Evaluation of Meat Hygiene at Slaughterhouses in Khartoum State

TAG ELDIN ALI A. AHMED
NOURA MOHAMMED ELHASSAN
Department of Food Science and Technology
Faculty of Agriculture, Al- Zaiem Al- Azhari University
Khartoum, Sudan

Abstract

The study was carried out to evaluate meat hygiene at slaughterhouses in Khartoum state which work in preparation of meat for export and local consumption. There slaughterhouses obtained for study (A, B, and C) by verifying the hygienic practices by investigation of total count of bacteria total mould and yeast, and pathogens (**Staphylococcus aureus**, Salmonella spp. and Escherichia coli) for (306) samples taken from carcasses, workers hands, air, walls, floors, knives and hooks at different sites in the slaughter hall which are skinning, evisceration, inspection, washing and shipping sites and water at the slaughterhouses.

The results showed that the highest mean value of total viable bacterial colony count in meat was (5.03) at evisceration area in slaughterhouse (C), while the lowest mean value was (2.93) at skinning site in slaughterhouse (A) and in workers hands the highest mean value of total viable bacterial colony count was (5.56) at evisceration area in slaughterhouse (C), while the lowest mean value was (4.29) at inspection and shipping areas in slaughterhouse (A). In air the highest mean value of total viable bacterial colony count was (3.00) at evisceration area in slaughterhouse (C), while the lowest mean value was (1.72) at skinning area in slaughterhouse (A), and in walls the highest mean value of total viable bacterial colony count was (5.43) at evisceration area in slaughterhouse (C), while the lowest mean value was (4.58) at inspection area in slaughterhouse (A), and in floors the

2983

highest mean value of total viable bacterial colony count was (5.90) at skinning area in slaughterhouse (C), while the lowest mean value was (4.68) at inspection area in slaughterhouse (A), and in knives the highest mean value of total viable bacterial colony count was (5.01) at skinning and inspection areas in a slaughterhouse (C) and (B) respectively, while the lowest mean value was (4.38) at inspection area in a slaughterhouse (A), and in hooks the highest mean value of total viable bacterial colony count was (5.01) at skinning and inspection areas in a slaughterhouse (C), while the lowest mean value was (4.76) at washing area in a slaughterhouse (A), and in water the highest mean value of total viable bacterial colony count was (4.84) at a slaughterhouse (C)and the lowest mean value was (4.80) at a slaughterhouse (A). The results of detection showed presence of Staphylococcus aureus, moulds and yeasts in carcasses, workers hands, walls, knives and hooks at a slaughterhouse (B) and (C), while in water only moulds and yeasts were detected at a slaughterhouse (B) and (C), while at a slaughterhouse (A) Staphylococcus aureus was detected only in worker's hands. No Salmonella or Escherichia coli were detected at the three slaughterhouses.

The study concluded that the evisceration area was the dirtiest area at the three slaughterhouses and good hygienic practices lead to less microbial contamination as in a slaughterhouse (A).

Keywords: Meat Hygiene, Slaughterhouses, Khartoum State

INTRODUCTION

Meat is animal flesh that is eaten as food. It refers to skeletal muscles and associated fat and other tissues which is raised and prepared for human consumption (Womack and Allan, 1987). Meat is classified into two major types which are red meat (such as beef meat, sheep meat and camel meat) and white meat (such as poultry meat and fish meat) (John and Holy, 2003). Red meat is produced at slaughterhouse which is a facility where animals are slaughtered and prepared for human consumption and it acts as starting point of meat industry so it is important for management of slaughterhouse to be fully informed of their duties in respect to hygiene (John and Holly, 2003). The aim of meat hygiene is to ensure clean, safe and wholesome meat as

contamination of meat by micro-organisms or their toxins render the meat un acceptable or potentially harmful to consumer (Gracey,1981). Hygiene is the condition and measures necessary to ensure the safety and suitability of food at all stages of food chain (Codex Allimentarius, 2009). Meat quality and safety are critical issues for livestock and meat industry. The first consumer right is to have a product of good quality and not constituting any health hazard (Sally, 2016). Meat quality is crucial for the palatability of fresh meat and its suitability for processing as well as health and microbiological safety. Quality products are those that meet some need expectation of consumer and are fit to use (Ejobi, 2012). Meat safety is a discipline describing handling, preparation and storage of meat in ways that prevent meat borne illness. It aims to prevent meat from becoming contaminated and causing food poisoning to avoid health hazards (Sally, 2016). The aim of this study is to evaluate meat hygiene at slaughterhouses in Khartoum state in Sudan, to assess microbial situation in the meat production lines at the slaughterhouses and to identify sources of microbiological hazards at slaughterhouses.

MATERIALS AND METHOD:

Area: The study was carried out at three slaughterhouses in Khartoum state in Sudan (A, B, and C) which were established for sheep, cattle and camel meat production for export and local consumption.

Samples collection: Number of (306) samples were collected by swabs from the carcasses, worker's hands, air, walls, floors, knives and hooks at different sites in the slaughter hall (skinning, evisceration, inspection, washing and shipping sites), also samples from water were taken from the three slaughterhouse.
Total viable bacterial colony count was done for all and also detection for Staphylococcus, Salmonella, Escherichia coli and Moulds and Yeasts was done.

Carcasses samples: Samples were taken by swabbing the carcasses for 15 seconds at five sites in the meat production line: skinning, evisceration, inspection, washing and shipping sites.

 Workers hands (Meat handlers) samples: Samples were taken by swabbing workers hands for 15 seconds at five sites in the slaughter hall: skinning, evisceration, inspection, washing and shipping areas.

Air samples: Air samples were collected and taken by opening Petri dishes containing prepared sterile plate count agar media for 30 minutes at five areas which are skinning area, evisceration area, inspection area, washing area and shipping area.**Walls samples**: Samples were taken by swabbing an area of 3 square centimeter for 15 seconds at five areas which are skinning area, evisceration area, inspection area, washing area and shipping area.

Floor samples: Samples were taken by swabbing an area of 3 square centimeters for 15 seconds at five areas which are skinning area, evisceration area, inspection area, washing area and shipping area.

Knives surfaces samples: Samples were taken by swabbing the knives surface for 15 seconds at three sites in the slaughter hall: skinning, evisceration and inspection areas.

Hooks samples: Samples were taken by swabbing an area of 3 square centimeters for 15 seconds from hooks at five areas in the slaughter hall which are skinning, evisceration, inspection, washing and shipping areas.

Water samples: Water samples were taken in sterile bottles from a tap directly after sterilization of the tap by using flame after cleaning the outside nozzle of the tap from grease, then the water was allowed to run for one minute and the sterile bottles were filled from the gentle flow of the tap water and the caps of the bottles were replaced.

Sterilization of equipment: Petri dishes, test tubes, flasks and pipettes were sterilized in hot air oven at 160^oC for one hour. Wire loops were sterilized by flame (Oxoid,1981).

Sterilization of culture media and solution: Culture media and solutions were sterilized in autoclave at 15 pound per square inch for 15 minutes at 121^oC (Oxoid,1981).

Culture media: Plate count agar media were prepared for culture. It consists of casein enzymichydrolysate (5) gram, yeast extract (2.5) gram, dextrose (1) gram and agar (9) gram. dried weight of (17.5) gram of powder were dissolved in one liter of distilled water by boiling pH 7 ± 2 (Oxoid,1981).

Diluents:

Normal saline solution: It was prepared by dissolving (8.4) gram of sodium chloride in one liter of distilled water, the pH was adjusted to 7 and the solution was sterilized at $121^{o}C$, 15pound pressure per square inch for 20 minutes (Andrews and Richard, 2005).

Inoculation and incubation of samples:

Inoculation and incubation of samples for total viable bacterial colony count: Each of the swab samples was emerged in 9 ml normal saline in a test tube and was shaken well and serially diluted in normal saline i,e 1-10 ,1-100 , 1-1000 and 1-10000 and 50 micro liter from dilutions were spread over a petri dish containing plate count media and incubated at $37^{o}C$ for 48 hours . Then total bacterial colony count was made for each (Barrow and Feltham, 1993).

Inoculation and incubation of air samples for total viable bacterial colony count: Petri dishes containing air samples were incubated at $37^{o}C$ for 24 hours then total viable bacterial colony count was made for each (Barrow and Feltham, 1993).

Physical analysis:

pH value: As described by (Myers, 2010) 10 grams of meat was minced and mixed with 90 ml distilled water for 3 seconds using a blender. Then the sample was turned into abeaker and the pH value was read by using pH meter.

Chemical analysis:

Moisture content: Moisture content of samples was determined according to AOAC, (2002) as follows: 5 grams of sample were weighed accurately on pre-cleaned, pre-dried, pre-weighed steel moisture dishes. Then transferred to air oven at $130^{o}C$for 2 hours, cooled in desiccators until they reached the room temperature and then

reweighed and transferred to oven again for one hour and then cooled and weighed again.

Moisture content of samples is calculated as follows:

$$\text{Moisture (\%)} = \frac{W_2 - W_3}{W_2 - W_1} \times 100$$

Where W1 = weight of the empty dish

W2 = weight of the sample + dish

W3 = weight of dried sample + dish

Ash content: Ash content was determined according to AOAC, (2002) as follows: Crucibles were dried in an oven at 100 ± 5^oC for 2 hours and cooled to room temperature and placed in dissector till they were ready to use.3 grams of the sample were weighed accurately into prepared, pre-weighed crucibles. The samples were placed in a muffle furnace regulated at 550^oC for 3 hours until a light grey or white ash remained. Finally, the crucibles were removed from the furnace, cooled in a dissector and then reweighed.

The ash was calculated according to the following formula:

$$\text{Ash (\%)} = \frac{\text{weight of residue(g)}}{\text{weight of sample(g)}} \times 100$$

Crude protein content: Crude protein content was determined by Kjeldahl method according to the AOAC, 2002 using semiautomatic distilling unit for organic nitrogen determination by Kjeldahl method as follows: In Kjeldahl method flask, 2gms of sample were placed followed by addition of catalase mixture tablet (10 band of K2SO4 T01 band of CuSo3). Twenty-five milliliters of concentrated sulphuric acid H2SO4 (density 1.86 g\ml) were added to samples. The flasks were placed on the digestion apparatus, heated firstly at low heat, and then heating was continued with increased heating until the mixture was colorless (3hours). The flasks were removed and left to cool.

The digested samples were poured in volumetric flasks (100 ml) and diluted to 100 ml with distilled water. Five milliliters were taken and neutralized using 10 ml of 40% NaOH. The distillate was received in a conical flask containing 25 ml of 2% boric acid plus 3 drops of indicator (bromocresol green plus methyl red). The distillate was continues until the volume in the flask was 75mls. The flask was then removed from the distiller. The distillate was then titrated

against 0.1 N HCL until the end point was obtained (red color).Protein content was calculated as follows:

$$\text{Total nitrogen (\%)} = \frac{T \times N \times 0.014 \times 100}{W}$$

$$\text{Crude protein (\%)} = \text{Total nitrogen} \times 6.25$$

Where: T = Titration figure

N = Normality of hydrochloric acid.

W = Weight of sample (g).

0.014 = Atomic wt of $N_2 \backslash 1000$.

6.25 = Protein conversion factor

-

Fat content: Fat was determined according to the AOAC, (1991) by ether extract method. 2 grams of the sample were taken on soxhlet apparatus , the sample was subjected to continuous extraction with therefore 6 hours. The sample then removed from extractor and allowed to dry for 2 hours at 100 C^o in a drying oven till no trace of ether remained. The sample was then cooled and weighted for the extraction percentage. Fat percentage was calculated as follows:

$$\text{Fat \%} = \frac{fatweight}{sampleweight} \; X \; 100$$

Peroxide value: It was determined according to AOAC, (1991) by dissolving 5 grams of the sample in 30 ml of acetic acid solution (60% glacial acetic acid $CHOCH\text{-}CH_3$), then 5 ml of saturated Potassium iodine solution was added (10.4 grams of potassium iodine crystals in 5 ml of distilled hot water) and the solution was allowed to stand for exactly 1 minute, then 30 ml of distilled water was added. The solution should be orange-yellow in color. The solution was then titrated with 0.1 normal sodium sulphate dissolved in 1000 ml distilled water ($Na_2S_2O_3.5H_2O$). A few drops of stable starch indicator were then added to give a bride blue color; titration was continued until the color was disappeared.

Calculation:

$$\text{Mile equivalent of peroxide per 1000 grams} = \frac{(mlofThio)(N)(1000)}{weightingram}$$

Microbiological analysis:

Total Count of Bacteria: Each swab sample was emerged in 9 ml normal saline in a test tube and was shaken well and it was serially diluted in normal saline to 10^{-4} and 50 microliters from dilutions were spread over a petri dish containing plate count media and was incubated at 37°C for 48 hours, then total bacterial colony count was done. (Miller etal,1993).

Staphylococcus aureus*:* From suitable dilution of meat product sample, 0.1 ml was aseptically transferred into sterile Petri dish containing Baired-parker medium. The inoculums were spread all over the plates using sterile bent glass rod. Plates were then incubated 37C° for 24 hours. After the period of incubation had been finished the plates were examined. Staphylococcus aureus after 24 hours appear black shiny convex and surrounded by a zone of clearing 2-5mm in width of colony (Miller *etal*,1993).

Salmonella Spp.: Ten grams of meat product samples were aseptically weighed and mixed well with 100 ml sterile broth, then incubator at 37 C° for 24 hours. Then ten ml were aseptically drawn and added to 100 ml sterile broth. The broth was incubated at 37C for 24 hours. A loop full of 24 hours incubate was transfer aseptically into sterilizes selenite cysteine broth and incubate at 37C for 24 hours. Using a loop full, streaking was carried out into solidified Bismuth sulphite agar plates and was incubating at 37 C for 24 hours. Black metallic shine discrete colonies indicated the presence of Salmonella. A confirmatory test was carried out by taking a discrete black sheen colonies and sub culturing it in triple sugar iron agar tube. After incubation the production of black color at the bottom of the tube confirmed the presence of salmonella (Barrow and Feltham,1993).

Escherichia coli.: The medium used in this test was EC broth (Escherichia Coli Media) from every tube showing positive result in the presumptive test incubated atest tube of EC broth containing Durham tube. The tubes were incubated at 44.5 C for 24 hours. Tube showing any amount of gas was concentrated positive then the most probable number (MPN) was recorded for further confirmation of tubes of EC showing positive result at 44.5 C 24 hours were streaked

on Eosin Methylene Blue (EMP) agar plates. The plates were incubated at 37 C for 48 hours. Colonies of E.coli with green metallic shine gave a positive taste (Barrow and Feltham,1993).

Total Moulds and Yeasts: From suitable dilutions of sample 0.1 ml was aseptically transferred onto solidified potato dextrose agar containing 0.1g Cholraphenicol per one liter of medium to inhibit bacterial growth. The sample was spread all over the plates using sterile bent glass rod plates were then incubated at 28C for 72 hours. Colonies were counted by using a colony counter and the results were presented as cfu/g (Andrews and Richard, 2005).

RESULTS AND DISCUSSION

Results:

Table (1) Chemical analysis and pH value of meat

Content	A	B	C
Moisture	67.20	64.81	65.74
Protein	19.85	18.98	19.77
Fat	12.67	12.30	11.87
Ash	1.16	1.02	1.18
Peroxide value	1.53	1.96	1.18
pH value	5.9	6	5.8

Table (2): Mean values and their standard errors of total viable count of bacteria ($\log_{10}$cfu/g) of carcasses at different sites at the three slaughterhouses

Treatment	Slaughterhouses		
	A	B	C
Skinning	2.93[e] ±0.06	4.97[ab] ±0.04	5.02[a] ±0.03
Evisceration	3.43[c] ±0.04	4.99[a] ±0.04	5.03[a] ±0.02
Inspection	3.38[c] ±0.02	4.93[b] ±0.04	5.01[a] ±0.03
Washing	3.28[d] ±0.03	4.93[b] ±0.04	4.99[a] ±0.02
Shipping	3.29[d] ±0.04	4.92[b] ±0.04	5.00[a] ±0.02
Lsd[0.05]	0.05273[*]		
SE±	0.01826		

abcde

Values are mean ± SD.

Mean value(s) having different superscript(s) in columns and rows are significantly different (P≤0.05) according to DMRT.

Table (3): Mean values and their standard errors of total viable count of bacteria (log_{10}cfu/g) of worker hands at five sites at each a slaughterhouse

Treatment	Slaughterhouses		
	A	**B**	**C**
Skinning	4.50[cd] ±0.05	5.02[b] ±0.60	5.37[a] ±0.03
Evisceration	4.65[c] ±0.03	5.47[a] ±0.03	5.56[a] ±0.04
Inspection	4.29[d] ±0.04	5.00[b] ±0.04	5.01[b] ±0.03
Washing	4.30[d] ±0.03	4.99[b] ±0.02	5.01[b] ±0.01
Shipping	4.29[d] ±0.03	4.98[b] ±0.02	5.00[b] ±0.02
Lsd$_{0.05}$	0.2837*		
SE±	0.09129		

abcd

Values are mean ± SD.

Mean value(s) having different superscript(s) in columns and rows are significantly different (P≤0.05) according to DMRT.

Table (4): Mean values and their standard errors of total viable count of bacteria (log_{10}cfu/g) of air at different sites at the three slaughterhouses

Treatment	Slaughterhouses		
	A	**B**	**C**
Skinning	1.72[c] ±0.03	2.98[a] ±0.02	3.00[a] ±0.03
Evisceration	1.80[b] ±0.02	2.96[a] ±0.06	3.00[a] ±0.02
Inspection	1.78[b] ±0.02	2.94[a] ±0.06	3.00[a] ±0.02
Washing	1.79[b] ±0.01	2.96[a] ±0.03	2.99[a] ±0.02
Shipping	1.77[bc] ±0.01	2.98[a] ±0.02	3.00[a] ±0.02
Lsd$_{0.05}$	0.05273*		
SE±	0.01826		

abc

Values are mean ± SD.

Mean value(s) having different superscript(s) in columns and rows are significantly different (P≤0.05) according to DMRT.

Table (5): Mean values and their standard errors of total viable count of bacteria (log$_{10}$cfu/g) of walls at different sites at the three slaughterhouses

Treatment	Slaughterhouse		
	A	**B**	**C**
Skinning	4.62[gh] ±0.06	5.40[abc] ±0.03	5.41[ab] ±0.01
Evisceration	4.69[f] ±0.02	5.39[abc] ±0.03	5.43[a] ±0.01
Inspection	4.58[h] ±0.02	5.29[e] ±0.03	5.36[bcd] ±0.02
Washing	4.61[gh] ±0.03	5.41[ab] ±0.02	5.34[cde] ±0.02
Shipping	4.66[fg] ±0.03	5.36[bcd] ±0.02	5.33[de] ±0.03
Lsd$_{0.05}$	0.05273*		
SE±	0.01826		

abcdefgh

Values are mean ± SD.

Mean value(s) having different superscript(s) in columns and rows are significantly different (P≤0.05) according to DMRT.

Table (6): Mean values and their standard errors of total viable count of bacteria (log$_{10}$cfu/g) of floor at different sites at the three slaughterhouses

Treatment	Slaughterhouses		
	A	**B**	**C**
Skinning	4.72[e] ±0.04	5.90[b] ±0.02	5.65[a] ±0.02
Evisceration	4.72[e] ±0.03	5.53[c] ±0.04	5.67[a] ±0.02
Inspection	4.68[e] ±0.02	5.49[c] ±0.01	5.60[b] ±0.03
Washing	4.70[e] ±0.02	5.37[d] ±0.01	5.67[a] ±0.02
Shipping	4.70[e] ±0.05	5.37[d] ±0.03	5.59[b] ±0.02
Lsd$_{0.05}$	0.0273*		
SE±	0.01826		

abcde

Values are mean ± SD.

Mean value(s) having different superscript(s) in columns and rows are significantly different (P≤0.05) according to DMRT.

Table (7): Mean values and their standard errors of total viable count of bacteria ($\log_{10}$cfu/g) of knives at different sites at the three slaughterhouses

Treatment	Slaughterhouses		
	A	**B**	**C**
Skinning	4.71[d] ±0.07	4.98[a] ±0.03	5.01[a] ±0.01
Evisceration	4.79[c] ±0.01	5.01[a] ±0.03	5.00[a] ±0.02
Inspection	4.38[e] ±0.04	4.88[b] ±0.02	4.98[a] ±0.02
Washing	-	-	-
Shipping	-	-	-
Lsd$_{0.05}$	0.05425*		
SE±	0.01826		

abcde

Values are mean ± SD.
Mean value(s) having different superscript(s) in columns and rows are significantly different (P≤0.05) according to DMRT.

Table (8): Mean values and their standard errors of total viable count of bacteria ($\log_{10}$cfu/g) of hooks at different sites at the three slaughterhouses

Treatment	Slaughterhouses		
	A	**B**	**C**
Skinning	4.79[c] ±0.01	4.93[e] ±0.07	5.01[a] ±0.01
Evisceration	4.80[c] ±0.02	4.99[ab] ±0.01	5.00[a] ±0.01
Inspection	4.79[c] ±0.01	4.97[ab] ±0.02	5.01[a] ±0.03
Washing	4.76[ac] ±0.03	4.97[ab] ±0.04	5.00[a] ±0.03
Shipping	4.77[c] ±0.01	4.97[ab] ±0.01	5.00[a] ±0.02
Lsd$_{0.05}$	0.05273*		
SE±	0.1826		

abc

Values are mean ± SD.
Mean value(s) having different superscript(s) in columns and rows are significantly different (P≤0.05) according to DMRT.

Table (9): Mean values and their standard errors of total viable count of bacteria ($\log_{10}$cfu/g) of water at the three slaughterhouses

Slaughterhouses	Total viable count ofbacteria ($\log_{10}$cfu/g)
A	4.80^a ±0.18
B	4.82^a ±0.16
C	4.84^a ±0.13
Lsd$_{0.05}$	$0.2941^{n.s}$
SE±	0.0587

a

Values are mean ± SD.

Mean value(s) having different superscript(s) in a column are significantly different (P≤0.05) according to DMRT.

Table (10) Detection of Staphylococcus aureu

Slaughterhouses	Carcass	hands	Air	wall	Floor	Knives	hooks	Water
A	-ve	-ve	-ve	-ve	-ve	-ve	-ve	-ve
	-ve	-ve	-ve	- ve	-ve	-ve	-ve	-ve
	-ve	+ve	-ve	-ve	-ve	-ve	-ve	-ve
B	+ve	+ve	+ve	+ve	+ve	+ve	-ve	-ve
	-ve	+ve	-ve	-ve	-ve	-ve	+ve	-ve
	+ve	+ve	-ve	-ve	-ve	+ve	-ve	-ve
C	+ve	+ve	-ve	-ve	+ve	+ve	+ve	-ve
	+ve	+ve	-ve	-ve	-ve	+ve	-ve	-ve
	+ve	+ve	-ve	+ve	-ve	+ve	+ve	-ve

Table (11) Detection of Salmonella spp.

Slaughterhouses	Carcass	hands	Air	Wall	Floor	Knives	hooks	Water
A	-ve	-ve	-ve	-ve	-ve	-ve	-ve	-ve
	-ve	-ve	-ve	- ve	-ve	-ve	-ve	-ve
	-ve	-ve	-ve	-ve	-ve	-ve	-ve	-ve
B	-ve	-ve	-ve	-ve	-ve	-ve	-ve	-ve
	-ve	-ve	-ve	-ve	-ve	-ve	-ve	-ve
	-ve	-ve	-ve	-ve	-ve	-ve	-ve	-ve
C	-ve	-ve	-ve	-ve	-ve	-ve	-ve	-ve
	-ve	-ve	-ve	-ve	-ve	-ve	-ve	-ve
	-ve	-ve	-ve	-ve	-ve	-ve	-ve	-ve

Table (12) Detection of Escherichia Coli

Slaughterhouses	Carcass	hands	Air	Wall	Floor	Knives	hooks	Water
A	-ve	-ve	-ve	-ve	-ve	-ve	-ve	-ve
	-ve	-ve	-ve	- ve	-ve	-ve	-ve	-ve
	Ve	-ve	-ve	-ve	-ve	-ve	-ve	-ve
B	-ve	-ve	-ve	-ve	-ve	-ve	-ve	-ve
	-ve	-ve	-ve	-ve	-ve	-ve	-ve	-ve
	-ve	-ve	-ve	-ve	-ve	-ve	-ve	-ve
C	-ve	-ve	-ve	-ve	-ve	-ve	-ve	-ve
	-ve	-ve	-ve	-ve	-ve	-ve	-ve	-ve
	-ve	-ve	-ve	-ve	-ve	-ve	-ve	-ve

Table (13) Detection of Total Moulds and Yeasts

Slaughterhouses	Carcass	hands	Air	Wall	Floor	Knives	hooks	Water
A	-ve	-ve	-ve	-ve	-ve	-ve	-ve	-ve
	-ve	-ve	-ve	-ve	-ve	-ve	-ve	-ve
	-ve	-ve	-ve	-ve	-ve	-ve	-ve	-ve
B	+ve	+ve	-ve	-ve	-ve	-ve	+ve	+ve
	+ve	-ve	-ve	-ve	+ve	+ve	-ve	+ve
	-ve	+ve	-ve	+ve	-ve	+ve	+ve	-ve
C	+ve	+ve	-ve	-ve	-ve	+ve	-ve	+ve
	+ve	+ve	-ve	-ve	+ve	-ve	+ve	-ve
	+ve	-ve	-ve	+ve	-ve	+ve	+ve	+ve

DISCUSSION

The data in table (1) explains the results of chemical analysis and the pH value of meat samples taken from three slaughterhouses (A, B, and C) in Khartoum state. The results showed that the mean value of moisture content is (65.58), protein content is (19.53), fat is (12.27), ash is (1.12) and that of peroxide value is (1.77). The results also showed that the mean value of the pH value of the meat at the three slaughterhouses is (5.9). This result is in agree with (Wafa, 2009), who reported that the highest value of pH was (6.00), while the lowest was (5.7).

The data in table (2) explains the mean values and their standard errors of total viable count of bacteria in carcasses at different sites in the slaughter halls at the three different slaughterhouses. The data explained that the highest mean of values at the three slaughterhouses is (5.03) at the evisceration area at a slaughterhouse (C) whereas the lowest is (2.93) at the skinning area at a slaughterhouse (A). This variation may due to cleaning and hygienic practices followed at the three slaughterhouses and it may

also due to intestinal rupture or dirty hands and clothes at the evisceration area. These results are in agree with (Wafa , 2009), who found that the total viable count of bacteria at skinning area was (3.12), but the results are in disagree with her at the evisceration area where she found that the total viable count of bacterial was (3.88).

The data in table (3) explains the mean values and their standard errors of total viable count of bacteria in workers hands at different sites in the production line at the three slaughterhouses. The data explained that the highest mean value at the three slaughterhouses is (5.56) at the evisceration area at a slaughterhouse (C) whereas the lowest is (4.29) at the inspection and shipping areas at a slaughterhouse (A).This variation may due to poor personal hygiene or bad habits practiced by the workers such as sneezing and it may also due to intestinal rupture at evisceration area. These findings are in agree with (Wafa, 2009), who found that the highest mean of values of total viable count of bacteria in workers hands was (5.59) while the lowest was (3.27) and the average value was (4.43), but the results are in disagree with (Fatima, 2004) who reported that the mean of values of total count of bacteria in workers hands at skinning area was (6.15).

The data in table (4) explains the mean of values and their standard errors of total viable count of bacteria in air at different sites in the slaughterhouses halls at the three different slaughterhouses. The data explained that the highest mean value at the three slaughterhouses is (3.00) at the skinning, evisceration, inspection and shipping areas at a slaughterhouse (C) while the lowest is (1.72) at the skinning area at a slaughterhouse (A).This variation may due to cleaning and hygienic practices followed at the three slaughterhouses or it may also due to differences in ventilation and exchange techniques at the three slaughterhouses and it may also due to number of workers and their continuous talking without wearing muzzles.

These results are in agree with (Wafa , 2009), who found that the total viable count of bacteria in air at skinning area was (1.71) but disagree with her at evisceration and inspection areas where she found that the total viable count of bacteria in air at these areas were(1.91) and (1.06) respectively.

The data in table (5) explains the mean of values and their standard errors of total viable count of bacteria in walls at different

sites in the slaughter halls at the three slaughterhouses. The data explained that the highest mean value at the three slaughterhouses is (5.43) at the evisceration area at a slaughterhouse (C) while the lowest is (4.58) at the inspection area at a slaughterhouse (A).This variation may due to cleaning and hygienic practices followed at the three slaughterhouses and it may also due to intestinal rupture or dirty hands and clothes at evisceration area. These results are in agree with (Fatima , 2004), who found that the mean of values of total viable count of bacteria in walls at the beginning of the slaughter hall was (5.42) and at the end of the slaughter hall was (4.78).

The data in table (6) explains the mean of values and their standard errors of total viable count of bacteria in floor at different sites in the slaughter halls at the three slaughterhouses. The data explained that the highest mean of values at the three slaughterhouses is (5.90) at the skinning area at slaughterhouse (B) while the lowest is (4.68) at the inspection area at slaughterhouse (A). This variation may due to cleaning and hygienic practices followed at the three slaughterhouses or it may due to presence of dirty animals in the slaughter hall and it may also due to continuous movement of workers from area to another in the slaughter hall.

These results are in agree with (Fatima, 2004), who found that the mean values of total viable count of bacteria in floor at the beginning of the slaughter hall was (5.86) but the results are in disagree with her at the end of the slaughter hall where she found that the total viable count of bacteria was (6.18).

The data in table (7) explains the mean of values and their standard errors of total viable count of bacteria in knives at different sites in the slaughter halls at the three slaughterhouses. The data explained that the highest mean of values at the three slaughterhouses is (5.01) at the evisceration area at slaughterhouse (B) and at the skinning area at slaughterhouse (C) while the lowest is (4.38) at the inspection area at slaughterhouse (A). This variation may due to cleaning and sterilization methods followed at the three slaughterhouses. These results are in agree with (Wafa, 2009), who found that the highest total viable count of bacterial was (5.41) while the lowest was (3.85) and the average was (4.64), the results are in disagree with (Fatima ,2004), who reported that the mean of values of total viable count of bacteria at evisceration and inspection areas were (6.30) and (5.47) respectively.

The data in table (8) explains the mean of values and their standards error of total viable count of bacteria in hooks at different sites in the slaughter halls at the three slaughterhouses. The data explained that the highest mean value at the three slaughterhouses is (5.01) at the skinning and inspection areas at a slaughterhouse (C) while the lowest is (4.76) at the washing area at a slaughterhouse (A). This variation may due to differences in cleaning and hygienic practices followed at the three slaughterhouses and may also due to differences in sanitizing agents used. These findings are in agree with (Wafa , 2009), who found that the highest mean of values of total viable count of bacteria in hooks was (5.59) while the lowest was (3.28) and the average was (4.58).

The data in table (9) explains the mean values and their standard errors of total viable count of bacteria in water at three slaughterhouses in Khartoum state.   The data showed that the highest mean of values is (4.84) at a slaughterhouse (C) while the lowest is (4.80) at a slaughterhouse (A). This variation may due to differences in sanitizing agents used at the three different slaughterhouses. These results are in disagree with (Fatima, 2004), who reported that the mean of values of total viable count of bacteria in water used in a slaughterhouse was (2.34), the results are also in disagree with (Adedji*etal*, 2013), who found that the total viable count of bacteria in water was ranged between (1.98-3.56).

The data in table (10) explains Staphylococcus aureus detection in carcasses, workers hands, air, walls, floors, knives, hooks and water at the three slaughterhouses (A), (B) and (C).

Results showed that at a slaughterhouse (A) staphylococcus aureus was detected only in workers hands, while at a slaughterhouse (B) and (C) staphylococcus was detected in carcasses, hands, walls, floor, knives and hooks. This variation may due differences in cleaning, sanitation and hygienic operations followed at the three slaughterhouses and it may also due to poor personal hygiene or bad habits practiced by the workers such as sneezing.

These results are in agree with (Ahmed, 2004), who detected staphylococcus aureus in carcasses, workers hands and knives, the results are also in agree with (Fatima , 2004), who detected staphylococcus aureus in carcasses, workers hands, walls and floors and the results are also in agree with (Tabitha, 2007), who detected staphylococcus genera at different sites in slaughterhouses.

The data in table (11) explains Salmonella spp. detection in carcasses, workers hands, air, walls, floors, knives, hooks and water at the three slaughterhouses.

Results showed that No Salmonella spp. were detected at the three slaughterhouses. These results are in disagree with (Fatima, 2004), who detected enteric bacteria in carcasses, workers hands, air, floor and knives, the results are also in disagree with (Alrasheed, 2007), who detected salmonella spp. in carcasses.

The data in table (12) explains Escherichia coli detection in carcasses, workers hands, air, walls, floors, knives, hooks and water at the three slaughterhouses.

Results showed that No E. coli were detected at the three slaughterhouses. These results are in disagree with (Ahmed, 2004), who detected E. coli from workers hands and knives, the results are also in disagree with (Fatima, 2004), who detected enteric bacteria in carcasses, workers hands, air, floor and knives, the results are also in disagree with (Alrasheed , 2007), who detected E. coli in carcasses.

The data in table (13) explains Total moulds and yeasts detection in carcasses, workers hands, air, walls, floors, knives, hooks and water at the three slaughterhouses. Results showed that at slaughterhouse (A) no moulds and yeasts were detected. At slaughterhouse (B) and (C) moulds and yeasts were detected in carcasses, worker's hands, walls, floors, knives, hooks and water. This variation may due to differences in cleaning, sanitation and hygienic practices at the three slaughterhouses. These results are in agree with (Alrasheed , 2007), who detected moulds and yeasts in carcasses.

The variation in all results between the three slaughterhouses may due to differences in hygienic practices, sanitation and sanitizing agents used, cleaning and sterilization methods, differences in ventilation techniques and may also due to differences in personal hygiene.

CONCLUSION

- The study revealed that staphylococcus aureus was detected at a slaughterhouse (A) in worker's hands, while staphylococcus aureus, moulds and yeasts were detected at

slaughterhouses (B) and (C) in carcasses, worker's hands, walls, floor, knives and hooks.

- No Salmonella spp or E. coli were detected at the three slaughterhouses.
- The study revealed that the evisceration area was the dirtiest area at the three slaughterhouses
- The study showed that the sources of contamination of meat at the three slaughterhouses were worker hands, walls, floor, knives and hooks.
- The study also revealed that the highest contamination was showed at a slaughterhouse (C) because the traditional one, while the lowest was showed at a slaughterhouse (A) because modern one.

RECOMMENDATION

Implementation of good hygienic practices, fumigation and good ventilation measures for air are needed, also teaching and training should be considering, Finally, further researches for Implementation strict meat hygiene system.

REFERENCES

1. Adedji, O. D, Oladeru. B. K. and Olay. I. L. (2013) Role of water in food safety. *Journal of environmental science.*151 (3) 76-83.
2. Ahmed. K. K.(2004). Meat Hygiene Assessment in a Slaughter House in Khartoum State. M.Sc. Thesis. Faculty of veterinary science. University of Khartoum.
3. Alrasheed, A. A. (2007). Bacteriological quality of meat at slaughterhouse. Phd. Thesis. Faculty of veterinary science. University of Khartoum.
4. Andrews, W. J and Richard, G. P (2005) Food borne pathogens. Microbiological and Molecular Biology. Caister academic press 2nded. Cambridge. U.K. 321-327.
5. AOAC,1991. Association of Official international Agricultural Chemists. Journal of AOAC international

6. Barrow, G. I. and Feltham, R. K. (1993). Cowan and Steel manual for identification 0f medical bacteria. Cambridge university press.67-69.

7. Codex Allimentarius Commission, FAO/ WHO Food and Agriculture organization/World Health organization, 2009. Food Safety. 54-56. Rome. Italy.

8. Ejobi, F. M. (2012). Manual in Building HACCP capacity for exportation of meat. 2nd. ed. Makerere university press. Kampala. Uganda. 57-63.

9. Fatima, E. H.(2004). Sanitation and its impaction on meat preparation at AlKadro export abattoir in Khartoum state. M.Sc. Thesis. Faculty of veterinary science. University of Khartoum.

10. Gracey, J. F. (1981). Thornton's meat hygiene. 6$^{th.}$ ed. BailliereTindall. London. England.

11. John, D.H. and Holy, E. S. (2003). Improving slaughter hygiene using HACCP and monitoring. *Journal of food protection*.431: 239-246.

12. Miller, J. M, Rhoden, D. L and Hancock, G.A. (1993) Identification of staphylococcus spp. *J*ournal of clinical microbiology 31(3) 490-493.

13. Myers, R. G.(2010) One hundred years of pH *Journal of Chemical Education*. 87 (1) 30-32.

14. Oxoid, L.J. (1981) Oxoid manual of culture media and other laboratory services. 4th ed. Oxoid limited press. London. U.K. 256-260.

15. Sally, S. K. (2016). Meat safety and quality. Journal *of food protection 234*: 178-181.

16. Tabitha. S. M. (2009). Bacteriological quality of meat in Lesotho. Thesis.   Faculty of veterinary science. University of Pretoria.

17. Wafa. E. E. (2009). Evaluation of meat safety based on pre-requisite program of HACCP in AlKadro slaughterhouse. M.Sc. Thesis. Faculty of veterinary science. University of Khartoum.

18. Womack, G. J. and Allan, B. N. (1987). Hand book of Basic food microbiology. ERS. Lowa. USA.4th ed.: 233-289.