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Full Length Research Article

MICROBIOLOGICAL QUALITY OF READY–TO–EAT DOG MEAT SOLD IN SOME PARTS OF PLATEAU STATE, NIGERIA

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ABSTRACT
The Microbiological quality of ready-to-eat dog meat obtained from eight different locations in Jos-North, Jos-South and Pankshin Local Government areas (LGA) of Plateau state was determined in order to ascertain their safety. A total of One hundred ready-to-eat dog meat samples were analyzed. Samples from Pankshin LGA are the most contaminated with a total mean bacterial load of 4.97 x 10^9 CFU/g, followed by samples from Jos-South LGA (4.07 x 10^8 CFU/g) and the least being samples from Jos-North LGA (3.88 x 10^7 CFU/g). Samples from Jos-South LGA have the highest enterobacteriaceae count of 4.25 x 10^8 CFU/g with the least being samples from Jos-North LGA (2.91 x 10^7 CFU/g). *Staphylococcus aureus* is the most predominant isolate with a frequency of occurrence of 76% followed by *Escherichia coli* (36%). Other bacterial isolates include *Salmonella spp* (15%), *Citrobacter freundii* (25%), *Proteus vulgaris* (10%), *Staphylococcus epidermidis* (25%), *Pseudomonas aeroginosa* (8%). Fungal isolates include *Aspergillus niger* (25%), *Trichophyton spp* (25%), *Penicillium spp* (25%), *Mucor spp* (24%) and *Aspergillus fumigates* (20%). The high bacterial count and diversity of bacterial and fungal isolates from the dog meat analysed is an indication of its low bacteriological quality and this can make it a potential source of food infection.

Keywords: Microbiological Quality, Ready-To-Eat, Dog Meat, Sold

INTRODUCTION

In some countries, apart from being kept as pets, certain dogs are raised on farms and slaughtered for their meat. Dog meat may be consumed as an alternative source of meat or for specific medicinal benefits attributed to various parts of dogs. In parts of the world where dogs are kept as pets people generally consider the use of dogs for food to be a social taboo (Wikipedia, 2009). Cultural attitude and history regarding eating dog meat varies from country to country. Very little statistical information is available on attitudes to the consumption of dog meat (Sunnamkum, 2003).
Dogs are eaten in some states of Nigeria including, Cross River, Plateau, Taraba and Gombe (Kim-yung, 1994).
In other parts of the world such as South Korea, dog meat is widely consumed particularly during the summer days. In Seoul area alone there are 6,000 restaurants, selling dog meat (Hopkins, 2004). Annually 2 million dogs are butchered for human consumption in South Korea (Wikipedia, 2009). Dog meat is also widely consumed in other countries such as Indonesia, Germany, Japan Switzerland (Wikipedia, 2009).
All foods contain a residual microflora and in their processing they usually become further contaminated. Although many microflora on food are harmless, some may be potentially pathogenic (I.C.M.S.F., 2009).
Meat has traditionally been implicated as a major source of bacteria food borne diseases (CFIA, 2007). The food producing animals themselves are often contaminated with pathogenic organism, such as *Campylobacter coli*, *Clostridium jejuni, Clostridium perfringens, Escherichia coli, Listeria monocytogenes, Salmonella spp, Staphylococcus aureus or Yersinia enterocolitica,* (CFIA, 2007) .
Ready - to – eat meats are frequently identified as being responsible for outbreaks of food borne diseases which is primarily caused by recontamination from raw or undercooked products during handling in processing and catering establishment and in the home kitchen (CFIA, 2007).
Poor handling of ready-to-eat meat by producers and sellers exposes the meat to pathogenic microorganisms that can cause ill-health to human (CFIA, 2007).
The Seoul city Administration has announced that many of the dog's meat Restaurants in Seoul city were found to contain unhygienic kitchen filled with cockroaches (Wikipedia, 2009).
Deviation in processing methods such as possible contamination of the processing line or raw materials, insufficient heat exposure during cooking, improper cooling procedures, or extended storage that may result in the unsatisfactory products can pose health hazard to consumers (Wikipedia, 2009).
In the local government areas studied, dog meat is consumed by a large number of people with a number of the eaters even describing dog meat ''as the most delicious meat''. Unfortunately, most of the ready-to-eat dog meat is sold in unhygienic conditions such as on open trays exposed to dust and other environmental contaminants. There is no published information on the microbiological quality of ready-to-eat dog meat in Plateau state as well as in the entire country Nigeria. This work was therefore aimed at determining the microbiological safety of dog meat sold in parts of Plateau state, Nigeria.

MATERIALS AND METHODS

Sampling Area

Jos-North, Jos-South and Pankshin Local Government Areas, Plateau state,
Nigeria.

Collection of Samples

A total of 100 samples were purchased from different parts of Jos and Bukuru metropolis and transported to the laboratory in clean polythene bags. These locations are Angwan Rukuba, Zaramaganda, Kugiya market, Fwaghul market and Angwan Kare in Jos and Bukuru metropolis. Other locations are the Monday

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market, Kasuwan Dare and Kangvel in Pankshin town.

Aerobic Plate Count of the Samples
A stock dilution of each of the sample was made by blending 10g of each sample into 90ml of sterile peptone water and shaken. A ten-fold serial dilution was made from each stock sample. Aliquots of 1ml of each of the last two dilutions were inoculated on Plate Count agar using pour plate method. The plates were incubated at 370C for 24 h. Colonies were counted and results expressed as colony forming units per gramme (CFU/g) (Oranusi *et al*., 2009).

Enterobacteriaceae Count
Aliquots of 1ml of each of the last two dilutions were inoculated into MacConky agar no. 3 (Bridson, 1995) using pour plate method. The plates were incubated at 37^{O}C for 24hours. Bacterial colonies were counted and results expressed as CFU/g (Oranusi *et al.*, 2007).

Fungal counts
Aliquots of 1ml of each of the last two dilutions were inoculated on Potato Dextrose agar using pour plate method. The plates were incubated at 25^{0}C for 2-5 days. Colonies were counted and results expressed as CFU/g (Oranusi *et al,* 2007).

Isolation and Identification of *Salmonella* sp.
All stock samples were inoculated on Salmonella-Shigella agar (SSA) and incubated at 37^{O}C for 24hours. Suspected *Salmonella* colonies were identified based on their Gram reaction and biochemical characteristics as described by Cheesbrough, (2005).

Identification of other Bacterial Isolates
All bacterial isolates on the PCA and MCA plates were identified based on biochemical characteristics as described by U.S.FDA manual online (2001, 2002) and Cheesbrough (2005).

Identification of Fungal Isolates
All fungal isolates were identified based on their macroscopic and microscopic appearance with reference to manual of Barnett and Hunter, (1972), Larone (1995) and Mycology online of Ellis (2006).

RESULTS
The results obtained show that samples from Pankshin LGA were the most contaminated with a mean bacterial load of 4.95x10^{9}, followed by samples from Jos-South LGA with a mean bacterial load of 4.07x10^{8} and the least being samples for Jos-North LGA with a mean count of 3.88x10^{7} CFU/g. The mean APC counts for the sampled areas are 3.37x10^{10} CFU/g, 6.7x10^{9} CFU/g, 3.8x10^{9} CFU/g, 6.01x10^{8} CFU/g, 4.43x10^{8} CFU/g 4.4x10^{8} CFU/g, 3.36x10^{6}CFU/g and 3.32x10^{6} CFU/g for Kugiya market, Monday market, Kasuwan Dare, Fwaghul market, Angwan Kare, Kangvel, Zarmaganda and Angwan Rukuba respectively (Table 1).
The results of the enterobacteriaceae counts showed that samples from Pankshin LGA had the highest mean count of 3.13 x 10^{8} CFU/g, followed by samples obtained from Jos-South LGA with mean count of 4.25 x 10^{8} CFU/g and the least being samples from Jo-North LGA with mean count of 2.91 x 10^{7} CFU/g (Table 1).
The fleshy part of the meat has the highest mean APC count of 3.55x10^{9} CFU/g, followed by the offals with mean APC count of 3.03x10^{9} CFU/g and the least contaminated being the bony part with mean APC of 2.59x10^{9} CFU/g (Table 2).
Staphylococcus aureus was the most frequent contaminant with a frequency of occurrence of 76 representing76.00% followed by *Escherichia coli* with a frequency of occurrence of 36 (36.00%), *Citrobacter freundii* and *Staphylococcus epidermidis* both with frequency of occurrence of 25%. Other isolates include *Salmonella typhi* (15%), *Klebsiella aerogenes* (15%), *Proteus vulgaris* (10%) and *Pseudomonas aeruginosa* (8%). (Table 3).
The most predominant fungal contaminants obtained in this study were *Aspergillus Niger, Penicillium* spp and *Trichophyton* spp with a frequency of occurrence of 25%, followed by *Mucor spp* (24%) and Aspergillus *fumigatus* with frequency of occurrence of 20% (Table 4).

Table 1: Aerobic Plate Count (APC) and Enterobacteriaceae Count of the Ready-To-Eat Dog Meat Samples based on location (CFU/g)

	Aerobic Plate Count		Enterobacteriaceae	Count
Location	**Range of APC**	**Mean APC**	**Range of Enterobacteriaceae Count**	**Mean Enterobacteriaceae Count**
Jos-North LGA				
Angwan-Rukuba	3.1x10^{6}- 4.7x10^{6}	3..32x10^{6}	1.5x10^{6}- 4.5x10^{6}	2.68x10^{6}
Angwan-Kare	3.1x10^{8}- 6.5x10^{8}	4.43x10^{8}	2.2x10^{8}- 4.2x10^{8}	3.14x10^{8}
Total Mean		3.88x10^{7}		2.91x10^{7}
Jos-South LGA				
Kugiya market	6.70x10^{9}- 1.90x10^{10}	3.37x10^{10}	3.80x10^{9}- 1.40x10^{10}	2.36x10^{10}
Fwaghul market	3.4x10^{8}- 9.0x10^{8}	6.01x10^{8}	2.20x10^{8}- 5.30x10^{8}	3.54x10^{8}
Zarmaganda	2.3x10^{6}- 4.6x10^{6}	3.36x10^{6}	1.0x10^{6}- 3.10x10^{6}	2.49x10^{6}
Total Mean		4.07x10^{8}		4.25x10^{8}
Pankshin LGA				
Monday market	3.5x10^{9}- 7.0x10^{9}	6.7x10^{9}	1.2x10^{9}- 6.6x10^{9}	3.70x10^{9}
Kasuwan Dare	1.0x10^{9}- 6.0x10^{9}	3.8x10^{9}	1.3x10^{8}- 4.6x10^{8}	2.70x10^{8}
Kangvel	3.5x10^{8}- 7.0x10^{8}	4.4x10^{8}	1.3x10^{8}- 5.3x10^{8}	2.98x10^{8}
Total Mean		4.97x10^{9}		3.13x10^{8}

Table 2: Aerobic Plate Count (APC) and Enterobacteriaceae Count of the Ready -To-Eat Dog Meat Samples Based on Parts of the Meat (CFU/g)

	Aerobic Plate	Count	Enterobacteriaceae	Count
Part of Meat	**Range of APC**	**Mean APC**	**Range of Enterobacteriaceae Count**	**Mean Enterobacteriaceae Count**
Fleshy parts	1.0x10^{9}- 7.0x10^{9}	3.55x10^{9}	1.5x10^{8}- 4.1x10^{9}	1.55x10^{9}
Offals	3.2x10^{9}- 6.0x10^{9}	3.03x10^{9}	1.3x10^{8}- 6.6x10^{9}	1.63x10^{9}
Bony parts	3.8x10^{8}- 4.5x10^{9}	2.59x10^{9}	1.6x10^{8}- 5.5x10^{9}	1.14x10^{9}

Table 3: Frequency of Occurrence of Bacterial Isolates in the Dog Meat Samples

					Bacterial	isolates				
Location	**No. of samples analysed**	***Staph. Aureus* (%)**	***Salmonella typhi* (%)**	***Escherichia Coli* (%)**	***Cirobacter Freundii* (%)**	***Staph. Epidermidis* (%)**	***Klebsiella Aerogens* (%)**	***Proteus Vulgaris* (%)**	***Pseudomonas Aeroginosa* (%)**	**Total**
Kugiya market	10	8(80.00%)	3(30.00%)	4(40.00%)	3(30.00%)	2(20.00%)	0(0.00%)	3(30.00%)	0(0.00%)	23(10.60%)
Fwaghul	10	9(90.00%)	2(20.00%)	4(40.00%)	4(40.00%)	1(10.00%)	0(0.00%)	4(40.00%)	0(0.00%)	24(11.04%)
Angwan kare	10	8(80.00%)	2(20.00%)	1(10.00%)	0(0.00%)	1(10.00%)	0(0.00%)	0(0.00%)	8(80.00%)	20(9.20%)
Angwan rukuba	10	6(60.00%)	1(10.00%)	4(40.00%)	3(30.00%)	2(20.00%)	0(0.00%)	1(10.00%)	0(0.00%)	17(7.82%)
Zarmaganda	10	8(80.00%)	0(0.00%)	5(50.00%)	0(0.00%)	2(20.00%)	0(0.00%)	2(20.00%)	0(0.00%)	2(7.82%)
Monday market	20	19(15.00%)	3(15.00%)	9(45.00%)	7(35.00%)	9(45.00%)	2(45.00%)	0(0.00%)	0(0.00%)	56(25.76%)
Kasuwan dare	15	6(40.00%)	2(13.00%)	5(33.00%)	4(26.60%)	4(26.60%)	3(20.00%)	0(0.00%)	0(0.00%)	24(11.43%)
Kangvel	15	12(80.00%)	2(20.00%)	4(26.60%)	4(26.60%)	4(26.60%)	3(20.00%)	0(0.00%)	0(0.00%)	29(13.00%)
Total	**100**	**76(76.00%)**	**15(15.00%)**	**36(36.00%)**	**25(25.00%)**	**25(25.00%)**	**15(15.00%)**	**10(10.00%)**	**8(8.00%)**	**210**

Table 4: Frequency of Occurrence of Fungal Isolates in the Dog Meat Samples

				Fungal isolates			
Location	**No. of samples analysed**	***Aspergillus niger* (%)**	***Aspergillus fumigates* (%)**	***Mucor* sp. (%)**	***Penicillium* sp. (%)**	***Trichophyton* sp. (%)**	**Total**
Kugiya market	10	0(0.00)	0(0.00)	0(0.00)	0(0.00)	0(0.00)	0(0.00)
Fwaghul	10	2(20.00)	1(10.00)	4(40.00)	3(30.00)	1(10.00)	11(8.46)
Angwan kare	10	0(0.00)	0(0.00)	0(0.00)	0(0.00)	0(0.00)	0(0.00)
Angwan Rukuba	10	0(0.00)	0(0.00)	1(10.00)	2(20.00)	2(20.00)	5(3.85)
Zarmaganda	10	2(20.00)	1(10.00)	4(40.00)	4(40.00)	3(30.00)	14(10.78)
Monday market	20	10(50.00)	0(0.00)	16(80.00)	15(75.00)	9(45.00)	50(38.50)
Kasuwan dare	15	6(40.00)	0(0.00)	5(33.33)	6(40.02)	6(40.02)	23(17.71)
Kangvel	15	5(33.33)	0(0.00)	9(89.73)	9(89.73)	4(26.68)	27 (20.79)
Total	**100**	**25(25.00%)**	**2(20.00%)**	**24(24.00%)**	**25(25.00%)**	**25(25.00%)**	**130**

DISCUSSION

The aerobic plate count, enterobacteriaceae count and frequency of occurrence of isolates were used as index of microbiological quality.

It was observed during the sampling that the dog meat in most of the sampled areas in all the LGAs are sold in open trays, some close to refuge heap and gutters thus accounting for the high bacterial load of all the samples. However, the application of higher temperature during cooking was expected to have reduced the bacterial load of the meat products. The relatively high bacterial counts despite heat treatment suggest possible post-production contamination. The mean bacteria load from all the locations is above the level specified by International Commission on Microbiological Specification for Food (ICMSF) which is <10^5 CFU/g.

Enterobacteriaceae are useful indicators of hygiene and of post-processing contamination of heat processed foods .Their presence in high numbers (>10^4 per gram) in ready to eat food indicates that an unacceptable level of contamination has occurred or there has been under processing (inadequate cooking) (ICMSF, 1986). The enterobacteriaceae count of all the samples in this work is above the acceptable level (< 10^4 per gram) specified by ICMSF (2009).

The level of contamination of some Nigerian foods depends on poor sanitary conditions rather than the innate characteristic of individual food to support the growth or survival of some bacterial (Yusuf *et al*., 1992).

The high level of contamination of the samples with *Staphylococcus aureus* is an indication of possible contamination from human sources. *Staphylococcus aureus* is a normal flora of the skin of human and can be transmitted from person to product through unhygienic practices (Postgate, 2006). Enterotoxin producing strains of *Staphylococcus aureus* have been isolated from food handlers and the possibility of their transmission has been highlighted. *Staphylococcus aureus* enterotoxin A (SEA) is a leading cause of food intoxication (Rasooly *et al.,* 1997). *Staphylococcus aureus* enterotoxin A is an extremely potent gastrointestinal toxin, as little as 100mg is sufficient to cause symptoms of possible contamination from enteric sources (Dainty and Mackey, 1992). Kwon *et al*., 2006 have reported the isolation of methicillin-resistant *Staphylococcus aureus* in hospitalized dogs.

The isolation of *Salmonella* sp from some of the samples is of major concern because the organism is a highly pathogenic agent of foodborne infections such as salmonellosis and enteric fever. *Salmonella* sp have been isolated from dogs fed raw diets in Ontario and Alberta (Lefebvre *et al*., 2008).

The incidence of *Escherichia coli* may be as a result of poor hygiene since dog meat is commonly sold along streets, in open markets, and in an open trays or containers. This is of public health concern considering the role of *Escherichia coli* in food borne infection (Rasooly *et al.,* 1997).

The isolation of *Pseudomonas aeruginosa* from some of the meat samples tested is an indication of possible post production contamination as the organisms are expected to have been destroyed due to high temperature during cooking. *Pseudomonas* has been reported as a dominant meat spoilage organism (Dainty and Mackey, 1992; Borch *et al.*, 1996).

Proteus vulgaris is an enteropathogen and is associated with urinary tract infection. It is an important nosocomial pathogen (Yusufu *et al*., 1992).

Conclusion

From the findings of this work, it can be concluded that the ready-to-eat dog meat samples are of poor microbiological standard and therefore may pose serious health risk to the consumers. The agents of food borne illnesses as well as other pathogenic bacteria isolated imply that ready-to-eat dog meat maybe a major vehicle for the transmission of these disease agents

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