial pathogens identified with food poisoning, gastroenteritis and enteric fever can be harbored in un-hygienically prepared soymilk [Adebayo-Tayo *et al.,* 2008]. Mycetomas in human have been caused by some potential pathogenic contaminants of dairy food [Cheesbrough, 2005]. Foodborne or waterborne microbial pathogens cause diarrheal diseases, which is a leading causes of illness and death in less developed countries, killing an estimated 1.9 million people annually at the global level [Nawal *et al.,* 2013]. *Aspergillus flavus* is involved in allergic aspergillosis [pulmonary aspergillosis] and also produces aflatoxin that is highly carcinogenic [Prescott *et al*., 2005] This study was carried out to assess the microbiological quality of locally produced and industrially processed soybean products sold in Port Harcourt and its environs, Nigeria.

2. Materials and Methods

The study Area

The study area chosen falls within Port Harcourt city and Obio-Akpor Local Government Area of Port Harcourt, the capital of Rivers State, Nigeria. They are the biggest cities in River state which has an estimated population of 5,185,400, making it the sixth-most populous state in the country; its geographical coordinates are 4° 47' 21" North, 6° 59' 55" East. It is economically significant as the center of Nigeria's oil industry city with over a million people, made up of people from different ethnic groups.

Sample Collection

A total of forty [40] samples were collected for analysis: Ten [10] samples of locally produced soybean beverage and soymilk each were collected from Alakahia, Rumuokoro, Choba, Mile II, Rumuosi, University of Port Harcourt Teaching Hospital [UPTH], Agrey Road, Mile III, Mile I and Emenike markets in the Port Harcourt metropolis, Nigeria. Ten samples each of industrially processed soybean beverage and soymilk were purchased at the Everyday Emporium and Next time supermarkets in Port Harcourt, Rivers state, Nigeria. Two homemade samples were used as control for the soy bean beverage and milk. The samples were transported to the Microbiology Laboratory of the University of Port Harcourt, Nigeria for immediate microbiological examination.

Enumeration of Microorganisms

The samples collected were serial diluted and plated using the pour plate method. Enumeration of total viable count was done using plate count agar [Oxoid, CM325, Harrigan and McCane, 1976]. Coliform counts were done using Violet red bile agar Oxoid [1985]. Yeast and mould counts were done on Sabouraud dextrose agar [Oxoid]. The plates were incubated at 37°C for 24-48 h for bacteria and at 25°C for 3 - 5 days for fungi. After incubation, distinct colonies that developed were enumerated in CFU/g or ml for each sample. The resultant microbial colonies were isolated into pure cultures and preserved in slants for further analysis.

Characterization and identification of microbial isolates

Growth representative of colonies were sub-cultured on nutrient agar medium and incubated for 24 h at 37°C. The colonial characteristics on agar plates were taken into consideration. The characterization and identification of isolated bacteria were carried out using the procedures of [Cowan and Steel, 1985; Holt *et al.,* 1994]. The chemical and biochemical tests carried out include: Gram's staining, coagulase reaction, oxidase reaction, motility, catalase, urease, citrate utilization and sugar fermentation. Resultant characteristics reaction of the isolates in this study were compared with those of known taxa using scheme of Cheesbrough [2004] and Bergey's Manual of Determinative Bacteriology by Holt *et al.* [1994]. For fungi, a wet mount preparation of the mycelial growth of each isolate was made using lactophenol cotton blue staining technique and observed under the microscope. The microscopic morphology was determined using the scheme of Pepper and Gerba [2005] and Ellis *et al.* [2007]. The identification of the fungi was based on the examination of the conidial heads, philiades, conidiophore and the presence of foot cells or rhizoids. The resultant morphology viewed microscopically and compared with the scheme provided by Samson and Varga (2007) and Watanabe (2010).

Antibiotic Sensitivity of Isolated Bacteria

The antibiotic sensitivity testing was carried out using the disc diffusion method on Mueller-Hinton agar as described by Bauer *et al.,* [1966] and was interpreted according to the guidelines [CLSI, 2002]. The antibiotics used were Ampiclox, Amoxicillin, Ciprofloxacin, Streptomycin, Erythromycin, Streptomycin, Chloramphenicol, Rifampicin, Levofloxacin and Norfloxacin.

Statistical Analysis

The Statistical Package for the Social Sciences version 18 [SPSS Inc., USA] was used to calculate the mean and Standard Deviation [SD]. The Student's T-test and Analysis of Variance [ANOVA] test was used to test for the significant difference at p-values < 0.05 within the groups measured at 95% confidence level.

3. Results and Discussion

Table 1 shows the mean heterotrophic count recorded in the soybean flour samples. The total heterotrophic bacteria count recorded in industrially processed soybean flour ranged from 2.1 – 2.8 x 10^4 CFU/g, while in locally produced soybean flour ranged from 2.3 - 4.8 X 10^4 CFU/g, with a significant statistical difference [$p < 0.05$] between heterotrophic counts of both groups but that of the control sample was 1.9 x 10^4 CFU/g [Table 1]. Heterotrophic count of locally processed soymilk ranged from 2.7 - 3.8 x 10^4 CFU/ml, while in industrially processed soy milk ranged from 2.5 – 3.4 x 10^4 CFU/ml, with a significant difference [$p < 0.05$] between both groups of soy milk and the control sample had a heterotrophic count of 2.4 x 10^4 CFU/ml as presented in table 1. The results are in agreement with studies by Odu and Egbo, [2012]; Nazim *et al.,* [2013] which reported significant differences [$p < 0.05$] between heterotrophic bacteria count of industrially processed and locally processed soy products. Likewise significant lower heterotrophic bacteria counts were seen in industrially processed products. This may be due to proper handling, preparation and processing of these products during industrial production, indicating a significant level of adherence to hazard analysis and critical control points [HACCP] during industrial processing of these products [Adebayo-Tayo *et al.,* 2008; Agboke *et al.,* 2011]. While the high level heterotrophic bacteria count in locally processed products could be an indication of poor handling during processing, inadequate equipment and poor sanitary conditions which could lead to bacterial contamination of the products from processing to storage and ultimate consumption of these products. The relatively low occurrence of potentially harmful bacteria and fungi in industrially processed soy flour is attributed to the chemical treatment of flour in a sterile environment during production [Esho *et al.,* 2013; Gbolagade *et al.,* 2011]. This treatment will ultimately reduce the occurrence of these potentially harmful organisms and increase the shelf life of the products.

Locally processed soy had fungal counts ranging from [2.5 – 4.5 x10^4 CFU/g] were significantly higher [$p < 0.05$] than fungal counts of industrially processed flour <10, according to serial dilution examined [0 – 3.1 x 10^4 CFU/g]. Locally processed soy milk samples also had fungal counts ranging between 1.9 – 3.4 x 10^4 CFU/ml when compared to fungal counts recorded in industrially processed soy milk [1.9 – 3.1 x 10^4 CFU/ml] [Table 2] with no significant difference observed [$p > 0.05$]. The results are similar to studies by [Adebayo-Tayo *et al.,* 2008; Nazim *et al.,* 2013], which reported significantly higher fungal counts in locally processed soy products when compared to fungal counts in industrial products. The relatively higher fungal counts in locally produced flour and milk may indicate a contamination of the products during processing. This could cause the growth of potentially harmful fungi in these products, and may also lead to certain ill health when consumed [Adelekan *et al.,* 2013].

Table 1. Total Heterotrophic bacteria count (THC) of the industrial and local soybean products

	Soybean flour			**Soymilk**	
Sampling location	**Locally made**	**Industrially made**	Sampling location	**Locally made**	**Industrially made**
	10^4 CFU / g			10^4 CFU / ml	
Alakahia	2.5	2.1	Alakahia	3.5	2.5
Rumuokoro	3.8	2.4	Rumuokoro	4.1	3.1
Choba	4.1	2.6	Choba	3.8	2.8
Slaughter	2.9	2.7	Mile II	2.7	2.8
Rumuosi	2.4	2.1	Rumuosi	3.9	2.7
UPTH	3.1	2.1	UPTH	2.8	3.4
Aba Rd	4.8	2.4	Rumuola	3.1	3.1
SlaughterI	2.9	2.3	Mile III	2.8	2.7
Mile I	2.5	2.5	Mile I	3.4	2.8
Emenike	2.3	2.8	Aba road	2.8	2.6
Control	1.9		Control	2.4	
Statistical Analysis					
ANOVA (p-value)		0.002*		0.002*	
T-Test (p-value)					
Local v Industrial		0.029*		0.029*	
Local v Control		0.008*		0.008*	
Industrial v Control		0.006*		0.006*	

*Difference is statistically significant (p< 0.05)

Table 2. Total Fungal count (TFC) of the industrial and local soybean products

	Soybean flour			Soymilk	
Sampling location	**Locally made**	**Industrially made**	Sampling location	**Locally made**	**Industrially made**
	10^3 CFU / g			10^3 CFU / ml	
Alakahia	2.5	2.8	Alakahia	2.4	2.3
Rumuokoro	3.1	0	Rumuokoro	1.9	1.9
Choba	4.5	3.1	Choba	2.3	1.9
Slaughter	2.8	2.4	Mile II	3.4	2.4
Rumuosi	3.1	2.6	Rumuosi	3.6	2.7
UPTH	3.1	2.4	UPTH	4.2	3.1
Aba Rd	2.9	0	Rumuola	3.4	2.6
SlaughterI	2.5	2.9	Mile III	2.6	2.8
Mile I	3.2	1.9	Mile I	2.7	2.9
Emenike	3.2	2.1	Aba road	2.8	2.6
Control	2.1		Control	2.4	
Statistical Analysis					
ANOVA (p value)		0.028*		0.133**	
T-Test (p value)					
Local v Industrial		0.014*		0.125**	
Local v Control		0.792**		0.160**	
Industrial v Control		0.022*		0.378**	

*Difference is statistically significant (p< 0.05)
**Different is statistically not significant (p>0.05)

The occurrence of bacteria isolated from locally and industrially processed soymilk is shown in Figure 1. Bacteria isolated include: *Proteus* sp., *Pseudomonas* sp., *Micrococcus* sp., *Bacillus* sp., *Staphylococcus* sp. and *Escherichia* sp. The most occurring bacteria in the locally produced soymilk were *Micrococcus* sp. and *Staphylococcus* sp. [22.2% each], while the least occurring bacteria were *Pseudomonas* sp. and *Escherichia* sp. [11.1% each]. *Proteus* sp. was the most occurring bacterium in industrially processed soymilk [27.2%], while *Micrococcus* sp. and *Pseudomonas* sp. were the least occurring bacteria in industrially processed products [9.09% each]. The isolated bacteria from soybean flour include *Bacillus* sp., *Pseudomonas* sp., *Staphylococcus* sp., *Streptococcus* sp. and *Micrococcus* sp. *Pseudomonas* sp. and *Staphylococcus* sp. were the most occurring bacteria [26.7% each] in locally produced soybean flour, while *Pseudomonas* sp. was also the most occurring isolate [37.5%] in industrially processed soybean flour as shown in Figure 2. The presence of some potentially pathogenic bacteria shows relatively high frequencies in locally or industrially processing products which may be attributed to the unhygienic processing environment. Results indicate that faecal contamination of soymilk is due to the presence of coliforms such as *Escherichia* sp. in the products [Adebayo-Tayo *et al*., 2008]. The presence of *Pseudomonas* sp. and other bacteria may be as a result of the composition of the soymilk and the handling processes during manufacturing and storage [Osho *et al*., 2010]. Potentially harmful bacteria such as *Staphylococcus* sp., *Pseudomonas* sp. and *Streptococcus* sp. presence in these products may cause diseases in the individuals that consume them. They may cause foodborne illnesses and quick spoilage of the food products leading to not only a public health risk but also an economic loss to producers and retailers. The presence of *Staphylococcus* sp. *Escherichia* sp. and *Salmonella* sp. in high frequencies is associated with food spoilage, food borne illnesses and food poisoning leading to diarrhea, fever and other complications in individuals [Adelekan *et al.,* 2013; Nawal *et al.,* 2013].

Fungi isolates from locally and industrially processed soymilk include: *Mucor* sp., *Rhizopus* sp., *Saccharomyces* sp. and *Aspergillus* sp. were shown in Figure 3. *Rhizopus* sp. was the most occurring fungi in both local and industrial soymilk products [42.8% and 44.4% respectively]. *Saccharomyces* sp. was the least occurring fungi [14.3%] in locally processed soymilk. The least occurring fungus in the industrially processed soymilk was *Aspergillus* sp. [11.1%]. Figure 4 shows that *Rhizopus* sp. was the most occurring fungal isolate in both locally processed soybean flour [40%], while the least occurring isolates in locally processed soybean flour were *Saccharomyces* sp. and *Aspergillus* sp. [30%]. But in the industrially processed products, all the isolates had an equal occurrence rate [33.3%]. The frequencies of occurrence of *Aspergillus* sp. in industrially processed samples were higher than those isolated from locally produced samples [Figure 3]. The isolates reported are naturally occurring fungi in soybean products, however, the occurrence of *Aspergillus* sp. is a cause for concern as it can produce potentially harmful aflatoxins in the products when they are consumed [Adebayo –Tayo *et al*., 2008]. Mycotoxins in food are not always beneficial, for instances some species of *Aspergillus* in food products could lead to food poisoning probably due to their ability to produce toxic substances [Odom *et al.,* 2012]. Some of the mycotoxins produced by *Aspergillus* species include aflatoxins, ochratoxins and sterigmatocystine [Hashem, 2011]. Other health problems associated with aflatoxin include carcinogenicity, teratogenicity, toxigenicity, immunotoxigenicity and mutagenicity [Pratiwi *et al.,* 2015; Wild and Gong, 2010 & Akinyemi *et al.,* 2011], Zygomycosis [mucrormycosis] caused by some species of *Rhizopus*.

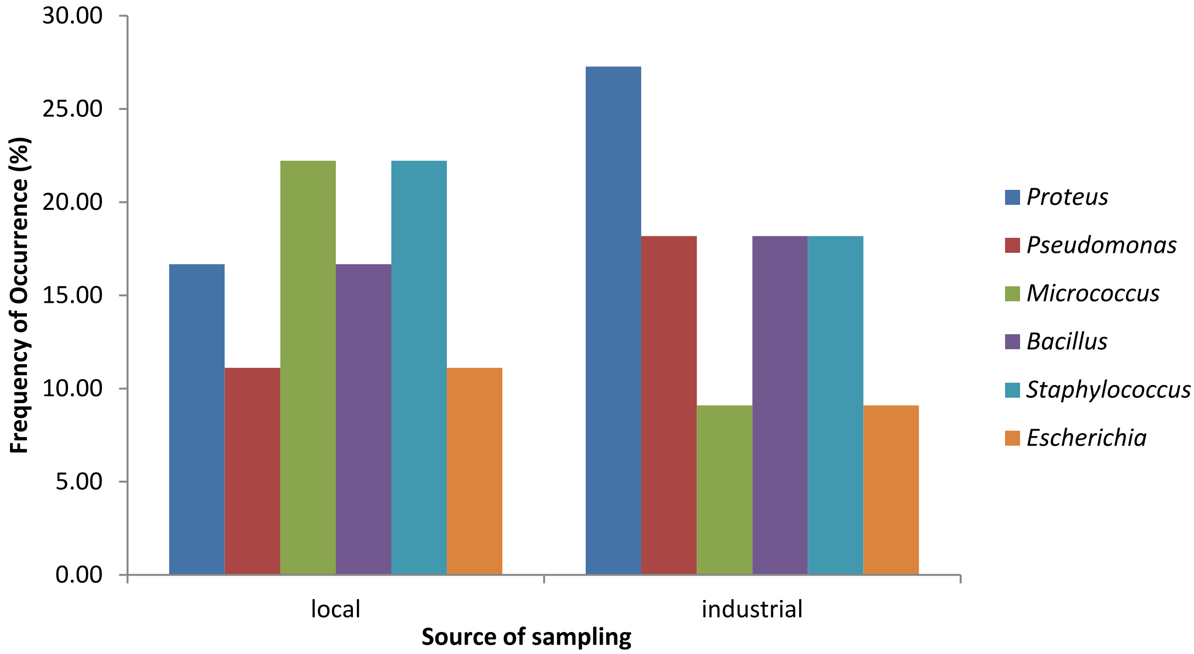

Figure 1. Frequency of Occurrences of isolated Bacteria from soymilk samples

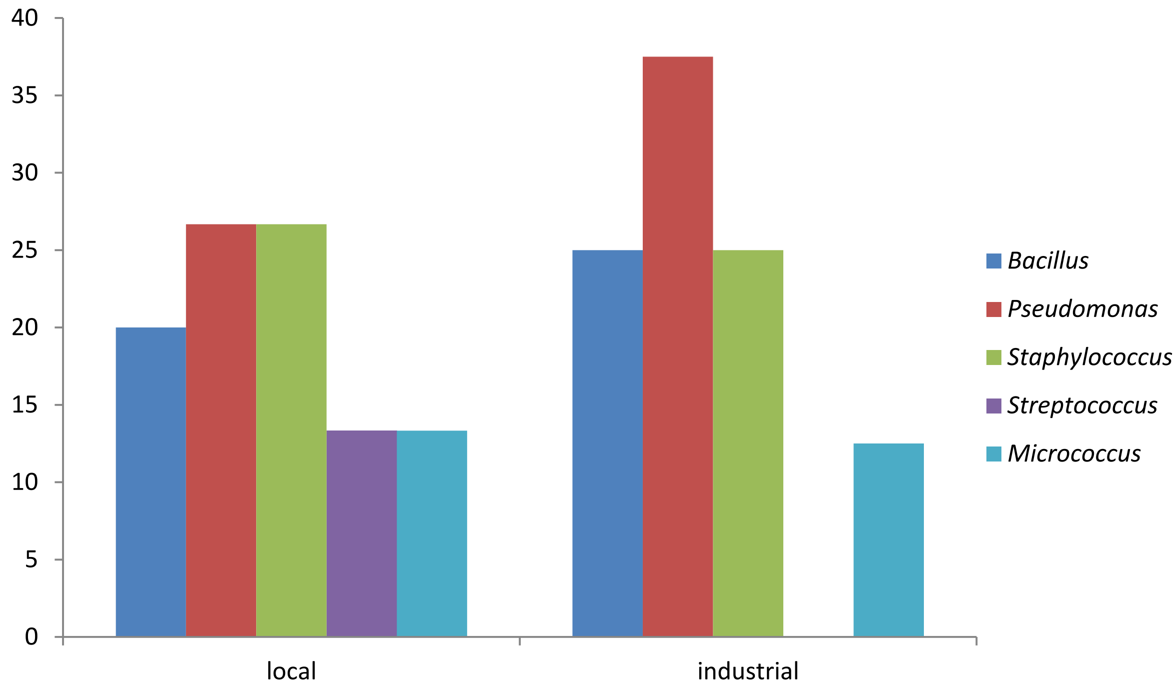

Figure 2. Frequencies of Occurrences of isolated bacteria from soybean flour samples

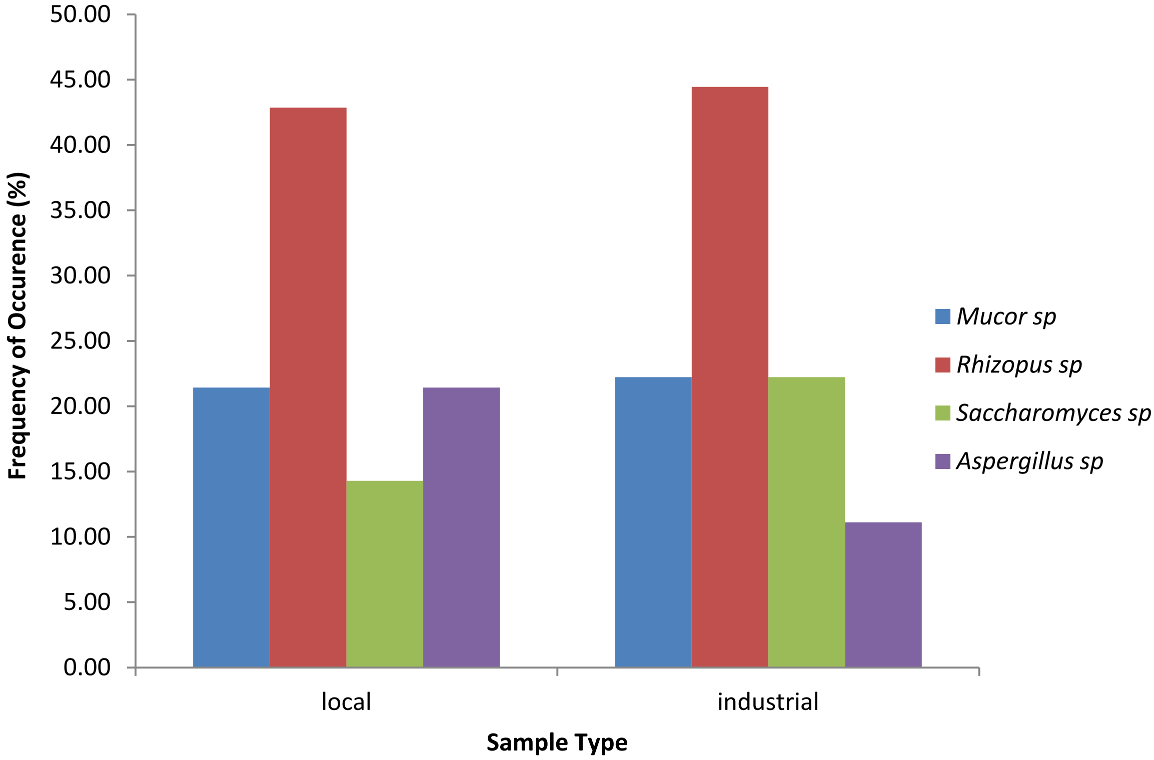

Figure 3. Frequency of occurrence of fungal Isolates soymilk

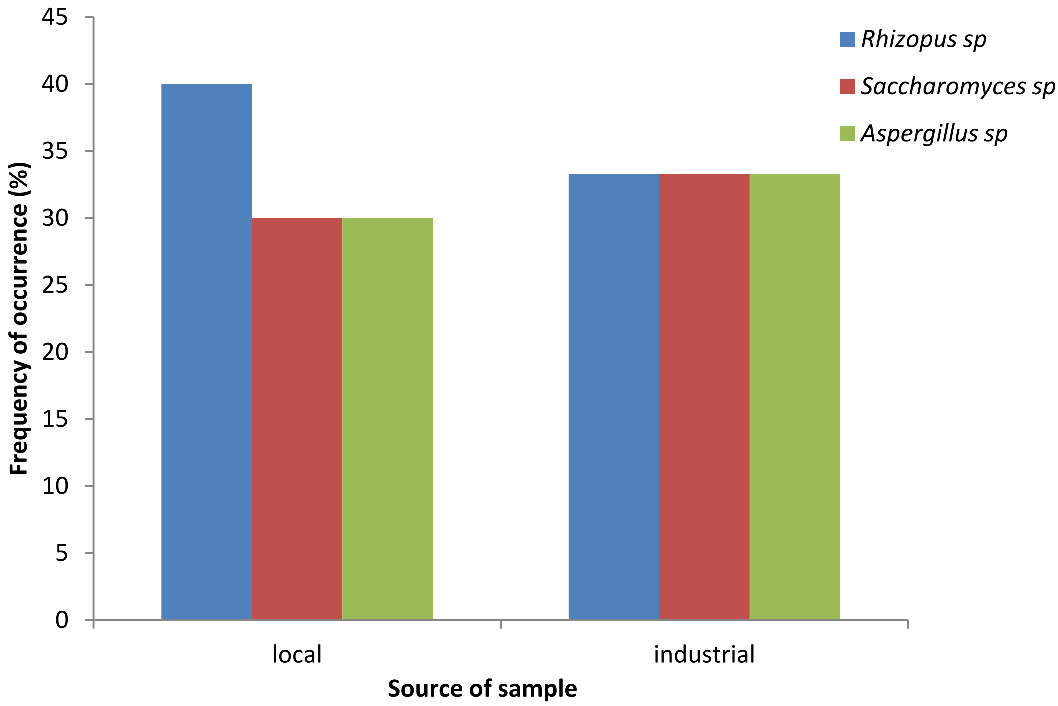

Figure 4. Frequency of Occurrence of fungal isolates from soybean flour samples

Most of the organisms found in soy products are known to cause several diseases in human. For instance, bacteria such as *Pseudomonas, Streptococcus* and *Bacillus* sp. are pathogenic and are major health concern to man [Akhigbemidu *et al*., 2015]. Coliforms are known to cause varying degree of gastroenteritis depending on the strain. *Micrococcus* sp., which is a saprophytic bacterium, its occurrence may be from the skin of human and animals [Seiyaboh *et al.,* 2013]. Enteric fever, food poisoning and bacillary dysentery are some of the potential diseases that may be caused by bacteria found in soy products. Some species of *Bacillus* can cause bacteremia /septicemia, endocarditis and gastrointestinal tract diseases [Izah *et al.,* 2015; Orutugu *et al.,* 2015; Turnbull, 1996]. Food poisoning syndrome such as rapid and slower onset emetic syndrome [Turnbull, 1996], bacteremia are caused by some species of *Pseudomonas* [Bush and Perez, 2014], and toxic shock are caused by *S. aureus* [Orutugu 2015]. Consumption of food contaminated by strains of *S. aureus* toxins may lead to Staphylococcal gastroenteritis [Akhigbemidu *et al.,* 2015] and staphyloxanthin a carotenoid pigment that act as virulent factor [Akhigbemidu *et al.,* 2015]. Typically, the intensity of the disease symptoms produced may depend on the quantity of contaminated food ingested and susceptibility of the individuals to the toxin [Odu and Imaku, 2013].

Table 3 shows the antibiotic sensitivity of bacteria isolated from locally made soybean flour. *Bacillus* sp. was resistant to tested antibiotics expect for ciprofloxacillin and Ofloxacin. *Pseudomonas* sp., *Micrococcus* sp. and *Streptococcus* sp. followed the same trend and were resistant to all tested antibiotics expect for ciprofloxacillin, while *Staphylococcus* sp. was sensitive to all tested antibiotics expect for ceftazimidine and ciprofloxacillin [Table 3]. Table 4 shows the antibiotic sensitivity pattern of the bacteria isolated from the industrial products, the most sensitive antibiotics were gentamycin and ofloxacin [75%] each, while ceftazimidine was the least sensitive antibiotic (25%), the most sensitive isolate was *Bacillus* sp. [62.5%] while other isolates had a sensitivity of 50% each. This finding is supported by the works of [Daniyan and Ajibo, 2011] which reported that *S. aureus* was resistant to pefloxacin but susceptible to streptomycin, ciprofloxacin, ceftriaxone and cefuroxime. A study by [Srinu *et al.,* 2012] also reported that *S. aureus* was sensitive to streptomycin, cotrimoxazole and ciprofloxacin. *B. cereus* was susceptible to erythromycin, ciprofloxacin and streptomycin but resistant to ampiclox. In a similar study [Agwa *et al.,* 2012] although the findings of this study showed that B. cereus was resistant to erythromycin and ampiclox. However Srinu *et al*. [2012] also reported that *E. coli* was sensitive to Streptomycin, cotrimoxazole and ciprofloxacin, the findings of this study shows that *E. coli* isolated was resistant to streptomycin. There is need for the vendors to practice good hygiene to reduce contamination of soy products with foodborne pathogens.

Table 5 shows the antibiotic susceptibility pattern of the bacteria isolated from the locally produced soy milk samples, Ciprofloxacin was the most sensitive antibiotic [83.3%], while cefuroxine, nitrofloxacin and ampicillin were the least sensitive antibiotics [33.3%] each. Table 6 shows the antibiotic sensitivity pattern of the bacterial isolates in the industrially processed soy milk samples, Augmentine and gentamycin were the most sensitive antibiotics [66.7%], while cefuroxime and nitrofloxacin were the least sensitive [33.3%]. Antibiotic sensitivity patterns recorded in this study are in contrast to the findings of Adelekan *et al.,* [2013] which reported an 80% sensitivity of isolates from industrially processed soybean products to augumentin and ciprofloxacin. These contrasting antibiotic susceptibility patterns may be due to the exposure of these products to different preservative chemicals or improper handling and storage of these products before it is sold to the final consumer [Agboke *et al.,* 2011]. The varying antibiotic sensitivity patterns could lead to an occurrence of antibiotic resistant bacterial diseases that may be difficult and expensive to treat [Prescott *et al.,* 2005].

Table 3. Antibiotic sensitivity pattern of bacterial isolates from locally produced Soybean flour

Isolate	CAZ	CRX	GEN	CPR	OFL	AUG	NIT	AMP
Bacillus	R	R	R	S	S	R	R	R
Pseudomonas	R	R	S	S	S	R	R	S
Staphylococcus	R	S	S	R	S	S	S	S
Streptococcus	R	R	R	S	R	R	R	R
Micrococcus	R	R	S	S	S	R	R	R
%S	**0**	**20**	**60**	**80**	**80**	**20**	**20**	**40**
%R	**100**	**80**	**40**	**20**	**20**	**80**	**80**	**60**

Key: **CRX:** Cefuroxime; **CAZ:** Ceftazimidine
GEN: Gentamycin; **CPR:** Ciprofloxacillin
OFL: Ofloxacin; **AUG:** Augmentine
NIT: Nitrofuratoin; **AMP:** Ampicloxacillin
S: Sensitive, R: Resistant.

Table 4. Antibiotic sensitivity pattern of bacterial isolates from industrially processed soybean flour

Isolate	CAZ	CRX	GEN	CPR	OFL	AUG	NIT	AMP
Bacillus	S	R	R	S	S	R	S	S
Pseudomonas	R	R	S	S	S	S	R	R
Staphylococcus	R	S	S	R	R	S	R	S
Micrococcus	R	S	S	R	S	R	S	R
% S	**25**	**50**	**75**	**50**	**75**	**50**	**50**	**50**
%R	**75**	**50**	**25**	**50**	**25**	**50**	**50**	**50**

Key: **CRX:** Cefuroxime **CAZ:** Ceftazimidine
GEN: Gentamycin **CPR:** Ciprofloxacillin
OFL: Ofloxacin **AUG:** Augmentine
NIT: Nitrofuratoin **AMP:** Ampicloxacillin
S: Sensitive, R: Resistant.

Table 5. Antibiotic sensitivity pattern of bacterial isolates from locally produced soymilk

Isolate	CAZ	CRX	GEN	CPR	OFL	AUG	NIT	AMP
Proteus	R	S	R	S	S	S	R	R
Pseudomonas	R	R	S	S	R	S	R	S
Micrococcus	R	S	S	R	S	R	S	R
Bacillus	R	R	R	S	R	S	R	R
Staphylococcus	R	R	S	S	S	S	R	R
Escherichia	S	R	R	S	S	R	S	S
%S	**16.7**	**33.3**	**50**	**83.3**	**66.7**	**66.7**	**33.3**	**33.3**
%R	**83.3**	**66.7**	**50**	**16.7**	**33.3**	**33.3**	**66.7**	**66.7**

Key: **CRX:** Cefuroxime **CAZ:** Ceftazimidine
GEN: Gentamycin **CPR:** Ciprofloxacillin
OFL: Ofloxacin **AUG:** Augmentine
NIT: Nitrofuratoin **AMP:** Ampicloxacillin
S: Sensitive, R: Resistant

Table 6. Antibiotic Sensitivity Pattern of Bacterial Isolates from industrially processed soy milk

Isolate	CAZ	CRX	GEN	CPR	OFL	AUG	NIT	AMP
Proteus	S	R	R	S	S	R	S	S
Pseudomonas	R	R	S	S	S	S	R	R
Micrococcus	R	S	S	R	R	S	R	S
Bacillus	R	R	S	S	R	S	R	S
Staphylococcus	R	S	S	R	S	R	S	R
Escherichia	R	R	R	S	R	S	R	R
%S	**16.7**	**33.3**	**66.7**	**50**	**50**	**66.7**	**33.3**	**50**
%R	**83.3**	**66.7**	**33.3**	**50**	**50**	**33.3**	**66.7**	**50**

Key: **CRX:** Cefuroxime **CAZ:** Ceftazimidine
GEN: Gentamycin **CPR:** Ciprofloxacillin
OFL: Ofloxacin **AUG:** Augmentine
NIT: Nitrofuratoin **AMP:** Ampicloxacillin
S: Sensitive, R: Resistant

4. Conclusions

The microbial quality and safety of vending operations are a major source of concern for food control and health officers in developing countries. These finding shows varying public health concerns in both locally produced and industrially processed soybean products. The occurrence of organisms such as *Escherichia* sp., *Streptococcus* sp. and *Aspergillus* sp. are indications of various levels of contamination of these products. These organisms could cause foodborne diseases and serious public health concern for the consumers. Antibiotic sensitivity pattern of the bacterial isolates indicate an occurrence of antibiotic resistant bacteria most likely due to the exposure of these products to several preservatives and sometimes unhygienic processes of production. The study shows an unacceptable microbiological quality of these products and a dire need for the strict implementation HACCP protocols during production of these products to prevent the occurrence of food contamination, antibiotic resistant organisms and other serious public health concerns especially with locally processed products.

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