

Assessment of Microbial Activity on Meat Sold At Selected Abattoir, Markets and Meat Shop in Owerri Municipal Council

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Abstract

Background: The assessment of microbial activity on meat sold at abattoir, markets and meat shop in Owerri municipal council was carried out. This research aimed to determine the level of microbial load or contamination on meat from these sources, to determine which organism (s) are likely involved in the contamination and deterioration and their effects on nutritional value of meat

Methods: Samples were collected from Ekeonunwa market, Relief market, Owerri modern abattoir and meat shop respectively. These samples were processed aseptically and subjected to laboratory analysis. Standard analytical methods were used to determine the crude fat, crude protein, moisture content, and ash composition of the meat samples. Standard laboratory evaluation was employed to obtain information on the microbial activity on meat from the above sources. The result was subjected to statistical analysis to determine the mean and standard deviation. Analysis of variance (ANOVA) was also calculated to determine existence of significant differences in the nutrient composition of the samples.

Result: The result of the analysis showed that the microorganisms implicated include *Clostridium spp*, *Salmonella spp*, *E.coli*, and *Streptococcus spp*. Sample from meat shop was more acceptable having the least cfu/ml of 6.3×10^5 as against the greatest values 9.5×10^5 and 8.6×10^5 from Ekeonunwa and Relief markets respectively. Samples from Ekeonunwa and Relief market recorded a decrease in protein content ($17.62 \pm 0.000\%$) and ($18.33 \pm 0.036\%$) respectively. This is same with carbohydrate content of samples from Abattoir and Relief markets, ($0.46 \pm 0.050\%$) and ($0.84 \pm 0.028\%$) respectively. The moisture content is least in New market sample ($72.77 \pm 0.024\%$) and highest in samples from relief market ($75.84 \pm 0.024\%$).

Conclusion: Meat is contaminated by microorganisms and activities of microorganisms results in deterioration and loss of nutritional value of meat. Consumers should therefore apply proper cooking methods to reduce to safe level of the microbial load.

Keywords: Microbial Activity, Meat, Abattoir, Markets, Meat Shop

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I. Introduction

Meat is widely consumed as principal source of protein in many developing countries including Nigeria (Olaoye, 2011). Meat is either eaten cooked or processed into other meat products before it is eaten (Olaoye & Onilude, 2010). Canadian Food and Drugs Act and Regulations (CFDAR) (1990) defined meat as ‘the edible part of the skeletal muscle of an animal that was healthy at the time of slaughter’. Meat is a rich source of both macronutrient (except carbohydrates) and micronutrient. The major chemical composition of meat water, protein, lipid, and minor components as vitamins, enzymes, pigments and flavour compounds as well as minerals like iron (Olaoye, 2011; Lambert et al., 1991). Due to the high nutritional density of meat, it undergoes progressive deterioration from the time of slaughter until consumption (Lambert et al., 1991).

The activities of microorganisms in meat could have various effects both on human health and the meat itself. Meats and other animal foods are mostly contaminated by microorganisms living in it naturally or entering it from the surroundings, such as those resulting from processing operations and their spoilage is rapid if it is not properly preserved because of microbial activities. Hence one of the most important aspect in all meat production plants is maintenance of proper hygiene and adequate sanitary conditions. In the production of animals for food, most attention should be focused on the interactions between animal production and the environment, realizing environmental conditions and structures in animal production, which not only seek to produce wholesome and safe animal food but should also avoid environmental pollution and the associated human risks (Moran et al., 1980).

Urbanization, population growth calls for establishment of more slaughterhouses. Different types of markets where meats are sold and meat shops are found in Owerri Municipal as it is common in other cities in Nigeria. Owerri Municipal is located in the very heart of Owerri, the capital territory of Imo State. Abattoir is a

premise approved and registered by the controlling authority for hygienic slaughtering and inspection of animals, processing and effective preservation and storage of meat products for human consumption (Alonge, 1991). The major and only abattoir found in Owerri Municipal is the Owerri modern abattoir popularly known as Somachi Slaughter House. An average number of thirty cattles are killed daily in non-festive periods and about 50 – 60 cattles during festive periods. The Municipal has three major markets in which red meat are sold and they include: New Market, Ekeonunwa Market and Relief Market. There are also few meat shops located at various points within the municipal which facilitate patronage of red meat.

Poor meat inspection facilities and uncooperative attitude of butchers is common in the Municipal abattoir and markets. This coupled with the nomadic management practiced by the cattle rearers may ease the distribution of infested carcasses to the population. At the Owerri Municipal abattoir, ante-mortem examination is nil as animals are off-loaded and conveyed straight to the slaughter slab. There is no slaughter hall or slaughterhouse. Animals are then slaughtered using any choice technique of decapitation on the bare slab with skinning and burning of the carcasses commencing immediately. Evisceration and dressing are done on the slab (floor) in the open air. Hygiene problems are not limited to slaughtering but are also associated with incorrect processing and marketing practices. Transport facilities are often inadequate and unhygienic. Most distribution chains in Nigeria are frequently long and involve different intermediary, which renders controls difficult. Under tropical conditions, food of animal origin tends to deteriorate more rapidly and become an important vehicle for infections, thereby endangering consumer's health. It is to examine the reasons for the rate at which meat purchased from abattoirs, meat markets, and meat shops deteriorate within a very short period of time. Unhygienic practices and its corresponding handling could cause variation or alteration in the composition of meat from abattoirs, markets and meat shops.

The main purpose of this study is to determine the presence and impact of microorganisms on nutritional quality of meat in the area under study. The following are the specific objectives of the study;

- (a) To assess the level of microbial contamination or microbial load on meat from abattoirs, markets and meat shops.
- (b) To determine the likely microbes involved in the contamination and deterioration.
- (c) To determine the effect of microbial activities on the nutrient content of meat.

This study specifically is on the assessment of microbial activity on meat from various abattoirs, markets and meat shops in Owerri Municipal Council. The study is strictly embarked upon red meat especially on beef.

II. Materials And Methods

Sample Collection

The samples analyzed in this study were collected in a space of time as given below; by 8:08am, the first sample was collected from Owerri Modern Abattoir. The collected sample was then refrigerated at $< -18^{\circ}\text{C}$ to hinder microbial activity on the sample. On the same day by 11:32am, another sample was collected from Ekeonunwa Market, and others as follows; by 12:00 noon, sample collected from meat shop, by 12:35pm, sample collected from Relief Market, and finally, by 1:34pm, sample collected from New Market. All the samples were given the same treatment in terms of hygiene principles and were objectively analyzed at the same time. The time spacing especially between the abattoir and other sources was due to the distribution of the sources.

Preparation of Samples

The sample was examined and any extraneous materials (i.e. dirt) were removed. It was then divided into two groups (A and B). Group A was used for the proximate analysis while group B was used for microbiological assay.

Determination of Microbial Load (Bacteria/ Fungi Load)

The pour plate total viable count method described by International Commission on Microbiological Specification of Foods, ICMSF (1978) was used. 1g of each sample was aseptically dispensed in 9mls of sterile distilled water. The resulting suspension was diluted serially, to the sixth dilution (10^{-6}), 1ml of the 4th diluent from each sample was dispensed into sterile petri-dishes in duplicate for each microbe type (bacteria and fungi). About 15mls of each medium; nutrient agar for bacteria and Sabourand's Dextrose Agar (SDA) for fungi was aseptically dispensed into the different plates and to the control plates. The plates were incubated at 37°C for bacteria and at 25°C temperature for fungi.

Counts of microbial load were taken after 48 hours for bacteria and 96 hours for fungi. The microorganisms were identified with the aid of microscope using the prescription given by Gibbons (1974), for bacteria and Kregarvan-Gij (1952), for fungi. A mean of the counts from the duplicate plates was obtained and multiplied by the appropriate dilution factor to obtain the microbial loads as the total viable microbial colonies per unit weight of the sample expressed as the Colony Forming Unit (cfu) per gramme of the sample. It was calculated using the formula below:

$$\text{cfu/g} = \frac{1}{W} \times N \times D$$

Where: W = Weight of sample analyzed
 N = Average number of colonies per late
 D = Dilution factor.

In all cases, the microbial counts were taken from plates supporting not more than 300 colonies (Holzapfel, 1998).

Microscopic Examination

The isolates were examined microscopically to determine their motility and cellular arrangement including shapes and sizes of cell reaction to specific dyes such as gram stain, spare stain, flagella and capsule stain were also observed. Microscopically, results of these tests with dyes gave indication of the presence or absence of spores, capsules, flagella, etc. Gram’s reaction reveals the cell morphology as well as grouping isolates into two major categories; gram +ve and gram –ve (Holzapfel, 1998).

Biochemical Reactions

Isolates that cannot be identified by colonial and microscopic examination were identified based on few biochemical reactions such as enzymes production, catalase, coagulase, oxidase and production of H₂S. Reduction of nitrite, indole production. Other tests such as methyl red and voges were also carried out and results recorded (Holzapfel, 1998).

Determination of Proximate Composition

The moisture content was determined by the Gravimetric Method of AOAC (1990). The protein content of the sample was determined by the Kjeldahl Method, (James, 1995). Ash was determined by the furnace incineration gravimetric method (James, 1995). The Soxhlet Solvent extraction Method (James, 1995) was employed for determination of fat content. Crude Fibre was determined using Weende Gravimetric (Sawyer, 1975). The carbohydrate content of each test sample was determined by estimation using the Arithmetic Difference Method described variously by Pearson (1976).

III. Results

This section displays various tables showing results of microbiological analysis – microbial load, microbial spectrum (organisms involved), biochemical test and proximate composition of the samples.

Table 1: The Microbial Load and Microbial Spectrum (organisms involved) in Meat Contamination and Deterioration

S/No	Dilution Factor	CFU/MI	Organisms Identified
AB ¹	10 ⁴	7.8 x 10 ⁵	A, B
AB ²	10 ⁴	6.9 x 10 ⁵	A, C
MS	10 ⁴	6.3 x 10 ⁵	A, B, D
OG ¹	10 ⁴	9.5 x 10 ⁵	A, B, C
OG ²	10 ⁴	8.6 x 10 ⁵	B, C, D

KEY: CFU/MI = Colony Forming Unit per mil
 AB¹ = Sample from New Market
 AB² = Sample from Modern Abattoir
 MS = Sample from Meat Shop
 OG¹ = Sample from Ekeonunwa Market
 OG² = Sample from Relief Market
 A = Clostridium spp
 B = Salmonella spp
 C = Escherichia coli
 D = Streptococcus spp

The result in table 1 above reveals a critical microbiological condition of $>10^4$ - $<10^5$, but is acceptable relatively with respect to the specific sample. It has colony forming unit per mil (cfu/ml) ranging from $(6.3 \times 10^5 - 9.5 \times 10^5)$ with the least microbial load recorded in the sample from Meat Shop and highest from Ekeonunwa Market. Among the organisms identified are Clostridium spp, Salmonella spp, Escherichia coli and Streptococcus spp. Two bacteria spp are identified in each of samples from New Market and Abattoir, whereas three are isolated in each of Meat Shop, Ekeonunwa and Relief Market respectively.

Table 2: The Biochemical Test of the Organisms Involved

Biochemical Test	Escherichia Coli	Salmonella spp	Streptococcus spp	Clostridicum spp
Catalase	+	+	-	-
Coagulase	-	-	+	-
Oxidase	-	+	+	-
VogesProskauer	-	-	-	-
Indole	+	-	-	-
Methyl Red	+	+	-	+
Cultural Characteristics	Dark metallic sheen colonies on EMBA	Translucent colonies on DCA	Discrete and convex colonies on BA	Large circular hemolysis on BA
Mortality	+	+	-	-
Gram Stain Reaction	-	-	+	+
Cell Arrangement	Rod Shaped Cells	Single Short Rods	Cocci in Chains	Rod Shaped in Pairs

KEY: BA = Blood Agar
 DCA = Deoxycholate Citrate
 EMBA = Eosin Methylene Blue Agar

The above table 2 gives the biochemical test showing that the organisms mentioned in table 1 were really implicated in the samples. It reveals their cultural characteristics, stain reaction, motility and cell arrangement – E. coli is rod shaped, Salmonella spp is single short rod, Streptococcus spp is cocci in chain and Clostridium spp is rod shaped in pairs.

Table 3: The Proximate Composition of Meat Samples from various Sources

S/NO	% Moisture	% Dry Matter	% Ash	% Crude Fibre	% Fat	% Protein	% Carbohydrate
AB ¹	72.77 ^a ±0.024	27.24 ^a ±0.024	1.46 ^a ±0.010	1.25 ^b ±0.010	2.74 ^c ±0.000	19.31 ^b ±0.014	2.49 ^a ±0.010
AB ²	74.54 ^a ±0.028	25.46 ^a ±0.028	1.39 ^b ±0.000	1.18 ^a ±0.000	2.60 ^a ±0.000	19.84 ^a ±0.024	0.46 ^a ±0.050
MS	73.93 ^d ±0.036	26.08 ^b ±0.036	1.25 ^a ±0.000	1.36 ^a ±0.000	2.90 ^a ±0.000	18.50 ^c ±0.000	2.07 ^b ±0.036
OG ¹	75.60 ^b ±0.000	24.40 ^d ±0.000	1.07 ^d ±0.024	1.18 ^a ±0.028	2.85 ^b ±0.000	17.62 ^c ±0.000	1.69 ^a ±0.050
OG ²	75.84 ^a ±0.024	24.17 ^c ±0.024	1.23 ^b ±0.014	1.14 ^a ±0.000	2.64 ^d ±0.000	18.33 ^d ±0.036	0.84 ^d ±0.078
LSD(P < 0.05)	0.04	0.06	0.04	0.02	0.008	0.07	0.16

Values are means ± standard deviation of duplicate determinations. Means in the same column with different superscript letter are significantly different from each other (P < 0.050)

Key: AB¹ = Sample from New Market
 AB² = Sample from Modern Abattoir
 MS = Sample from Meat Shop
 OG¹ = Sample from Ekeonunwa Market
 OG² = Sample from Relief Market

The proximate composition of meat samples collected from different locations in Owerri Municipal Council are summarized in table 3 above. The moisture content ranged from $(72.77 \pm 0.024 - 75.84 \pm 0.024)\%$ with the highest in sample from Relief Market. The protein content ranges from $(17.62 \pm 0.000 - 19.84 \pm 0.024)\%$ with sample from Abattoir having the highest protein. The carbohydrate (CHO) in the other hand varies considerably from $(0.46 \pm 0.050 - 2.49 \pm 0.070)\%$. The Abattoir has the least amount of carbohydrate. The fat content ranges from $(2.60 \pm 0.000 - 2.90 \pm 0.000)\%$, with the sample from Meat Shop recording the highest fat content. Other constituents are ash ranging from $(1.07 \pm 0.024 - 1.46 \pm 0.010)$ and crude fibre ranging from $(1.14 \pm 0.000 - 1.36 \pm 0.000)\%$.

IV. Discussion

A comparative look at the range of values obtained in the table 3, in terms of protein composition, there was similar range of values as in those earlier studies. For instance, the protein values obtained from Abattoir and New Market relatively agreed with the values (19.44 ± 0.22), earlier reported by Nur-Azlina, et al. (2007).

The moisture content values as recorded in the work of Nur-Azlina, et al. (2007) are relatively higher than those obtained in this study namely (78.90 ± 0.02). The high moisture contents of the samples are also an indication of low keeping quality (shelf-life). The carbohydrate value obtained showed a narrower value in samples from Abattoir and Relief Market and a higher range in samples from New Market, Ekeonunwa and Meat Shop compared with earlier values recorded by Lawrie et al. (2006) (1.20 ± 0.24). The low carbohydrate value in Abattoir sample could be possibly due to pre-slaughter stress on the animal in which the glycogen composition of the muscles are used up prior to slaughter (Williams & Demello, 2007). However, it could be that a particular microorganism(s) grew on or attacked majorly the carbohydrate portion of the sample. However, the protein content increased appreciably above what is recorded by Nur-Azlina et al. (2007). This is possibly due to age of the animal, feed fed to the animal prior period of slaughter (Ronsner et al., 2001), or due to high protein conversion rate, which is a genetic factor. A close examination of the protein content of the sample from Meat Shop when compared with that from Abattoir and New Market revealed a decrease. This is not majorly due to microbial activity since the activity of microorganisms is reduced when compared to other samples in table 1. This could rather be due to thawing process in which the protein is lost via the exudates. The valued obtained for the fat composition are quite higher than those obtained from earlier work of Nur-Azlina et al. (2007) (1.19 ± 0.02). The range obtained from ash showed ($1.07 \pm 0.024 - 1.46 \pm 0.010$). These values overlap with the values earlier reported by Bodwell et al., (1989) showing a range of (1.9 ± 0.02).

Table 1 showed a critical microbiological condition though acceptable. This is in line with the prescription by Hadley (1997), stating that total plate count per cm^2 between 10,000 – 100,000 ($>10^4 - <10^5$) is acceptable, but above 100,000 (i.e. $>10^5$) is not acceptable. However, the sample from Meat Shop relatively showed most acceptable result. It actually fell among the samples with more number of organism, but their activities are hampered by handling procedures and storage or marketing facilities so that the cfu/ml is lowered to 6.3×10^5 compared with the samples from different markets having higher cfu/ml up to 9.5×10^5 .

Clostridium spp and *Salmonella* spp are virtually identified in all the samples with others in few samples. All the microorganisms are bacteria, no fungi is isolated. This is in agreement with Lewicki (1993), that among the organisms that grow on meat, bacteria play the most important role. The increase in microbial load of most samples from different markets revealed possibly the poor hygiene and inadequate sanitary condition maintained by most butchers in the market (Aladi, 1999). Their attendant microbial activity is quite suggestive of the reason for low protein composition in the samples from Ekeonunwa and Relief Market (17.62 ± 0.000) and (18.33 ± 0.036) respectively as shown in table 3. These values are quite narrower compared with values obtained earlier from the work of Nur-Azlina et al. (2007) (19.44 ± 0.22). However, there are variations in the values of nutrients obtained in this study when compared with the existing values reported by earlier research works on similar samples studied. These differences could be attributed to different reasons such as: time factor, analytic methods used, environmental factors and species of the animal food samples.

V. Conclusion And Recommendations

Meat is indeed contaminated by the unavoidable activity of microorganisms. Contamination results in deterioration and loss of nutritional value of meat. This is because organisms causing breakdown feed and/or grow on the nutrient composition of meat. Microbial activity is possibly reduced by adequate sanitary condition and storage facilities (freezing and refrigeration). It could as well be reduced by high temperatures.

Consumers should be very conscious of the fact that no meat in the market is free of contamination. Hence, proper cooking methods to reduce to safe level the microbial load should be applied. Also, for the purpose of safety and maintaining nutritional value of meat, butchers should maintain adequate personal hygiene and sanitary conditions. Government on her own should equip the Municipal abattoir with the necessary storage facilities, build waste water channels, adequate slaughter halls, ensure proper ante-mortem inspection of cattles. Regulations and laws should be promulgated in relation to the standard that must be met for all already existing and intending butchers in the markets. Regulations should also see that pre-slaughter stress on beef cattles be reduced to the barest minimum to avoid loss of nutrients.

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