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Full Length Research Paper

Determination of microbial contamination in meat and fish products sold in the Kumasi metropolis (A Case Study of Kumasi central market and the Bantama market)

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Abstract

Food borne diseases are considered to be the most wide spread health problem in most parts of the world especially in the developing countries. This is mainly due to the way food is handled by the producer and the final consumer. The food safety risks associated with meat and fish products have been widely documented. This study evaluates the level of microbial contamination of meat and fish products that are sold in two major markets in the Kumasi metropolis of the Ashanti Region in Ghana. Ten samples of different meat portions and fish samples each were selected from the two markets (5 meat and 5 fish samples from Bantama market and then 5 meat and 5 fish samples from Kumasi Central market). The samples were analyzed for total viable bacteria count, total coliforms count, Escherichia coli and salmonella using different biochemical test. Pathogens like *Staphylococcus aureus*, mould, Pseudomonas spp. *Salmonella* and Bacillus spp. were also isolated from both the meat and fish products. The study suggested that most of the meat and fish products that are sold are commonly contaminated with pathogenic microorganisms. Bantama market recorded the highest level of contamination. This contamination may play a significant role in the transmission of potentially harmful microorganisms which causes different diseases such as cholera, diarrhea and skin infections. It is therefore expedient that great care is taken during handling and the preparation of our meat and fish products to avoid or reduce the level of microbial load and contamination. Thorough cooking processes and good hygiene practices could help reduce the microbial load to harmless level.

Keywords: Microbial contamination, Food safety, pathogenic micro-organisms, meat and fish.

INTRODUCTION

The issue of food security is a complex one in both developed and developing countries, where proteins source from animals such as meat and meat products, fish and fish products are generally regarded as high risk and unwholesome commodities with respect to pathogen contents, availability of natural toxins and other possible contaminants and also the use of adulterants (Yousuf *et al*., 2008).

Food borne infections and illnesses have become a major international health problem with consequent reduction in economic growth. It is also identified as a major cause of illness and death worldwide (Adak *et al*., 2005). Recognizing this, the World Health Organization (WHO) developed its Global Strategy for Food Safety (Adak *et al*., 2005).

In the developing world, foodborne infection leads to the death of many children, as well as resulting in diarrheal disease which can have long-term effects on children's growth as well as on their physical and noesis development and it also heavily affects the healthcare systems (Adak *et al*., 2005).

According to Clarence *et al*., (2009), food borne diseases are diseases resulting from ingestion of bacteria, toxins and cells produced by microorganisms present in food. The intensity of the signs and symptoms may vary with the amount of contaminated food ingested and susceptibility of the individuals to the toxin (Clarence *et al*., 2009).

Lengthy food supply procedures, mass catering complex associated with increased international movement, changes in eating habits and poor hygiene practices are major contributing factors (Hedberg *et al*., 1992).

Contaminated raw meat and fish is one of the main sources of food-borne illness (Bhandare *et al*., 2007). It has been known that most food contaminations are caused by food-borne pathogens such as bacteria, fungi, mold and others.

Clarence *et al*., 2009 reported that gram negative bacteria accounts for approximately 69% of the cases of bacterial food borne disease.

Bacterial gastrointestinal infections continue to cause illness and death and contribute to economic loss in most parts of the world, including high-income generating countries that have developed surveillance and control programs (Ternhag *et al*., 2008).

The possible sources of these bacteria are likely to come from the skin of the animal from which the meat was obtained. Other potential sources of microbial contaminations are the equipment used for each operation that is performed until the final product is eaten, the clothing and hands of personnel and the physical facilities themselves are all implicated (Rombouts and Nouts, 1994).

Retail cut could also result in greater microbial load because of the large amount of exposed surface area, more readily available water, nutrient and greater oxygen penetration available (Forest, *et al*., 1985). Hence retail cuts displayed are conducive for microbial growth and proliferation which leads to spoilage of the meat (Ayres, 1995). However in Africa, a number of foods (meat and fish inclusive) have been reported to have high incidence of bacteria (Caroline *et al*., 2005).But there is limited information on the health challenges from food-borne diseases from fresh meat and fish retailed within a highly populous community.

There have been cases of numerous outbreak of food borne diseases and gastrointestinal illness such as dysentery, cholera, diarrhea in many cities in Ghana which have been associated with the consumption of meat and fish products that are contaminated by microorganisms through unhygienic practices. Microbial pathogens such as *Salmonella, Escherichia coli, Shigella sonnie* and *Listeriamonocytogenes* have been found in water used in washing produce (Stafford et *al*., 2002).

A comprehensive understanding and study of the microbial ecology of meat and fish produce sold in our markets and the factors that lead to microbial contamination and their multiplication is needed for effective management and maintenance of high quality and safe food.

The main objective of this study therefore was to determine the level of microbial contamination on fish and meat products sold in the Kumasi metropolis.

Specific objectives include: To isolate and identify the type of microbial organism present in meat and fish products sold in the metropolis and determine the quality of fish and meat products.

MATERIALS AND METHODS

The study covered two in major markets, "Kumasi Central Market" and the "Bantama Market" in the Kumasi Metropolis. Ten samples of different meat portions and fish samples each were selected from the two markets (5 meat and 5 fish samples from Bantama market then 5 meat and 5 fish samples from Kumasi Central market). The samples were collected in a clean polyethylene bag and transferred immediately to the laboratory for further analysis.

Identification and Enumeration of Microorganisms

Standard methods (Ms Excel, ANOVAs) and Most Probable Number (MPN) were used for enumeration and statistical analysis of bacteria counts.

Laboratory Analysis and Techniques

All materials needed for the study were thoroughly sterilized using a combination of the most appropriate methods of sterilization such as flaming, chemical sterilization, Ultra Violet light, hot air ovens and autoclaving to ensure that experimental materials brought in from the two major markets were not contaminated from the laboratory.

Test for Total Viable Count (TVC)

Microorganisms were isolated and enumerated by the pour plate method and growth on plate count agar (PCA). Serial dilutions of 10^{-1} to 10^{-4} were prepared by diluting 1g of the sample (meat or fish) into 10ml of sterilized distilled water. One millimeter aliquots from each of the dilutions were inoculated into petri dishes with already prepared PCA. The plates were then incubated at 35°C for 24hrs. After incubation all white spots or spread were counted and recorded as total viable counts using the colony counter. The counts for each plate were expressed as colony forming unit of the suspension (cfu/g).

Test for the presence of Salmonella

Prepared 10 ml of manufactured formula of Buffered peptone water (BPW) was in a bottle and serial dilution of samples added to it. It was incubated at 37°C for 24 hours. 0.1 ml of the sample from BPW was placed in a 10 ml of selenite broth in a universal bottle and incubated at 44°C for 48 hours. Swaps from the bottle onto SS Agar were incubated at 48 hours at 37°C. Black colonies on the SS Agar indicated the presence of *Salmonella*.

Test for Mould (fungi)

Mould (fungi) were isolated and enumerated by pour plate method and growth on Potato Dextrose Agar (PDA). Serial dilutions of 10^{-1} to 10^{-4}were prepared by diluting 1 g of the sample into 10ml of sterilized distilled water. One millimeter aliquots from each of the dilutions were inoculated on petri dishes with already prepared PDA. The plates were then inoculated at 25°C for 24 hrs. After incubation all white spots and spread were counted and recorded as moulds using the colony counter.

Test for Faecal Coliforms

Most Probable Number (MPN) method was used to determine faecal coliforms in the sample. Serial dilutions of 10^{-1} to 10^{-4} were prepared by picking 1 ml of the sample into 9 ml sterile distilled water. 1 ml aliquot from each of the dilution were inoculated with 5 ml of Mac Conkey broth and inoculated into at 44°C for faecal coliforms for 18-24 hours. Tubes showing changes from purple to yellow were identified as positive for faecal coliforms. Counts per 100 ml were calculated from Most Probable Number (MPN) tables.

Test for the presence of *Escherichia coli* (Thermo tolerant Coliforms)

From the positive tubes that were identified, a drop was transferred into a 5 ml test tube of trypton water and incubated at 44°C for 24 hours. A drop of Kovacs reagent was then added to the tube of trypton water. All tubes showing a red colour development after gentle agitation denoted the presence of indole and were recorded as presumptive for thermo tolerant coliforms (*E. coli*). Counts per 100 ml were calculated from Most Probable Number (MPN) tables. A drop of culture from TVC plate was placed on slide, spread with a flamed sterile loop, allowed to dry and fixed the bacteria by passing the slide two times through a Bunsen flame.

Bacterial Identification

The bacterial smear was stained with 0.5% crystal violet for two minutes. It was then washed with water, drained off the water and stained with dilute iodine for two minutes. The crystal violet and iodine form a purple/black complex inside the bacterial cell. A drip of absolute alcohol was carefully dropped onto the smear and allowed to run off. This was repeated three times and washed off with water (the alcohol dissolves the lipid layer surrounding the gram negative cells and allow the crystal violet and iodine complex to wash off). It was counter stain with 1% safranin for 2 minutes and then washed and slide dried. The slide was observed under a microscope and cells which were stained purple or black were identified as gram positive bacterial cells whilst those cells stained light pink identified as gram negative bacterial cells.

Statistical Analysis

All data collected was subjected to statistical analysis of variance using JMP. Differences between treatment means were determined using LSD test at 5% (P=0.05).

RESULTS

Types of micro-organisms in various meat and fish products found in two major markets in the Kumasi Metropolis

Table 1 shows total bacterial count (1ml/CFU), total faecal coliform (100 ml/CFU), *E. coli*(100ml/CFU) and *Salmonella* (100ml/CFU) that were found in the meat and fish products. There was significant difference between the micro-organisms found on meat and fish products from Bantama market and Central market with Bantama market recording significantly higher values on all the micro-organisms identified ($1.85x10^7$- $4.71x10^4$) than those recorded for Central market recording the least ($1.55 x10^7$-$3.82x10^4$).

Table 1. Types of micro-organisms identified in meat and fish products in two major markets in the Kumasi metropolis.

MARKET	TBC (1 ml/CFU)	TFC (100ml/CFU)	*E.coli* (100ml/CFU)	*Salmonella* (100ml/CFU)
Bantama	$1.63x10^5$a	$1.85x10^7$a	$2.56\ x10^5$a	$4.71x10^4$a
Central market	$1.62\ x10^5$b	$1.55\ x10^7$b	$1.25\ x10^5$b	$3.82x10^4$b

Note: TBC=total bacterial count, TFC=total faecal coliform, *E.coli=Escherichia coli.*
Levels not connected by the same letters are significantly different at 0.05 probability level THS.

Table 2. Level of micro-organisms found in various meat and fish products in two major markets in the Kumasi metropolis.

Meat and fish	TBC (1ml/CFU)	TFC (100ml/CFU)	*E.coli* (100ml/CFU)	*Salmonella* (100ml/CFU)
Wale	$3.12x10^5$a	$3.90x10^7$b	$5.57x10^5$a	$7.05\ x10^4$b
goat meat	$2.20x10^5$b	$3.52x10^7$c	$2.46x10^5$d	$4.43\ x10^4$d
cattle meat	$2.13x10^5$c	$2.14\ x10^7$d	$4.28x10^5$b	$3.93\ x10^4$e
Intestines	$1.36x10^5$g	$5.23x10^7$a	$3.63x10^5$c	$5.77\ x10^4$c
salted beef	$1.68x10^5$e	$2.10x10^7$d	$1.30x10^5$e	$3.90x10^4$e
salmon	$1.92x10^5$d	$5.07x10^5$e	$6.65x10^4$f	$8.80\ x10^4$a
Kobi	$1.66x10^5$f	$7.18x10^4$e	$2.42\ x10^4$f	$1.92\ x10^4$g
Tuna	$7.94x10^4$i	$1.92x10^5$e	$3.23x10^4$f	$1.32\ x10^4$h
keta S. B	$8.33\ x10^4$h	$6.35x10^4$e	$2.80\ x10^4$f	$1.97\ x10^4$g
Amane	$5.95x10^4$j	$2.58x10^5$e	$3.05\ x10^4$f	$3.57\ x10^4$f

Note: keta s.b = keta school boys, TBC = total bacterial count, TFC = total faecal coliform*, E. coli* = *Escherichia coli*. Levels not connected by the same letters are significantly different at 0.05 probability level THS.

Level of micro-organisms in various meat and fish products found in two major markets in the Kumasi Metropolis

Total Bacterial Count (1 ml/CFU)

From Table 2, it could be said that there was significant difference in total bacterial count among the various meat and fish products. Wale recorded the highest value of total bacterial count ($3.12x10^5$) whiles amane recorded the least value of total bacterial count ($5.95x10^4$).

Total Faecal Coliforms (100ml/CFU)

From table 2, intestines showed significant difference among the various products. It recorded the highest value of total faecal coliforms ($5.23x10^7$), whiles kobi recorded the least value of total faecal coliforms ($7.18x10^4$). There was no significant difference between cattle meat and salted beef.

Escherichia coli (100 ml/CFU)

From table 2, wale recorded the highest level of *E.coli* ($5.57x10^5$), whiles kobi recorded the least ($2.42x10^4$). There were significant differences between wale, goat meat, cattle meat, intestines and the other products. Salmon, kobi, tuna, keta school boys and amane showed no significant differences and with salmon having the highest level of *E.coli* ($6.65x10^4$) whiles kobi had the least ($2.42x10^4$).

Salmonella (100ml/CFU)

From table 2, there was no significant difference between kobi ($1.92\ x10^4$) and keta school boys ($1.97\ x10^4$). Also, there was no significant difference between cattle meat ($3.93\ x10^4$) and salted beef ($3.90\ x10^4$). Salmon ($8.80\ x10^4$) recorded the highest level of *salmonella* contamination followed by wale ($7.05\ x10^4$). Tuna, recorded the least level of *salmonella* contamination ($1.32\ x10^4$).

Correlation of micro-organisms found in various meat and fish products in two major markets in the Kumasi metropolis

From Table 3, the correlation between the total faecal coliforms and *E.coli* was highly significant (0.83). Total bacterial count also showed highly positive correlation

Table 3. Correlation of micro-organisms found in various meat and fish products in two major markets in the Kumasi metropolis.

Source	TBC(1ml/CFU)	TFC(100ml/CFU)	*E.coli*(100ml/CFU)
TFC	0.55		
E.coli	0.76	0.83	
Salmonella	0.60	0.43	0.48

Note: TBC=total bacterial count, TFC=total faecal coliform, *E.coli*=*Escherichia coli*.

Table 4. Level of micro-organisms found on meat and fish products by market interaction in two major markets in the Kumasi metropolis.

Meat and fish type X market interaction	TBC (1ml/CFU)	TFC (100ml/CFU)	*E.coli* (100ml/CFU)	*Salmonella* (100ml/CFU)
Wale (b.m)	$3.22x10^5$a	$4.90x10^7$c	$3.77\ x10^5$d	$5.03x10^4$ g
Wale (c.m)	$3.02\ x10^5$b	$2.90x10^7$e	$7.37\ x10^5$b	$9.07x10^4$b
g.meat (b.m)	$2.49x10^5$c	$9.17x10^4$f	$3.53x10^4$g	$2.07x10^4$
g.meat (c.m)	$1.90x10^5$i	$7.03x10^5$a	$4.57\ x10^5$cd	$6.80x10^4$e
c.meat (b.m)	$1.97x10^5$h	$7.03x10^7$f	$2.20x10^4$g	$4.23x10^4$h
c.meat (c.m)	$2.28x10^5$e	$4.20x10^7$d	$8.33x10^5$a	$3.63x10^4$j
Intestines (b.m)	$1.65\ x10^5$j	$6.37x10^7$ b	$5.03x10^5$c	$7.53x10^4$d
Intestines (c.m)	$1.07x10^5$p	$4.10x10^7$d	$2.23x10^5$e	$4.00x10^4$i
Salted beef (b.m)	$2.17x10^5$f	$4.13x10^7$d	$1.68x10^5$ef	$4.07x10^4$i
Salted beef (c.m)	$1.18x10^5$m	$5.87\ x10^5$f	$9.27x10^4$fg	$3.73x10^4$j
Salmon (b.m)	$1.38x10^5$k	$2.73x10^5$f	$4.67x10^4$g	$8.20x10^4$c
Salmon (c.m)	$2.45\ x10^5$d	$7.40x10^5$f	$8.63x10^4$fg	$9.40x10^4$a
Kobi (b.m)	$2.02\ x10^5$g	$5.30x10^4$f	$1.20x10^4$g	$2.23x10^4$k
Kobi (c.m)	$1.29x10^5$l	$9.07x10^4$f	$3.63x10^4$g	$1.60x10^4$n
Tuna (b.m)	$4.61x10^4$s	$5.23x10^4$f	$2.67x10^4$g	$1.23x10^4$p
Tuna (c.m)	$1.13\ x10^5$n	$3.32x10^5$f	$3.80x10^4$g	$1.40x10^4$o
Keta s.b (b.m)	$5.49x10^4$r	$6.03x10^4$f	$2.50x10^4$g	$2.03x10^4$lm
Keta s.b (c.m)	$1.12x10^5$o	$6.67x10^4$f	$3.10x10^4$g	$1.90x10^4$m
Amane (b.m)	$3.85x10^4$t	$7.57x10^4$f	$3.07x10^4$g	$1.53x10^4$no
Amane (c.m)	$8.06x10^4$q	$4.40x10^5$f	$3.03x10^4$g	$5.60x10^4$f

Note: (b.m) =Bantama market, (c.m) =Central market, *E. coli*=*Escherichia coli*. c.meat=cattle meat, g.meat=goat meat, keta s.b=keta school boys. Levels not connected by the same letters are significantly different THS.

with *E.coli* (0.76).Total bacterial count showed moderately significant correlation with *Salmonella* (0.60). However, total bacterial count was moderately significant with total faecal coliforms (0.55).

Level of micro-organisms found in meat and fish products by market interaction in two major markets in the Kumasi metropolis

Total Bacterial Count (1 ml/CFU)

Table 4 indicates that there was significant difference between meat and fish products by market interactions on total bacterial count. Wale from Bantama market had the highest level of total bacterial count contamination ($3.22x10^5$), whiles amane from Bantama market recorded the least level of total bacterial count ($3.85x10^4$).

Total Faecal Coliforms (100ml/CFU)

Table 4 shows significant difference on total faecal coliforms in goat meat from Central market, intestines from Bantama market, wale from Bantama market and wale from Central market. Goat meat from Central market recorded the highest level of total faecal coliforms ($7.03x10^7$), followed by intestines from Bantama market

Table 5. Correlation of micro-organisms in various meat and fish products by market interaction in two major markets inthe Kumasi metropolis.

	TBC(1ml/CFU)	TFC(100ml/CFU)	*E.coli*(100ml/CFU)
TFC	0.43		
E.coli	0.55	0.76	
salmonella	0.50	0.41	0.47

Note: TBC=total bacterial count, TFC=total faecal coliform, *E. coli*=*Escherichia coli*.

($6.37x10^7$). Tuna from Bantama market recorded the least ($5.23x10^4$). However, there was no significant difference between salted beef from Bantama market, intestines from Central market and cattle meat from Central market.

Escherichia coli (100ml/CFU)

There was significant difference in the level of *E. coli* between wale from Bantama market and that from Central market, cattle meat from Central market, intestines from both Bantama market and Central market. There was no significant difference between goat meat, cattle meat, salmon, kobi, tuna, keta school boys, amane (all from Bantama market), amane, keta school boys, tuna and kobi (all from Central market). There was also no significant difference between salted beef from Central market and salmon from Central market. However, cattle meat ($8.33x10^5$) fromCentral market recorded the highest level of *E. coli* contamination followed by wale ($7.37x10^5$) from Central market, whiles, kobi from Bantama market recorded the least ($1.20x10^4$) as shown in table 4.

Salmonella (100ml/CFU)

From table 4, Salmon ($9.40\ x10^4$) from Central market recorded the highest level of *Salmonella* contamination and tuna from Bantama market recorded the least ($1.23\ x10^4$).There was no significant difference between cattle meat and salted beef from Central market. There was also no significant difference between intestines from Central market and salted beef from Bantama market. However, there was significant difference between salmon from Central market and that from Bantama market. Intestines and Tuna fish from Bantama market, goat meat and Wale from Central market showed no significant difference.

Correlation of micro-organisms in various meat and fish products by market interaction in two major markets in the Kumasi metropolis

Table 5 indicates that total faecal coliforms showed high significant correlation with *E. coli* (0.76). There was moderate significant correlation between total bacterial count with *E. coli* (0.55) and *Salmonella* (0.50).There is less significant correlation between total faecal coliform and *Salmonella* (0.41).

DISCUSSION

Total Bacterial Count (1ml/CFU)

The level of total bacterial count was higher in Bantama market than in Central market. The higher values could be as a result of contamination from the processing area, equipment used and also the means of transportation which was used in bringing the produce to the market centers. The high total bacterial counts recorded in this study also showed the microbial diversity (differences in form or species) in these markets, condition of the market and the hygienic practice employed by meat sellers and butchers. The slaughter of meat animals under unhygienic conditions, the use of contaminated water, use of unsterilized equipment such as knifes, rusted hooks, poor and unhygienic condition of markets followed by production and processing of meat and fish products without adhering to good manufacturing practices can result to the increased level of total bacterial count in the meat and fish products (Geldrich and Bordner, 1971; Meat Inspectors Manual, 2007). Also, from the studies, it can be seen that wale recorded the highest level of total bacterial count and this may be due to the way it is prepared. The meat during its preparation remains in the ground for a long time which creates an avenue for microbial pathogens to proliferate on it. From the results, it is evident that meat products from Bantama market recorded high total bacterial count compared to the fish products, this may be because of the way they package the fish products at the market. The fish products that were sold at Bantama market were wrapped in airtight rubber bags which prevented the produce from being contaminated with microorganisms through airborne. The meat produce were exposed to direct air which carries airborne pathogenic organisms, and thus resulted in the meat products at Bantama having the high level of microbial contamination compared to the fish produce that were wrapped in airtight rubber bags. The results from this study agrees with previous reports by El-Gohany (1994) that foods of animal origin (minced meat) either cooked or uncooked contains high level of bacterial count. This may be because meat offers a rich nutrient media for microbial growth (Phillips, 2003).

Total Faecal Coliforms (100ml/CFU)

The level of total faecal coliforms was higher in Bantama market compared to Central market. The higher values of total faecal coliforms could be as a result of sellers who visit toilets and do not wash their hands well with soap. The presence of faecal coliforms is an indication of contamination by humans, birds or contaminated water used in washing both at the processing site and at the retail level (Talaro *et al*., 2006). The result from this study is in line with the report of Jeffery *et al*., (2003) that the workers hands and the equipment were the sources of meat contamination. From this study it was revealed that intestines recorded the highest level of total faecal coliforms, this may be due to the way the produce is being displayed openly at the market. Intestines sold at the market are put in rubber buckets or bowls containing water, the produce remains in the water until they are all sold, then other intestines are put in that same water. This increases the level of total faecal coliforms on the intestines that has been put into the water from which the previous ones were sold from. Mostly, the rubber bucket containing water with intestines is not covered which also exposes the produce to microorganisms which are carried by air and also by houseflies. The results from the study also show that there were no significant difference between salted beef and cattle meat but the cattle meat recorded higher value than the salted beef. The presence of high faecal coliforms in food depicts poor hygienic practices of handling of the meats during slaughtering and processing or due to possible contamination from the skin, mouth or nose of the handlers which might be introduced directly into the meat (Schroeder *et al*., 2005).

Escherichia coli (100ml/CFU)

From the study it is known that *E. coli* from Bantama recorded the highest value of *E. coli* contamination than Central market. *E. coli* is an indicator organism and its presence indicates faecal contamination. *E. coli*, which is a normal flora of the human and animal intestine, have been identified as a leading cause of food borne illness all over the world. Diarrhea caused by enterotoxigenic *E. coli* (ETEC) is highly prevalent in young children in developing countries. It is believe to spread through contaminated water and food (Qadri *et al*., 2005). The potentially high mortality associated with *E. coli* strain infection makes its presence in any food material perturbing and of serious public health concern as most of the outbreaks that are recorded has been traced to the consumption of beef contaminated with the *E. coli* 0157:H7 strain (Hussein, 2007). Its high level at Bantama market could be due to poor handling by retailers, exposure to direct air; it could also be from contamination of the vehicle or transport used. Most retailers transport their produce especially meat by carriages which do not protect the products from flies but rather expose the produce to the open atmosphere. Wale recorded the highest level of *E.coli* contamination from the study. This makes it unsafe for consumption as the presence of *E. coli* is a potential cause of food borne diseases. It can also be known from the study that the meat products recorded higher levels of *E. coli* contamination and this could be attributed to the fact that meat offers a rich nutrient media for microbial growth (Phillips, 2003)

***Salmonella* (100ml/CFU)**

The isolation of *Salmonella* sp. in this study is of practical importance. This organism might have contaminated the meats as a result of poor handling by meat sellers. *Salmonella* contamination from Bantama market was significantly higher than that from Central market. This can be attributed to the way produce are handled in the market. Also, the size and structure of the market could contribute to the increased incidence of *Salmonella* contamination. Highly populated area where there is compactness of retailers and consumers can increase microbial contamination by the skin, mouth or nose of the handlers and consumers which might be introduced directly into the meat (Schroeder *et al*., 2005). With the contamination of *Salmonella*, salmon recorded the highest value and this could be due to contamination from the water used by the retailer in washing the produce, its exposure to direct air and also from the tables of the retailers from which produce is displayed.

Correlation of micro-organisms found on meat and fish products from two majormarkets in the Kumasi metropolis

Total Bacterial Count (1ml/CFU)

The level of correlation between the total bacterial count and total faecal coliform is moderately significant. It showed a positive correlation and this implies that a change in the level of total bacterial count will significantly influence level of total faecal coliform. That is an increase in the total bacterial count will lead to an increase in the total faecal coliform whiles a decrease in the total faecal coliform will also lead to a decrease in the total faecal coliform. However, the correlation between total bacterial count and *E. coli* is moderate but a change in one of the variables will be accompanied by a higher change in the other as compared to the correlation between total bacterial count and total faecal coliform. This could be attributed to the condition that from the total faecal coliform *E. coli* was dominant than the other faecal contaminants present. The correlation between total bacterial count and *Salmonella* also showed moderate significance. Thus, an increase in the total bacterial count will lead to an increase in the level of *Salmonella* in the produce. The correlation between total bacterial counts and total faecal coliform of meat and fish types by market interaction showed less significant correlation. This connotes that a decrease or increase in one of the variables will not greatly affect the other.

Total Faecal Coliforms (100ml/CFU)

From table 3, the correlation between total faecal coliform and *E.coli* showed moderately significant correlation. This implies that the level of *E.coli* can influence and can also be influenced by total faecal coliforms. However, there was less significant correlation between total faecal coliform and *Salmonella*. The level of *Salmonella* could not greatly influence the total faecal coliform count in the produce. There was moderate significant correlation between *E.coli* and total faecal coliform as shown in table 5.

E.coli (100ml/CFU)

The correlation between the *E.coli* and *Salmonella* from table 3 shows less significant correlation. The degree at which *salmonella* influences *E.coli* is not of great importance.

CONCLUSION

From the study, it can be concluded that there was presence of indicator organism including *E. coli* and salmonella and previous studies have shown that the presence of these organisms in food makes food unhealthy for consumption. The exposure of meat and fish products to unhygienic practices from the point of production to retail level increases the level of microbial contamination in the produce. Therefore to safe-guard against the risks of disease infection from moderate severe as described by Mossel *et al*. (1980) on incidence of staphylococcal food poisoning and *E. coli* contamination in foods, there is the need to educate and advocate for good production practices among food processors and food vendors. It was also evident that produce from both markets showed signs of contamination but Bantama market recorded the highest level of contamination on all the parameters, thus it is expedient that good hygienic practices should be observed at the market. The possible sources of these contaminants are due to the unhygienic manner of handling meat in the abattoirs. This implies that these meat and fish products are viable sources of various diseases. Some of these diseases could spread and acquire epidemic status which could pose serious health hazards.

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