

Microbial Contamination on Ready-To-Eat Dog Meat in Jos, North Central Nigeria

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ABSTRACT

Contamination of meat and meat products during and after processing may be the major cause of outbreaks of food borne diseases. In this study, a total of 20 dog meat samples were randomly collected from different selling points in 20 different locations of Jos North and South for bacterial and fungal analysis. The results obtained revealed that the bacterial load count ranged from 0.02×10^6 to 2.65×10^6 CFU/ml. The highest bacterial count was from Vom market and the lowest from Zawan and Rayfield. The bacterial organisms isolated were: *Bacillus* spp, *Escherichia coli*, *Enterobacter* spp, *Salmonella* spp, *Shigella* spp, *Staphylococcus* spp, *Streptococcus* spp and *Klebsiella* spp. *Escherichia coli* had the highest percentage prevalence of 90.0% and *Bacillus* spp had the lowest percentage prevalence with 15.0%. On the basis of bacterial isolates in relation to location, Vom market had the highest bacterial contamination of six (6) organisms followed by K-vom and Abattoir with five organisms; Zawan and Ray field had the lowest contaminants of two (2) organisms. The fungal organisms isolated from the study were: *Candida albicans* (75.0%), *Aspergillus* spp (25.0%), *Bipolaris zeicola* (15.0%) and *Torula graminis* (15.0%). The study revealed that dog meat sold in Jos and environs is contaminated with a number of microbial organisms which could be due to poor hygiene and improper handling of the meat during and after processing; this therefore calls for urgent response in the education of dog meat vendors and consumers on the hazards of these organisms and importance of meat hygiene practices.

Keywords: Microbial contamination, Dog meat, Jos, Meat vendor, Public health

INTRODUCTION

The microbiological safety of food is achieved by as far as possible ensuring the absence of pathogenic microorganisms and by all means preventing their multiplication [1]; but unhygienic handling of products poses great danger to public health by the introduction of pathogenic bacteria. Bacteria are microscopic organisms that are ubiquitous [2]. The consumption of food contaminated with moulds (microscopic filamentous fungi) and their toxic metabolites results in the development of food-borne mycotoxicosis [3]. [4], defined fungi as

eukaryotic organisms comprising of both yeast and mould.

Meat is defined as the flesh of animals which are suitable as food [5]. Historically, human consumption of dog meat has been recorded in many parts of the world and in Nigeria, dog meat is eaten in Plateau and Gombe states in the North and it is becoming quite popular in other parts of the country including Kaduna and Adamawa with Abuja as the newest entrant.

The growing microbial contamination of food is of global public health significance as it results into various food-borne diseases [6]

consumption of ready-to-eat meat indicates that the product indeed constitutes a food safety risk [7]; [8]. This study is therefore aimed at highlighting the public health implication of consuming heavily contaminated dog meat.

The Food and Agricultural Organisation of United Nations and the World Health Organization [9] stated that illness due to contaminated food is perhaps the most widespread health problem in the contemporary world and an important cause of reduced economic productivity. Food contamination by street food vendors and the premises renders them unacceptable for human consumption and has become a global health problem. Although the microbial quality of many ready-to-eat food has been the subject of numerous investigations in most developing countries [10]; in Plateau state where dog meat is highly consumed as a delicacy, there is paucity of information on the microbial quality and safety of dog meat. Therefore, examination of bacterial load and fungal contamination on ready-to-eat dog meat in Jos becomes imperative in order to enlighten consumers, meat vendors and the general public on its public health significance.

MATERIALS AND METHOD

Study Area

The study was conducted in Jos, Plateau state. Jos is the administrative capital of Plateau state, located 9° N 56 E, N8°N 53E with an area of 291Km². The city has an altitude of 406feet (1217m) above sea level and so enjoys a more favourable climate than the rest of Nigeria [11].

Sampling Sites

The sites for sample collection included: Farin gada, Tina junction, Tudun Wada, West of Mines, Gada biu, Lamingo, Rikkoss, Nasarawa, Angwan Rukuba, Odus, Angwan kare, Vom market, K-Vom, Anguldi, Zawan, Bukuru, Abattoir, Rayfield, Gyel, Hwolshe.

Sample Collection

The samples were collected at random from the settlements indicated above. Sterile polythene bags and disposable hand gloves were used in the collection of samples from the point of purchase and transported on ice pack to the microbiology laboratory of the Federal College of Animal Health and Production Technology Vom for analysis. A total number of 20 samples were collected.

Sterilization Techniques

All wares used were thoroughly washed with detergents, rinsed with clean water and dried. Glass wares were wrapped in aluminium foil paper, put into a canister and sterilized by autoclaving at 121°C for 15minutes except otherwise stated.

Laboratory Processing Of Samples

One gram (1g) of each of the samples was weighed and macerated then picked and placed into 9mls of peptone water broth to form a homogeneous solution and incubated overnight at 37°C [12].

Preparation of Potatoe Dextrose Agar

Two hundred gram (200g) of peeled potatoes were washed and boiled with one litre of water for one hour to obtain the potatoe broth. It was allowed to cool (after which chloramphenicol was added to kill any bacteria) and become potatoe dextrose agar. The PDA was dispensed into sterile petri-dishes and allowed to solidify. After setting, the plates were incubated at 37°C for 24hours to check for sterility. The dog meat sample obtained was then aseptically poured on the dried agar and the pool streaked using a sterile wire loop to obtain well separated colonies and incubated at 37°C for 24hours. And the colonies were counted and recorded [12].

Preparation of Blood Agar and Mcconkey Agar

The McConkey bottles were placed into the autoclave and steaming was done to dissolve the gel (Nutrient agar and McConkey agar). The bottles were removed and allowed to cool to 55°C about 2ml of the sterile defibrinated blood was added to 9mls of nutrient agar each. The mixture was then poured into sterile petri-dishes and swirled gently one to distribute agar evenly over the plate surface and that of McConkey agar was also poured gently into sterile petri-dishes and they were all allowed to solidify after setting. The plates were incubated at 37°C for 24hrs to check for sterility. The dog meat samples obtained was then aseptically smeared on the dried plates. The pool was then streaked with sterile wire loop to obtain well separated colonies and incubated at 37°C for 24hours [12].

Culture Method

Bacterial Load Count

Eight (8) test tubes were arranged and labelled 10¹, 10², 10³, 10⁴, 10⁵, 10⁶, 10⁷ and 10⁸. 9ml of

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distilled water was added to each test tube and 1ml of the sample was added to the 1st test tube and subsequently 1ml drawn from the 1st test tube into the 2nd and then 1ml was picked from the 2nd into the 3rd and this continued to the 8th test tube after which 1ml was discarded from the

8th test tube. 1ml from the 8th test tube was then picked and poured into sterile nutrient agar, was spread and allowed to soak before incubating at 37^oC for 18-24hours. The plate was counted using Stuart colony counter after incubation was completed.

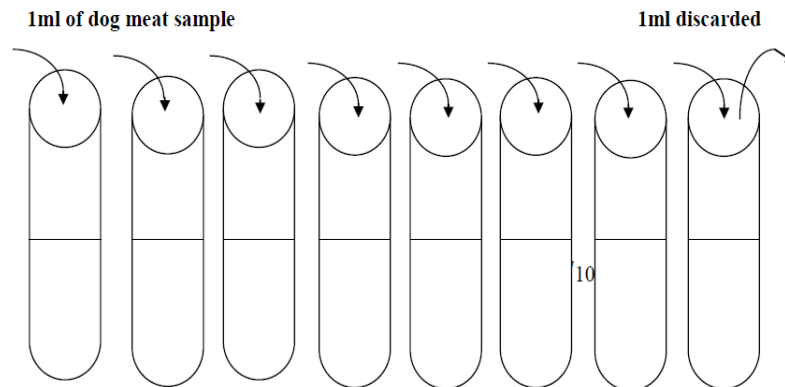


Figure1. Showing serial dilutions of dog meat samples in 8 test tubes containing 9mls of distilled water each

Expression of Results

The CFU/ml was calculated using the formula:

$$\text{CFU/ml} = \frac{(\text{no. of colonies} \times \text{dilution factor})}{\text{volume of culture plate}} [13].$$

Subculture Procedure

Discrete colonies from the nutrient agar were sub cultured in blood agar and McConkey agar. Colonies were picked based on macroscopic examination and streaked with a flamed wire-loop on the blood and McConkey agars and incubated at 37^oC for 18-24hours.

DETECTION AND CHARACTERIZATION OF BACTERIA

Gram Staining

A smear of each bacterial isolate was prepared using a drop of sterile water on a clean grease free slide. The smear was air dried and then fixed by passing it over flame twice. It was then flooded with crystal violet for about 45seconds; drained and rinsed with water. It was yet flooded with Lugol's iodine which was left for few seconds and the slide was rinsed with water and drained off.

The slide was then flooded with acetone alcohol until the slide appeared free of violet stain. It was then rinsed with water and flooded with neutral red for 30 seconds after which it was drained and blotted dry.

Microscopic examination was done under the oil immersion objective lens. Gram positive bacteria stained purple while Gram negative bacteria stained red [11].

Motility Test

Hanging drop method was used where one loop full of a smooth suspension of isolates was applied and placed on a clean cover slip then the edges were fixed with Vaseline. A cavity slide was then inverted over the cover slip and the preparation examined under the X40 objective lens for evidence of motility [12].

Catalase Test

A smooth suspension of each isolate was prepared on a glass slide and three drops of hydrogen peroxide (H₂O₂) were added. A positive result was shown by immediate effectiveness of the mixture [12].

Indole Test

Peptone water was incubated with the isolate organisms and incubated at 37^oC for 24hours and 0.5ml of Kovac's reagent was added. The mixture was examined after one minute for the development of a rose pink colour at the peptone water culture Kovac's reagent interphase [12].

Citrate Crystalization Test

Slants of Simean's citrate agar was inoculated with isolate from pure stock culture and incubated at 37^oC for 24hours. Blue colour and streak of growth indicated a positive result while negative result was shown by the retention of the original green colour and absence of growth [12].

Methyl Red Test

Peptone sugar broth in test tubes was incubated with isolates at 37^oC for 24hours. After this, 5

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drops of methyl red reagent were added to 5ml of culture and the reaction was indicated by the brigade red colour of the broth while a yellow colour indicated a negative result [12].

Coagulase Test

A small speck of growth from different places were picked with a sterile loop and dropped on glass slides. Few drops of plasma were applied on the inoculums and smear was made and slides were rocked for 2minutes. Positive result produced clumps while negative result produced no colour change [12].

Detection and Isolation of Fungal Organisms

Identification of fungi was carried out using Teasing method

RESULTS

Table1. Showing bacterial load count

Location	No of Colonies	Volume of Diluent	Dilution Factor	Population in CFU/ml
Hs	36	1ml	10^8	0.36×10^6
Fg	42	1ml	10^8	0.42×10^6
Tj	43	1ml	10^8	0.43×10^6
Tw	46	1ml	10^8	0.46×10^6
Wm	71	1ml	10^8	0.71×10^6
Gb	43	1ml	10^8	0.43×10^6
Lg	56	1ml	10^8	0.56×10^6
Rk	70	1ml	10^8	0.70×10^6
Ns	51	1ml	10^8	0.51×10^6
Ar	47	1ml	10^8	0.47×10^6
Od	47	1ml	10^8	0.47×10^6
Ak	43	1ml	10^8	0.43×10^6
Vm	265	1ml	10^8	2.65×10^6
Kv	90	1ml	10^8	0.90×10^6
Ad	27	1ml	10^8	0.27×10^6
Zw	2	1ml	10^8	0.02×10^6
Bk	20	1ml	10^8	0.20×10^6
Ab	14	1ml	10^8	0.14×10^6
Gl	105	1ml	10^8	1.05×10^6
Rf	2	1ml	10^8	0.02×10^6

KEY: Gb= Gadabiyu, Lg= Tina junction, Fg= Farin gada, Lg= Lamingo, Rk= Rikkoss, Ns= Nasarawa gwong, Ar= Angwan rukuba, Od= Odus, Ab= Abattoir, Wm= West of Mines, Tw= Tudun wada, Ak= Angwan kare, Vm= Vom market, Kv= K-vom, Ad= Anguldi, Zw= zawan, Bk= Bukuru, Rf= Rayfield, Gl= Gyel, Hs= Hwolshe.

The table above shows the bacterial load count based on location; Vom market had the highest population of bacteria in colony forming units per ml (CFU/ml) with 2.65×10^6 then Zawan and Rayfield had the lowest bacterial load count with 0.02×10^6 .

Table2. Showing bacterial identification

Isolates	Morphology	Microscopy
<i>Bacillus spp</i>	Large, grey white, irregular colonies with wavy edges	Gram positive rod in chains
<i>Escherichia coli</i>	Mucoid, pinkish or green metallic sheen	Gram negative rod
<i>Enterobacter spp</i>	Non-mucoid, large, grey white	Gram negative rod
<i>Salmonella spp</i>	Pale coloured with black centers	Gram negative rod
<i>Shigella spp</i>	Pale coloured	Gram negative rod
<i>Staphylococcus spp</i>	Yellow to creamy	Gram positive cocci in clusters
<i>Streptococcus spp</i>	Small, colourless, dry, shiny or mucoid	Gram positive cocci in chains
<i>Klebsiella spp</i>	Large, grey, white, usually mucoid	Gram negative rod

With the aid of a sterilized wire loop, a pea sized culture growth was picked and dropped on a clean grease free slide. Drops of Lacto phenol cotton blue was dropped on the prepared slide. Sterilized surgical knife was used to tease the picked tissue into pieces and covered with cover slip. It was then observed microscopically with x10 and x40 objectives [11]

Data Analysis

Data collected were analysed using simple percentages and Chi-square test was used to compare the contaminants in respect to organisms. The significance level was measured at $p = 0.000$. Results are presented in tables.

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From the bacterial identification table above, eight organisms were isolated which include: *Bacillus spp*, *Escherichia coli*, *Enterobacter spp*, *Salmonella spp*, *Shigella spp*, *Staphylococcus spp*, *Streptococcus spp* and *Klebsiella spp*.

Table3. Bacterial prevalence in respect to location

Location	<i>Bacillus spp</i>	<i>Escherichia coli</i>	<i>Enterobacter spp</i>	<i>Salmonella spp</i>	<i>Shigella spp</i>	<i>Staphylococcus spp</i>	<i>Streptococcus spp</i>	<i>Klebsiella spp</i>	
Tj	-	+	-	+	+	-	+	-	4
Fg	-	+	-	-	-	+	-	+	3
Gb	-	+	+	-	-	+	+	-	4
Lg	-	+	-	+	+	-	-	-	3
Rk	-	+	-	+	-	-	+	+	4
Ns	-	+	-	-	+	+	-	-	3
Ar	-	+	-	+	-	-	+	-	3
Od	-	-	-	+	-	+	-	-	2
Ab	-	+	+	+	+	-	-	+	5
Wm	-	+	-	-	-	+	-	-	2
Tw	-	+	-	-	+	-	+	-	3
Ak	-	+	-	-	-	+	-	-	2
Vm	+	+	+	+	-	+	+	-	6
Kv	+	+	-	+	+	-	-	+	5
Ad	-	+	+	+	-	+	-	-	4
Zw	-	+	-	-	-	-	+	-	2
Bk	-	+	-	-	+	+	-	-	3
Rf	-	-	-	-	+	-	-	+	2
Gl	-	+	-	-	+	+	-	-	3
Hs	-	+	-	+	-	-	+	-	3

KEY: - = Absent, + = Present

Gb = Gadabiyu, Lg = Tina junction, Fg = Farin gada, Lg = Lamingo, Rk = Rikkoss, Ns= Nasarawa gwong, Ar= Angwan rukuba, Od= Odus, Ab= Abattoir, Wm= West of Mines, Tw= Tudun wada, Ak= Angwan kare, Vm= Vom market, Kv= K-vom, Ad= Anguldi, Zw= zawan, Bk= Bukuru, Rf= Rayfield, Gl= Gyel, Hs= Hwolshe.

Table4. Showing prevalence of bacterial organisms

Organisms	Sample Size	Occurrence	Prevalence
<i>Bacillus spp</i>	20	3	15.0%
<i>Escherichia coli</i>	20	18	90.0%
<i>Enterobacter spp</i>	20	4	20.0%
<i>Salmonella spp</i>	20	11	55.0%
<i>Shigella spp</i>	20	8	40.0%
<i>Staphylococcus spp</i>	20	10	50.0%
<i>Streptococcus spp</i>	20	8	40.0%
<i>Klebsiella spp</i>	20	4	20.0%

$$X^2 = 34.971, df = 7, p = 0.000$$

The table above shows the occurrence and prevalence of each bacterial isolate in relation to location; with *Escherichia coli* having the highest percentage prevalence of 90.0% and *Bacillus spp* having the lowest percentage prevalence of 15.0%.

Table5. Showing fungal identification

Isolates	Morphology	Microscopy
<i>Candida albicans</i>	Creamy and pasty	Small, oval, single budding of cells
<i>Aspergillus spp</i>	Mouldy and powdery	Hyphae, septate with v-shaped branching
<i>Bipolaris zeicola</i>	Canidia and powdery	Pale to dark brown hyphae and septate
<i>Torula graminis</i>	Black, somewhat appressed to the substrate	Branched, septate, sub-hyaline to brown hyphae

The table above shows the fungal identification of the fungal organisms isolated which are: *Candida albicans*, *Aspergillus spp*, *Bipolaris zeicola* and *Torula graminis*.

Table6. Showing fungal prevalence in respect to location

LOCATION	<i>Candida albicans</i>	<i>Aspergillus spp</i>	<i>Bipolaris zeicola</i>	<i>Torula graminis</i>	
Tj	+	-	-	-	1
Fg	+	+	-	-	2
Gb	-	-	-	-	0
Lg	+	-	-	-	1
Rk	+	-	-	+	2
Ns	+	+	-	-	2
Ar	+	-	-	-	1
Od	+	+	-	-	2
Ab	+	+	-	-	2
Wm	+	-	-	+	2
Tw	+	-	-	-	1
Ak	+	-	+	-	2
Vm	+	-	+	-	2
Kv	+	-	-	-	1
Ad	+	+	-	-	2
Zw	+	-	-	-	1
Bk	+	-	+	-	2
Rf	+	-	-	+	2
Gl	+	-	-	-	1
Hs	-	-	-	-	0

KEY:- = Absent, + = Present

The table above shows the prevalence of fungal organisms in respect to location; with *Candida albicans* being the most prevalent fungal organism while *Bipolaris zeicola* and *Torula graminis* had the lowest occurrence.

Table7. Showing fungal prevalence

Isolates	Sample Size	Occurences	Prevalence
<i>Candida albicans</i>	20	15	75.0%
<i>Aspergillus spp</i>	20	5	25.0%
<i>Bipolaris zeicola</i>	20	3	15.0%
<i>Torula graminis</i>	20	3	15.0%

$$X^2 = 22.564, df = 3, p = 0.000$$

The table above shows te percentage prevalence of fungi from the samples collected with *Candida albicans* having the highest percentage prevalence of 75.0% and *Bipolaris zeicola* and *Torula graminis* having the lowest percentage prevalence of 15.0% each.

DISCUSSION

The food we eat carries some form of microbial association. Micro-organism affecting food come from natural micro flora or is introduced by manufacturing steps ranging from processing to storage and distribution. In some cases, these micro floras have no effect on the food and can be consumed without consequences but those that are introduced during the course of processing depending on the type and level of contamination can spoil the food and cause food borne disease.

This study revealed that dog meat samples collected from streets and market in Jos and environs contained microbial contaminants which can pose a threat to the health of regular consumers.

The total viable count of bacterial population in the dog meat samples ranged from 0.02×10^6 to 2.65×10^6 as shown in table 1. Generally, Vom market samples recorded the highest number of bacterial growth with 2.65×10^6 CFU/ml while Zawan and Rayfield had the lowest bacterial load count of 0.02×10^6 CFU/ml. The high load can be as a result of contamination during and after processing and also poor hygiene and inadequate knowledge of food processing of dog meat sellers in the area.

The international commission for microbial specifications for foods [14]stated that ready-to-eat foods with plate count between $0-10^3$ is acceptable; while 10^4-10^5 is tolerable and 10^6 and above is unacceptable. Hence dog meat sold in Jos and environs from this study is of unacceptable microbiological quality.

Table 2: showed the bacterial identification using the morphological and microscopic appearance to identify isolates, in this study, eight bacterial organisms were isolated and these include: *Bacillus spp*, *Escherichia coli*, *Enterobacter spp*, *Salmonella spp*, *Shigella spp*, *Staphylococcus spp*, *Streptococcus spp* and *Klebsiella spp*. This in agreement with previous studies [6] where *Escherichia coli*, *Salmonella spp*, *Staphylococcus spp*, *Streptococcus spp*, *Klebsiella spp*, *Corynebacteria*, *Clostridium*, *Bacillus* and *Serratia spp* were isolated from roasted chicken. Bacterial species like *Escherichia coli*, *Salmonella spp* and *Klebsiella spp* are of public health importance as they have been incriminated in various diseases of man such as gastroenteritis [9].

Table 3: showed bacterial prevalence in respect to location; from the table, Vom market had the highest level of contamination with a total of six (6) organisms present and these are: *Bacillus spp*, *Escherichia spp*, *Enterobacter spp*, *Salmonella spp*, *Streptococcus spp* and *Odus*. West of mine, Zawan and Rayfield had the lowest number of bacterial organisms. The reason Vom market had the highest level of contamination could be because of the hygienic state of the market environment and also poor processing and handling by dog meat sellers and buyers. These findings agree with the earlier publications of [9], which stated that in developing countries and like Nigeria, Salmonellosis, Shigellosis, Klebsiellosis, Colibacillosis are prevalent due to peoples feeding habits as well as hygienic way of preparing and cooking of meat.

Escherichia coli and *Salmonella spp* are especially of fecal origin and have been indicated in various food borne diseases. In this study, *Escherichia coli* and *Salmonella spp* had the highest percentage prevalence of 90.0% and 50.0% respectively as shown on table 4; this is an indication of possible fecal contamination of food, water or meat workers and also poor hygienic processing by meat sellers. The presence of *Staphylococcus spp* is largely as a result of human contact and this suggests poor hygienic processes of the vendors since the organism is a normal flora of the skin and nasal passages. This organism continues to be a major cause of food borne intoxication and its presence in food constituents an important problem for food processors, food service workers and consumers.

Enterobacter is a family of organisms that do not form spores; they are among the most

common bacteria that cause diseases. The presence of these organisms in ready-to-eat meat depicts a deplorable state of poor hygiene and sanitary practices employed in the processing and packaging of the meat.

Table 5, showed the fungal identification through morphological and microscopic appearance of the isolates which are: *Candida albicans*, *Aspergillus spp bipolaris zeicola* and *Torula graminis*. Fungal organisms have also been reportedly isolated from meat in other studies [48] the identification of fungal organisms particularly Aflatoxigenic moulds is very significant because these moulds produce mycotoxins which have pathogenic effects on man by destroying the liver and kidney resulting in death. The presence of *Aspergillus spp* could be due to the fact that they are spore formers and their heat resistant spores may have survived processing while the vegetative cells were eliminated. Mould and yeast contamination also occurs due to handling processes, spicing and washing with polluted water also due to dust, flies, air, workers, equipments and fluctuations of temperature during processing [15].

Table 6 showed the fungal prevalence of fungal organism isolated in this study in relation to location *Candida albicans* is the most occurring fungal organism in the study following by *Aspergillus spp* and then *Bipolaris zeicola* and *Torula graminis* this variation could be due the materials and different processing methods used by dog meat sellers at different location this is in line with the findings of [16], which stated that the quality of meat produced by processor varies due to lack of standard and method of preparation that would ensure consistent production quality. The fungal prevalence and occurrences of fungal organism is shown in table 7, in this study *Candida albicans* had the highest percentage prevalence of 75% with 15 occurrences followed by *Aspergillus spp* with 25.0% prevalence and *Biporis zeicola* and *Torula graminis* with the lowest prevalence of 15.0%. The presence of these fungal organisms could be as a result of unhygienic handling of dog meat by sellers, displaying of dog meat on roadsides, markets and unhygienic selling spots resulting in contaminants; this is in agreement with [18] who stated that meat may have surface contamination from flies, dust, fomites, the butcher, meat vendors and or buyers.

Generally, the bacterial and fungal organisms isolated in this study are of food processing and

public health concern and as a result can be hazardous and injurious to human health if consumed.

CONCLUSION

From the results in this study, it was observed that bacterial and fungal contaminants are present in dog meat sold in Jos and environs. Eight bacterial organisms were isolated from the dog meat samples analysed; with *Escherichia coli* and *Salmonella spp* having the highest prevalence which could be as a result of fecal contamination of the dog meat. In relation to location, Vom market sample had the highest bacterial organisms and bacterial load count in CFU/ml and this may be due to inadequate processing of the meat, post processing contamination from the environment, cross contamination through cutting knives and hands of sellers and spices introduced during serving. *Candida albicans* and *Aspergillus spp* were the fungal organisms with the highest prevalence from the dog meat samples analysed.

The International Commission for Microbial Specification for Foods [14] states that ready-to-eat foods with plate count between $0-10^3$ is acceptable, between 10^4-10^5 is tolerable while 10^6-10^8 is unacceptable, therefore dog meat sold in Jos and environs is of unacceptable microbial quality; contamination of dog meat by these species of organisms could be due to the presence of organisms in the environment and their entrance into food or meat as a result of poor processing or handling and display of the meat at selling spots; it could also be as a result of contact of dog meat with the seller when slicing for sale and buyers who may be carrying these organisms on their hands. The isolation of *Klebsiella spp*, *Staphylococcus spp*, *Escherichia coli*, *Salmonella* and *Aspergillus spp* corroborates the findings of [1; 48] where these organisms were implicated in ready-to-eat-foods. However, the isolation of these microbial organisms from dog meat could be as a result of the spices added after processing, possible fecal contamination of meat, water or hands of sellers and also from exposure of meat to dust flies and other pollutants at selling spots. This agrees with [48] who stated that, contamination of food may have resulted from inappropriate processing, incomplete heating or secondary contamination through meat contact with contaminated equipment and utensils.

In conclusion, the use of proper sanitation is the best approach for reducing microbial contamination as there is no substitute for good

sanitation in the meat industry as rightly pointed out by [26]; this could be done by providing portable clean water to ensure good meat processing, education of meat sellers and consumers on food processing and hygiene and also the provision of hygienic retail markets in order to improve the sanitary conditions of dog meat and enhance health of consumers by reducing the level of contamination as much as possible.

Although complete elimination of pathogens from meat and food processing environment is difficult particularly when many food pathogens are known to attach to food contact surfaces, the level of contamination by microbial organisms can be reduced by passing dog meat purchased from roadsides, streets and markets to some degree of heating as done in 'suya'.

RECOMMENDATIONS

- Dog meat displayed at selling points should be covered to avoid contamination by flies, dust and other pollutants.
- Dog meat purchased from roadsides, streets and markets should be re-heated before consumption.
- Poorly prepared spices should be avoided as these can serve as media for bacterial growth.
- Dog meat sellers should be sensitized on meat hygiene and safety during and after processing to avoid contamination.
- Consumers should avoid touching of meat displayed for sale with their hands as this could result in the introduction of microbial organisms from the hand.
- Good source of water should be used in the preparation of meat and washing of equipments to avoid contamination of meat by microbial organisms.
- It is recommended that further studies be carried out on different processing methods of dog meat like roasting, frying and boiling to determine which is of higher microbial contamination with aim to reduce contamination.
- It is also recommended that the generally acceptable microbial guideline value for ready-to-eat foods set at $<10^6$ be adopted locally until a more precise microbial criteria for dog meat could be developed through an appropriate scientific process

REFERENCES

- [1] Edema MO, Omeme AM Bankole MO. Microbiological safety and quality of ready-to-eat foods in Nigeria. In the abstract of the 29th Annual Conference and General Meeting (Abeokuta, 2005) on Microbes as agents of sustainable development organised by Nigerian Society for Microbiology (NSM), University of Agriculture, Abeokuta. 2005: 26-28.
- [2] Alonge DO. Bacteria causing beef spoilage in meat shops in Ibadan. *Nigerian Journal of Microbiology*. 2001:2, 168-172.
- [3] Ashraf SH and Randa MA. Incidence of fungal infections and mycotoxicosis in Pork meat and pork by-products in Egyptian markets. *World Academy of Science, Engineering and Technology*. 2015: 9, 1184-1187.
- [4] Hubalek Z. Keratinophilic fungi associated with free living mammals and birds. *Revista Iberoamericande microbiology*. 2000: 93-103.
- [5] Forrest JC, Aberle ED, Gerrard DE, Mills WE, Hedrick HB, Judge MD and Merke RA *The principles of Meat Science*; 4th Edition, Kendal/Hunt Publishing Company U.S.A. 2001, 56-65.
- [6] Ogbu KI, Pam VA, Chuckwudi IC, Momoh AH, Agwu EO. Survey of bacterial and fungal contamination on Beef Suya sold in Jos and Environs. *International Journal of Science and Applied Research*. 2016: 1(1), 28-31.
- [7] Inyang CU, Igyar MA, Uma EN. Bacterial Quality of Smoked Meat product (Suya). *Nigerian Food Journal*. 2005:23, 239-242.
- [8] FAO/WHO (Food and Agriculture Organization/World Health Organization), Codex Alimentarius Commission. Recommended Code of Practice Shrimps/ prawns (CAC/RCP 17-1978; Quick Frozen shrimps/prawns. 2000: 1-1995.
- [9] Van K. The microbiological quality of street food in Jakarta as compared to home prepared foods and foods from tourist hotels. *International Journal of Food, Science and Nutrition*. 1998: 49, 17-26.
- [10] State Creation for Rapid Development. History of Plateau State. Retrieved 03/03/2015 from www.plateaustate,nigeriahistorygeographicinformation.html. 2001.
- [11] Cheesebrough MB. District Laboratory practice in tropical Countries. Dunung Book Series 28 Obasa/Sanusi Street, Ibadan (2nd Edition).2003: 220-240.
- [12] Kanyeka HB. Assessment of microbial quality of raw cow's milk and antimicrobial susceptibility. *Agriculture for Nutrition and Health*.2014: 28, 230.
- [13] International Commission on Microbiological Specifications for Foods. Salmonellae-264. In: Micro-organisms in Foods 5: Characteristics of Microbial Pathogens. London: Chapman & Hall. 1996: 217-299.
- [14] Farghaly RM. Some studies on the aflatoxin producing aspergilla in meat cold stores. *Assuit Veterinary Medicine Journal*. 1998: 31, 111-120.
- [15] Igene JO, Farouk MM, Akambi C. Preliminary studies on the quality and drying characteristics of 'suya'. *Nigerian Food Journal*. 2009:7, 29-38.
- [16] Ologhobo AA, Omode AB, Ofongo ST, Molofo S, Jibir M. Safety of street vended and beef Suya. *African Journal of Biotechnology*. 2010:9, 4091-4097.
- [17] Doyle MP and Evans PD. Foodborne pathogens of recent concern. *Annual Revised Nutrition*. 1999: 6, 25-41.

Citation: Oguche Moses Ojonugwa et.al, "Microbial Contamination on Ready-To-Eat Dog Meat in Jos, North Central Nigeria", *Annals of Microbiology and Infectious Diseases* 2(3), 2019, pp.12-20.

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