Microbial and Heavy Metal Screening of Kpomo (Cow-Hide) Displayed for Sales in the Market

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ABSTRACT

Kpomo serves as a major source of meat in Nigeria and due to it's unhygienic processing conditions could pose public health risks. This study investigated the microbiomes of kpomo meat sold in markets. Results obtained revealed that kpomo meat had the highest total heterotrophic bacterial count (THBC) of 2.46x10^7 cfu/g > water used to soak the meat (1.77x107 cfu/ml) > the 2,06x10^6 and 1.3x105 cfu/5cm3 on tray and knife swabs. Staphylococcus counts of all samples showed counts of 1.96x107cfu/g, 5.65x10^{4}cfu/5cm^3, 9.90x10^{4}cfu/5cm^3 and 7.90x10^{7}cfu/ml for meat, knife, tray and water samples respectively. Coliform counts of the kpomo meat revealed counts ranged from 1.01x10^5 to 9.0x10^5 cfu/g while that on tray samples ranged from 1.0x10^4 to 1.3x10^4 Cfu/cm^3. Knife and water samples showed counts ranging from 5.3x10^3 to 8.15x10^4 cfu/5cm^3 and 1.02x10^5 to 8.9x10^5 cfu/ml. kpomo meat samples fungal count ranging from 1.08x10^4 to 9.5x10^4 Cfu/g; while the water had count of 5.05x10^4 to 8.75x10^4 Cfu/ml; the tray samples had counts of 4.45x10^4 to 8.65x10^4 Cfu/5cm3which was higher than that of the knife samples which had growths ranging from 4.0x10^3 to 7.6x10^3 Cfu/5cm3. Staphylococcus sp. (12.0%), Salmonella sp. (5.3%), Escherichia coli (9.8%), Bacillus sp. (12.0%), Psuedomonas aeruginosa (7.1%), Micrococcus sp. (10.2%), Enterobacter sp. (8.0%), Streptococcus sp. (107%), Protues sp. (11.1%) are all bacteria isolated from this study. Rhizopus sp., Penicillium sp., Aspergillus niger, Fusarium sp., Saccharomyces sp. and Candida sp. were all fungal species isolated. Determination of the heavy metal level done on the samples showed varying quantities of these metals which is probably due to Singeing . Proper cooking and washing of kpomo meats with salt and clean water, prior to cooking, adequate cooking before consumption, maintaining hygienic conditions at market places during sales and regular change of water used in soaking kpomo are all recommended.

INTRODUCTION

The global demand for meat and dairy products like milk, yoghurt and egg as part of human diets over the years with rapid growth has reflected in its demand in livestock industry around the world (Okiel *et al.*, 2009). The nutritional demand obtained from livestock products containing essential component has tremendously contributed to its daily diet intake (FAO, 2003).

The nutritional component of animal product containing protein are of more biological values with essential amino acids, vitamins, niacin, phosphorus, zinc and iron which help in

nourishing body cell, promote growth, repair and maintenance of worn out tissues (Williams *et al*., 2002). Raw hides are by-product obtained from farm animals in meat industry used for leather production. It protects the body from injuries, climatic and environmental influences, and body temperature regulation. The tanning industry and the downstream industries such as footwear, furniture automotive, clothing, leather goods, and saddler are entirely dependent for their raw material on suppliers of cattle hides, sheep skin and small number of goat and other skins (ICT, 2010). Hide to the living animal is to accomplish several essential functions, including protecting the body from injuries, climatic and environmental influences, and body temperature regulation (Lanxess, 2010). It was also stated that the raw hides/skins are provided as by-product of the meat industry for leather production of which majority are made from farm animals. However, the types of leather produced in a particular area are often a matter of tradition and linked to the available hides and skins of domestic animals from this region Basically, the skin of animals is made up of collagen. Collagen is composed of three polypeptide chains that are wound together into an X-helix-like three strands twisted together and held by hydrogen bonding. It was further indicated that, as the animal ages, the cross-links in the collagen chains increase and this makes it tougher. The ACS in 2003 stated that gelatin is basically processed collagen which is a structural protein in animal's connective tissue, skin and bones.

Kpomo is known to contain less nutritional value despite its appeal taste deliver to the taste buds when consumed (FAO, 2003). Kpomo is a meat product obtained from the tenderization of hide of beef or cattle in hot water followed by scrapping with sharp object like razor blade (Okiel*e tal*., 2009). Kpomo is usually off-white or brown in colour depending on the type of animal used. In Nigeria, the unprocessed cow-skin usually sold in the market is mostly transported from the Northern part to the West. Processing of Kpomo for human consumption involves different stages such as: drying, singe, scraping, boiling and washing. Kpomo is used as major delicacy and important food ingredients in the preparation of several stews in various cultures in Nigeria especially at several public outings (Obiri-Danso *et al*., 2008). Consumption of Kpomo has been found high among the low-class people in Nigeria depending on the financial strength and interest. The high poverty level in Nigerians and other developing countries have made more people opting for cow-skin and its product because of economic reasoning. For this reason, most Nigerians love to eat Kpomo as much, believing that, daily meal without Kpomo is incomplete.

Even though meat has been known for its nutritive composition, it can also serve as a rich medium of growth for harmful microorganisms. Meat infected with microorganisms is the cause of many food borne diseases. Contamination with microorganisms of the quality of meat can be as results of the surrounding where these animals are kept as well as the way they are processed after slaughtering (Adegoke,, 2005). Obeng *et al*. (2013) reported in their study that although there could be the presence of contaminant on meats, it does not necessarily constitute meat spoilage.

However, the presence of microbial isolates such as *Streptococcus* spp., *Staphylococcus* spp., *Salmonella* and *Escherichia coli* on meats sold in retail outlets is worrying due to their ability to cause diseases. Improper and unhygienic handling by butchers and retailers, processing, transportation, storage, sanitary conditions at various retail outlets and environmental conditions

may be the most probable sources of contamination.

Raw meat remains an important and probably the major source of human food borne infection with pathogenic bacteria. In spite of decades' effort, it has been difficult to obtain food animals free of pathogenic bacteria (Kinsella *et al.*, 2008). The presence of bacteria in meat and meat products have been widely reported from different parts of the world Kinsella *et al.*, 2008. The occurrence of these microorganisms may be due to lack of proper quality control measures in handling and processing of the meat. In some abattoir site and Kpomo processors, singe is a common practice to get rid of the fur (FAO, 2003). In recent time, the scarcity of firewood has resulted in local butchers using scrap tyres, plastics and spent engine oil mixed with fire-wood (Obiri-Danso *et al.*, 2008). These materials confer potentially toxic organic substances such as benzene, lead and dioxin to the hide which can contaminate, render them unfit for human consumption and cause disease (Okiel *et al.*, 2009). The use of Kpomo as major meat source to average Nigerians if processed under unhygienic condition might result in disease outbreak.

Meat and its derivatives including Kpomo may provide appropriate nutrient for microbial proliferation and further exposure of these products to unhygienic conditions increases the probability and diversity of microorganism able to proliferate on them. In a typical Nigerian market, meats especially Kpomo are displayed during sales while the once not sold are soaked in water. This exposure and soaking may provide adequate conditions for the growth of both bacteria and fungi. Considering the fact that these are edible products, pathogenic microorganisms of public health importance may proliferate on exposed and soaked meat. Bearing in mind that these Kpomo are half cooked and most buyers cultivate the habit of eating with extra cooking, there is a tendency of disease establishment to the populace, hence the need to investigate the possible contaminants of these meat derivatives. Once liberated into the environment, heavy metals are taken into the body via inhalation, ingestion, and skin absorption where they gradually build up and accumulate faster than the body's detoxification pathways can dispose of them. In addition to the hazards at home and outdoors, many occupations involve daily heavy metal exposure, of which Hg alone has been implicated. (Farr, 2004). Heavy metal pollution is a problem mostly associated with areas of intensive industry. However, road ways and automobiles now are considered to be one of the largest sources of heavy metals pollution,

According to Farr (2004) heavy metal toxicity studies confirm that heavy metals can directly influence behavior by impairing metal and neurological function, influencing neurotransmitter production and utilization and altering numerous metabolic body processes

The study is designed to aim at the microbial composition and levels of heavy metals in hides/skins Kpomo processed and sold in the market for human consumption.

MATERIALS AND METHOD

Study Area/ sample Collection

A total of 60 samples (30 Kpomo, 10 water used to soak Kpomo , 10 knife swabs and 10 tray swabs) were sourced from three markets within Obio-Akpor Local Government Area, of Rivers State and was transported into a sterilized bags and containers to the Microbiology laboratory for analysis.

Microbial analysis of Samples

25g of the Kpomo sample were added into 225 ml of peptone water, swirled and allowed to stay for about 3hours on a shaker, after which a ten-fold serial dilution was done by pipetting 1 ml from the stock solution into the next test tube (10^{-2}), the process was done repeatedly up to (10^{-5}). The swab samples were soaked in 1ml of peptone water and subsequently the 1ml was transferred into 9mls diluents to dilute the sample. 10mls of water samples were introduced into 90mls of peptone water to prenrich and then 1ml was transferred for serial dilution.

From the prepared diluents, 0.1 ml of each last two prepared dilutions were transferred into sterile Petri plates containing the different media used and was spread gently using sterile glass rod. The plates were incubated at 37 ^{o}C for 18-24 hours (h) for the bacteriological media used for bacteria growth which includes Plate count agar, Mannitol salt agar and Nutrient agar and Potato dextrose agar for fungi isolation. The microbial count for each sample was obtained from the previously incubated Petri plates and was expressed as a colony forming unit (cfu/g and cfu/ml). Single colonies of bacteria growth on plat count agar were randomly selected from different media plates based on their morphology and were subcultured and incubated at 37^{o}C for 24 hours (h) to obtain pure colonies. Isolates were identified based on their morphological and cultural characteristics on growth media. Identification materials, reagents and protocols according to (Cheesebrough, 2000) were used to identify discrete colonies from the bacteriological media of sub-cultured isolates. The cultural characteristics of each fungi isolates were identified according to their colour, shape and the cell morphology was done based on mycelia, hyphae, septate, spore formation using lactophenol blue. A piece of the mycelium from the Petri plates was mounted on a clean grease free slide using a sterile wire loop and covered with a cover slip, after which a drop of lactophenol cotton blue was added and examined with the microscope.

HEAVY METAL ANALYSIS

Heavy metal analysis was done as described by Kalu et al .2015

Statistical analysis

All measurements were done in duplicates for each of the samples, and data were reported for duplicate analyses of the same Samples. All statistical analyses were carried out using analysis of variance (ANOVA) . Significance of the differences was ascribed at the 0.05 level for ANOVA

RESULTS

TOTAL HETEROTROPHIC BACTERIA COUNT

The total heterotrophic bacteria count of the Kpomo samples, indicates that the Kpomo samples had the highest heterotrophic bacteria count ranging from $1.54x10^{-7}$ to $2.48x10^{-7}$, the water from soaked Kpomo samples had count of $1.24x10^{7}$ to $1.77x10^{7}$ followed by the tray samples with counts ranging from $1.21x10^{5}$ to $2.06x10^{6}$ which was higher than that of the knife samples which had growths ranging from $8.9x10^{4}$ to $1.30x10^{5}$ cfu/g

TOTAL *Staphylococcus* COUNT

The knife samples had the lowest Staphylococcus count of $3.8x10^{3}$ to $5.84x10^{4}$ cfu/cm shows the counts from the tray samples ranging from $1.01x10^{4}$ to $9.9x10^{4}$. A higher *Staphylococcus* count was recorded for the Kpomo samples followed by the water samples which was $1.14x10^{4}$ to $9.7x10^{4}$ cfu/g

TOTAL COLIFORM COUNT

The lowest count recorded for knife samples ranging from $5.3x10^{3}$ to $8.15x10^{4}$, followed by tray with counts of $1.00x10^{4}$ to $1.30x10^{4}$. Counts ranging from $1.02x10^{5}$ to $8.9x10^{5}$ for water samples and Kpomo samples having counts ranging from $1.01x10^{5}$ to $9.0x10^{5}$ cfu/g

TOTAL FUNGAL COUNT

The fungal count of Kpomo samples ranging from $1.08x10^{4}$ to $9.5x10^{4}$, the water from soaked samples Kpomo had count of $5.05x10^{4}$ to $8.75x10^{4}$ as represented in fig 4.16, the tray samples had counts of $4.45x10^{4}$ to $8.65x10^{4}$ which was higher than that of the knife samples which had growths ranging from $4.0x10^{3}$ to $7.6x10^{3}$

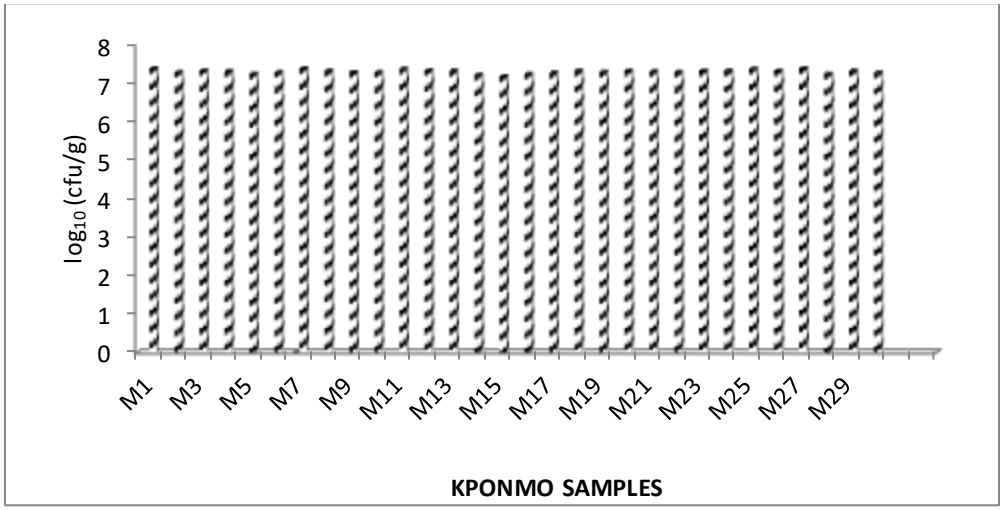

Figure .1: Total heterotrophic bacterial count from meat samples

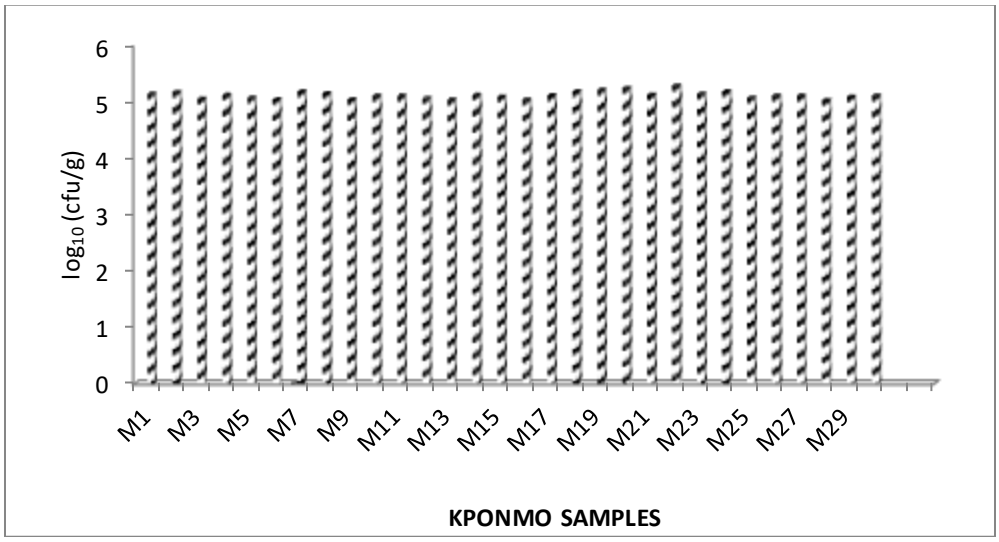

Figure .2: Total *Staphylococcus* count of meat samples

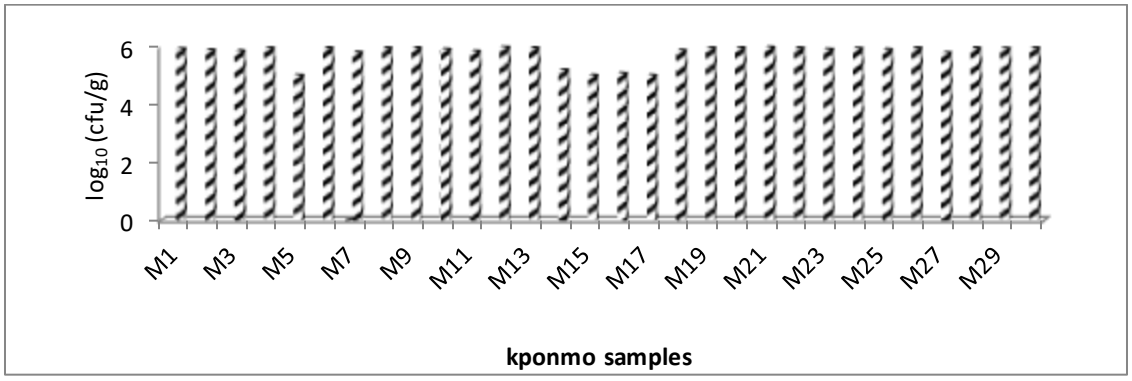

Figure .3: Total coliform count from meat samples

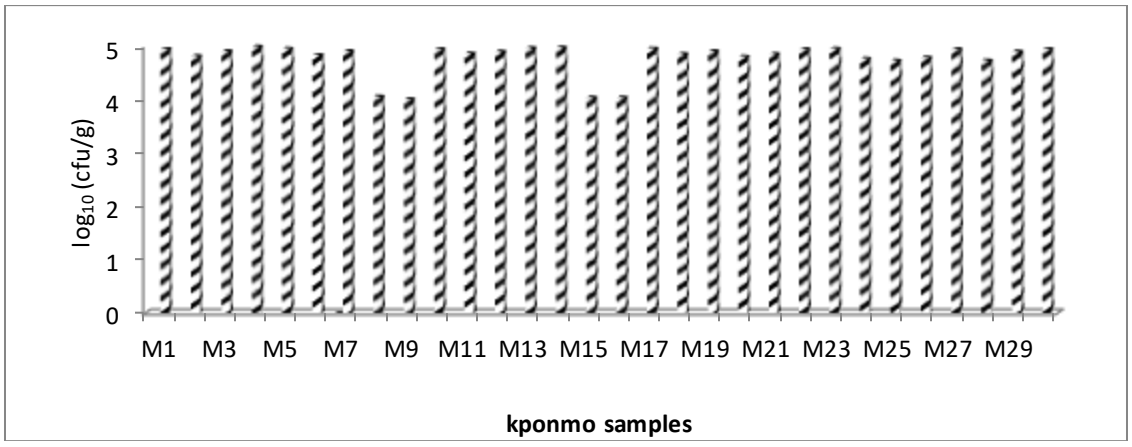

Figure .4: Total fungal count from meat samples

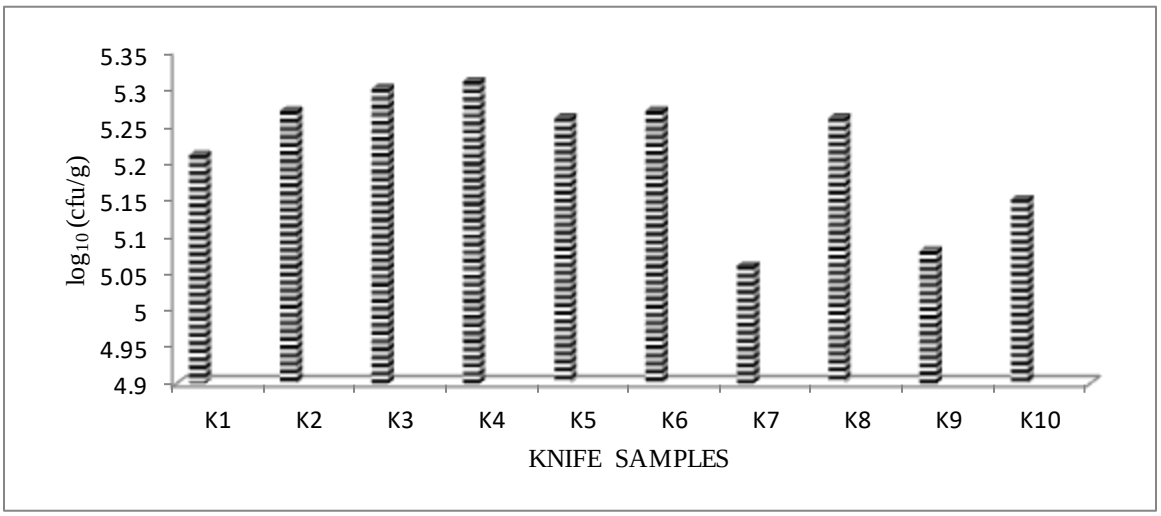

Figure .5: Total heterotrophic bacterial counts from knife samples

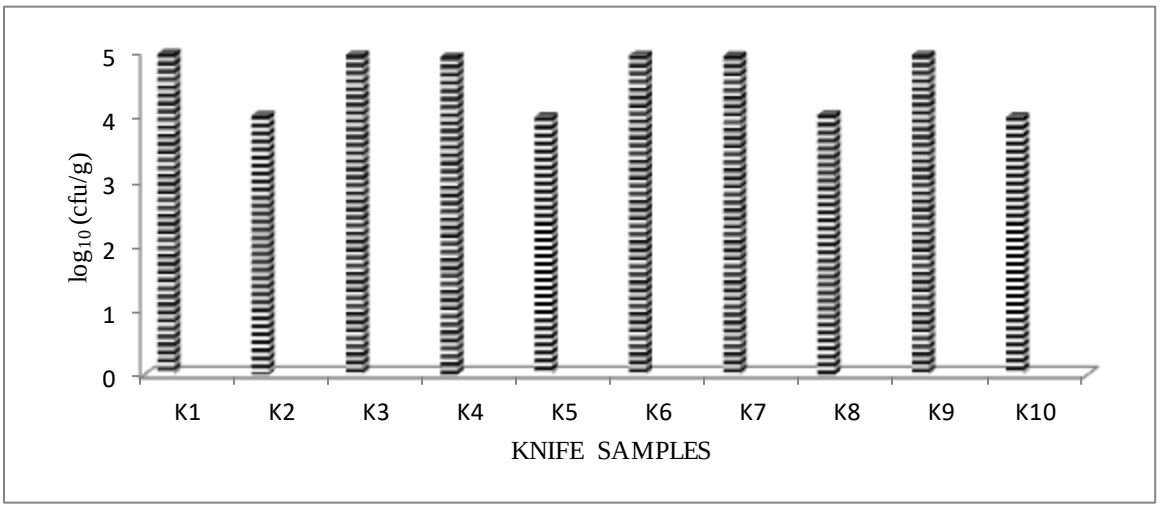

Figure .6: Total Staphylococcus counts from knife samples

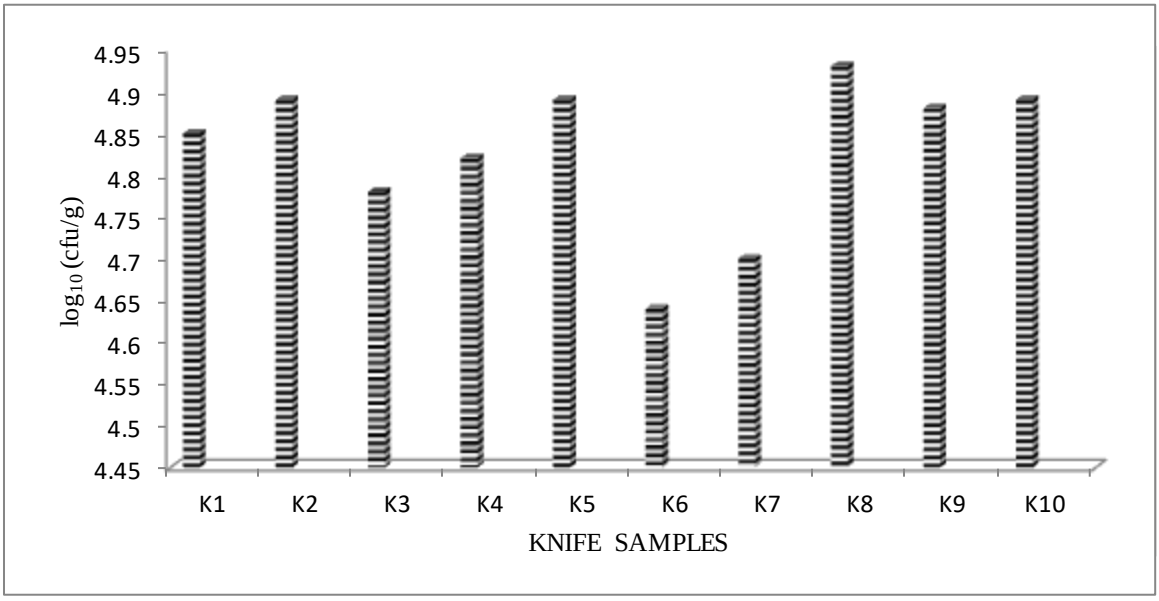

Figure .7: Total coliform counts from knife samples

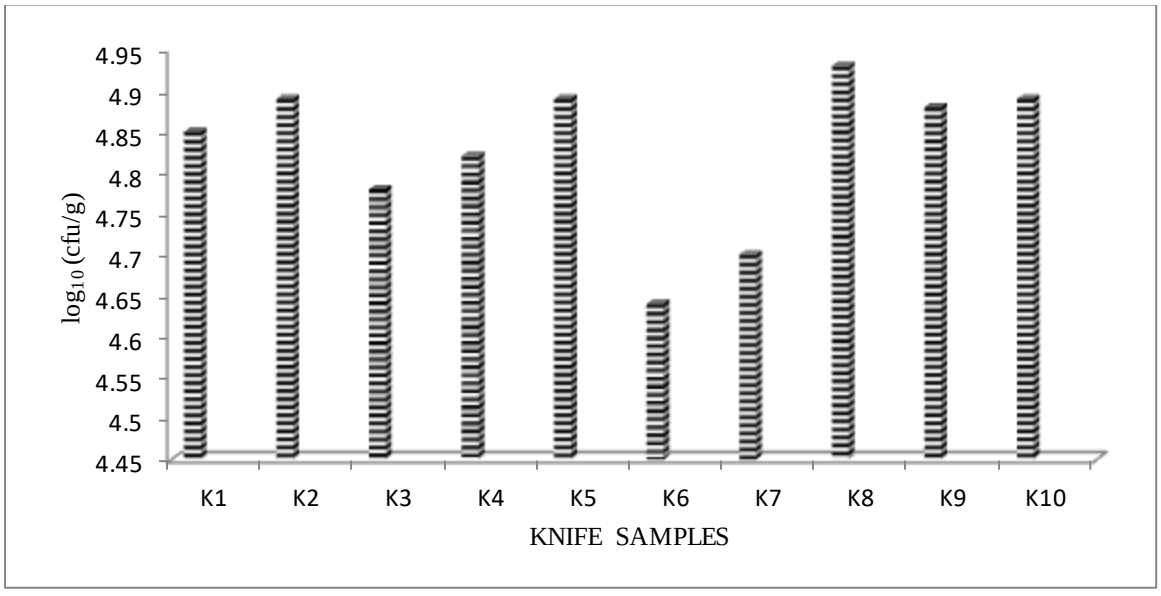

Figure .8: Total fungal counts from knife samples

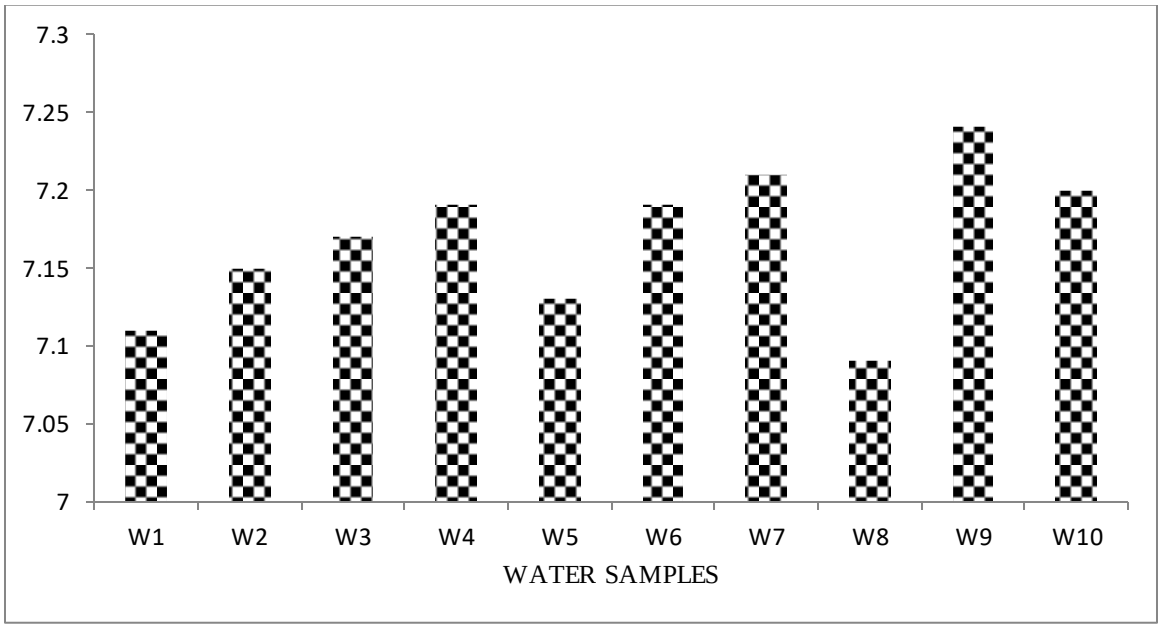

Figure .9: Total heterotrophic bacterial counts from water samples Log_{10}cfu/)

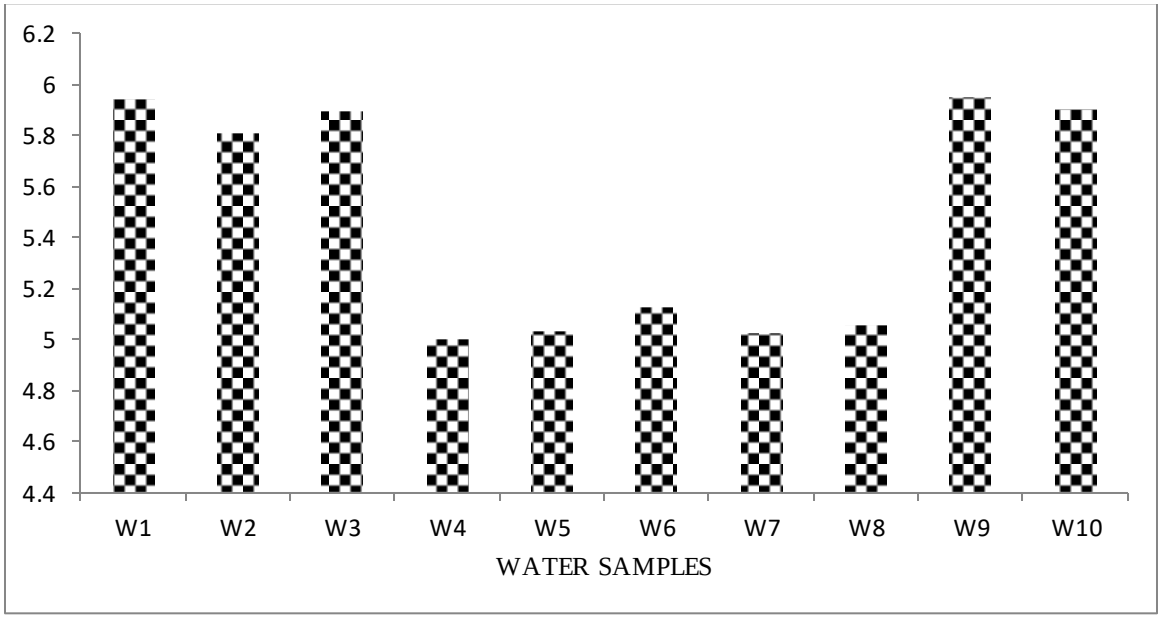

Figure 10: Total coliform counts from water samples Log_{10}cfu/ml

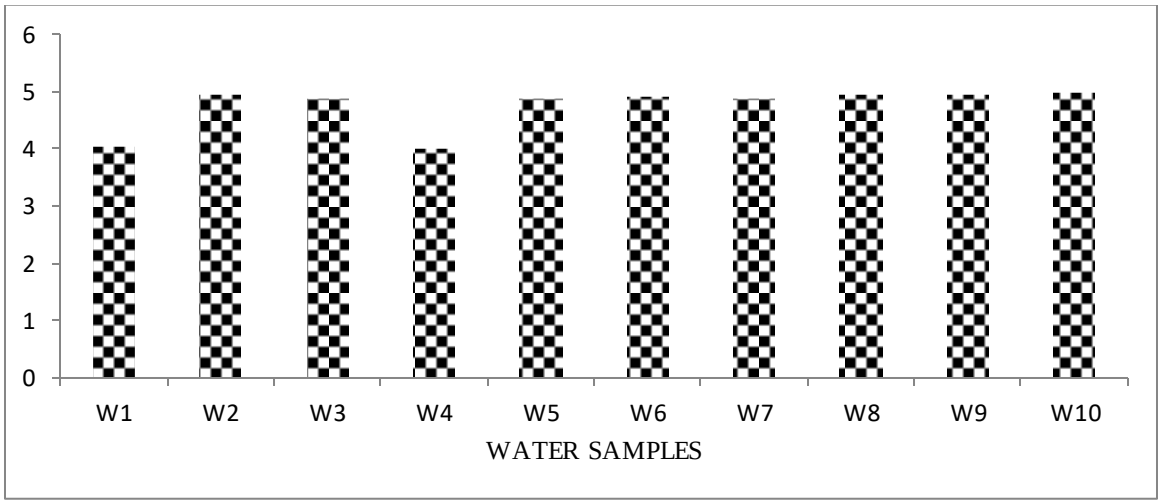

Figure.11: Total *Staphylococcus* counts from water samples (Log_{10}cfu/ml)

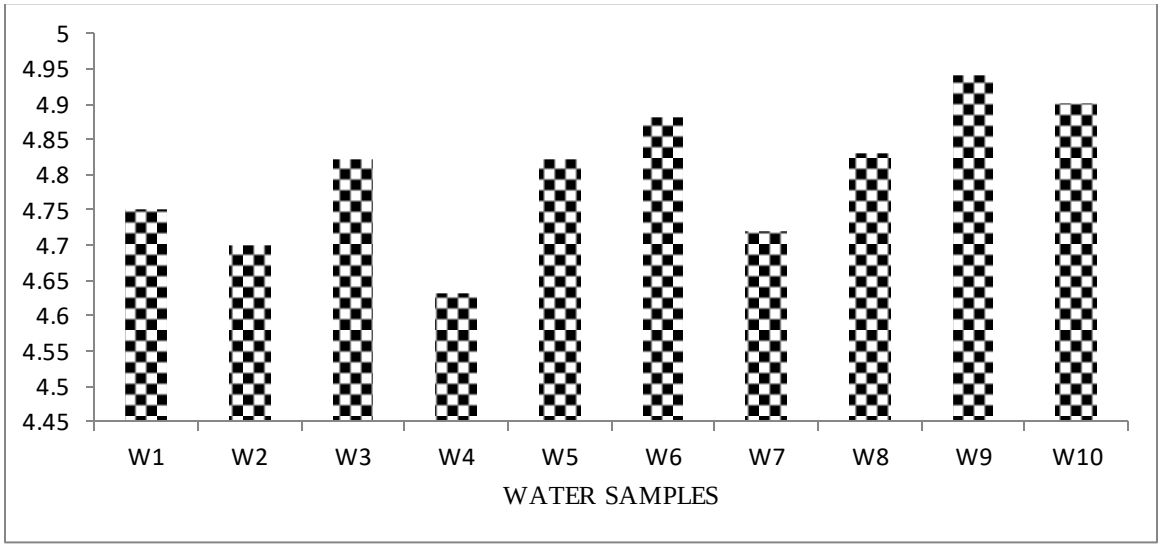

Figure .12: Total fungal counts from water samples (Log_{10}cfu/ml)

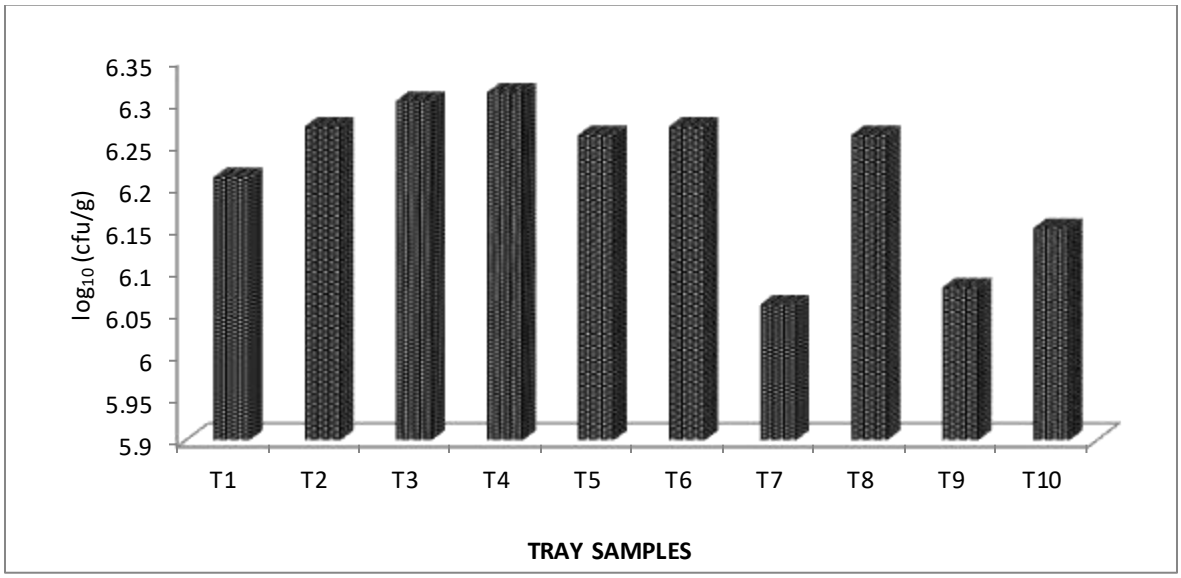

Figure .13: Total heterotrophic bacterial counts from tray samples

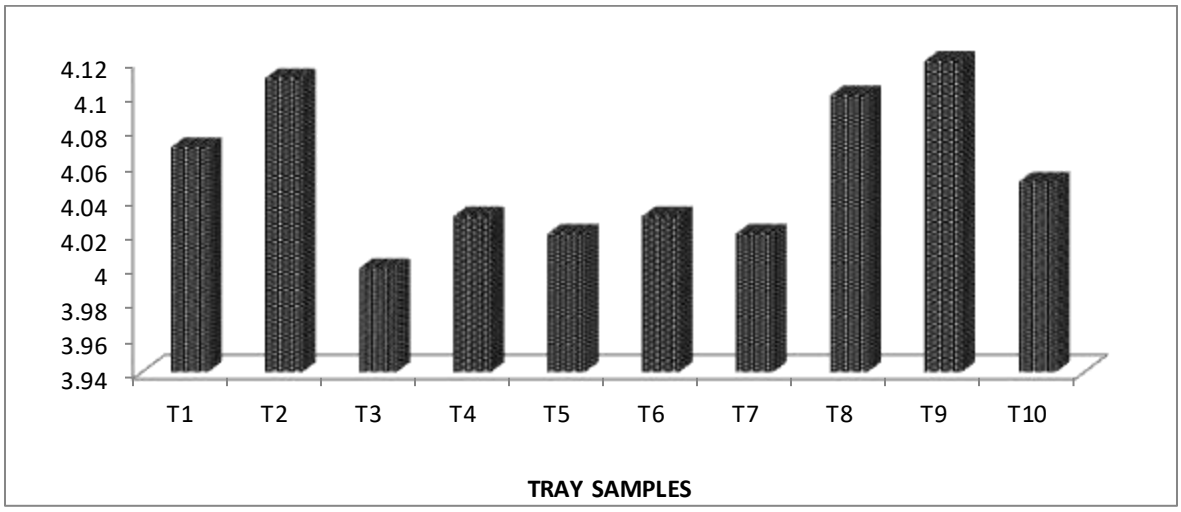

Figure .14: Total coliform counts from tray samples($Log_{10}cfu/cm^{3)}$

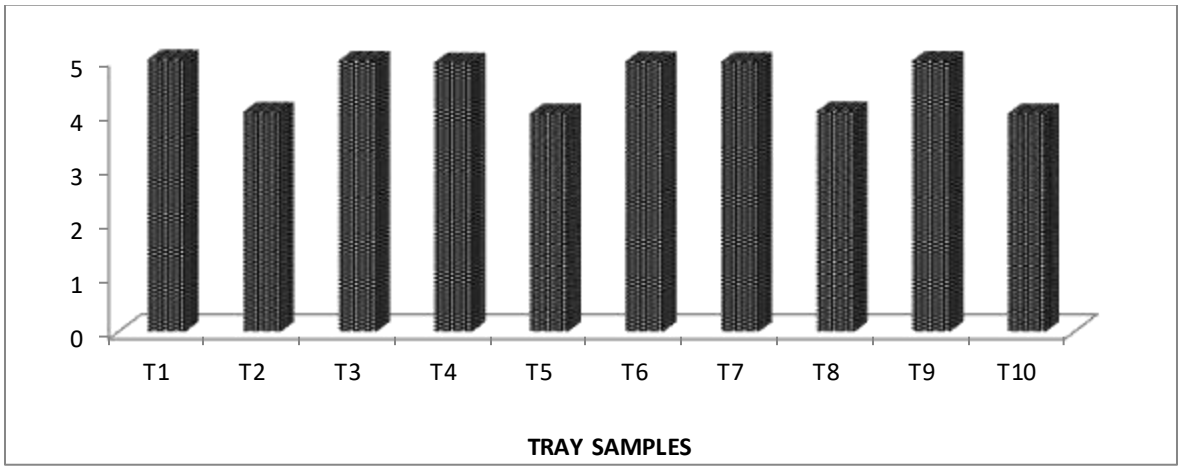

Figure 15: Total *Staphylococcus* counts from tray samples ($Log_{10}cfu/cm^{3)}$

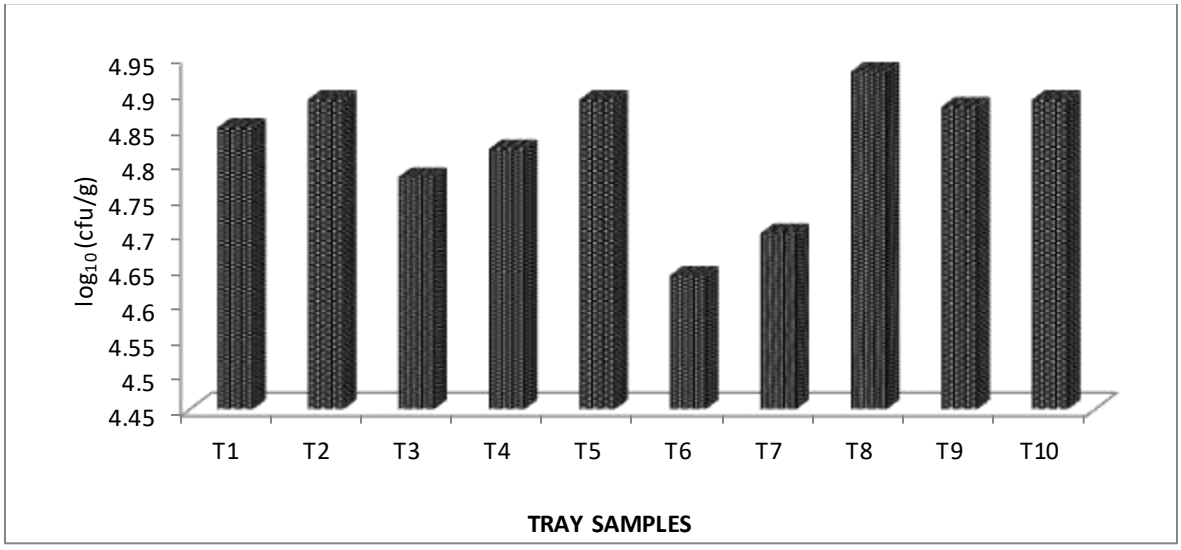

Figure 16: Total fungal counts from tray samples($Log_{10}cfu/cm^{3)}$

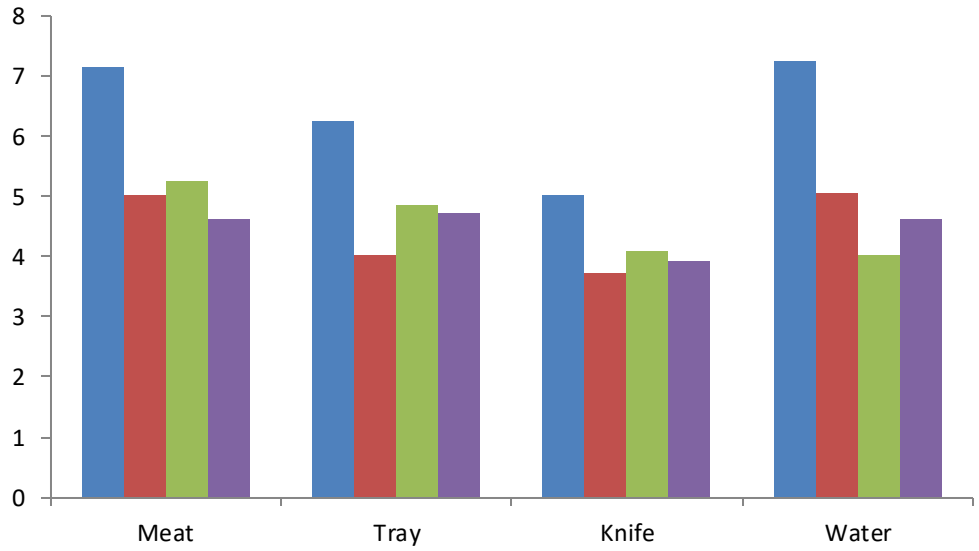

Fig .17: Average Microbial Counts Obtained from all Samples Studied

Table 1 Percentage Occurrence of the Different Organisms Isolated from the Different Samples

		Kpomo n (%)	Knife n (%)	Tray n (%)	Water n (%)	Total N (%)
1	***Bacillus* sp.**	9 (8.9)	5(16.7)	7(17.1)	6(11.5)	**27(12.0)**
2	***Staphylococcus* sp.**	21(20.6)	11(36.7)	10(24.5)	16(30.8)	**58(25.8)**
3	***Salmonella* sp.**	8(7.8)	0(0)	2(4.8)	2(3.9)	**12(5.3)**
4	***E. coli***	16(15.7)	2(5.7)	4(9.8)	0(0)	**22(9.8)**
5	***Pseudomonas* sp.**	13(12.7)	0(0)	0(0)	3(5.8)	**16(7.1)**
6	***Proteus* sp.**	13(12.7)	3(10.0)	5(12.1)	4(7.7)	**25(11.1)**
7	***Streptococcus* sp.**	13(12.7)	2(6.7)	4(9.8)	5(9.6)	**24(10.7)**
8	***Micrococcus* sp.**	9(8.9)	3(10.0)	5(12.1)	6(11.5)	**23(10.2)**
9	***Enterobacter* sp.**	0(0)	4(13.3)	4(9.8)	10(19.2)	**18(8.0)**
	Total	**102(100)**	**30(100)**	**41(100)**	**52(100)**	**225(100)**

Table 2 Average Microbial Counts Obtained from all Samples Studied

	THBC	Coliform Count	Staph Count	Fungal Count
Kpomo	7.16	5.02	5.24	4.64
Tray	6.26	4.03	4.86	4.72
Knife	5.02	3.72	4.10	3.93
Water	7.24	5.05	4.02	4.64

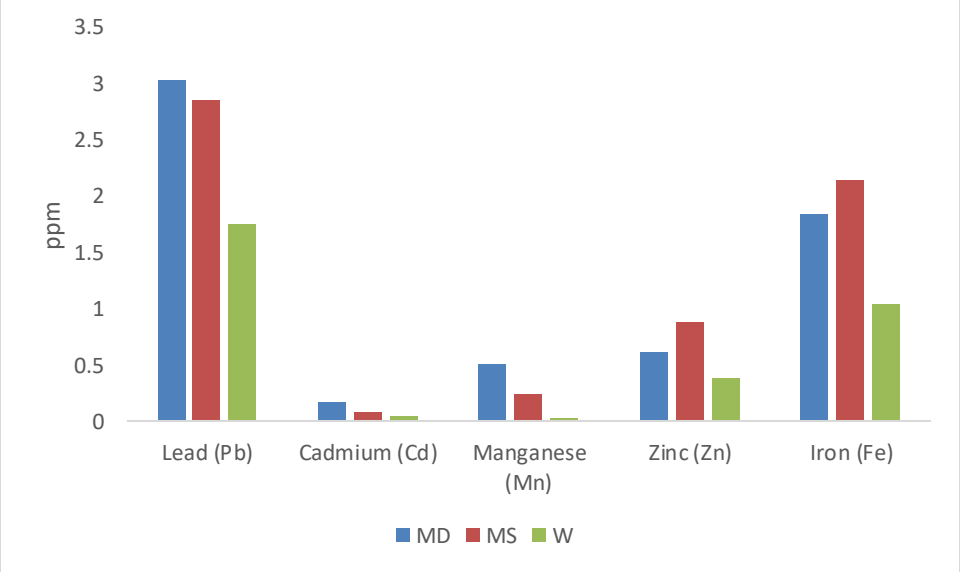

Fig 18 Heavy Metal Composition of Kpomo and Water Samples Studied

Key:
MD = Kpomo Meat Displayed
MS= Kpomo Meat Soaked
W= Water used in Soaking Kpomo

Discussion

Raw meat and its different parts are important and probably the major source of human food borne infection with pathogenic bacteria and fungi which has over the years resulted to food-borne diseases which could cause morbidity and mortality. In spite of decades' effort, it has been difficult to obtain food animals free of pathogenic bacteria (Kinsella *et al.*, 2008; Olukitibi *et al.*, 2017). There has been a wide recognition of the role of foods in spreading diseases and therefore the need for general awareness to set up safety and quality systems in food production and food safety due to its vital role (Marambio *et al.*, 2001)

This study investigated the microbial load and diversity on kpomo meat (edible cow hide) sold in the market. The meat itself and accessories used in sales including knife used to cut the meat, tray used in displaying the meat as well as the water in which the kpomo is soaked were all analyzed in this study. The total heterotrophic bacterial count (THBC) of kpomo meat sampled ranged from $1.59x10^7$ to $2.46x10^7$ CFU/g while the tray swabbed samples had THBC ranging from $1.16x10^6$ to $2.06x10^6$ CFU/5cm^3 areas swabbed. Swabs of the knife used in processing cow skin showed THBC ranging from $8.2x10^4$ to $1.30x10^5$ CFU/5cm^3 while the viable count of water used in soaking sampled revealed loads ranging from $1.2x10^7$ to $1.77x10^7$ Cfu/ml.

These results from the total heterotrophic bacterial count reveals that the bacteria load in kpomo meat samples ($2.46x10^7$ Cfu/g) is greater than (>) that of water sample ($1.77x10^7$ cfu/ml) >

$2.06x10^6$ cfu/$5cm^3$ observed for tray swabs > $1.3x10^5$ cfu/$5cm^3$ observed for knife swabs. All the heterotrophic bacterial count obtained from the sample are significantly different from each other ($p<0.05$). Standards acceptable by the World Health Organization requires that all fresh meats that will be edible has aerobic bacterial count less than $log_{10}5.0$ Cfu/g of meat. Aerobic counts obtained in this study reveals that all samples are unfit for consumption but may be fit if proper and adequate pasteurization and cooking are employed as heat may reduce the microbial load drastically before the meats are consumed.
Staphylococcus count of the meat samples showed counts that ranged from $1.08x10^7$ to $1.96x10^7$ Cfu/ cm3; knife samples ranged from $3.0x10^3$ to $5.65x10^4$ Cfu/$5cm^3$. The meat samples was significantly higher than the water samples ($p<0.05$) ,Tray samples had counts ranging from $1.0x10^4$ to $9.9x10^4$ cfu/$5cm^3$ and the water samples had staphylococcus count ranging from $1.10x10^7$ to $7.90x10^7$cfu/ml. The counts obtained are far above the standard count of <105 approved by Food and Drug Agency (FDA) stipulated for food.

Coliform counts of the kpomo meat revealed counts ranging from $1.01x10^5$ to $9.0x10^5$cfu/g while that of tray samples ranged from 1.0x104 to $1.3x10^4$ vfu/cm^3. Knife and water samples showed counts ranging from $5.3x10^3$ to $8.15x10^4$ cfu/$5cm^3$ and $1.02x10^5$ to $8.9x10^5$ cfu/ml. The counts obtained are far above the 5.0×10^3 colonies per gram of sample approved by World Health Organization stipulated for coliform bacterial permitted in food. Kpomo meat samples fungal count ranging from $1.08x10^4$ to $9.5x10^4$ Cfu/g; while the water had count of $5.05x10^4$ to $8.75x10^4$ Cfu/ml; the tray samples had counts of $4.45x10^4$ to $8.65x10^4$ Cfu/5cm3 was significantly higher than that of the knife samples which had counts ranging from $4.0x10^3$ to $7.6x10^3$ Cfu/5cm3. ($p<0.05$)
.A total of ten bacterial species including *Staphylococcus epidermidis*, *Staphylococcus aureus*, *Salmonella* sp., Escherichia *coli*, *Bacillus* sp., *Psuedomonas aeruginosa*, *Micrococcus* sp., *Enterobacter* sp., *Streptococcus* sp., *Protues* sp. *Pseudomonas aeruginosa* and *Salmonella* sp., isolated and identified in the present were consistent with the report of (Olukitibil *et al*., 2017) who found that processed Kpomo and unprocessed kpomo samples from Ogbese market were contaminated with *Bacillus subtilis, Staphylococcus aureus, Staphylococcus epidermis, Streptococcus mitis, Micrococcus luteus, Escherichia coli, Shigella dysenteriae and Salmonella typhimurium*.

This result is also in conformity with the findings of Ibrahim *et al*., 2014 and Obeng *et al*., 2013 who isolated same species on human hands and other parts of the human body. Therefore, using bare hands during the processing of kpomo and selling of the processed product in an open bowl in the marketplace could increase the susceptibility of the contaminants. The presence of *Micrococcus* sp. could be the natural microflora in the samples (Shede *et al*., 2003) *Salmonella ttyphimorium* and *Escherichia coli* in the Kpomo might arise from feacal contaminant due to the poor personal hygiene by the food handler and marketers and dust from post contamination of processed Kpomo . However, the absence of some species in this present study could be due to the differences of environmental factors such as temperature and humidity. Exposure to these pathogens causing several illnesses including typhoid, diarrhea etc.

However, in this research, Kpomo samples contained higher bacterial colony counts (2.46×10^7 cfu/g) which also corroborate with the findings on street foods (FAO, 2006), which were found

to be contaminated with different microorganisms some of which could be pathogenic and may be from sources such as fecal coliforms that are of public health concern in most of the developing African countries. The Kpomo samples are normally sold under unhygienic conditions (most often on open tables or in bowls) with contaminated water. The occurrence of these bacterial species in samples investigated in this study could be due to lack of proper quality control measures in handling of water used in preserving, conversing, coughing and sneezing on the processed cow hide by the sellers and buyers could all be sources of contamination as had been reported by (Bhandare *et al*., 2007)

Kpomo meat samples fungal count ranging from $1.08x10^4$ to $9.5x10^4$ Cfu/g; while the water had count of $5.05x10^4$ to $8.75x10^4$ Cfu/ml; the tray samples had counts of $4.45x10^4$ to $8.65x10^4$ Cfu/5cm3which was significantly higher than that of the knife samples which had counts ranging from $4.0x10^3$ to $7.6x10^3$ Cfu/5cm3. ($p<0.05$)

Fungi are common contaminants of Kpomo , they either cause spoilage or produce mycotoxins, making it dangerous for consumption. The result obtained in this study showed that a total number of five fungi *Mucor* sp., *Aspergillus niger, Penicillium* sp., *Aspergillus flavus and Rhizopus stolonifer, Fusarium* sp. *Candida* sp. were isolated and identified from the kpomo, water, tray and knife samples. Some fungal species causes spoilage by forming black, white or blue-green spots on the surface of Kpomo and meat products when contaminated with these species. Similarly, *Penicillium spp* are responsible for the appearance of blue-greenish spots on meat, thus these fungi grow very slowly at low temperatures.

The samples might be contaminated with fungi from the air, water, slaughterhouse walls, floors, slaughterhouse processing, feces, intestinal content, water, personnel, barely touching kpomo with unwashed hands, bowl use, bad habits of employees and market places. (Ackerley *et al*., 2010).

The main sources of contamination foods with yeasts are working surfaces, air, and water (Hernández et al., 2018). The high prevalence of fungi obtained in this study could be due to fact that raw Kpomo had moisture content, water that is used in washing or preserving it and bowl or tables use in selling at the market, all these may favor microbial proliferation during sale.

All the metal analyzed were detected in the samples in varying quantities, this might be due to Singeing. Slaughtered ruminants such as goats, sheep and cattle are normally singed to get rid of the hair. is largely favored in many respects in African countries as it maintains the carcass hide for consumption and evokes flavors in meat that are highly acceptable by the local populace (Food and Agriculture Organization (FAO),1985). These hides are prepared by singeing off the hair in flames fueled by substances such as wood mixed with engine oil, plastics mixed with refuse or tyres. Hides processed in this manner may contain toxic organic compounds such as polyaromatic hydrocarbons (PAH), dioxins, furans and benzene, heavy metals which can contaminate the hides (United States Environmental Protection Agency (US EPA), 1994; Agency for Toxic Substances and Disease Registry (ATSDR), 1998). Heavy metals are released during burning of hides with# plastics, polystyrene polymers, tyres and woods fueled with engine oil (Okiei et al., 2009) Reports have also shown that singeing of hides with hazardous substances could contaminate meat products and have adverse health implications (Okiei et al., 2009); in addition, the environment and meat processors are also at risk (Okiei et al., 2009). Continuous exposure and consumption of such potentially contaminated meat product poses a

great source of health risk (Costa, 2000;

Heavy metals such as manganese, iron, Zinc are essential metals since they play important roles in biological systems, whereas cadmium and lead are non-essential metals but they are toxic, even in trace amounts(Fernandes *et al;*2008). Heavy metals are bioaccumulate and therefore require close monitoring (Bhattacharya et al., 2008). In conclusion, ten bacteria were isolated from kpomo, *Staphylococcus epidermidis*, *Staphylococcus aureus*, *Salmonella* sp., *Escherichia coli*, *Bacillus* sp., *Psuedomonas aeruginosa*, *Micrococcus* sp., *Enterobacter* sp., *Streptococcus* sp., *Proteus* sp. were equally found in similar studies. Dirty environment, equipment, elevated temperatures, blood, low concentration of salt and bad hygiene are factors that may favor the multiplication of these and similar microorganisms in kpomo in the study area. Proper sanitation and cleaning would be the best approach to reducing microbial contamination which could be done by providing portable clean water and modern abattoir and retail markets in order to improve on the sanitary conditions of the kpomo sellers and very clean handling would allow easier preservation by reducing contaminants of kpomo to minimum level.

REFERENCES

Ackerley N., Sertkaya A. and Lange, R. (2010). Food transportation safety: Characterizing risks and controls by use of expert. *Food Protection Trends,* 30 (4), 212– 222.

Adegoke G .O and Falade, G. O. (2005). Meat quality. Journal *of Food, Agriculture and Environment*, 3 (1): 87- 90

FAO, (2003). Global production and consumption of animal source foods. *Journal of Nutrition*, 11(2): 4048S – 4053S

Farr, G., (2004). The Hair Tissue Mineral Analysis/ Why Heavy Metals Are a Hazard to Your Health? BecomeHealthyNow.com

Food and Agriculture Organization, (2006). Street Foods: ASsummary of FAO Studies. Boston: FAO.

Hernández A., Pérez-Nevado F., Ruiz-Moyano, S., Serradilla, M. J., Villalobos, M. C., Martín, A. and Córdoba, M. G. (2018). Spoilage yeasts: What are the sources of contamination of foods and beverages? *International Journal of Food Microbiology*, 286: 98– 110.

Ibrahim, B. U., Baba, J. and Sheshi, M. S., (2014). Isolation and Identification of Bacteria Associated with Fresh and Smoked Fish (Clarias Gariepinus) In Minna Metropolis, Niger State, Nigeria. *Journal of Applied Environmental Microbiology*, 2: 81-85.

Kinsella K.J., Prendergast D.M., McCann M.S., Blair I.S., McDowell D.A., Sheridan J.J. (2008) The survival of Salmonella enterica serovar Typhimurium DT104 and total viable counts on beef surfaces at different relative humidity and temperatures. *J App Microbiol*., 106:171-180

Lanxess, (2010).Hide as raw material. Lanxess Energizing Chemistry. www.Lanxessleather.com /rawhidesandskins/ hidesasrawmaterial.

Marambio, E., Cordano A. M., Insunza, M., Fernandez, M. and Astorga, J., (2001). Determination of Bacterial Pathogen in Foods for Export and their Raw Material. Proceedings of a Final Research Coordination Meeting held in Mexico City, Mexico, IAEA-TECDOC1431

Obeng, A. K., Johnson, F. and Appenteng, S. O. (2013). Microbial Quality of Fresh Meat from

Retail Outlets in Tolon and Kumbungu Districts of the Northern Region of Ghana. *International Journal Science and Technology*, 2(6): 423-427

Obiri-Danso, K., Hogarh, J.N. and Antwi-Agyei, P. (2008). Assessment of the contamination of singed hides from cattle and goats by heavy metals in Ghana. *African Journal for Environmental Science and Technology*. 2 (8): 217-221.

Obiri-Danso, K., Hogarh, J.N. and Antwi-Agyei, P. (2008). Assessment of the contamination of singed hides from cattle and goats by heavy metals in Ghana. *African Journal for Environmental Science and Technology*. 2 (8): 217-221.

Okiel, W., Ogunlesi, M., Alabi, F., Osiughwu, B and Sojinrin, A., (2009). Determination of toxic metal concentrations in flame treated meat products, Ponmo .*African Journal of Biochemistry Research* 3 (10): 332 - 339.

Olukitibi,1, T.A., Adetuyil, F. C., Adeleke, B. S. and Abe, S. C. (2017) Isolation and Antibiogram of Bacteria Isolated from Processed and Unprocessed Cow-Hide (Ponmo) in Ogbese Market. *Journal of Advances in Microbiology*, 2(4): 1-8.

Shede, P. N., Kanekar, P. P., Polkade, A. V., Sarnaik, S. S, Dhakephalkar, P. K., Chiplonkar, S., Speedy, A. W. (2003). Global production and consumption of animal source foods. Animal production and health division, *Food and Agriculture Organization of the United Nations, Rome* Italy.11-19.

.Williams, P., Droulez, V and Levy, G., (2002). Nutrient composition of Australian red meat. *Gross Composition Data of Food*. 58: 173-81.

Bhattacharya AK, Mandan SN, Das AK (2008). Heavy metals accumulation in water sediment and tissues of different edible fishes in upper stretch of Gangetic West Bengal. Appl. Sci. Res. 3:61-68.

Fernandes C, Fontainhes-Fernandes A, Cabral D, Salgado MA (2008).Heavy metal in water, sediment and tissues of *liza saliens* from Esmoriz-paramos lagoon, Portugal. Environ. Monit. Asses.136:267-275.

Okiei W, Ogunlesi M, Alabi F, Osiughwu B, Sojinrin A (2009).Determination of toxic metal concentrations in flame treated meat products, ponmo. Afr. J. Biochem. Res. 3(10):332-339.

US EPA (US Environmental Protection Agency), (1994). Healt Assessment Document for 2, 3, 7, 8-Tetrachlorinated Dibenzo-pdioxin (TCDD) and Related Compounds. External review draft. EPA report no. 600/6-88/001a-c. United States EnvironmentalProtection Agency, Office of Health and Environmental Assessment, Office of Research and Development, Washington, DC.

FAO (1985). Manual of the Slaughter of Small Ruminants in developing countries: Slaughtering practices and techniques. FAO Animal Production and Health Paper No. 49.

Agency for Toxic Substances and Disease Registry (ATSDR) (1998). Toxicological Profile for Chlorinated Dibenzo-p-Dioxins (update). US Department of Health and Human Services, Public Health Service, Atlanta, GA