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Evaluation of Poultry Meat Safety Based on ISO 22000 As Food Safety Management System

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Abstract: This study was conducted to evaluate the quality and safety of poultry meat from slaughter plant at various levels of standard (modern full automated plant, full automated plant, automated plant). The study considered the role of equipment used in plants beside the different production steps and their impact on product quality and safety. The microbial study showed that water from scalding and chilling tank from slaughter A. B recorded highly bacterial growth (uncountable). While the counter surface of slaughter B was clean from bacteria. The study showed highly significant differences ($p \leq 0.05$) with respect to chemical and physical properties where the poultry A recorded higher mean value of moisture content while the poultry B recorded the highest mean value of protein and lowest mean value of peroxide value and poultry C recorded the highest mean value of peroxide value and fat content. The study of production steps revealed that there were four important steps (evisceration, reprocessing, chilling, finished product storage) that could be a source of contamination in absence of control and monitoring which are defined as critical control point. The research findings Implementation of ISO22000 speeds and simplifies processes, increase efficiency and reduces costs. Also improves food safety and hazard control. Finally, this study has suggested the application of food safety management system (ISO 22000) to Sudan poultry slaughter plant as meat safety tool to ensure the safety of poultry products.

Key words: Poultry meat, slaughter plant, food safety

INTRODUCTION

A complete quality control system consists of a cycle which begins and ends with consumers' requirements or specifications. The specifications are the heart of the system and the purpose of quality control is to satisfy the buyers' specifications at the least cost (Ihekoronye *et al.*, 1992).

In recent years there has been a large increase in the production and consumption of meat and meat products, at the same time there is an increasing consumer demand for a health, safe and balance diet (Ordonez *et al.*, 2000).

Food safety is a global issue affecting billions of people who suffer from diseases caused by contaminated food. This is one of the most wide spread health problems and an important cause of reduced economic productivity. Both developed and developing countries share concerns over food safety as international food trade and cross-border Movements of people and live animals increase (Yong, 2009).

Many developing countries in the region, however, have only a few food-exporting, food products from such countries cannot compete well in the international food market due to the lack of quality (Alemanno, 2007).

This situation demands immediate attention to improve the quality perception of the food-processing industry. This could be achieved by improvement concepts such as food safety management system (ISO2200) including Hazard Analysis and Critical Control Point (HACCP) which has become the internationally recognized system for the management of food safety for all companies (Alemanno, 2007).

The International Food Safety Management Standard, ISO 22000, was developed in response to a need for a worldwide standard supported by an independent, international organization which would encourage harmonization of national and private standards for food safety management. ISO 22000 uses generally recognized methods of food safety management such as interactive communication across the food chain, system management, control of food safety hazards through PRPs and HACCP plans and continual improvement as well as periodic updating of the management system. ISO 22000:2005 integrates both the quality management system (ISO 9001:2000) and HACCP system (Alemanno, 2007).

Meat and poultry products are sensitive to micro-organism contamination (bacteria, viruses and parasites) Bacterial contamination and growth is a problem because it may result in food borne illness. To improve product safety, the meat and poultry industries are adopting a process control system known as "hazard analysis critical control point (HACCP) (Rooney and Wall, 2003).

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Raw chicken and poultry can carry the Salmonella bacteria which is responsible for more cases of food poisoning than any other pathogen. Fortunately it's easy to avoid getting sick from chicken and poultry, as long as you follow safe food handling practices (Arvanitoyannis, and Hadjicostas, 2001) With greater consumer awareness of food hygiene and safety issues, the need is greater than ever for food processors and establishments to develop and maintain an effective food safety management system. Your journey towards HACCP or ISO 22000 compliance and/or certification begins with the Food Safety Manual and associated procedures. This study provides guidance to implementation food safety management system (ISO 22000) include the implementation of HACCP systems in Poultry slaughter plant (Arvanitoyannis and Hadjicostas, 2001).
The research aimed to evaluate safety of poultry meat produce by various slaughters. The second objective is to study the source and type of hazards in poultry slaughter lines. And possibility of implementation ISO 22000 in poultry line.

MATERIALS AND METHODS

Sample: From three poultry plants we take six samples with tow replicates in separated time from different six steps in poultry slaughter production line and subjected to microbiological and proximate analysis the steps including, after defeathering-evisceration-washing-after immersion chilling in (plant c use dry chilling so we take the sample from chilling room) -after backing-after freezing bellow-8°C. Swabs from tables and staff hands were taken and water investigation was done.

Analytical methods

Physical properties

pH value: The pH value measured according to (ISO-2917, 1999) The pH of the muscles was determined by homogenizing the muscle samples with distilled water at a ratio of 1:5 (wt/vol). The homogenate was subjected to pH measurement using a combined glass electrode pH meter.

Chemical properties: Determination of moisture content, ash content, fat content and crude protein content were performed according to AOAC, 1999.

Peroxide Value (PV): Peroxide Value (PV) of fat indicates not only the extent of overall oxidation but also resistance of fat to oxidation. The (Pv) of the fat samples was determined according to the AOAC method (1984).
One gram of the sample was accurately weighed into 250 ml conical flask. Thirty mls of a mixture of glacial acetic acid and chloroform (3:2) were added and the solution was swirled gently to dissolve the fat. A 0.5 ml of 0.1 N KL was added to the flask and then the content of the flask was left to stand for one minute before adding 30 ml of distilled water. After awhile, the content was titrated with 0.01 N sodium thiosulphate until the yellow colour almost disappeared. A 0.5 ml of 1% starch solution was added and the titration continued with vigorous shaking until the blue colour completely disappeared. The number of ml of 0.01s sodium thiosulphate required (a) were recorded. The same process was repeated for blanks. The number of mls of 0.01 N sodium thiosulphate required by the blank (b) was recorded.

Calculation:

$$\text{Peroxide Value (PV) of meat fat} = (b-a) \times N \times 100/S$$

Where:

a : Reading of fat sample (ml)
b : Reading (ml)
s : Original weight of fat sample (gm)

Microbiological analysis

Total bacterial count: 23.5 grams of plate count agar weighed and dispersed in one liter of deionized water brought to boiling with frequent stirring to dissolve the ingredient.
Dispensed into tubes and sterilized by autoclaving at 121c for 15 minutes cooled to 46 c for three hours prior to use.
Total viable count was carried out using the pour plate count method as described by Hrrigan (1998) 1 ml of solution from suitable dilution was transferred aseptically into sterile Petri dishes to each dilution 15 ml melted and cooled (45°C) plate count agar was added. The inoculums was mixed with medium and allowed to solidify. The plates were incubated in an incubator at 37°C for 48 hours. A colony counter was used to count viable bacteria .

Mould and yeast enumeration: 50 grams of malt-extract agar weighed and dispersed 1 litre of deionized water, allowed to soak for 10 minutes, swirled to mix then sterilized at 121°C for 10 minutes. 5 ml vial of XO37 added to lower the PH of medium to 3.5-4.0 cooled to 47°C before making additions and pouring plates. from suitable dilutions of sample 0.1 ml was aseptically transferred onto solidified malt-extract agar containing 0.1gm chloramphenicol per one litre of medium to inhibit bacterial growth. The sample was spread all over the plates used sterile bent glass rod. Plates were then incubated at 28°C for 48 hours as described by Harrigan, 1998 and Harrigan and Mac Cance, 1976.

***Staphylococcus* spp.:** 149g of the staphylococcus 110 suspended in 1 litre of purified water. Mixed thoroughly

heated with frequent agitation and boiled for I minute to completely dissolve the powder sterilized by autoclaved at 121°C for 10 minutes. Evenly disperse the precipitate when dispensing.
Test samples of the finished product for performance using stable, typical control cultures. From suitable dilutions, 0.1 ml was spread on dried staphylococcus medium 110 and the plates were incubated at 37°C for 24 hours as described by (Harrigan, 1998) and (Harrigan and Mac Cance, 1976).

***Salmonella* spp.:** 63 grams of salmonella shegella media powder was suspended in 1 liter distilled water. Steamed to dissolve completely, the pH was adjusted to 7.4 and the medium was then sterilized by Flaming. Then 1 ml aliquot from suitable dilution was transferred aseptically into solifed Petri dis. (Harrigan and Mac Cance, 1976).

***E. coli*:** 36.58 grams of Hichrome *E. coli* Media powder was suspended in 1 liter distilled water. Steamed to dissolve completely, the pH was adjusted to 7.4 and the medium was then sterilized by autoclaving at 121°C for 20 min. Then 1 ml aliquot from suitable dilution was transferred aseptically into solifed Petri dish (Harrigan and Mac cance, 1976).

Statistical analysis: Data generated was subjected to SAS software package. Two-factor RCD was performed, where Factor A = Treatment and Factor B = Condition of samples. Means were then tested and separated using DMRT as reported by Steel *et al.* (1997).
The microbiological data was transformed using log 10 CFU/g before running analysis.

RESULTS AND DISCUSSION

Chemical properties of poultry meat from different production lines: The poultry meat was collected from three different modern automated slaughters (A, B, C). Were analyzed for moisture content the data Fig. 1 showed significant differences among the three samples, where the poultry from slaughter C (automated slaughter plant) reported the lowest moisture content (70.25), compared to the poultry from A, B where the moisture content of poultry A was relatively higher (77.62) than poultry B (76.30), respectively, this variation in moisture content may be due to variation of chilling method where the slaughter C (automated slaughter plant) use air chilling method and other plants use the chilling water tank.
These data are in agreement with finding of Alan (2001) who found air chilling carcasses can have less moisture content, reflecting the drying effect of this chilling method, The change that occurred during frozen storage in moisture content in Fig. 1 is one of the problems associated with the frozen meat, the results show that

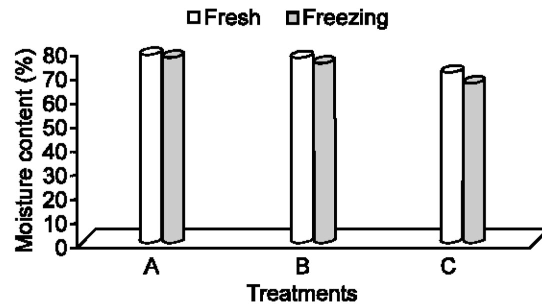

Fig. 1: Moisture content of the various treatments

the poultry from slaughter A(full automated slaughter plant) recorded the highest mean value of moisture content (76.47) followed by the poultry from slaughter B (73.88) and slaughter C (65.81), respectively.
This variation in moisture content may be due to effect of freezing in protein quality lead to protein denaturation which affect the ability of the protein to bind water, these result agreed with the finding of Miller *et al.* (1994) who reported that, the ability of the protein to bind water decrease as result of freezing and storage condition that effect moisture content.
Also the poultry samples analyzed for protein content Fig. 1 showed significant differences among the treatment samples where poultry A contained the highest mean value of protein (19.60) followed by poultry B (19.53) and poultry C (18.48), respectively.
Although the statistical analysis showed there were significant differences but, the actual data as it s may due to the slight different in poultry species.
Data in Fig. 1 showed there were no significant differences between the plants A, B for fat content and ash content where the average for fat is 0.82 and 0.95 for ash content, where the plant C show significant different were it show the highest mean value of fat and ash content (2.03, 1.30), respectively.
All plants did not showed significant change in fat and ash content after freezing.
The peroxide value of the different poultry samples Fig. 1 was significantly different. The highest mean of value for peroxide value reported by slaughter C (0.50) while slaughter A (0.45) B (0.22), respectively. The effect of freezing on the peroxide value is significant differ among samples were slaughter C show the highest mean value of peroxide value (1.35) were the slaughter B gave the lowest mean value of peroxide value (0.48), this could be due to storage condition.

Physical properties: The result of pH value in Fig. 2 showed significant differences among the treatment samples. The poultry A had highest pH value (6.17) while the poultry of the other slaughter B (5.63) and C (5.68) were not significantly different. This result could be due to the long time between slaughters and chill the carcass.

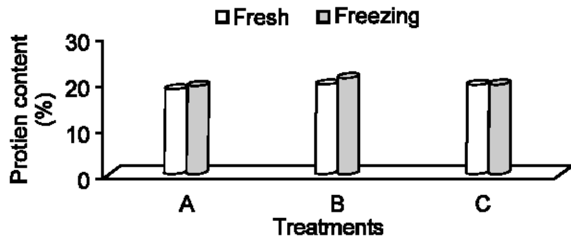

Fig. 2: Protein content of the various treatments

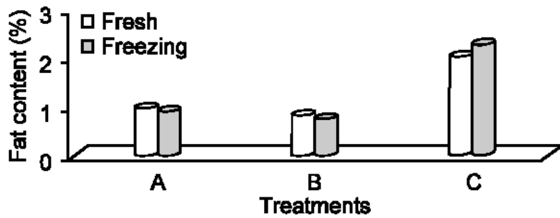

Fig. 3: Fat content of the various treatments

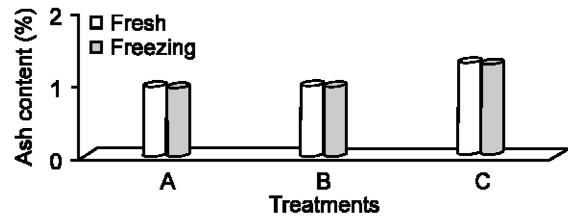

Fig. 4: Ash content of the various treatment

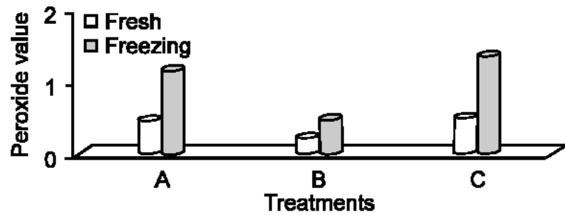

Fig. 5: Peroxide value of the various treatments

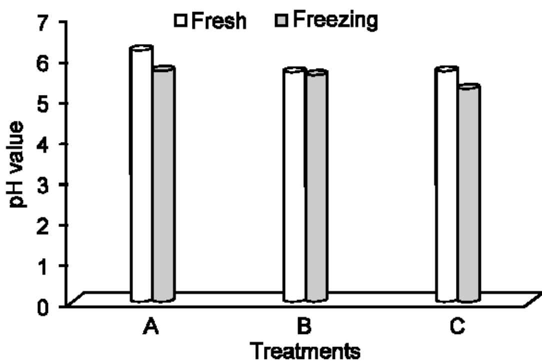

Fig. 6: pH value content of the various treatments

The result shows a decrease in pH value by storage in all samples this could be due to biochemical change

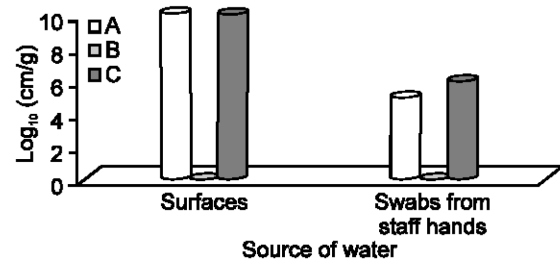

Fig. 7: Total viable count in equipment

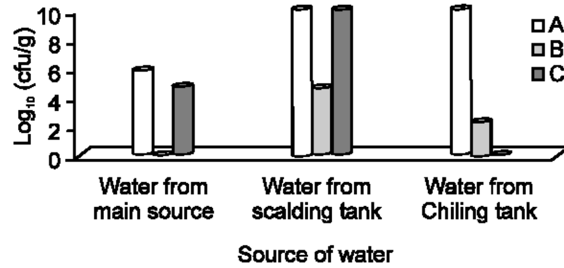

Fig. 8: Total viable count in slaughter water

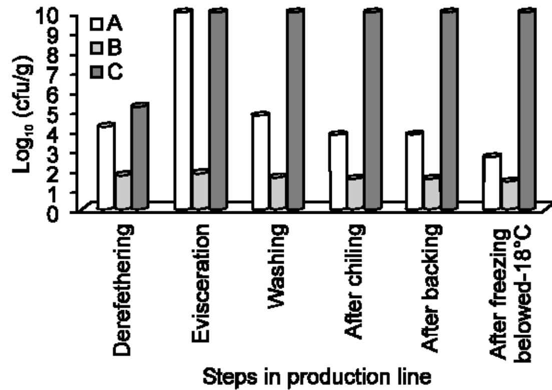

Fig. 9: Total viable count in production line

occurring during storage. The results are in agreement with the finding of Judge *et al.* (1989) who found that the pH value decrease during storage.

Microbial properties of poultry during different production steps

Microbiological properties of equipment: The result of the swabs analysis from counter surface and staff hands presented in Table 3, the highest mean value of total viable count of bacteria was reported by staff hand of slaughter C (5.9 x 10^5) followed by staff hand of slaughter A (4.9 x 10^4) while the staff hand of slaughter B did not show any microbial growth, the counter surface in slaughter A and C showed highly microbial growth and slaughter B did not show any microbial growth, this result due to used of microbial detergent on surface and hands, It had reported using microbial detergent

and disinfectant on surface and hands eliminated microbial growth.

The contamination of the staff hands with *Staphylococcus aureus*: The result of swabs analysis detecting the present of *Staphylococcus aureus* in the staff hands of slaughter A and C, While it did not detecting in staff hand of slaughter B. As showed in Table 4.

The present of *Staphylococcus aureus* indicate the lake of personal hygiene.

Water as sours of contamination in poultry slaughter plants: Table 5 showed the results of investigated water, the samples was taken from the main source of slaughter before enter the production line and from scalding tank and chilling tank.

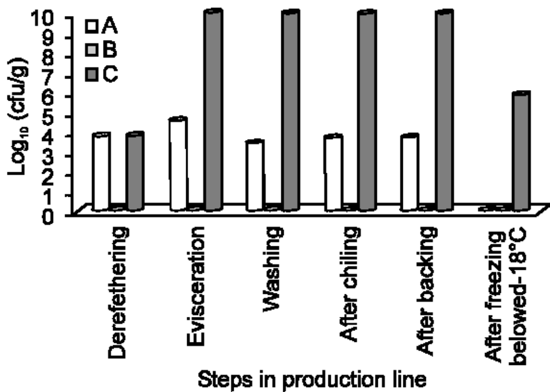

Fig. 10: *E. coli* in equipment

The water from main source of slaughter A showed the highest mean value of total viable count of bacteria (5.82) followed by slaughter C (4.70), respectively.

While the water from main source of slaughter B did not detecting microbial growth, this due to method used to treated water.

The water from scalding and chilling tank showed highly bacterial growth in slaughter A and C while the slaughter B showed the lowest total bacterial count. This could be due to the bird-to-bird contact via water results in a greater potential for spreading bacteria (including pathogens).

Table 6 showed the contamination of water by *E. coli*. The result showed that the water of main source of all slaughter plant free from *E. coli* but it detected in scalding and chilling tank these result could be due to that When birds are immersed in the scalding tank, some of the dirt, fecal material and other contaminants on the surface of the bird are removed and contaminate the scald water; hence, scalding could be a source of cross-contamination.

This result are agreement with the finding of Adriana *et al*. (2008) who said The microbial contamination of water from scald tank was 10^2 cfu/cm^3 at the beginning and after 3-4 hours, a count of 10^4 cfu/cm^3 has been recorded. Increasing of microbial contamination level is normally for scalding tanks with static regimes of water and it is followed by germs concentration resulted from the feathers and faeces.

Total viable count of Bacteria from different steps in production line of poultry: The result of total viable count of bacteria from different steps in production line showed in Table 7, the highest mean value was reported by the poultry from slaughter A and C (uncountable bacteria) in step tow evisceration while the

Table 1: Mean value and their standard errors (SE±) for chemical Properties of the various treatments

	Treatments*							
	A		B		C			
Independent variables	Fresh	Frozen	Fresh	Frozen	Fresh	Frozen	$LSD_{0.05}$	SE±
Moisture content (%)	77.62±0.08^a	76.47±0.06^b	76.30±0.26^b	73.88±0.35^c	70.25±0.32^d	65.81±0.45^e	0.6656*	0.2160
Protein content%	18.48±0.38^c	19.28±0.40^b	19.60±0.13^b	20.93±0.08^a	19.53±0.28^b	19.62±0.37^b	0.0500*	0.1623
Fat content (%)	0.97±0.02^b	0.91±0.08^b	0.82±0.08^b	0.75±0.08^b	2.03±0.08^a	2.29±0.08^a	0.5709*	0.1853
Ash content (%)	0.97±0.01^b	0.95±0.01^b	0.97±0.12^b	0.95±0.01^b	1.30±0.07^a	1.28±0.36^a	0.07956*	0.02582
Peroxide value	0.45±0.02^a	1.17±0.15^a	0.22±0.01^d	0.48±0.03^c	0.50±0.02^c	1.35±0.15^a	0.1591*	0.05164

Mean±SD value (s) bearing different superscript (s) within rows are significantly different ($P \leq 0.05$).
*A: Full automated slaughter plant. B: Modern full automated slaughter plant. C: automated slaughter plant.

Table 2: Mean value and their standard errors (SE±) for pH-value of the various treatments

	Treatments*							
	A		B		C			
Independent variables	Fresh	Frozen	Fresh	Frozen	Fresh	Frozen	LSD0.05	SE±
pH-value	6.17±0.03^a	5.67±0.25^b	5.63±0.07^b	5.57±0.04^b	5.68±0.01^b	5.23±0.01^c	0.1949*	0.06325

Mean±SD value(s) bearing different superscript(s) within rows are significantly different ($P \leq 0.05$).
*A: Full automated slaughter plant. B: Modern full automated slaughter plant. C: Automated slaughter plant.

Table 3: Mean value and their standard errors (SE±) for total viable Count of bacteria (log10 cfu/g) of equipment

	Treatments*		
Equipment	A	B	C
Surfaces	*uncounted	N.D[d]	*uncounted
Swabs from staff hands	**4.96±0.03[c]	N.D[d]	**5.93±0.00[b]
$LSD_{0.05}$	0.0005626*		
SE±	0.0001826		

Mean±SD value (s) bearing different superscript (s) within columns and rows are significantly different (P≤0.05).
*: Highly bacterial growth,
**: Medium bacterial growth,
ND: No bacterial growth detected.
*A: Full automated slaughter plant.
B: Modern full automated slaughter plant.
C: Automated slaughter plant.

Table 4: Detection of *Staphylococcus aureus* in the staff hands

	Treatments*		
Swabs	A	B	C
Swabs from staff hands	+	-	+

+: Positive; -: Negative.
*A: Full automated slaughter plant.
B: Modern full automated slaughter plant.
C: Automated slaughter plant.

Table 5: Mean value and their standard errors (SE±) for total viable Count of bacteria (log_{10} cfu/g) of the slaughters water

	Treatments*		
Samples	A	B	C
Water from main source	5.82±0.06[b]	0.00±0.00[f]	4.70±0.06[c]
Water from scalding tank	*uncounted±0.00[a]	4.62±0.00[d]	*uncounted±0.00[a]
Water from chilling tank	*uncounted±0.00[a]	2.25±0.00[e]	#
$LSD_{0.05}$	0.05425*		
SE±	0.1826		

Mean±SD value (s) bearing different superscript (s) within columns and rows are significantly different (P≤0.05).
#: Not available (slaughter C using dry chilling room).
*Uncountable bacterial growth.
*0.00: No bacterial growth.
*A: Full automated slaughter plant.
B: Modern full automated slaughter plant.
C: Automated slaughter plant.

lowest mean value of TVCB was reported by the slaughter B (1.43 x 10) after freezing.

The result showed highly increase in microbial load in step tow (evisceration) this result may be due to improper of removal of intestine where result of breakage intestine what result in fecal contamination of Caracas this result are agreement with the finding of Cunningham (1996) who said a Poor adjustment of evisceration machine can cause it to cut the intestine, resulting in fecal and bacterial contamination of the carcass.

The total count of mould and yeast in different step in Production line of poultry slaughter plant: The result in Table 8. Showed that total mould and yeast were not detected in all poultry samples. This result may be due to that poultry meat is not good media for mould and yeast growth.

Table 6: The effect of treatment on *E. coli* of the slaughters water

	Treatments*		
Samples	A	B	C
Water from main source	-	-	-
Water from scalding tank	+	+	+
Water from chilling tank	+	+	#

+: positive,
-: Negative.
*A: Full automated slaughter plant.
B: Modern full automated slaughter plant.
C: Automated slaughter plant.

The contamination with *Escherichia coli* during production line (cfu/g): The result presented in Table 9 revealed that the poultry produce by slaughter B did not show any *E. coli* growth even after storage, this could be due to Good Hygienic Practice (GHP), while poultry processed by slaughter C showed the highest mean value of *E. coli* (uncountable) which decreased greatly after freezing. Table also showed the highest mean value of *E. coli was* reported in step tow (evisceration), this could be due to improper handling of evisceration and this in agreement with Cunningham (1996) who said, Poor adjustment of machine can cause cut the intestine, resulting in fecal and bacterial contamination of the carcass.

The contamination with *Staphylococcus aureus* during production: The data presented in Table 10 detected the growth of *Staphylococcus aureus* in line A, C, in all steps, while it wasn't detected in poultry from slaughter B.

The freezing did not result in any growth of *Staphylococcus. aureus* Except in slaughter C. This result could be due to that low temperature cause injure to bacterial cell well which lead to death of bacteria. The result are in a agreement with finding of Aberls (2001) who reported that low temperature decrease microbial loads.

Contamination with *Salmonella* spp. during production line: Generally the data in Table 11 revealed that the samples from all slaughter in different steps of production line were contaminated with *Salmonella* except the samples from step six (after freezing) this could due to microbiological statue of the live bird and cross contamination during transportation which lead to that each carcass can contribute microorganism to scalding water which become highly contaminated and these are in agreement with the finding of Bell and

Table 7: Mean value and their standard errors (SE±) for total Viable count of bacteria (log_{10} cfu/g) of the various steps in Production line

	Treatments*		
Steps in production line	A	B	C
Defeathering	4.17±0.04[b]	1.78±0.09[b]	5.19±0.00[b]
Evisceration	*uncounted±0.00[a]	1.86±0.02[b]	*uncounted±0.00[a]
Washing	4.76±0.04[b]	1.61±0.02[b]	*uncounted±0.00[a]
After chilling	3.79±0.03[b]	1.57±0.03[b]	*uncounted±0.00[a]
After backing	3.80±0.04[b]	1.59±0.06[b]	*uncounted±0.00[a]
After freezing below -18°C	2.65±0.05[b]	1.43±0.04[b]	*uncounted±0.00[a]
$LSD_{0.05}$	0.2028*		
SE±	0.07071		

Mean±SD value (s) bearing different superscript (s) within columns and rows are significantly different ($P \leq 0.05$).
*uncountable bacteria. *A: Full automated slaughter plant. B: Modern full automated slaughter plant. C: Automated slaughter plant.

Table 8: The effect of treatment on total mould and yeasts at the various steps in production line

	Treatments*		
Steps in production line	A	B	C
Defeathering	-	-	-
Evisceration	-	-	-
Washing	-	-	-
After chilling	-	-	-
After backing	-	-	-
After freezing bellow -18°C	-	-	-

-: Negative.
*A: Full automated slaughter plant.
B: Modern full automated slaughter plant.
C: Automated slaughter plant.

Kyriakides, (2002) who reported that salmonella once attached to the Caracas surface cannot be eliminated by rinsing or washing *Salmonella* infection is spread among poultry through the use of contaminated feed and the incidence tends to reach a peak where intensive stock raising is practiced. But freezing elimination the salmonella growth this result could be due to that low temperature cause injure to bacterial cell well which lead to death of bacteria. The result are in a agreement with finding of Aberls (2001) who reported that low temperature decrease microbial loads.

Hazard analysis critical control point of poultry production slaughter plant: HACCP is preventive system of control, particularly with regard to microbial hazards. Hazard analysis, is define as the identification of sensitive ingredients critical process points and relevant human factors as they effect product safety. Critical Control Points (CCP) are described as those processing determiners whose loss of control would result in an unacceptable food safety risk (Bauman, 1974).

HACCP as defined in meat inspection is based on the application of seven principle to all operation on slaughter with objective of making product as safe as possible and documenting that product was processed in as safe a manner as possible (Aberle *et al*., 2001).

Hazard analysis: A sanitary process should effectively protect raw products from physical (i.e., metal, plastic, packaging materials etc.), chemical (residues of cleaning and disinfection chemicals, lubricants, coolants etc.) and biological (food borne pathogens and/or their toxins) hazards.

Hazard analysis of equipment: The analysis of swab samples from the counter (where the manual packing of poultry done) showed that the level of total viable count of bacteria did not detect as showed in Table 3 and hand of staff did not show growth of total viable count of bacteria and *Staphylococcus aureus* as showed in Table 4.

Hazard analysis of production steps: The data from statistical analysis is showed that might be five steps that could cause problem in absence of control during production line:

Step seven (Evisceration) -step ten (reprocessing) step thirteen- (chilling) -step fifteen finished product storage

Determination of critical control points CCP in production line of poultry slaughter plant: The CCPs of poultry slaughter plants determined as shown by decision tree of (Aberle *et al*., 2001).

Evisceration is the first CCP; relative to total viable bacterial and pathogen that manly from improper of evisceration of carcass what lead to fecal contamination, there by good manufacturing practice and good hygienic practice is required to reduce the microbial load as far as possible as showed in Table 7-9.

Reprocessing is second CCP; Carcasses are usually washed after evisceration with chlorinated water (concentration 10-100 ppm) to remove organic material and micro-organisms. Alternatively, trimming has been employed to remove fecal contamination from evisceration.

Chilling is third CCP, Bird to bird contact Literature indicates that improperly controlled chilling systems can

Table 9: Mean value and their standard errors (SE±) for *E. coli* of bacteria (log_{10} cfu/g) of the various steps in production line

	Treatments*		
Steps in production line	A	B	C
Defeathering	3.75±0.06^{d}	0.00±0.00^{g}	3.77±0.06d
Evisceration	4.62±0.03^{c}	0.00±0.00^{g}	*uncounted±0.00^{a}
Washing	3.35±0.05^{f}	0.00±0.00^{g}	*uncounted±0.00^{a}
After chilling	3.67±0.03^{e}	0.00±0.00^{g}	*uncounted±0.00^{a}
After backing	3.68±0.02^{e}	0.00±0.00^{g}	*uncounted±0.00^{a}
After freezing below -18°C	0.00±0.00^{g}	0.00±0.00^{g}	5.85±0.02^{b}
$LSD_{0.05}$	0.05237*		
SE±	0.012816		

Mean±SD value (s) bearing different superscript (s) within columns and rows are significantly different ($P \leq 0.05$).
*uncountable bacterial growth. *0.00: No bacterial growth. *A: Full automated slaughter plant. B: Modern full automated slaughter plant. C: Automated slaughter plant.

Table 10: The effect of treatment on *Staphylococcus aureus* at the various step in production line

	Treatments*		
Steps in production line	A	B	C
Defeathering	+	-	+
Evisceration	+	-	+
Washing	+	-	+
After chilling	+	-	+
After backing	+	-	+
After freezing bellow -18°C	-	-	+

+: Positive; -: Negative
*A: Full automated slaughter plant.
B: Modern full automated slaughter plant.
C: Automated slaughter plant.

Table 11: The effect of treatment on *Salmonella* spp. at the various steps in production line

	Treatments*		
Steps in production line	A	B	C
Defeathering	+	+	+
Evisceration	+	+	+
Washing	+	+	+
After chilling	+	+	+
After backing	+	+	+
After freezing bellow -18°C	-	-	-

+: Positive; -: Negative.
*A: Full automated slaughter plant.
B: Modern full automated slaughter plant.
C: Automated slaughter plant.

result in higher prevalence of pathogens in the final products, Proper chilling system retards subsequent microbial growth; minimizes cross contamination of product.

Finished product storage is fourth CCP there for, control of freezing room temperature to ensure the correct temperature for cold storage efficiency Establishment of critical limits for each CCP.

The study suggests that for poultry evisceration Zero visible fecal: Contamination after processing; equipment kept properly adjusted; no gut breakage due to improper equipment adjustment; range of 20-50 ppm chlorine For reprocessing step should apply Chlorinated water Vacuuming Proper trimming, Zero visible faecal contamination after re-processing; equipment kept properly adjusted; for chilling Temperature of 5°C or less will be reached within 4 hours on all product. Chlorine dioxide level in chiller will be maintained at >20 ppm and for product storage (cold) Finished product will not exceed 5°C.

Established of monitoring procedures: Monitoring procedures should include a planned sequence of observations or measurements to assess whether a CCP is under control and produce an accurate record for future use in verification, Visible check (at least once per hour of production); check chlorine at start up and every two hours using documented random sampling procedures to demonstrate control. Recording of results in appropriate Log and Equipment adjustment will be checked.

Establishment of corrective action: According to this analysis of evisceration step Quality Assurance (QA) will reject or hold product until zero fecal tolerance is achieved. Equipment will be properly adjusted to assure zero contamination. All suspect products will be visually examined between evisceration and after final wash.

Contaminated product will be rejected or reconditioned. Equipment maintenance and adjustments will be reviewed and compared to flock size and manufacturer's specs in chilling step QA will reject or hold product depending on time, temperature and/or antimicrobial level deviation. Quality assurance will identify the cause of the deviation and prevent reoccurrence. Maintenance will check chiller circulation and water exchange Rate and make adjustments as required. Any necessary repairs Will be made. QA will monitor temperature and antimicrobial Level in chiller.

Verification: Verification consists of the use of methods, procedures, or tests in addition to those used in monitoring to determine that the HACCP system is in compliance with the HACCP plan and whether the

HACCP plan needs modification. Verification involves, Once per shift, the QA supervisor will review the plant antimicrobial sheet and observe chlorine level testing. Twice per shift, maintenance supervisor will review equipment maintenance log, Maintenance supervisor will verify the accuracy of the Product temperature log once per shift. QA will check all thermometers used for monitoring and verification activities for accuracy daily and calibrate.

Documentation and record keeping: Efficient and accurate record keeping is essential to the application of a HACCP system. Documentation including hazard analysis, CCP determination and critical limit determination. Record including Plant Finished Product Standard Form Deviation/Corrective Action Log. All records should include date, time of observation and initials of operator conducting monitoring.

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