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Effect of Boiling Time On The Proximate Composition And Microbiological Quality Of Various Parts Of Cattle Meat Sold In Owerri, Imo State, Nigeria.

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Abstract

The effect of boiling time on the proximate composition and microbiological quality of various parts of cattle meat were evaluated using standard methods. Moisture, fibre and fat contents of cattle meat reduced with boiling time, while protein content increased with boiling time, with optimum values at 50 minutes of boiling. At 60 minutes boiling time, protein content reduced due to escape of sarcoplasmic proteins. Moisture content had the highest value (%) in the unprocessed sample of skin (73.37 ±0.07), with the least in the 60 minutes boiled sample of muscle (64.58 ±0.03). Fibre content had the highest value (%) in the unprocessed sample of muscle (3.62 ±0.07), with the least in the 60 minutes boiled sample of skin (3.04 ±0.07). Fat content had the highest value (%) in the unprocessed sample of large intestine (6.32 ±0.06), with the least in the 60 minutes boiled sample of muscle (2.04 ±0.07). Boiling had no significant ($p>0.05$) effect on ash and carbohydrate contents of cattle meat. High microbial mean counts were recorded in the unprocessed samples of small intestine ($3.95x10^5$ ±0.95 CFU/g) and the least microbial mean counts were recorded in the boiled muscle samples (0.00 CFU/g). Six (6) bacterial isolates were identified to include *Pseudomonas* species, *Salmonella* species, *Clostridium* species, *Staphylococcus aureus*, *Escherichia coli*, and *Bacillus* species, while five (5) fungal isolates were identified to include *Mucor* species, *Rhizopus* species, *Rhodotorula* species, *Aspergillus* species, and *Penicillium* species. Cross contamination and personal hygiene during the various stages of slaughtering from inherent intestine and prevailing environment could be linked with the high microbial counts recorded in the unprocessed samples. Therefore, there is need to educate the

teeming consumers on the effect of boiling time on both nutritive and microbiological quality of consumed cattle meat.

Key words: Cattle meat**,** Boiling time, Temperature, Proximate, Microbiological.

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Introduction

Meat has a crucial role in human evolution and is an important component of a healthy and balanced diet due to its nutritional quality. The increase in population with consequent pressing demand for enhanced requirements of food has led to a continued search for novel sources of food and protein. Ruminants such as cattle and other herbivores convert materials into balanced source of protein and energy for human consumption and are called meat. Meat is an animal flesh that is eaten as food and excellent source of protein in human diet. It is highly susceptible to microbial contaminations, which can cause its spoilage and food borne infections in human, resulting in economic and health losses [14]. It is normally eaten after it has been cooked and seasoned or processed in a variety of ways.

Meat is one of the most perishable foods and its composition is ideal for the growth of a wide range of spoilage bacteria [17]. Meat is considered as the most nutritive source of protein consumed by humans. Age and sex of the animal has a major influence on the quality of meat that is produced from animals. Most meats have high water content with corresponding water activity of approximately $0.99a_w$ which is suitable for microbial growth [21]. Public concern has risen due to widespread microbial contamination, leading to food poisoning and food borne illnesses.

Meat is gotten from animals like sheep, and cattle etc. The widely used animal for meat is the cattle which is also called cow and it has many essential parts that are also used as meat, such parts are the beef (red meat), intestines (small and large), and the skin which is also called hide. Meat is the most common food that provides nutrition to our diets. Although, muscles of healthy animals do not contain microorganisms, meat tissues get contaminated during the various stages of slaughter and transportation [6]; [13]. The health status of animals prior to slaughtering and prevailing circumstances in the slaughter house contributes to the quality of meat from such animals [24].

It may be noted that most of the meats have a final ultimate pH of about 5.6 and above. This makes these products susceptible to bacteria as well as to mold and yeast spoilage. With respect to the

keeping quality of meats, it is well established that meat from fatigued animals spoils faster than that from rested animals and this is a direct consequence of final pH attained upon completion of rigor mortis. The death of a well-rested meat animal, triggers conversion of 1% glycogen to lactic acid, which directly causes a depression in pH values from about 7.4 to about 5.6, depending on the type of animal. The pH value for beef was found to be lowest at 5.1 and highest at 6.2 after rigor mortis. The usual pH value attained upon completion of rigor mortis of beef is around 5.6 [13].

The possible sources of contamination are likely to come from the skin (animal hide), gastrointestinal tract, and lymph nodes of the animal from which the meat was obtained. Other primary sources of microbial contaminations are the equipment and the physical facilities (the stick knife, containers, retail tables) used in each operation before the final product is eaten. The clothing, hands of handlers, handling and storage environment are all implicated [13]. Spoilage is caused by the practically unavoidable infection and subsequent decomposition of meat by bacteria and fungi, which are borne by the animal itself, and the people handling the meat and their implements. A great diversity of microbes inhabit fresh meat generally, but different types may become dominant depending on pH, composition, textures, storage temperature, and transportation methods involved [1]; [6]; [16].

Raw meat may harbour many important pathogenic microbes such as *Salmonella* species, *Campylobacter jejuni*, *Yersinia enterocolitica*, *Escherichia coli*, S*taphylococcus aureus* and to some extent, *Listeria monocytogenes*, making the meat a risk for human health, of which without proper handling and control of these pathogens, food borne illnesses may occur [20]. The slaughtering of animals usually takes place under very unhygienic conditions. This coupled with high ambient temperature, high humidity, shortage of portable water and poor handling practices exposes meat products to microbial contamination and rapid deterioration. Therefore, this study is targeted to determine the effect of boiling time on nutritive and microbiological qualities of various parts of cattle meat sold in Owerri metropolis, Imo State, Nigeria.

Materials and Methods

Sample sources and collection

The various parts of cattle meat (large intestine, small intestine, skin and muscle) were purchased at random from different sellers at Relief Market in Owerri. Pooling method was used to achieve homogeneity. These samples were aseptically packaged in sterile ziploc bags in icebox for nutritive and

microbiological analysis. Samples were analyzed in the laboratory within thirty (30) minutes of collection, otherwise stored in the refrigerator.

Preliminary treatments and boiling of various cattle meat parts

The various samples of cattle meat (large intestine, small intestine, skin and muscle) were washed in clean water. The meat parts were trimmed and one (1) gram of each sample part was weighed and boiled separately in 250ml of water using heating mantle at 100^0C for periods of 30, 40, 50 and 60 minutes.

Proximate analyses of various meat samples

Proximate analyses of the various parts of cattle meat were carried out (in replicates) using the methods of [2] for the moisture, fibre, ash, fat, protein and carbohydrate contents.

Microbiological studies

Ten fold serial dilutions of samples were done using sterile peptone water as diluent. One (1) gramme of each meat sample was mashed in a sterile mortar, transferred aseptically to a sterile test tube containing 9.0ml of sterile peptone water as diluent, and was shaken vigorously to ensure adequate disengagement of microorganisms to obtain 10^{-1} dilution. Serial dilutions of the homogenates were continued and made stepwisely till the fifth (5th) tube, to obtain dilutions of 10^{-2} to 10^{-5} dilutions. Spread plate techniques [5] were used to enumerate bacteria and fungi in the samples, and each dilution was plated in replicates using plate count agar for mean aerobic bacteria enumeration, tergitol agar for coliforms enumeration, and fortified sabouraud dextrose agar (SDA) for fungal enumeration. The plates were incubated at 35±2°C for 72 hours and 24 hours for mean bacterial and coliform counts respectively and 25±2°C for 120 hours for mean fungal counts.

Data analysis

Analysis of variance (ANOVA) was employed in this work and used to analyze all data obtained from the determinations. Descriptive statistics in form of mean and standard deviation and Duncan post hoc were also used to assess the data. The analyses were done using **(**Statistical Product and Service Solutions) SPSS 16.

Results

Proximate study

The proximate results for moisture, fibre, ash, fat, protein and carbohydrate contents are shown in Tables 1, 2, 3, 4, 5 and 6. Mean moisture content (%) was highest in unprocessed samples with skin (73.37±0.07), followed by small intestine (68.17±0.05), large intestine (67.34±0.06) and muscle sample (65.39±0.04) in that order, while the lowest in boiled (processed) samples was at 60 minutes boiling time with muscle (64.58±0.03), followed by large intestine (67.18±0.06), small intestine (67.71±0.05) and skin sample (73.11±0.06) in that order (Table 1). The mean moisture content (%) was highest in skin sample (73.37±0.07) than in other unprocessed meat samples, while muscle sample of the unprocessed meat recorded the least moisture percentage (65.39±0.04). Also, same muscle sample in the processed meat (boiled) recorded the least mean moisture content (%) at 60 minutes boiling time (64.58±0.03). From the results in Table 2, unprocessed meat had significantly ($p<0.05$) higher mean fibre content {muscle (3.62±0.07), small intestine (3.43±0.06), large intestine (3.21±0.04) and skin (3.14±0.05)}, when compared with boiled (processed) meat samples at 60 minutes boiling time {muscle (3.46±0.05), small intestine (3.26±0.04), large intestine (3.09±0.06), and skin (3.04±0.07)}. The results obtained in Table 3 showed that ash content did not follow any definite trend rather values were variable during boiling. Unprocessed meat sample had mean ash content values (%) as follows: small intestine (1.31±0.10), large intestine (1.25±0.05), skin (1.21±0.07) and muscle (1.42±0.03), while processed meat (boiled) samples had mean ash content values (%) for 60 minutes as follows: small intestine (1.32±0.04), large intestine (1.24±0.05), skin (1.23±0.07) and muscle (1.48±0.04).

In Table 4**,** fat content had higher values in the unprocessed meat {large intestine (6.32±0.06), small intestine (4.50±0.07), skin (3.50±0.05) and muscle (2.20±0.06)} when compared with the processed (boiled) meat. In the boiled samples, the least in mean fat content (%) was recorded at 60 minutes boiling time in muscle (2.04±0.07), followed by skin (3.37±0.05), small intestine (4.33±0.06) and large intestine (6.16±0.04). Protein content (Table 5) showed highest mean values (%) in boiled meats at 50 minutes boiling time {small intestine (22.88±0.04), large intestine (21.90±0.05), skin (18.82±0.12) and muscle (27.88±0.04)} with significant difference ($p<0.05$) than in unprocessed meats {small intestine (22.25±0.05), large intestine (21.55±0.10), skin (18.44±0.07) and muscle (27.02±0.06)}. Results obtained in (Table 5) showed that long boiling periods, especially at 60 minutes caused reduction in

protein content {small intestine (22.79±0.05), large intestine (21.85±0.06), skin (18.77±0.03) and muscle (27.15±0.03)} when compared with that of 50 minutes boiling time. The results of carbohydrate content (Table 6) showed no definite trend rather variable mean values were observed during unprocessed and processed (boiled) conditions. Unprocessed meat sample had mean carbohydrate content values (%) as follows: small intestine (0.35±0.10), large intestine (0.35±0.05), skin (0.36±0.06) and muscle (0.36±0.04), while processed meat (boiled) samples had mean carbohydrate content values (%) for 60 minutes boiling time as follows: small intestine (0.34±0.06), large intestine (0.34±0.04), skin (0.36±0.05) and muscle (0.36±0.06).

Table 1: Moisture Content Determination of Different Parts of Cattle Meat

	Moisture Content (%)					
Cattle Meat Samples	**Boiling Time (mins)**					
	0	**30**	**40**	**50**	**60**	**LSD**
Small Intestine	68.17±0.05^{a}	68.14±0.05^{b}	67.90±0.04^{c}	67.79±0.07^{d}	67.71±0.05^{e}	0.01
Large Intestine	67.34±0.06^{a}	67.28±0.04^{b}	67.24±0.06^{c}	67.20±0.03^{d}	67.18±0.06^{d}	0.03
Skin	73.37±0.07^{a}	73.21±0.03^{b}	73.17±0.05^{bc}	73.14±0.04^{c}	73.11±0.06^{c}	0.07
Muscle	65.39±0.04^{a}	65.21±0.06^{b}	65.01±0.04^{c}	64.77±0.06^{d}	64.58±0.03^{e}	0.06

Values are given as mean ± SD (standard deviation). Within rows, values followed by the same alphabets are not significantly different but those followed by different alphabets are significantly different. Legend: LSD - Least Significant Difference..

Table 2: Fibre Content Determination of Different Parts of Cattle Meat

	Fibre Content (%)					
Cattle Meat Samples	**Boiling Time (mins)**					
	0	**30**	**40**	**50**	**60**	**LSD**
Small Intestine	3.43±0.06^{a}	3.39±0.05^{b}	3.35±0.06^{c}	3.31±0.03^{d}	3.26±0.04^{e}	0.02

Large Intestine	3.21±0.04[a]	3.17±0.07[b]	3.13±0.05[c]	3.12±0.06[cd]	3.09±0.06[d]	0.04
Skin	3.14±0.05[a]	3.11±0.06[b]	3.09±0.03[c]	3.07±0.05[d]	3.04±0.07[e]	0.02
Muscle	3.62±0.07[a]	3.57±0.05[b]	3.53±0.04[bc]	3.50±0.04[cd]	3.46±0.05[d]	0.05

Values are given as mean ± SD (standard deviation). Within rows, values followed by the same alphabets are not significantly different but those followed by different alphabets are significantly different. Legend: LSD - Least Significant Difference.

Table 3: Ash Content Determination of Different Parts of Cattle Meat

	Ash Content (%)					
Cattle Meat Samples	**Boiling Time (mins)**					
	0	**30**	**40**	**50**	**60**	**LSD**
Small Intestine	1.31±0.10[a]	1.32±0.06[a]	1.33±0.03[a]	1.32±0.05[a]	1.32±0.04[a]	0.03
Large Intestine	1.25±0.05[a]	1.24±0.04[a]	1.25±0.05[a]	1.25±0.06[a]	1.24±0.05[a]	0.03
Skin	1.21±0.07[a]	1.21±0.05[a]	1.22±0.04[a]	1.23±0.04[a]	1.23±0.07[a]	0.04
Muscle	1.42±0.03[a]	1.45±0.03[b]	1.46±0.06[b]	1.46±0.05[b]	1.48±0.04[a]	0.02

Values are given as mean ± SD (standard deviation). Within rows, values followed by the same alphabets are not significantly different but those followed by different alphabets are significantly different. Legend: LSD - Least Significant Difference.

Table 4: Fat Content Determination of Different Parts of Cattle Meat

	Fat Content (%)					
Cattle Meat Samples	**Boiling Time (mins)**					
	0	**30**	**40**	**50**	**60**	**LSD**
Small Intestine	4.50±0.07^{a}	4.47±0.11^{b}	4.43±0.03^{c}	4.38±0.05^{d}	4.33±0.06^{e}	0.03
Large Intestine	6.32±0.06^{a}	6.28±0.04^{ab}	6.24±0.12^{bc}	6.20±0.04^{cd}	6.16±0.04^{d}	0.05
Skin	3.50±0.05^{a}	3.46±0.02^{b}	3.44±0.04^{c}	3.40±0.10^{d}	3.37±0.05^{e}	0.01
Muscle	2.20±0.06^{a}	2.12±0.05^{b}	2.10±0.04^{bc}	2.05±0.06^{bc}	2.04±0.07^{c}	0.08

Values are given as mean ± SD (standard deviation). Within rows, values followed by the same alphabets are not significantly different but those followed by different alphabets are significantly different. Legend: LSD - Least Significant Difference.

Table 5: Protein Content Determination of Different Parts of Cattle Meat

	Protein Content (%)					
Cattle Meat Samples	**Boiling Time (mins)**					
	0	**30**	**40**	**50**	**60**	**LSD**
Small Intestine	22.25±0.05^{c}	22.35±0.06^{c}	22.67±0.10^{b}	22.88±0.04^{a}	22.79±0.05^{ab}	0.13
Large Intestine	21.55±0.10^{d}	21.71±0.05^{c}	21.81±0.04^{b}	21.90±0.05^{a}	21.86±0.06^{ab}	0.08
Skin	18.44±0.07^{c}	18.66±0.04^{b}	18.76±0.07^{a}	18.82±0.12^{a}	18.77±0.03^{a}	0.08
Muscle	27.02±0.06^{e}	27.30±0.12^{c}	27.57±0.05^{b}	27.88±0.04^{a}	27.15±0.03^{d}	0.05

Values are given as mean ± SD (standard deviation). Within rows, values followed by the same alphabets are not significantly different but those followed by different alphabets are significantly different. Legend: LSD - Least Significant Difference.

Table 6: Carbohydrate Content Determination of Different Parts of Cattle Meat

Cattle Meat Samples	Carbohydrate Content (%)					
	Boiling Time (mins)					
	0	30	40	50	60	LSD
Small Intestine	0.35±0.10[a]	0.34±0.05[a]	0.34±0.04[a]	0.34±0.05[a]	0.34±0.06[a]	0.05
Large Intestine	0.35±0.05[a]	0.34±0.06[a]	0.35±0.06[a]	0.35±0.04[a]	0.34±0.04[a]	0.03
Skin	0.36±0.06[a]	0.36±0.04[a]	0.34±0.07[a]	0.35±0.03[a]	0.36±0.05[a]	0.04
Muscle	0.36±0.04[a]	0.37±0.03[a]	0.34±0.04[a]	0.36±0.05[a]	0.36±0.06[a]	0.04

Values are given as mean ± SD (standard deviation). Within rows, values followed by the same alphabets are not significantly different but those followed by different alphabets are significantly different. Legend: LSD - Least Significant Difference.

Microbiological study:

The results of microbial loads of various parts of cattle meat are shown in Tables 7, 8 and 9. In unprocessed meat, mean aerobic bacterial and coliform counts (CFU/g) were highest in samples of small intestine ($3.95x10^5$±0.95; $2.25x10^2$±0.25), followed by large intestine ($3.40x10^4$±1.04; $2.15x10^2$±0.15) skin ($4.30x10^3$±0.72; $6.60x10^1$±1.08) and muscle ($2.20x10^3$±0.75; $5.85x10^1$±1.05); while fungal count (CFU/g) was highest in samples of large intestine ($2.95x10^3$±0.35), followed by small intestine ($2.70x10^3$±0.40), skin ($2.17x10^3$±0.65) and muscle ($1.69x10^3$±0.46). Boiling had significant effect ($p<0.05$) on the microbial load of the processed meat. In the boiled meat samples for 60 minutes, mean aerobic bacterial counts (CFU/g) were highest in samples of small intestine ($1.10x10^1$±0.10), followed by large intestine ($0.85x10^1$±0.44), skin ($0.55x10^1$±0.10) and least in muscle ($0.45\ x10^1$±0.21); mean coliform count (CFU/g) had same count for small and large intestine ($0.05x10^1$±0.15; $0.05x10^1$±0.06) and no count for skin and muscle samples, while fungal counts (CFU/g) had same count for small and large intestine ($0.05\ x\ 10^1$±0.06; $0.05\ x\ 10^1$±0.06), skin ($0.1\ x\ 10^1$±0.10) and muscle ($0.15\ x\ 10^1$±0.10). Six (6) bacterial isolates were identified to include *Pseudomonas* species, *Salmonella* species, *Clostridium* species, *Staphylococcus aureus*, *Escherichia coli*, and *Bacillus* species while five (5) fungal isolates were identified to include: *Mucor* species, *Rhizopus* species, *Rhodotorula* species, *Aspergillus* species, and *Penicillium* species.

Table 7: Aerobic Plate Count of Different Parts of Cattle Meat

	Aerobic Plate Count (CFU/g)					
Cattle Meat Samples	**Boiling Time (mins)**					
	0	**30**	**40**	**50**	**60**	**LSD**
Small Intestine	$(3.95x10^5)$ $\pm 0.95^a$	$(2.85x10^3)$ $\pm 0.55^b$	$(2.10x10^2)$ $\pm 0.32^c$	$(5.10x10^1)$ $\pm 1.01^d$	$(1.10x10^1)$ $\pm 0.10^{de}$	$0.12x10^4$
Large Intestine	$(3.40x10^4)$ $\pm 1.04^a$	$(2.45x10^3)$ $\pm 1.06^b$	$(4.15x10^2)$ $\pm 0.26^c$	$(5.00x10^1)$ $\pm 0.72^d$	$(0.85x10^1)$ $\pm 0.44^{de}$	$0.12x10^3$
Skin	$(4.30x10^3)$ $\pm 0.72^a$	$(4.20\ x10^2)$ $\pm 0.17^b$	$(1.60x10^2)$ $\pm 0.36^{bc}$	$(3.60x10^1)$ $\pm 0.25^d$	$(0.55x10^1)$ $\pm 0.10^{de}$	$0.88x10^3$
Muscle	$(2.20x10^3)$ $\pm 0.75^a$	$(2.75\ x10^2)$ $\pm 0.75^b$	$(2.75x10^2)$ $\pm 0.15^b$	$(2.95x10^1)$ $\pm 0.35^c$	$(0.45x10^1)$ $\pm 0.21^{cd}$	$0.50x10^3$

Values are given as mean ± SD (standard deviation). Within rows, values followed by the same alphabets are not significantly different but those followed by different alphabets are significantly different. Legend: LSD - Least Significant Difference. .FSANZ, (2018).

Table 8: Coliform Count of Different Parts of Cattle Meat

	Coliform Count (CFU/g)					
Cattle Meat Samples	**Boiling Time (mins)**					
	0	**30**	**40**	**50**	**60**	**LSD**
Small Intestine	$(2.25x10^2)$ $\pm 0.25^a$	$(1.65x10^2)$ $\pm 0.15^b$	$(6.15x10^1)$ $\pm 0.75^c$	$(2.00x10^1)$ $\pm 0.20^d$	$(0.05x10^1)$ $\pm 0.15^d$	$0.29x10^2$
Large Intestine	$(2.15\ x10^2)$ $\pm 0.15^a$	$(1.05x10^2)$ $\pm 0.15^b$	$(4.50x10^1)$ $\pm 1.04^c$	$(1.85x10^1)$ $\pm 0.25^d$	$(0.05x10^1)$ $\pm 0.06^d$	$0.24x10^2$
Skin	$(6.60x10^1)$ $\pm 1.08^a$	$(4.50x10^1)$ $\pm 0.76^b$	$(2.90x10^1)$ $\pm 0.20^{bc}$	$(1.05x10^1)$ $\pm 0.38^d$	$(0.00)^e$	$0.61x10^1$
Muscle	$(5.85x10^1)$ $\pm 1.05^a$	$(3.50x10^1)$ $\pm 0.16^b$	$(2.60x10^1)$ $\pm 0.95^b$	$(0.65x10^1)$ $\pm 0.32^c$	$(0.00)^d$	$0.93x10^1$

Values are given as mean ± SD (standard deviation). Within rows, values followed by the same alphabets are not significantly different but those followed by different alphabets are significantly different. Legend: LSD - Least Significant Difference. .FSANZ, (2018).

Table 9: Fungal Count of Different Parts of Cattle Meat

	Fungal Count (CFU/g)					
Cattle Meat Samples	**Boiling Time (mins)**					
	0	**30**	**40**	**50**	**60**	**LSD**
Small Intestine	$(2.70x10^3)$ $\pm0.40^a$	$(7.65x10^2)$ $\pm0.38^b$	$(1.70\ x10^2)$ $\pm0.70^c$	$(3.35x10^1)$ $\pm1.07^d$	$(0.05x10^1)$ $\pm0.06^{de}$	$0.48x10^3$
Large Intestine	$(2.9\ x10^3)$ $\pm0.35^a$	$(1.20\ x10^3)$ $\pm0.45^b$	$(2.55x10^2)$ $\pm0.97^b$	$(3.10x10^1)$ $\pm0.49^c$	$(0.05x10^1)$ $\pm0.10^{cd}$	$0.43x10^3$
Skin	$(2.17x10^3)$ $\pm0.65^a$	$(1.39x10^2)$ $\pm0.20^b$	$(2.10x10^2)$ $\pm1.05^b$	$(2.95x10^1)$ $\pm1.03^c$	$(0.1x10^1)$ $\pm0.10^{cd}$	$2.3x10^3$
Muscle	$(1.69x10^3)$ $\pm0.46^a$	$(1.40x10^2)$ $\pm1.04^b$	$(8.50x10^1)$ $\pm0.19^c$	$(2.25x10^1)$ $\pm0.09^c$	$(0.15x10^1)$ $\pm0.10^{cd}$	$1.8\ x10^3$

Values are given as mean ± SD (standard deviation). Within rows, values followed by the same alphabets are not significantly different but those followed by different alphabets are significantly different. Legend: LSD - Least Significant Difference. FSANZ, (2018).

Discussion

Proximate study:

Water molecules are highly polar and attracted to the muscle proteins by ionizable basic and acidic groups such as arginine, histidine, lysine, glutamic acid, etc. The boiling breaks the bonding which led to the release of the water molecules in meat, which resulted in low moisture content of boiled meats than that of the unprocessed meat (control). Mean moisture content (%) was highest in unprocessed samples, while the lowest was in boiled (processed) samples at 60 minutes boiling time. Boiling reduced the moisture content of cattle meat significantly ($p<0.05$) as compared to the unprocessed, but the rate of moisture reduction is significantly ($p<0.05$) higher with increase in boiling time. Boiling affected moisture content of the processed meat samples significantly ($p<0.05$), with a decreasing trend in the observed results. With increase in the boiling time, there is a constant but significant ($p<0.05$) moisture reduction among various samples. The moisture losses obtained in this result were in agreement with the works of [15] and [4]. Similar results were reported for boiling of rainbow trout meat by [9], who found that boiling had considerable effect on the proximate composition and mineral contents of cooked fish, comparing it with the raw meat.

Unprocessed meat had significantly higher mean fibre content values ($p<0.05$) when compared with boiled meat samples. As the boiling time increases, there is a significant reduction ($p<0.05$) in the fibre content of processed meat. Boiling results in lower-quality texture processed meat, which leads to disintegration of the texture matrix, and finally, liberalization of large amounts of water and fat. Boiling increases the opportunities for dissolving intracellular materials into the boiling liquid. This causes increase of viscosity of the seeping liquid. The results obtained in this study were in agreement with the work of [8]. Ash content did not show any definite trend among samples during different boiling time, although values of processed were slightly higher than that of unprocessed samples. This result is in agreement with the assertions of [25]. Values obtained did not show any significant difference when compared ($p>0.05$). Fat content had higher values in the unprocessed meat when compared with the processed (boiled) meat, as fat reduces with increase in boiling time. Boiling increases fat losses and has significant effect ($p<0.05$) on the results obtained when compared between unprocessed and processed meat samples, but the rate of fat loss is significantly ($p<0.05$) higher with increase in boiling time. Boiling method has an influence on the magnitude of fat losses. The longer the boiling time, the higher the fat loss. Similar results were found by [22]: for veal brisket (boiled for one hour), the losses due to boiling were higher because of the long boiling time. Boiling brings about greater cook losses with reduction in moisture, fat and fibre content as weight reduction occurs, with increase in protein content [9]. The results obtained in this work were in agreement with the assertions of [9] and [22].

Protein content showed highest mean values (%) in boiled meats at 50 minutes boiling time with significant difference ($p<0.05$) than in unprocessed meats. In general, protein percentage increases in boiled meat than in unprocessed, because of reduced weight. The results of this study suggest that long boiling periods, especially at 60 minutes causes reduction in protein content as greater amounts of sarcoplasmic proteins seep out of the meat as a result of prolonged boiling. Prolonged boiling periods caused hydrolyzes of part of connective tissue and other protein in meat [19] and leaking out of sarcoplasmic proteins from the muscle fibers channel [18]. Hydrolysis of proteins and leaking out of sarcoplasmic proteins might be the reason for the higher loss of protein content from most meat samples boiled for 60 minutes. Conversely, boiling increases protein content with reduction in moisture, fat and fibre content as weight reduction occurs [9]. Sarcoplasmic proteins are sensitive to

long boiling time, and are contained in higher amounts in cattle meat. The results obtained in this study were in agreement with the works of [25]; [9]; and, [18]. [3] supported this assumption, having found that sarcoplasmic proteins are significantly higher in veal (cattle) than other meats during their work on comparative effects of cooking methods on chemical composition of meats. Carbohydrate content showed no definite trend rather variable mean values during unprocessed and processed (boiled) conditions. Boiling did not affect carbohydrate content of both unprocessed and processed (boiled) meat and had no significant ($p>0.05$) effect on the results obtained. This result is in agreement with the assertions of [25].

Microbiological study:

In unprocessed meat samples, highest values were found with mean aerobic bacterial counts (CFU/g), followed by fungal count (CFU/g) and coliform counts (CFU/g). The intestines had the highest microbial load with small intestine leading. This is followed by skin and muscle. The high microbial load in the skin and muscle could be linked to cross contaminations encountered during the various stages of slaughtering from inherent intestine and prevailing environment. Boiling had significant effect on the microbial load of the processed meat. Cattle meats are contaminated with pathogens from the intestinal tract or from faecal material deposits [13]. Cross contamination is another problem in the control of pathogens [23]. With high nutritive value, both essential macro and micronutrients, meat is an important part of a balanced diet for human and microorganisms [17]. Retailed meat and meat products are normally sold in markets in unhygienic conditions (most often in open tables). These are various sources of contamination that attested to the results of high microbial loads recorded in this study. Most of the microbial results obtained are in high thresholds and are serious indications of non-conformity in food safety management with looming food borne outbreaks, if unchecked. In this study, there were high aerobic bacterial, coliform and fungal counts which are indicative of heavy contamination. Meanwhile, muscles and tissues of healthy animals do not contain microorganisms, rather contamination is encountered during the various stages of slaughtering from inherent intestine, prevailing environment, transportation and handling [6]; [24].

Six (6) bacterial and five (5) fungal isolates were identified to include *Pseudomonas* species, *Salmonella* species, *Clostridium* species, *Staphylococcus aureus*, *Escherichia coli*, *Bacillus* species, and fungi: *Mucor* species, *Rhizopus* species, *Rhodotorula* species, *Aspergillus* species, and *Penicillium*

species. Most of the isolates obtained in this study were in agreement with the works of [11]; [1]; [6]; and [16]. *Bacillus* species are known as environmental contaminants and spore formers, inhabiting the air, water and soil. *Staphylococcus aureus* is known to inhabit the human skin as normal flora and opportunistic during a break or under depressed immunity. *Pseudomonas* and *Salmonella* species are inhabitants of water [12]. *Salmonella* species such as *Salmonella typhi* that causes typhoid fever is a major public health problem in developing countries, especially in Nigeria due to poor sanitary conditions and lack of or inadequate potable water [10]. *Escherichia coli* are known to be intestinal inhabitants of animals [13]. The presence of *Aspergillus*, *Penicillium*, *Rhizopus*, and *Mucor* species could be attributed to activities within the surrounding environment.

Also, presence of these microbes in higher thresholds could fast track spoilage of the meat. The high microbial loads could be linked to heavy contamination and cross contamination during slaughtering. The presence of these organisms in higher thresholds could be traced to poor hygienic conditions and cross contaminations from the slaughter house to points of sell. The use of bare hands and open display of meat on contaminated tables by sellers is another issue of concern in troubleshooting sources of huge contamination. However, most of the meat sellers and butchers are unaware of the implications of these crude practices, in relation to health hazards of consumers. The presence of coliforms could be traced to cross contamination from the intestine during slaughtering [13], and poor hygiene practices among butchers/ sellers. Coliform presence is a strong indication of faecal contamination. The results of microbial loads obtained in this study were in agreement with the works of [11] and [12]

Boiling significantly reduced the microbial loads in the meat samples. Most meat spoilage microorganisms belong to the mesophiles. Spoilage of meat is faster at ambient temperatures that favours the replication of mesophiles. Heat treatment is one of the major aspects of microbial growth control. As the boiling time increases, microbial loads significantly reduced ($p<0.05$) with the least count obtained at 60 minutes boiling time (0.00 CFU/g). Microbial counts obtained in this study between unprocessed and boiled (processed) samples, when compared are statistically significant ($p<0.05$).

Conclusion

Boiling influences the content of several nutrients in meat depending on the cut and boiling time. To determine how much of the respective nutrients were gained or lost, it is important to compare the contents in absolute terms and units. The results obtained in this study strongly suggest that a proper boiling duration is necessary to acquire a nutritious and high quality cooked cattle meat void of microbial contaminations that can lead to serious health issues. Excessive and prolonged boiling should be avoided to prevent loss of vital nutrients as evidenced in this study.

From the results, cattle meat boiled for 30 minutes is unfit for consumption as it recorded very high microbial count capable of posing health threats. Equally, for 60 minutes boiling, it was observed that there were serious boiling losses in protein, fats and fibre contents of cattle meat. However, boiling time range between 40 - 50 minutes may serve as the optimum boiling time for cattle meat. At the boiling duration of 40 minutes, fats and fibre were highest in values, while at boiling duration of 50 minutes, protein equally was highest in values, in the different meat parts, with minimum nutrient losses recorded. Also, at the boiling time range of 40 - 50 minutes, microbial loads were reduced to insignificant counts that have no health effects.

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