A COMPARATIVE ANALYSIS OF FOOD STORAGE SCORES AND MICROBIAL LEVELS OF FOOD SUBSTANCES IN ABIA

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ABSTRACT

The study carried out the comparative analysis of food storage scores and microbial levels of food substances in Abia. The population of this study consisted of all 932,411 citizen of Aba in Nigeria. The study adopted Cross sectional study design while simple random sampling technique was used in selecting the respondents. The instrument for data collection which was tagged (ASSESSMENT OF FOOD PREPARATION AND PRESERVATION', QUESTIONNAIRE (AFPPQ) was administered to the respondents and used for the study. The instrument was vetted by the researcher's supervisor who is an expert in the field before the reliability test was conducted which produced the reliability coefficient of 0.79 proving the instrument to be reliable for the study. Data collected were analyzed using Descriptive Analysis and Analysis of Variance (ANOVA). From the results of the data analysis, it was observed that all food establishments require training practices *on food storage and f*ood safety management in Abia State is below internationally accepted level. *It was therefore recommended that t*he Private sector should be involved in food safety management as government alone cannot handle this. *Government should formulate policies that will regulate food handlers from unhealthy means of transportation of food items to prevent contamination in transits.*

KEY WORDS: food storage scores, food handlers, microbial levels, food substances, Abia State, relation, Codex Alimenterius Commission, WHO/FAO.

Introduction

Food hygiene is an Environmental Health requirement. The activities include the inspection of food preparation, inspection of premises prior to commencement of operation, licensing of the food premises after satisfaction of the minimum requirement for such a license, ensuring that the food handlers are medically fit to handle food meant for public consumption etc (Litchfield, 2000). Food hygiene typically refers to rules and procedures within the food industry, whether during production, packaging, transporting or serving at the consumer level, such as in a home kitchen. Food hygiene ensures that food is uncontaminated and safe to eat.

The European Union (2005) asserts that food operators should implement the listed guidelines to ensure that the food served to public is wholesome and safe for consumption which include: the need for the food handlers and service staff to have awareness on good housekeeping and personal hygiene practices; To know the method to serve food hygienically; To know how to eat safely during festive period and what not to eat during festive period; To know how to store food properly in the refrigerators and the use of refrigerators; thawing of food; Good handling of eggs; Proper cleaning and sterilization of chopping boards and other implements and Proper Handling of raw vegetables and fruits.

In Nigeria as a whole and in Abia State in particular there are laws governing food hygiene and safety practices which are called Public Health Laws. The essence of these laws is to ensure protection of food to prevent mortalities and morbidities arising from consumption of unwholesome food. The Abia State Primary Health Care Management Board was established for enforcement of public health laws with respect to maintenance and regulation of primary health care activities which includes environmental health activities including food hygiene and safety. Food safety is a vital issue both in developed and developing countries; given that food borne illnesses contribute to millions of illnesses and thousands of deaths annually.

Statement of the Problem

The World Health Organization (WHO) estimated 200,000 people died from diarrhea each year in Nigeria (WHO 2008), as much as 70% of which may be attributable to contaminated food and water. Food-borne infection is endemic in Nigeria. The 1997 local government health system profile for Nigeria on reported leading causes of deaths in different zones showed that diarrhea cases account for 25% of mortality followed by malaria (21.0%) and accident (9.8%)) (FAO/WHO, 2002).

Mobility and mortality resulting from insanitary food handling is a mayor public Health problem in Nigeria. Statistics has shown that diarrhea cases account for 25% of mortality (FAO/WHO 2002). Therefore. this study is commissioned to address insanitary handling of food in Abia State because not many researchers have been conducted research in this discipline therefore this study is conducted to address unsanitary and unhygienic food handling in Abia State in order to reduce the prevalence of food borne diseases occasioned by poor food handling.

GENERAL OBJECTIVE:

To evaluate the safety standard of food and meat in Abia State using Hazard analysis critical control point standard operating procedure (HACCP- SOP) Check list.

SPECIFIC OBJECTIVES

1. To find out the differences in the mean food storage scores by food handlers in Abia State.
2. To compare the microbial levels of food substances in Abia State in relation to microbiological criteria of Codex Alimenterius Commission of WHO/FAO.

RESEARCH QUESTIONS

1. What are the differences in the mean food storage scores of food handlers in Abia State by their food establishment?
2. What are the microbial levels of food substances in AbiaState in relation to microbiological criteria of Codex Alimenterius Commission of WHO/FAO?

HYPOTHESES

1. H_0: There is no statistically significant difference in the mean food storage scores of food handlers in AbiaState on the HACCP-based SOPs Checklist by their food establishment.
   H_1: There is statistically significant difference in the mean food storage scores of food handlers in AbiaState on the HACCP-based SOPs Checklist by their food establishment

2. H_0: There is no statistically significant difference in the mean microbial load of food substance and the provision of the Microbiological criteria of Codex Alimentarius Commission of WHO/FAO.
   H_1: There is statistically significant difference in the mean microbial load of food substance and the provision of the Microbiological criteria of Codex Alimentarius Commission of WHO/FAO.

Literature Review

Proper Storage of Cooked and Uncooked Food

ILRI (2011) recommended that refrigerating food quickly after cooking can help keep the bacteria from multiplying. Cooking food to proper temperatures kills most bacteria, including *Salmonella, Listeria,* and all kinds of *E. coli* that cause illness, and Parasites. However, cooking does not kill most harmful bacteria; it is especially important when a pathogen is hard to wash off a particular kind of food, or if a bacterium can grow at refrigerator temperatures, as is true of *Listeria monocytogenes* and *Yersinia enterocolitica.* Hence, it is important to maintain the correct temperature of refrigerators and to keep them clean so that frozen and chilled food remains safe and that is why Food handlers should adopt the following guidelines when using the refrigerator.

(1) **Maintaining Safe Refrigerator Temperatures**

- ✓ Keep the temperature of chillers between 0ºC and 4ºC and the temperature of freezers at -18ºC and below.
- ✓ Use a refrigerator thermometer (one that can read temperatures below 0^0c) to ensure that the refrigerator temperature is correct. The temperature inside the refrigerator can be determined by following the steps below:

a. Place the thermometer near the Centre of the refrigerator in a convenient, easy-to- read location and close the refrigerator door.

(b) Leave the thermometer in the refrigerator for ten to fifteen minutes to allow the thermometer to obtain an accurate temperature reading.

(c) Read the thermometer without taking it out of the refrigerator. If the thermometer reading is not within the range of 0^0c to 4^0c (for chiller) or -18^0c and below (for freezer), adjust the thermostat dial to the required temperature. Read the thermometer reading again after fifteen minutes.

(d) Use a non- mercury thermometer in the refrigerator as mercury thermometers may break and contaminate the food.

(e) Ensure that both thermometer and refrigerator are in good working condition.

(f) Allow proper circulation of cool air by not overloading the refrigerator with too much food. Cool air should circulate freely to keep food properly chilled.

(e) Avoid leaving the refrigerator door open for too long as this will raise the refrigerators temperature.

2. **Storing Food Safely in the Refrigerator**

(a) Store food at the correct temperature as soon as it has been delivered or prepared. This prevents growth of harmful bacteria and minimizes the risk of food spoilage.

(b) Store cooked and ready-to-eat food above raw food. This is to prevent cross-contamination of the cooked or ready-to-eat food with the drippings from the raw food.

(c) Store food in separate, properly-covered containers in the refrigerator to prevent cross-contamination.

(d) Do not store sea food at room temperature as bacteria can multiply rapidly in food at room temperature. Place sea food in covered containers and store it in the refrigerator. Label food and include the date of purchase or preparation and the respective "use-by" date. Adopt a "first-in first-out" principle. Older food items that are stored in the refrigerator should be used first.

(e) Place hot food into small dishes or distribute them into smaller portions for rapid cooling before refrigeration.

(f) Do not store perishable food in the refrigerator door. Put them on the shelves in the main part of the refrigerator. The temperature of food stored in the door can increase when the refrigerator is opened.

Keeping the Refrigerator Clean

The followings are guidelines in keeping the refrigerators clean to avoid food contamination.

a. Wipe spills immediately with a damp cloth and dry with a clean cloth.

b. Clean the inside of the refrigerator using a clean sponge or cloth and warm, soapy water regularly. Rinse with a damp cloth and dry with a clean cloth.

c. Wash removable shelves and drawers with warm, soapy water and rinse with clean water. Dry with a clean cloth.

d. Clean the rubber lining of the refrigerator regularly.

e. Clean the condenser coil regularly with a brush to remove dirt and dust so that the refrigerator can work efficiently.

f. Conduct a stock-check every week to discard perishable food that has turned bad or has passed the use by date.

Dry Storage of Non-Perishable Foods

Nonperishable foods are food items that do not easily get spoil or decay, they can withstand months of shelf life. Canned food is safe as it concerns nonperishable food but dried food is preferable. Non-perishable foods shall be stored in the following manner:

a. Non-perishable foods should be stored in containers and kept in a designated space, lockers, cupboards, racks and shelves

b. All spaces, lockers and cupboards used for food preparation and food serving operations, should be constructed of the same materials and quality.

c. Food and food materials shall be stored separately from chemicals and disinfectants so as to avoid contamination.

d. Food storage rooms shall be insect and vermin proof.

e. Wet and dry food materials shall be stored separately.

MEAT SPOILAGE ORGANISMS

Beef is a high protein food which is widely consumed by the majority of the urban populace; its high nutritional content makes it susceptible to microbial invasion and subsequent deterioration (Roth, 2012). The presence of pathogenic and spoilage microorganisms in meat and its by-products remains a significant concern for suppliers, consumers and public health officials worldwide (Oboegbulem & Muogbo, 2008). Meat spoilage is not always evident, and consumers would agree that gross discoloration, strong off-odor, and the development of slime would

constitute the main qualitative criteria for meat rejection (Roth, 2012). In general, spoilage is a subjective judgment by the consumer, which may be influenced by cultural and economic considerations and background as well as by the sensory acuity of the individual and the intensity of the change (Roth, 2012). Spoilage results mainly from ''off-odors'' development, and product shelf-life is determined both by the number of spoilage organisms present initially and the temperature history of the product at all stages of production and handling (Oboegbulem & Muogbo, 2008).

Meat is said to be spoilt when it is unfit for human consumption (Okonko et al., 2010). Meat is recognized as one of the most perishable foods and refrigeration temperature are always used to delay spoilage of fresh meat. Fresh meat has a high water quality and a P^H between 5.5 and 7.0 (Oboegbulem & Muogbo, 2008).). Spoilage of meat can be considered as an ecological phenomenon that encompasses the changes of the available substrate (e.g. low molecular compounds) during the proliferation of bacteria that consist the microbial association of the stored meat (Oboegbulem & Muogbo, 2008).). Among the factors that affect microbial growth in meat are intrinsic properties (physical and chemical properties of meat), and extrinsic (environmental factors). However, the factors having the greatest influence on the growth of microorganisms in meat and meat products are the storage temperature, moisture and oxygen availability (Okonko et al., 2010). The development of organoleptic spoilage is related to microbial consumption of meat nutrients, such as sugars, and free amino acids and the release of undesired volatile metabolites (Litchfield, 2000).

Microorganisms commonly associated with meat include majorly the psychrophiles of the *genera Pseudomonas, Lactobacillus, Moraxella, Acinetobacter, Microbactria, Brochotrix, Klebsiella and Vibro*. The mesophiles include *Salmonella Spp, Escherichia coli, Clostridium perfringens, and the thermophiles include Streptococcus faecalis*; others include members of the genera *Flavobacterium, Bacillus, Leuconostoc, Proteus, Micrococcus* and *Achromobacter* (Litchfield, 2000). The common moulds on meat are the genera *Cladosporium, Sporotrichum, Oospora, Thamidium, Mucor, Penicillium, Alternaria and Monilia.* The yeasts found on meat are majorly of the Asporogenous genera and include *Torulopsis, Rhodotorula and Candida* (National Environmental Sanitation Policy, 2005). Temperature seems to be the most important factor that influences the spoilage as well as the safety of meat. Meat spoilage bacteria will grow if temperatures are not kept in the cooling (-1^{o}C to 4^o C) or freezing (below -1^{o}C) range.

MATERIALS AND METHODS

Study Design

Cross sectional study design was adopted for this work. Simple random sampling was employed.

Population of the Study

Aba, the study city, has a population of about 932,411 (Nigeria population census, 2007). It is the commercial nerve centre of Abia State, which has three main international markets – Ariaria Market, New Market/Ekeoha Shopping Centre and Cemetery Market. Apart from these main commercial centers the whole of Aba is filled with many small markets and industries.

Sampling

Random sampling was used for collection of biological samples for this study and has been accepted by ILRI 2011. 144 samples were collected from 6 markets sampling for administration of HACCP base SOP check list was done using a modified method of ILRI (2011).

Selection of Meat Markets and Abattoir

A number of markets exist in Aba, but six markets were randomly selected by ballot method. The markets selected from Aba were; waterside market, AhiaUmungasi, AmaOgbonna market, AhiaUdele, AhiaOhuru and cemetery market. The abattoir selected for this study was the main slaughter house in Ogbor-Hill located in the center of the city in Aba.

Meat Sampling at the Abattoir

The abattoir comprises several butchering stalls which were randomly selected, using the ballot method. 24 samples from different portions of fresh meat were aseptically collected from each market. A total of 144 meat samples were collected in all the meat market. While 28 samples each were collected from Raw and cooked foods respectively making a grand total of 200 samples.

Meat Sampling At the Markets

The meat stalls in a market were numbered and sequentially arranged. The balloting techniques were employed to select the meat stalls. In each market, 24 samples from different portions of fresh meat were selected.

Sampling Of Contact Surface at the Market and Abattoir

Five surface swab samples of each of the meat seller's knives, tables and hands were aseptically collected using the swabbing technique. 75 swab samples were collected from the markets while 15 swab samples were collected from the abattoir. Collection was dependent on the size of the market as well as on the cooperation of the meat sellers. A total of 90 swab samples were collected in all the meat markets.

Instrument for Data Collection

Instruments used for data collection in this study were; interviews, Questionnaire, microbial analysis,

Reliability of the Instrument

To test for the reliability of the two research instruments, Kuder Richardson techniques were used. The technique was used to ascertain the level of reliability of the researcher instrument named 'ASSESSMENT OF FOOD PREPARATION AND PRESERVATION', QUESTIONNAIRE (AFPPQ)).

Sampling Procedure

The samples were collected in twelve successive visits to the abattoir and to each of the market. The ICMSF sampling procedures were used. Sterile swabs for taking surface swab samples were used. The sampling areas were marked with sterile metal guide (e.g. 5, 50 or 100cm^2). Two sterile cotton swabs were used to swab the sample area. The first swab was moistened with peptone water and rubbed firmly across the exposed area several times in all direction. The second swab was used to dry by rubbing over the same area. The swabs were introduced into bottles containing 0.1% peptone water and vigorously shaken. The samples were kept in labeled bags and kept at 4^{o}C in an insulated cooler box while transported to the laboratory for further bacteriological analysis within two hours.

Sample Preparation

The sampling procedure was used. Two sterile cotton swabs was used to swab the sample area marked with sterile metal guide (e.g. 5, 50 0r 100cm^2). The first swab was moistened with peptone water and rubbed firmly across the exposed meat area in all direction. The second swab was used to dry by rubbing over the same area. The meat was held and cut open with a sterile spatula and scissors and the procedure was repeated. The swabs was pooled together into a bottle containing 0.1% peptone water and vigorously shaken and kept for further analysis.

Microbiological Analysis

The microbiological analysis was carried out in Abia State Teaching Hospital, Aba. The sample was cultured using pour plate method. All media used were prepared according to the manufacturer's instruction and sterilized at 121^{oc} for 15 minutes. From the 10 fold dilutions of the homogenates, 0.1 ml of 10^{-6}dilution was plated in replicate on nutrient agar for total viable aerobic bacteria and MacConkey for Staphylococcus .and Esherica Coli, coliform enumeration. The plates were incubated at 37^{oc} for 24 hours. After the incubation time, the plates were observed for countable colonies formed. The colonies were counted using digital colony counter. The counts were expressed as cfu/cm^2.

Total Viable Bacteria Count

The nutrient agar medium was prepared by dissolving 28g of the nutrient agar powder in 1000ml of distilled water sterilized by autoclaving at 121^{oc} for 15 minutes. It was dispensed in sterile Petri-dishes and cooled to 45 ^{oc}. 0.1ml of each sample was pipette into Petri-dishes; 20ml of the molten nutrient agar was later added aseptically. The Petri-dishes were rotated gently to distribute the bacterial cells evenly in the agar. The agar was allowed to cool and set (approximately 20 minutes). The plates were incubated at 37^{oc} for 24 hours. The plates were observed and the colonies formed were counted as cfu/cm^2 (Okonko et al., 2010).

Total Coliform Counts

The MacConkey agar medium was prepared by dissolving about 26g of the powder in 500ml of distilled water, sterilized by autoclaving at 121^{oc} for 15 minutes and cooled to 45 ^{oc}. From the ten-fold dilution, 0.1ml of 10^{-6} was pipette into Petri-dishes and 20ml of MacConkey agar was aseptically added. The petri dishes were rotated gently to distribute the bacterial cells evenly in the agar. The agar was allowed to cool and set. The plates were incubated at 37^{oC} for 24-48 hours, and colonies formed were counted and expressed as cfu/cm^2.

Isolation of Bacteria Isolates

Following the establishment of growth in the cultured samples, each culture plate was examined closely for the presence of distinct colonies. From such distinct colonies, inoculate were collected aseptically and transferred unto fresh nutrient agar media as sub-cultures. Upon the establishment of growth, the culture plates were examined for uniformity as a mark of purity. The resulting pure cultures were used for characterization of the isolates and their subsequent -- identification (Okonko et al., 2010).

Identification of Bacterial Isolates

The resulting pure cultures was carefully examined and characterized based on colony morphology, microscopic appearance, gram staining reaction and biochemical tests such as TSI test, ureas test, indole production, methyl red(MR), voges-proscauer(VP), motility, citrate test as described by Okonko et al., (2010).

Colony Morphology

The bacteria isolates was then identified based on matching characteristics with existing taxonomy using Bergery's, manual of determinative bacteriology.

Morphological and Biochemical Characteristics of Bacterial Isolates

Although the above named characters of the colony would be a pointer to the type of the bacterium, further tests are required for actual identification. Therefore, a stained preparation of the bacterium was made. The smears from isolated colonies were stained and examined under the microscope. A staining reaction was carried out for bacterial differentiation.

Gram Staining Reactions

Gram staining reaction has the wildest application, distinguishing nearly all bacteria as gram's positive or gram's negative according to whether or not they resist discoloration of methyl violet and subsequent treatment with iodine. A smear of the culture made on clean grease-free slide with a flamed inoculating loop. The film was air dried by waving it around for a while. The smear was heat fixed by waving it over a Bunsen flame. The slide was placed on a rack over a sink. The smear was covered with crystal violet reagent for 1 minute, rinsed in slowly running tap for 30-60 seconds. It was drained and was washed with lugol's iodine for 60 seconds. The slide was washed gently under the tap to drain off the iodine. The slide was washed in 95% ethanol until the slide appears free of violet stain. The slide was rinsed under the tap and flooded with safranin for 30 seconds. The slide was drained, washed and blotted dry.

Data Analysis

The data was analyzed using appropriate statistical techniques. For research question descriptive statistics (percentage analysis) was used to answer it while independent t-test analysis and one-way analysis of variance were used to test the hypothesis at 0.05 alpha level. Data were statistically analyzed using SPSS version 20.

RESULTS AND DISCUSSION OF FINDINGS

Research Question 1

What are the differences in the mean food storage scores of food handlers in Abia State by their food establishment?

Descriptive

TABLE 1 Food storage practices of respondents

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Fast food	68	35.5392	2.42631	.29423	34.9519	36.1265	25.00	38.89
Food vendor	216	35.9825	1.06387	.07239	35.8398	36.1252	30.56	38.89
Abattiors	62	35.9767	1.37078	.17409	35.6286	36.3248	30.56	38.89
Dry food	204	35.9205	1.39284	.09752	35.7282	36.1128	30.56	38.89
Total	550	35.9040	1.45169	.06190	35.7824	36.0256	25.00	38.89

Table 1 shows the respondent's food storage practices, food vendor had the highest score of 35.98 ± 1.06%, abattoir 35.97 ± 1.37%, dry food 35.92 ± 1.39%, fast food 35.54 ± 2.43%. The difference is statistically insignificant since F(3,549) = 2.090, ρ = 0.125.

ANOVA

TABLE 2 Food storage practices of respondents

			Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	(Combined)		10.763	3	3.588	1.709	.164
	Linear Term	Unweighted	6.566	1	6.566	3.128	.078
		Weighted	1.989	1	1.989	.948	.331

	Deviation	8.774	2	4.387	2.090	.125
Within Groups		1146.209	546	2.099		
Total		1156.973	549			

Tables 1 – 2 answer this question, one way analysis of variance revealed that food vendor had the highest score of 35.98± 1.06% followed by abattoir 35.89± 1.06%, Dry food 35.92± 1.3%. This is statistically insignificant since $F(3,549) = 2.090$, $\rho = 0.125$. The implication is that, all food establishments require training practices.

RESEARCH QUESTION 2

What are the microbial levels of food substances in Abia State in relation to microbiological criteria of Codex Alimenterius Commission of WHO/FAO?

Table 3 answers this question. The mean bacterial for the food substances was found to be $17.14 \times 10^4 \pm 1.67 \times 10^4$. This is higher than the value for the microbiological criteria for food which is stated to be 1.00×10^4 or less (Heinz and Hautinger 2007, The European Commission 2005, Turtle and Smith 2009). We therefore reject the null hypothesis which states H_0: there is no statistically significant difference in the microbial load of the food at the study LHAs and the Microbiological criteria of the Codex Alimentarius Commission of the WHO/FAO of the United Nations. We accept the alternative hypothesis which states, H_1: there is statistically significant difference in the microbial load of the food at the study LHAs and the Microbiological criteria of the Codex Alimentarius Commission of the WHO/FAO of the United Nations. The implication of this is that food safety management in AbiaState below internationally accepted level, giving to potential infection with pathogenic microorganisms.

Table 3 Mean total viable count (Cfu/cm^2)

Local Govt Area	Spleen	Heart	Intestine	Liver	Lungs	Kidney	Muscle	Lymph node	Total	Mean	St. Dev
Aba North	18.7 x10^4	17.1 x10^4	17.5 x10^4	16.6 x10^4	18.1 x10^4	17.0 x10^4	16.7 x10^4	13.3 x10^4	135 x 10^4	16.9 x 10^4	1.6 x 10^4

Aba South	17.5 x10^4	16.5 x10^4	17.7 x10^4	16.8 x10^4	17.8 x10^4	16.7 x10^4	15.2 x10^4	15.4 x10^4	133.6 x 10^4	16.7 x 10^4	1.0 x 10^4
Osisioma	17.2 x10^4	14.8 x10^4	21.0 x10^4	17.7 x10^4	17.6 x10^4	16.4 x10^4	14.7 x10^4	12.6 x10^4	132 x 10^4	16.5 x 10^4	2.6 x 10^4
Ugwunagbo	18.6 x10^4	17.5 x10^4	18.8 x10^4	17.1 x10^4	19.9 x10^4	17.2 x10^4	17.4 x10^4	16.3 x10^4	142.8 x 10^4	17.9 x 10^4	1.2 x 10^4
Obingwa	17.2 x10^4	18.2 x10^4	18.6 x10^4	15.4 x10^4	18.7 x 10^4	17.1 x10^4	13.6 x10^4	14.8 x10^4	133.6 x 10^4	16.7 x 10^4	2.0 x 10^4
Total	89.2 x 10^4	98.3 x 10^4	107.8 x 10^4	98.8 x 10^4	**109.7 x 10^4**	100.7x10^4	94.3 x 10^4	**86.1 x 10^4**			
Mean	17.8 x 10^4	16.4 x 10^4	18.0 x 10^4	16.5 x 10^4	18.3 x 10^4	16.8 x 10^4	15.7 x 10^4	14.4 x 10^4			
St. Dev	0.9 x 10^4	1.6 x 10^4	2.2 x 10^4	1.0 x 10^4	1.1 x 10^4	0.3 x 10^4	1.5 x 10^4	1.4 x 10^4			

Overall mean bacterial load = 17.14 X 10^4 ± 1.67 X 10^4

CONCLUSION

It is concluded that HACCP-SOP check list is not used in AbiaState by food handlers. This is confirmed that the result starting from Abia South which had 17.14 x 10^4± 1.67 x 10^4 against the codex Alimentarius commission standard of 1.000x10^4 or lower. This means that foods are contaminated with microorganisms in the study area leading to cases of diarrhea and death of many food consumers.

RECOMMENDATIONS

1. The Private sector should be involved in food safety management as government alone cannot handle this.

2. There should be further research on the quantitative microbial assessment for the risk of food consumption in AbiaState.
3. Government should formulate policies that will regulate food handlers from unhealthy means of transportation of food items to prevent contamination in transits.

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