Asian Journal of Poultry Science

ISSN 1819-3609

Academic Journals Inc.

www.academicjournals.com

Asian Journal of Poultry Science 9 (3): 165-171, 2015
ISSN 1819-3609 / DOI: 10.3923/ajpsaj.2015.165.171

Microbial Quality of Fresh and Smoked Guinea Fowl Meat Sold in the Bolgatanga Municipality, Ghana

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ABSTRACT

The study was conducted to determine the microbial quality of fresh (raw or uncooked) and smoked guinea fowl meats sold in the Bolgatanga Municipality of Ghana. Observations were also made to know the hygienic conditions under which guinea fowls are slaughtered and smoked. Guinea fowl meat samples were obtained from five different retail shops in the Bolgatanga Municipality. Twenty meat samples each (10 fresh and 10 smoked guinea fowl meats) were collected from five different retail shops. Collected samples were analyzed microbiologically using a modified procedure in the bacteriological analytical manual of the food and drugs administration-USA. Total aerobic count for the guinea fowl meats ranged from 3.63-6.19 log CFU cm^{-2}; so that, it was 3.99-6.19 log CFU cm^{-2} for fresh guinea fowl meat in compared with smoked guinea fowl's bacteria load that ranged from 3.63-5.25 CFU cm^{-2} ($p<0.05$). Fresh guinea fowl meat from Next Door (6.19 log CFU cm^{-2}) was the most contaminated meat sample and smoked guinea fowl meat from Speed Link (3.63 log CFU cm^{-2}) was the least contaminated meat sample. Bacterial species identified on the fresh and smoked guinea fowl meat samples were *Staphylococcus* spp., *Salmonella* spp., *Escherichia coli*, *Streptococcus* spp., *Pseudomonas* spp., *Proteus* spp. and *Bacillus* spp. *Staphylococcus* spp. and *Bacillus* spp., were the most common identified bacteria followed by *Escherichia coli*. Physical observation revealed that meat sellers were involved in unhygienic practices such as using of knives without sterilizing them, wearing of dirty aprons and clothes and busily conversing while smoking and selling meat. Generally the fresh guinea fowl meats had high microbial load than the smoked guinea fowl meats. Furthermore, fresh and smoked guinea fowl meat samples from Next Door were the most contaminated meat samples while fresh and smoked guinea fowl samples from Speed Link were the least contaminated meat samples. *Staphylococcus* spp., *Salmonella* spp., *Escherichia coli*, *Streptococcus* spp., *Pseudomonas* spp., *Proteus* spp. and *Bacillus* spp. were present in guinea fowl meats sold in the Bolgatanga Municipality.

Key words: Fresh guinea fowl meat, grilled guinea fowl meat, microbial quality, contaminated

INTRODUCTION

Foodborne infections still remain one of the major problems of public health worldwide. Data from different countries differ because food production, processing and distribution differ from country to country (Adzitey *et al*., 2012a). One of the major causes of foodborne infection is the consumption of meat and meat products contaminated with foodborne pathogens (Adzitey *et al*.,

2012a; EFSA., 2012; Public Health England, 2013). Meat itself is an excellent source of protein for humans and an excellent source of nutrient for the growth of microbes, some of which are bacterial foodborne pathogens (Public Health England, 2013; Warriss, 2000). Different types of bacterial foodborne pathogens including *Salmonella* spp., *Campylobacter* spp., *Listeria monocytogenes*, *Clostridium perfringens*, *Escherichia coli*, *Staphylococcus aureus* and many more have been isolated from meat and meat products (Alsheikh *et al*., 2012; Geidam *et al*., 2012; Adzitey *et al*., 2010, 2011a, 2012b, c, d, 2013, 2014; Liu *et al*., 2013; Geck *et al*., 2014; El Habib *et al*., 2014). Scallan *et al.* (2011) estimated that bacteria cause 3.6 million (39%) foodborne illnesses in the USA. Nontyphoidal *Salmonella* spp., *Clostridium perfringens* and *Campylobacter* spp. caused 1.0 million (11%), 1.0 million (10%) and 0.8 million (9%) foodborne illnesses, respectively (Scallan *et al*., 2011). Furthermore, among 31 pathogens that caused 2,612 deaths, bacteria was responsible for 64% of the deaths and the leading causes of death were nontyphoidal *Salmonella* species (28%), *Toxoplasmagondii* (24%), *Listeria monocytogenes* (19%) and norovirus (11%) (Scallan *et al*., 2011).

Guinea fowl meat is a favourite meat for many Ghanaians because of it nutritional value and low fat content (Gyebi, 2012). The demand for guinea fowl meat in Ghana far exceeds supply and hence the implementation of the enhanced guinea fowl project by the Ministry of Food and Agriculture (MoFA), Ghana and the International Centre for Enterprise and Sustainable Development (ICED) to increase guinea fowl production from the current 30 million birds annually, to 100 million in the next three years (Gyebi, 2012). The implication is that guinea fowl production in Ghana will continue to increase and the problems associated with the increasing diversity of foodborne bacterial pathogens contributed by guinea fowl are likely to become more important. Pre-slaughtering conditions on the farm coupled with the sanitary conditions of abattoirs or places where animals are slaughtered and its surrounding environment are major factors contributing to bacterial contamination of meat (Adzitey, 2011; Adzitey *et al*., 2011b; Adzitey and Nurul, 2011; Gill, 2007).

In Ghana, there are no abattoirs or well established places for slaughtering guinea fowls and these birds are slaughtered by individual processers normally under unhygienic conditions and without inspection by a qualified veterinary officer/meat inspector. Furthermore, guinea fowl meats are sold in the open sometimes with or without sieves and on tables that are not well maintained or cleaned after work. These expose guinea fowl meats to a number of bacterial foodborne pathogens. Therefore, this study was carried out to determine the microbial quality of fresh and smoked guinea fowl meats in the Bolgatanga Municipality of Ghana.

MATERIAL AND METHODS

Location, data collection and duration: The study was carried out in the Bolgatanga Municipality. The Bolgatanga District is located within the Upper East Region of Ghana on latitudes 10°30' and 1°55' North and Longitudes 0°33' and 1°00' West (Anonymous, 2015). The district is relatively small in size with a land area of 1,620 km² (Anonymous, 2015). The Bolgatanga District shares boundaries with Bongo District to the North, to the East with Nabdam District, to the South with Talensi District and to the West with KassenaNankana East District. Five retail guinea fowl meat shops, where people prefer to buy guinea fowl meats in the Bolgatanga Municipality were sampled. The retail shops were Atibere, Comeci, Next Door, Ojam and Speed Link, representing about 80% of guinea fowl meat sellers in the Municipality. A total of 100 guinea fowl meat (50 fresh and 50 smoked meats) samples were examined. Fresh guinea fowl meat here

means raw or uncooked guinea fowl meat. Twenty samples (10 fresh and 10 smoked) were collected from each retail shop. An area of 10 cm^2 was swabbed and swaps transported under 4°C to the University for Development Studies (UDS), Nyankpala Campus Spanish Laboratory for microbial analysis. Swab samples were taken because of cost (to avoid purchasing whole guinea fowls carcasses) and for ease of transportation from sampling site to the laboratory. Also fresh and smoked guinea meats were considered because they are the main form consumers buy guinea fowl meat in the Municipality. The experiment was carried out between the periods of April 2013 to June 2014.

Enumeration and identification of bacteria groups: This was done according to Adzitey *et al*. (2014). Swabs were placed in10 mL sterile peptone water and thoroughly shaked to obtain the neat (diluted sample to be analyzed). One milliliter of the neat was transferred into 9 mL sterile peptone water until a dilution of 10^{-6} was obtained. Serial dilutions (10^{-1}-10^{-6}) were spread plated onto blood and nutrient agar plates. Plates were incubated at 37°C for 24 h under aerobic condition and the colony forming units were counted to obtain the microbial load. Colony forming unit was calculated using the formula:

$$N = \Sigma C/[(1\times n_1)+(0.1\times n_2)]\times(d)$$

Where:
N = No. of colonies per cm^2
ΣC = Sum of all colonies on all plates counted
n_1 = No. of plates in first dilution counted
n_2 = No. of plates in second dilution counted
d = Dilution from which the first counts were obtained (Maturin and Peeler, 2001)

Some colonies with different shape, colour and appearance were picked at random from plate count agar and identified using gram staining. The morphology and colour of the colonies under the microscope was compared to that of Anonymous (2013) to aid in the identification of the various genera. Other tests like catalase test, oxidase test and growth on McConkey (lactose and sorbitol) agars and blood agar were used to confirm some of the isolates. In this study, financial constraints and lack of molecular equipment/tools prevented the authors from doing antibiotic sensitivity test and molecular confirmation/characterization of the isolates, despite their willingness to do so. General observations were also made during sampling to know the conditions under which they are slaughtered and smoked.

Statistical analysis: All data collected was analyzed using Analysis of Variance (ANOVA) of the Genstat Statistical Package, 6th edition.

RESULTS AND DISCUSSION

We reported for the first time in the Bolgatanga Municipality of Ghana on the microbial quality of fresh and smoked guinea fowl meats. Guinea fowl meat is relished and cherished by most Ghanaians because it is belief to have lean meat and less fat. The result obtained from sampling five meat retail shops is presented in Table 1. From Table 1, total bacteria count for the guinea fowl

Table 1: Total aerobic plate count of fresh and smoked guinea fowl meat sold in Bolgatanga, Ghana

Location	Type of guinea fowl	Aerobic plate count log (CFU cm^{-2})
Next door	Fresh	6.1900^{d}
Next door	Smoked	4.4500^{abc}
Comeci	Fresh	3.9900^{ab}
Comeci	Smoked	5.2500^{c}
Speed link	Fresh	4.2900^{ab}
Speed link	Smoked	3.6300^{a}
Atibere	Fresh	4.7100^{bc}
Atibere	Smoked	3.9500^{ab}
Ojam	Fresh	4.2500^{ab}
Ojam	Smoked	3.9200^{ab}
SED		0.4550
p-value		<0.001

Means (log CFU cm^{-2}) in the same column with different superscripts are significantly different ($p<0.05$), SED: Standard error of difference

meats ranged from 3.63-6.19 log CFU cm^{-2}. The total bacteria count for fresh and smoked guinea fowl meat samples ranged from 3.99-6.19 and 3.63-5.25 log CFU cm^{-2}, respectively. There were significant differences ($p<0.05$) in bacteria load among the fresh and smoked guinea fowl meats from the various meat retail shops. Fresh guinea fowl meat from Next Door (6.19 log CFU cm^{-2}) was significantly higher ($p<0.001$) than the rest. Ledward (1982) reported that meat samples with microbial load above 10^6 is said to be unsatisfactory, thus microbial load for fresh meat from Next Door is unsatisfactory. Smoked guinea fowl meat from Comeci (5.25 log CFU cm^{-2}) was significantly higher ($p<0.05$) than fresh meat samples from Comeci (3.99 log CFU cm^{-2}), Speed Linked (4.29 log CFU cm^{-2}), Ojam (4.25 log CFU cm^{-2}) and smoked guinea fowl meat samples from Speed Link (3.63 log CFU cm^{-2}), Atibre (3.95 log CFU cm^{-2}) and Ojam (3.92 log CFU cm^{-2}) but not smoked guinea fowl from Next Door (4.45 log CFU cm^{-2}) and Fresh guinea fowl from Atibre (4.71 log CFU cm^{-2}). Smoked guinea fowl meat samples from Next Door, Speed Link, Ojam and Atibere and fresh guinea fowl meats from Comeci, Speed Link and Ojam did not differ significantly ($p>0.05$) from each other.

Averagely bacteria count for both fresh and smoked guinea fowl meat was highest in meat samples collected from Next Door (5.32 log CFU cm^{-2}), followed by meat samples from Comeci (4.62 log CFU cm^{-2}), meat samples from Atibere (4.33 log CFU cm^{-2}) and meat samples from Ojam (4.09 log CFU cm^{-2}). The least contaminated meat sample was obtained from Speed Link (3.96 log CFU cm^{-2}). Warriss (2000) reported that when the microbial load is above 10^7 CFU g^{-1} spoilage of meat in eminent. In this study, none of the meat was spoiled since, they were all less than 10^7 CFU g^{-1}. Physical observation during sampling revealed that meat sellers in Speed Link observe better hygienic practices than those in Next Door, Comeci and Atibere. In Next Door, Comeci and Atibere, guinea fowl meats were placed on tables which seems not to be well cleaned from the previous day work. During a business day these tables are not cleaned regularly and thoroughly. Knives used in cutting meats were not sterilized regularly. The aprons of sellers in these places also looked dirty and it was common to see sellers busily conversing while cutting, smoking and selling meats. Muscle tissues of healthy animals are essentially free of microorganisms (Prescott *et al*., 2002). However, the muscle tissues are easily contaminated with both pathogenic and non-pathogenic microorganisms at the time of slaughter and post-slaughter conditions, when these are done poorly or under any faulty processing condition (Warriss, 2000; Adzitey *et al*., 2014). In addition the high nutritive value of meat makes it an ideal medium for bacterial growth (Adzitey *et al*., 2014).

Table 2: Genera of bacteria identified from fresh and smoked guinea fowl meat sold in Bolgatanga, Ghana

Sources	Fresh guinea fowl meat	Smoke guinea fowl meat
Ojam	*Staphylococcus* spp., *Streptococcus* spp., *Salmonella* spp., *Bacillus* spp., *Escherichia coli*	*Staphylococcus* spp., *Streptococcus* spp., *Salmonella* spp., *Bacillus* spp., *Escherichia coli*
Next-door	*Staphylococcus* spp., *Streptococcus* spp., *Salmonella* spp., *Bacillus* spp., *Escherichia coli*	*Proteus* spp., *Staphylococcus* spp., *Salmonella* spp., *Escherichia coli*., *Bacillus* spp.
Comeci	*Pseudomonas* spp., *Staphylococcus* spp., *Escherichia coli*, *Salmonella* spp., *Bacillus* spp.	*Pseudomonas* spp., *Staphylococcus* spp., *Bacillus* spp.
Speed link	*Staphylococcus* spp., *Bacillus* spp., *Salmonella* spp., *Escherichia coli*	*Pseudomonas* spp., *Staphylococcus* spp., *Bacillus* spp.
Atibere	*Escherichia coli*, *Staphylococcus* spp., *Pseudomonas* spp., *Salmonella* spp., *Bacillus* spp.	*Staphylococcus* spp., *Proteus* spp., *Bacillus* spp., *Salmonella* spp., *Escherichia coli*

Fewer researches are available on the microbiological load or prevalence of bacteria foodborne pathogens in guinea fowls and it related samples compared to chickens. Kilonzo-Nthenge*et al*. (2008) investigated the prevalence and antimicrobial resistance of pathogenic bacteria in chicken and guinea fowl and found the prevalence of *Salmonella* spp. in guinea fowl carcasses to be 23% (9/40). They also isolated *Campylobacter* spp., *Enterobacter* spp., *Escherichia coli*, *Citrobacter youngue*, *Klebsiella pneumonia* and *Pantoea* spp. in their guinea fowl carcasses. Comparable to this study, *Salmonella* spp. and *Escherichia coli* were identified but not *Campylobacter* spp., *Enterobacter* spp., *Citrobacter youngue*, *Klebsiella pneumonia* and *Pantoea* spp.

The genera of bacteria identified from fresh and smoked guinea fowl meat is shown in Table 2. From Table 2 fresh and smoked guinea fowl meats sold in the Bolgatanga Municipality were contaminated with various genera of bacteria. Overall seven different genera of bacteria was identified during the study and they were *Streptococcus* spp., *Proteus* spp., *Staphylococcus* spp., *Salmonella* spp., *Bacillus* spp., *Pseudomonas* spp. and *Escherichia coli*. All these seven genera of bacteria were identified in smoked guinea fowl meats. Six generally namely: *Streptococcus* spp., *Staphylococcus* spp., *Salmonella* spp., *Bacillus* spp., *Pseudomonas* spp. and *Escherichia coli* were identified in the fresh guinea fowl meat. Even though fresh guinea fowl meats had fewer bacteria genera, generally the fresh guinea fowl meats from the various places had more of the different bacteria species than the smoked guinea fowl meats (Table 2). Also cross contamination from other sources is responsible for the additional bacteria specie (*Proteus* spp.) found in the smoked guinea fowl meats. Most guinea fowl meat samples were contaminated by five different bacteria genera.

Staphylococcus spp. and *Bacillus* spp. were the most commonly identified bacteria in the guinea fowl meat samples examined. Adzitey *et al*. (2014) found *Staphylococcus* spp. and *Escherichia coli* to be the most common bacteria species in beef sold in the Yendi Municipality of Ghana. They attributed this to the poor slaughtering, handling and environmental conditions under which beef is handled in the Municipality. In this study, we found *Staphylococcus* spp. to be among the most commonly identified bacteria species in guinea fowl meats sold in the Bolgatanga Municipality. *Escherichia coli* was also identified in all the meat samples except smoked guinea fowl meats from Comeci and Speed Link (Table 2).

This work gives an indication that pathogenic bacteria species of *Staphylococcus* spp., *Salmonella* spp., *Escherichia coli*, *Streptococcus* spp., *Proteus* spp. and *Bacillus* spp. may be present in guinea fowl meats sold in the Bolgatanga Municipality. Fresh and smoked guinea fowl meats are also prone to spoilage due to the presence of *Pseudomonas* spp. Bacteria foodborne pathogens are of public health concern and have been implicated in a number of foodborne illnesses, hospitalizations and even deaths (Scallan *et al*., 2011; EFSA., 2012; Public Health England, 2013). Consumers of guinea fowl meats in the Bolgatanga Municipality are expose to the risk of contracting foodborne illnesses or poisoning. Therefore, guinea fowl meat sellers in the Municipality

have to improve upon their standard of slaughtering, processing and smoking guinea fowls. Consumers should also cook fresh guinea fowl meats very well before eating.

CONCLUSION

Fresh guinea fowl meats had higher bacteria load than smoked guinea fowl meats. Fresh guinea fowl from Next Door was the most contaminated meat sample while, smoked meat sample from Speed Link was the least contaminated meat sample. Fresh and smoked guinea fowl meats were contaminated by *Streptococcus* spp., *Proteus* spp., *Staphylococcus* spp., *Salmonella* spp., *Bacillus* spp., *Pseudomonas* spp. and *Escherichia coli*. *Staphylococcus* spp. and *Bacillus* spp. were identified in all the smoked and fresh guinea fowl meat samples from all the retail shops. General observation also revealed that bacteria load was lower in retail shops where the hygienic standard was better. It is recommended that butchers of guinea fowls should sterilise their knives routinely, clean their slaughter tables well and observe personal hygiene. Also, fresh guinea fowl meats in Ghana should be well cooked (72°C for 15 min) before consumption.

ACKNOWLEDGMENTS

The authors are thankful to the University for Development Studies, Faculty of Agriculture for the facilities provided to run this research.

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