

1 **EFFEECT OF COOKING METHODS ON THE MICROBIAL LOAD OF**
2 **BEEF COLLECTED AT DIFFERENT HOURS IN EKPOMA TOWN**
3 **MARKET.**
4

5 **Abstract**

6 A study on the effect of cooking methods on the microbial load of beef collected at different
7 hours of the day in Ekpoma town market was conducted. Meat samples were purchased at 8am,
8 1pm and 5pm from the market and taken to the laboratory for microbial load analysis. Another
9 portion of the meat was subjected to three cooking methods (boiling, broiling and roasting) and
10 microbial load analysed in a completely randomized design (CRD. Results from the study
11 showed that mean microbial load of beef collected at 8am were significantly ($P < 0.05$) less
12 compared with those collected at 1pm and 5pm, an indication that microbial load increase as
13 meat stays for longer hours of the day in the market. While boiling cooking method significantly
14 ($P < 0.05$) reduced the microbial loads of beef compared with broiling and roasting, an indication
15 that cooking meat with water reduced microorganisms more. Thus, beef meat should be
16 purchased in the early hours of the day (7am-9am) from the market and boiling cooking method
17 should be implored by home consumers when cooking meat.
18

19 **Introduction**

20 Meat is the flesh of an animal that is eaten as food. The advent of civilization allowed the
21 domestication of animals such as chicken, sheep and goats, cattle, pigs and rabbits, and
22 eventually their use in meat production on an industrial scale (Womack, 2010). The meat
23 industry is concerned with turning animal carcass into many different end-products. These end-
24 products are derived from all parts of the animal (muscle, bone, fat, cartilage, skin, fluids and
25 glands) and are produced through a range of physical, chemical and biological processes (Ozean
26 and Bozkurt, 2015). In achieving this, food safety is a matter of great concern and of public
27 health importance particularly when the environment in which such food is handled is heavily
28 contaminated (Soyiri *et al.*, 2008).

29 Most of the fresh food especially that of animal origin like beef is highly vulnerable to microbial
30 invasion and food poisoning, since meat is an ideal medium for the growth of a number of
31 microorganisms due to its nutritive value (Soyiri *et al.*, 2008). However, the consumption of
32 meat contaminated with pathogenic bacteria is the cause of many food-borne illnesses (Nouich
33 and Hamdi, 2009), with human health consequences ranging from illness to death (Iroha *et al.*,
34 2011; Hassan *et al.*, 2010). In most developing countries especially Nigeria, a number of foods
35 (meat inclusive) have been reported to have high incidence of bacteria (Okonko *et al.*, 2008a;
36 Clarence *et al.*, 2009). This is because the meat available at retail outlets comes through a long
37 chain of slaughtering and transportation, where each step may pose a risk of microbial
38 contamination. The sanitary conditions of abattoirs and its surrounding environment are major

Comment [WK1]: ??????

39 factors contributing to bacterial contamination of meat (Gill *et al.*, 2000). Consequently, it is
40 very important to implement hygiene and safety procedures not only during slaughter but also
41 when handling and processing meat.

42 Meat has to be cooked before consumption, and cooking of meat results in quality changes such
43 as flavour and taste enhancement, inhibition of microorganisms, shelf life increase and improved
44 digestibility (Broncano *et al.*, 2009). Cooking methods influence the colour, texture, flavour,
45 nutritional composition and microbial load of final meat products. Each cooking method has its
46 own advantages and disadvantages depending on the product processed (Cholean *et al.*, 2011).
47 Several studies have been conducted to assess the effect of cooking methods on quality and
48 storage stability of meat and meat products (Chettri *et al.*, 2011; Adedeji *et al.*, 2009 and Peiretti
49 *et al.*, 2012). Also, the effect of time and temperature on meat microbial load has generated
50 interest from most authors to carry out the study; results of which may be useful in solving
51 problems of meat spoilage during transportation, storage and up to its disposal to the consumers.
52 To this end, Bradeaba and Sivalcumaar (2013) reported significant difference between beef and
53 mutton products as well as beef and pork products. They stated that Coliform counts,
54 *Pseudomonas* and *Bacillus sp.* were noted, and significant differences were observed between
55 samples for Total viable counts (TVC), Coliform and Psychophilic sampled from 6.00am to
56 6.00pm, where higher values of microbial loads were observed as time progressed.

57 Understanding the prevalence and distribution of microorganisms in fresh meat retailed within
58 any given market and determining management strategies associated with lower prevalence is
59 key to decreasing the risk of high microbial loads at harvest (Foley and Lynne, 2008). To this
60 end, this study sorts to investigate the effect of cooking methods on the microbial load of beef
61 collected at different hours of the day in Ekpoma town market.

62 **Materials and Methods**

63 **Sample collection**

64 Meat samples were purchased from the open market in Ekpoma town. 1Kg of meat sample was
65 collected in the early hour (8am) of the day. It was cut into two portions. The first portion was
66 cut into ten (10) parts as replicates for microbiological loads determination. Same process was
67 applied for meat samples collected at 1pm and 5pm. While the second portion of meat samples
68 were subjected to three (3) cooking methods (boiling, broiling and roasting) to determine their
69 effects on microbial load. The experiment was carried out in the microbiology laboratory of
70 Animal Science Department, University of Ibadan.

71 **Culture media preparation**

72 The culture media was Nutrient Agar (NA), which was prepared according to the manufacturer's
73 specification. A total of 7g of the media was weighed into a clean conical flask and dissolved in
74 100ml distilled water. It was autoclaved at 121°C for 15 minutes.

75 **Microbial population determination**

76 The microbial load counts of beef meat samples were determined by using the pure – plate
77 culture described by Olutola *et al.*, (1991).

Comment [WK2]: color

Comment [WK3]: flavor

78 **Cooking methods**

79 **Boiling** – Meat sample was washed and boiled in an aluminum pot containing 100ml of water,
80 using a gas burner for 5 mins at a boiling temperature of 100⁰C. The was allowed to cool before
81 20g was weighed and taken for laboratory analysis.

82 **Broiling** – Meat sample was washed and put in an aluminum pot without the addition of water,
83 and placed on a regulating gas burner to boil for 5 mins at a temperature of 100⁰C. The meat was
84 then cooled and 20g weighed for analysis.

85 **Roasting** – Meat sample was roasted on an iron gauge placed on a cool pot containing hot
86 burning charcoal at a temperature of 100⁰C (full redness of charcoal) for 5 mins. The meat was
87 also allowed to cool and 20g taken for laboratory analysis.

88 **Serial dilution techniques**

89 Serial dilution was done for each portion of the samples. Nine (9) mls of sterile water was
90 introduced into sets of test tube and 1ml of the sample was put in a serial dilution method
91 replicated three (3) times. One (1) ml of the diluents was taken randomly into the pure-plate and
92 the nutrient agar (NA) added. It was shaken to cover the plate, well sealed and labeled. The
93 samples were taken to the incubator for 20 – 24 hours in order to coagulate, after which the
94 colony was formed and counts made on each plate sample, using a marker.

95 **Experimental Design**

96 The design for the experiment was a completely randomized design (CRD), one way analysis of
97 variance.

98 **Statistical Analysis**

99 All data were subjected to analysis of variance (ANOVA) using the SL Statistical programme for
100 windows SAS (2004) at 5% level of significance.

101
102 **Results and Discussions**
103 Results on the effect of cooking methods on the microbial load of beef collected at different
104 hours of the day in Ekpoma town market are shown on the Tables and discussed below.

105 **Table 1: Mean microbial load of beef collected at different hours of the day in Ekpoma**
106 **town market**

Microbial counts (Cfu/g)	8am	1pm	5pm	SEM
Dil ⁻¹	30.0 ^a	43.5 ^b	47.0 ^b	1.68
Dil ⁻²	22.0 ^a	31.5 ^b	45.0 ^c	2.61
Dil ⁻³	15.5 ^a	20.0 ^a	42.5 ^b	2.89

Comment [WK4]: cfu or CFU

abc: Means with similar superscripts along rows are not significantly (P<0.05) different.

SEM: Standard errors of means; Dil⁻¹⁻²⁻³: Diluents 1, 2, and 3.

107 Results on the mean microbial load of beef collected at different hours of the day showed that
108 microbial counts from Dil.⁻¹ were significantly (P<0.05) fewer at 8am with 30.0 counts,
109 compared with those of 1pm and 5pm which had 43.5 and 47.0 counts respectively, and did not
110 differ (P>0.05) from both hours. This implies that time of collection affects the microbial load of
111 beef sold in the market. This result was in line with the findings of Bradeaba and Sivakumaar
112 (2013), where higher values of microbial load were observed as time progresses. Result from
113 Dil.⁻² followed similar trend, with less microbial counts (22.0) recorded at 8am as against 31.5
114 and 45.0 recorded at 1pm and 5pm respectively, which were significantly (P<0.05) different.
115 Also, Dil.⁻³ showed similar result of less microbial load in the morning 8am (15.5), though not
116 significantly (P>0.05) different from 1pm (20.0) but differed significant (P<0.05) from 5pm
117 (42.5). Thus, the longer meat stays in the market or meat shop, the higher its microbial load.
118 Results from this study further revealed that microbial loads concentration tend to reduce as the
119 dilution increases, hence the reduction in microbial loads counts from diluents 1 to 3, as
120 observed in the result.

121 **Table 2: Effect of cooking methods on microbial load of beef**

Microbial counts (Cfu/g)	Boiling	Broiling	Roasting	SEM
Dil. ⁻¹	64.0 ^a	65.0 ^a	74.5 ^b	2.86
Dil. ⁻²	42.0 ^a	52.5 ^b	62.0 ^b	3.08
Dil. ⁻³	30.5 ^a	42.0 ^b	52.5 ^c	2.89

Comment [WK5]: cfu or CFU

122 abc: Means with similar superscripts along rows are not significantly (P<0.05) different.

123 SEM: Standard errors of means; Dil⁻¹⁻²⁻³: Diluents 1, 2, and 3.

124

125 Results on effect of cooking methods on the microbial load of beef showed that cooking methods
126 affected the microbial load of beef, with boiling significantly (P<0.05) reducing the microbial
127 loads of beef to 64.0 as against roasting (74.5) but did not differ (P>0.05) significantly from
128 broiling (65.0), from Dil.⁻¹. This implies that boiling cooking method tends to reduce microbial
129 load in meat, while roasting increases microbial load. In line with this finding, Ikeme (1990)
130 reported that submerging meat inside water with the application of heat at a high temperature
131 will cook the meat, thus reducing its bacterial contamination and enhancing its shelf life. The
132 result followed similar trend for Dil.⁻² with boiled meat sample having 42.0 microbial counts,
133 which was significantly (P<0.05) less than those of broiled meat (52.5). While, the microbial
134 counts of roasted meat were higher but not significantly (P>0.05) different from broiled meat.
135 Also, results from Dil.⁻³ showed that boiling significantly (P<0.05) reduced the microbial counts
136 of beef to 30.5 as against 42.0 and 52.5 recorded for broiling and roasting respectively. The study

137 revealed that higher microbial load was observed for the roasted beef samples on all three (3)
138 diluents replicates taken. The high microbial loads recorded for the roasted beef could be as a
139 result of the roasting process, which further exposes the meat to microbial contamination,
140 compared with boiling and broiling. In line with this, Anihouvi *et al.*, (2013) reported that
141 different processing methods had significant changes in the microbial content of meat samples as
142 a result of the processing environment. This study further revealed that the concentration of
143 microbes in meat sample-solution tends to reduce as dilution rate increases. This explains why
144 microbial load counts dropped gradually from Dil.⁻¹ to ⁻³ for the three (3) cooking methods
145 measured.

146

147 **Conclusion and Recommendation**

148 It can be concluded that time (hour) of purchase of beef meat from the market affects the
149 microbial loads of meat, as the longer the time meat stays in the market, the higher its microbial
150 content. Also, boiling cooking method reduces the microbial load of beef more, compared with
151 broiling and roasting cooking methods. Furthermore, that microbial concentration in meat
152 sample-solution reduces as dilution of concentration increases.

153 It is therefore recommended that beef meat should be purchased in the early hours of day from
154 the market, and boiling cooking method should be implored by home consumers when cooking
155 meat.

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