IJST EXPLORE International Journal of Science and Technology
CENTRE OF PROFESSIONAL RESEARCH PUBLICATIONS
ISSN 2049-7318

International Journal of Science and Technology Volume 2 No. 6, June, 2013

Microbial Quality of Fresh Meat from Retail Outlets in Tolon and Kumbungu Districts of the Northern Region of Ghana

A. K. Obeng, F. S. Johnson, S. O. Appenteng
Department of Biotechnology, Faculty of Agriculture, University for Development Studies, Tamale, Ghana

ABSTRACT

Microbiological quality of raw meat sold at retail outlets in the Tolon and Kumbungu districts of the Northern region of Ghana was evaluated using standard microbiological methods. Samples collected from retail outlet at Nyankpala in the morning, afternoon, and late afternoon had the highest mean total aerobic bacterial count of 5.74 X 10^6 cfu/cm^2, 7.58 X 10^6 cfu/cm^2, and 8.85 X 10^6 cfu/cm^2 respectively. The lowest total aerobic count was recorded in retail outlet at Gbulung (1.84 X 10^6 cfu/cm^2, 4.40 X 10^6 cfu/cm^2 and 5.75 X 10^6 cfu/cm^2 for morning, afternoon, and late afternoon samples respectively). Bacteria isolated from the samples were *Escherichia coli*, *Staphylococcus*, *Streptococcus*, and *Salmonella* species, of which some may be pathogenic and of public health concern. Variations in the total aerobic count and the type of bacteria were observed at different times of the day. The presence of various bacteria on raw meat sold in the Tolon and kumbungu districts is an indication of low standards of animal and meat handling practices from pre-slaughter to post–slaughter, sales of meat, abattoir facilities, and equipments.

Keywords: *raw meat, retail outlets, microbiological quality, contamination, standard*

1. INTRODUCTION

Livestock farming is very important in Ghana because it contributes a lot towards the development of the country (Ansah *et al*., 2006). For small scale farmers across the African continent, livestock farming provides major source of income. During major events such as festivals and other equally important functions, these animals are sold and slaughtered to grace such occasions. In Ghana, cattle, poultry, pigs, sheep, and goats are normally reared (Teye and Salifu, 2006).

Slaughtering of livestock continues to increase as a result of the increase in demand for meat and its products (Warris, 2010). Meat has been and continues to be an important constituent of our daily meals. This is because it provides us with proteins and serves as source of energy (Stufflebeam, 1983). Eaton and Konner (1985) in their work reported that meat and its products contribute about "a third" of the energy that humans need.

Notwithstanding the major role meat play in our meals, 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 (WHO, 1997). The source of these pathogenic microorganism may be the animals themselves or from outside. The surroundings where these animals are kept as well as the way they are processed after slaughtering can also result in contamination with microorganisms (Adeyemo, 2002). Meat infected with microorganisms is normally poor in quality (Mukhopadhyay, 2009). Microbes such as *Staphylococcus* spp., *Aspergillus* spp., *Salmonella* spp., *Enterococcus* spp., *Streptococcus* spp., and *Escherichia coli* have all been found on contaminated meat (James *et al*., 2005).

The dry, hot, and sometimes humid environmental conditions in Northern Ghana and hence the Tolon and kumbungu districts are ideal for growth and multiplication of microorganisms. Mukhopadhyay (2009) reported that, hot and humid climate areas contribute to increasing the total aerobic counts on meat.

This study was therefore undertaken to determine the microbial load at different times of the day as well as identify the type of microbes found on meat sold in the most popular outlets within these two districts.

2. MATERIALS AND METHODS

2.1 Study Area

This study was carried out in the Tolon and Kumbungu districts of the Northern Region of Ghana. Meat outlets from six towns namely Nyankpala, Tolon, Katinga, Waliboa, Gbulung, and Kumbungu were covered.

2.2 Sampling

Freshly slaughtered meat samples from the various outlets were collected into sterile plastic bags, stored at 4 ^{O}C in

ice chest filled with ice and transported to the laboratory for immediate analysis. Samples from the same slaughtered animals were collected in the morning, afternoon, and late afternoon.

2.3 Total Aerobic Count

Samples were analysed for total aerobic counts using nutrient agar (Oxoid Ltd., Basingstoke, Hampshire, England) as the medium for inoculation. Stock solutions of the various samples were prepared by rotating a sterile cotton swap over the surface of the meat samples. This was then placed in 5 ml of 0.1 % peptone water within a test tube and homogenised for about 2 minutes. Serial dilution was then carried out with one (1) ml of the various stock solutions from the different samples in nine (9) ml of 0.1 % peptone water. This was then vortexed to ensure uniform mixture and 1 ml of each dilution was inoculated on a solidified prepared nutrient agar (Oxoid Ltd., Basingstoke, Hampshire, England) for total aerobic counts. The inoculated plates were incubated aerobically at 37 ^{O}C for 24 hrs.

After 24 hrs of incubation, plates with countable colonies (30-300 cfu) were removed and counted using the colony counter (P. Selecta, Spain). The number of colonies was recorded as colony forming unit per cm^2 (cfu/cm^2).

2.4 Bacteria Isolation and Identification

For *E. coli* identification, 1 ml of the dilutions were inoculated on McConkay agar (Oxoid Ltd., Basingstoke, Hampshire, England) and incubated aerobically at 37 ^{O}C for 24 hrs. Colonies that were suspected to be *E. coli* were isolated and confirmed using gram staining and other biochemical tests.

Salmonella spp. were also identified by inoculating 1 ml of the dilutions on SS agar (Oxoid Ltd., Basingstoke, Hampshire, England) and incubated for 24 hrs at 37 ^{O}C. Colonies that were considered to be *Salmonella* spp. were also further identified using gram staining technique and other biochemical tests.

Staphylococcus spp. were isolated and identified by first sub-culturing colonies on nutrient agar to obtain pure cultures. Morphological characteristics of the pure cultures, gram staining as well as other biochemical tests were then used to confirm the species.

Streptococcus spp. were identified by inoculating 1 ml of the dilutions on blood agar and incubating at 37 ^{O}C for 24 hrs. Colonies were then further identified using their morphological characteristics, gram staining and other biochemical test.

2.5 Gram Staining and Biochemical Tests

Biochemical tests carried out included, catalase, modified oxidase, oxidative-fermentative, furazolidone & bacitracin susceptibility, oxidase, sugar fermentation, indole, citrate utilization, urease, and motility tests. Gram staining and all biochemical tests were carried out according to De, (2007). The various media were also prepared according to the manufacturer's instructions.

3. RESULTS AND DISCUSSION

3.1 Bacteria Species Isolated from Meat Sample

Different types of bacteria were identified on all the meat samples at different times of the day. The bacteria identified included *Streptococcus* spp., *Staphylococcus* spp., *Salmonella* spp., and *Escherichia coli*.

In the morning, *Streptococcus* spp., and *Staphylococcus* spp. were isolated from all the samples from the various outlets except that of Tolon where only *Staphylococcus* spp. was isolated (Table 1.). *Salmonella* spp. was also isolated from samples that were taken from all outlets in the morning except Gbulung retail outlet (Table 1.).

Bacteria found on samples collected in the morning were also present on samples that were collected in the afternoon at the various outlets. *E. coli* were also isolated from all samples in the afternoon except those taken from Gbulung and Waliboa outlets.

The same types of bacteria isolated from samples collected in the afternoon were again isolated from samples that were taken later in the afternoon from the different outlets.

The presence of the isolated bacteria species shown in table 1 above may be due to improper/unhygienic handling and processing of the meat. Meat is normally transported to the markets in unhygienic meat vans, taxis, motor cycles, motor kings, and sometimes on bicycles. It is also a common practice to see people carrying carcasses on their bare shoulders. According to Bhandare *et al*. (2007), the unhygienic practices of meat processing in developing countries results in these meat been contaminated with microorganisms. Meat sellers were also observed busily conversing, coughing, and sneezing which might result in contamination through introduction of saliva on the meat. Okonko *et al*. (2008) stated that, food can be infected with microorganisms as a result of "coughing" and "sneezing" from those who handle and process these foods. Koffi-Nevry *et al*. (2011) also stated that, "careless sneezing and coughing among butchers can lead to contamination of the products".

Table 1: The genera of bacteria isolated from meat samples at different times of the day

Retail outlets	Bacteria identified		
	Morning	Afternoon	Late Afternoon
Gbulung	*Streptococcus* spp.	*Streptococcus* spp.	*Streptococcus* spp.
	Staphylococcus spp.	*Staphylococcus* spp.	*Staphylococcus* spp.
Katinga	*Salmonella* spp.	*Salmonella* spp.	*Salmonella* spp.
	Streptococcus spp.	*Streptococcus* spp.	*Streptococcus* spp.
	Staphylococcus spp.	*Staphylococcus* spp.	*Staphylococcus* spp.
		E. coli	*E. coli*
Waliboa	*Salmonella* spp.	*Salmonella* spp.	*Salmonella* spp.
	Streptococcus spp.	*Streptococcus* spp.	*Streptococcus* spp.
	Staphylococcus spp.	*Staphylococcus* spp.	*Staphylococcus* spp.
Kumbungu	*Salmonella* spp.	*Salmonella* spp.	*Salmonella* spp.
	Streptococcus spp.	*Streptococcus* spp.	*Streptococcus* spp.
	Staphylococcus spp.	*Staphylococcus* spp.	*Staphylococcus* spp.
		E. coli	*E. coli*
Nyankpala	*Salmonella* spp.	*Salmonella* spp.	*Salmonella* spp.
	Streptococcus spp.	*Streptococcus* spp.	*Streptococcus* spp.
	Staphylococcus spp.	*Staphylococcus* spp.	*Staphylococcus* spp.
		E. coli	*E. coli*
Tolon	*Salmonella* spp.	*Salmonella* spp.	*Salmonella* spp.
	Staphylococcus spp.	*Staphylococcus* spp.	*Staphylococcus* spp.
		E. coli	*E. coli*

The presence of the isolated microorganisms on meat and other foods has been widely reported in other parts of the world. Ansah *et al.* (2009) in their work isolated *Streptococcus* spp., *Staphylococcus* spp., *Bacillus* spp., *Escherichia coli*, *Micrococcus* spp., *Diplococci* spp., and *Corynebacteria* spp. on eggs sold in Tamale Metropolis. Iddrisu (2007) isolated *Escherichia coli*, *Streptococcus* spp., *and Staphylococcus* spp. from samples of raw and fried cheese. Kutah (2010) in his work indicated the presence of *Escherichia coli, Streptococcus* spp., *Salmonella* spp., and *Staphylococcus* spp. on beef sold in the Tamale metropolis. Sharma *et al.* (1993) and Mukhopadhyay *et al.* (1998) identified *Staphylococcus aureus, E. coli*, and *Bacillus* spp. from chevon and beef carcasses.

3.2 Total Aerobic Counts at the Meat Outlets

Samples that were taken from Gbulung recorded the least total aerobic count of 6.7×10^4 cfu/cm^2 in the morning with samples taken from Katinga recording the highest with 1.20×10^6 cfu/cm^2 (Table 2). For samples taken in the afternoon, samples from Waliboa recorded the least total aerobic count of 1.35×10^6 cfu/cm^2 whilst Nyankpala recorded the highest with 6.58×10^6 cfu/cm^2. Later in the afternoon, samples from Waliboa recorded the least total aerobic count of 2.10×10^6 cfu/cm^2 whilst samples from Nyankpala recorded the highest with 8.44×10^6 cfu/cm^2 (Table 2). It can also be observed from table 2 below that, the total aerobic count for the various samples from the different outlets increased with time. Samples taken in the morning recorded the least followed by samples taken in the afternoon whilst samples taken late in the afternoon recorded the highest.

Table 2: Mean aerobic counts of bacteria on meat sample

Retail Outlets	Mean Bacteria Count cfu/cm^2		
	Morning	Afternoon	Late Afternoon
Gbulung	6.7×10^4	1.44×10^6	2.27×10^6
Katinga	1.20×10^6	2.75×10^6	8.15×10^6
Waliboa	1.27×10^5	1.35×10^6	2.10×10^6
Kumbungu	1.55×10^5	3.99×10^6	7.42×10^6
Nyankpala	9.92×10^4	6.58×10^6	8.44×10^6
Tolon	7.32×10^4	3.15×10^6	7.57×10^6

3.3 Differences in Bacteria Species and Total Aerobic Counts at the Meat Outlets

The various meat outlets have different hygienic levels as far as transportation, handling, and processing is concerned. This might have accounted for the variations in both bacteria isolates and total aerobic counts at the various meat outlets as shown in tables 1 and 2 respectively. This is in line with the work of Ruban and Fairoze (2011) who attributed the higher microbial levels from non-sophisticated outlets compared to the processing units to the differences in hygienic levels as far as meat processing was concerned. *E. coli* presence in some outlets is an indication of faecal contamination of the meat. This may be due to unhygienic handling of meat right from slaughtering, butchering equipments, handling, transportation, and processing (Warris, 2010). This goes to confirm the fact that, the differences in both microbial levels and species may be as a result of different levels of hygiene practices as far as transportation, handling, and processing is concerned.

3.4 Variations in Total Aerobic Count on Meat at Different Times of the Day

Variations in total aerobic count on meat samples at different times of the day as shown in table 2 above may be attributed to the length of time the meat surface is exposed to the environment. The dry, hot, and sometimes humid environmental conditions in Northern Ghana and hence the Tolon and kumbungu districts may have also contributed to the increase in total aerobic count. Koffi-Nevry *et al*. (2011) reported in their study that, high bacteria level on meat samples may be as a result of exposing the meat for a longer time in the market at high temperature. James *et al*. (2005) also stated that, the longer meat surface is exposed to the environment, the higher the microbial load. The low total aerobic count in the morning can be attributed to the fact that environmental conditions were not conducive for microbial growth and also because of the minimal processing operations observed in the morning. This finding is in line with the work of Adeyemo (2002) who stated that, animal product may be microbiologically contaminated by organisms living in them naturally or organisms entering them from the surrounding such as those resulting from processing operations.

3.5 Effect of Microbial Presence on Meat Samples

The high levels of microbial presence on the meat increase the chances of the meat getting spoiled within the shortest possible time. Although microbial load on the meat samples were high, they were below 10^7 cfu/cm^2 which is the required level for meat spoilage to occur (Warris, 2001). It can therefore be said that meat sold in the Tolon and Kumbungu Districts are not spoiled. Nevertheless the isolation of *Salmonella* spp., *Staphylococcus* spp., *Streptococcus* spp., and *E. coli* is worrying because certain strains of these bacteria cause food-borne infections. *Staphylococcus* spp., *Salmonella* spp., *Streptococcus* spp., and *E. coli* infections can be contracted through consumption of contaminated chevon and mutton (Adzitey *et al*., 2010). *Salmonella* spp. is an important cause of gastroenteritis. *Staphylococcus* spp. can be present on the skin of humans and animals and can be transmitted from person to product through unhygienic practices (Postgate, 2000). *Staphylococcus* spp. cause infections such as arthritis, black pox, boil, bronchitis, carbuncle, cystitis, endocarditis, meningitis, osteomyelitis, pneumonia, and scalded skin (Stuart, 2005). Some *Streptococcus* spp. causes sore throat, as well as scarlet fever (Warris, 2010). *Escherichia coli* is an enteric microorganism that is potentially pathogenic especially when they change their habitat (Basavarajappa *et al*., 2005; Igumbor *et al*., 2007). They cause illness ranging from gastrointestinal tract-related complications such as diarrhea, dysentery, urinary tract infection, pneumonia, and even meningitis (Johnson *et al*., 2006), although majority of the *Escherichia coli* strains are non-pathogenic and exists in the intestinal tract of humans and animals.

4. CONCLUSION

Streptococcus spp., *staphylococcus spp*., *Salmonella spp*., and *Escherichia coli* were present on meat sold in retail outlets within Tolon and Kumbungu Districts. Although the microbial load was generally high, these meats are not spoiled. However the presence of the microbial isolates stated above is worrying due to their ability to cause diseases. Improper/unhygienic handling by butchers and retailers, transportation, storage, sanitary conditions at the various retail outlets, and environmental conditions may be the most probable sources of contamination. Microbial load on meat was found to be low in the morning compared to the afternoon and late afternoon.

REFERENCES

[1] Adeyemo, O. K. (2002). Unhygienic operation of a city abattoir in South Western Nigeria: Environmental Implication. African Journal of Environmental Assessment and Management. 4(1), pp. 23-28.

[2] Adzitey, F., Teye, G. A., Ayim, A. G., and Addy, S. (2010). Microbial quality of chevon and mutton sold in Tamale Metropolis of Northern Ghana. Journal of Applied Sciences and Environmental Management. 14(4), pp. 53-55.

[3] Ansah, T., Dzoagbe, G. S. K., Djang-Fordjour, K. T., Agbolosu, A. A., and Wesseh, A. (2006). The role of churches in the sustainability of livestock production in the Northern Region. The Savanna Farmer. A magazine on Sustainable Agriculture. The Association of Church Development Project (ACDEP) of Ghana. p. 35.

[4] Ansah, T., Dzoagbe, G. S. K., Teye, G. A., Adday, S., and Danquah, J. K. (2009). Microbial quality of table eggs sold on selected markets in the Tamale municipality in the Northern Region of Ghana. Livestock Research for Rural Development. 21(8).

[5] Basavarajappa, K. G., Rao, P. N., and Suresh, K. (2005). Study of bacterial, fungal, and parasitic contamination of currency notes in circulation. Indian Journal of Pathological. Microbiology. 48, pp. 278-279.

[6] Bhandare, S. G., Sherikarv, A. T., Paturkar, A. M., Waskar, V. S., and Zende, R. J. (2007). A comparison of microbial contamination on sheep/goat carcasses in a modern Indian abattoir and traditional meat shops. Food Control. 18, pp. 854-868.

[7] De, R. K. (2007). Diagnostic Microbiology. Jaypee Brothers Medical Publishers Ltd., New Delhi, India. 1st Edition. pp. 53-131.

[8] Eaton, S. B. and Konner, M. (1985). Paleolithic nutrition. A consideration of its nature and current implications. New England Journal of Medicine. 312, pp. 228 – 289.

[9] Iddrisu, Y. (2007). Bacterial quality of locally produced milk and cheese in Peri-Urban areas in Tamale Metropolis. B.Sc. Dissertation, University for Development Studies, Tamale. P. 24.

[10] Igumbor, E. O., Obi C. L., Bessong, P. O., Potgieter, N., and Mkasi, T. C. (2007). Microbiological analysis of banknotes circulating in the Venda region of Limpopo province, South Africa. South African Journal of Science. 103, pp. 365-366.

[11] James, M. J., Martin, J. I., and Golden, A. D. (2005). Modern food microbiology. Springer Science plus Business Media, Inc. 7th edition. pp. 12 – 63.

[12] Johnson, J., Kuskowki, M., Menard, M., Gajewski, Xerecavins, M., and Garau, J. (2006). Similarity between human and chicken Escherichia coli isolation in relation to ciprofloxins resistance status. The Journal of Infectious Diseases. 194(1), pp. 71 – 78.

[13] Koffi-Nevry, R., Koussemon, M. and Coulibaly, S. O. (2011). Bacteriological quality of beef offered for retail sale in Cote d'ivoire. American Journal of Food Technology. 6(9), pp. 835-842.

[14] Kutah, W. N. (2010). Microbial quality of beef in selected meat Shops in the Tamale Metropolis. B. Sc. Dissertation, University for Development Studies Tamale. pp. 5 – 15.

[15] Mukhopadhyay, H. K., Pillai, R. M., Pal, U. K. and Ajay, V. J. (2009). Microbial quality of fresh chevon and beef in retail outlets of Pondicherry Tamilnadu. Journal of Veterinary and Animal Sciences. 5(1), pp. 33-36.

[16] Mukhopadhyay, H. K., Puvarajan, B. and Dorairajan, N. (1998). Detection of microbial load in fresh mutton and its impact to public health. Indian Journal Animal Health. 37, pp. 81-83.

[17] Okonko, I. O., Ukut, I. O. E., Ikpoh, I. S., Nkang, A. O., Udeze, A. O., Babalola, T. A., Mejeha, O. K. and Fajobi, E. A. (2008). Assessment of bacteriological quality of fresh meats sold in Calabar Metropolis, Nigeria. Electronic Journal of Environmental, Agricultural and Food Chemistry. 9(1), pp. 89-100.

[18] Postgate, J. R. (2000). Microbes and Man. Oxford, UK; New York: Cambridge University Press. p. 373.

[19] Ruban, S. W. and Fairoze, N. (2011). Effect of processing conditions on microbiological quality of market poultry meats in Bangalore, India. Journal of Animal and Veterinary Advances. 10(2), pp. 188-191.

[20] Sharma, N. K., Saini, S. S., Gill, J. P. S., and Kwatra, M. S. (1983). Occurrence of Clostridium perfringens in uncooked cock-tail sausages at retail level and its public health significance. Indian Journal of Animal Science. 63, pp. 112-114.

[21] Stuart, H. (2005). Essential microbiology. The University of Glamorgan, UK; John Wiley and Sons, Ltd.

[22] Stufflebeam, E. C. (1983). Meat and Wool. Principle of animal Agriculture. Prentics Hall, U.S.A. pp. 312 – 341.

[23] Teye, G. A. and Salifu, S. (2006). The contribution of the various ruminant species to meat production in the Tamale Metropolis. The Savanna Farmer Promoting local innovation in Northern Ghana. The Association of Church Development Projects (ACDEP). 7(2), pp. 35-37.

[24] Warriss, P. D. (2001). Meat hygiene, spoilage, and preservation: Meat Science, an introductory text, school of veterinary science, University of Bristol; CABI International, UK. pp.182-192.

[25] Warriss, P. D. (2010). Meat Science: An Introductory Text. CAB International, Cambridge University Press, Cambridge, UK. 2nd Edition. pp.77-84.

[26] WHO (1997). Food safety and foodborne diseases. World Health Statistics Quarterly. 50(1/2).