

Assessment of the Hygienic Condition of Chicken Shops in Alexandria and its Impact on the Bacteriological Quality of the Sold Carcasses

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ABSTRACT: Assessment of the hygienic condition of 15 chicken shops in Alexandria revealed that carcass handling had the highest mean score percentages in all zones ranging from 69.7% to 83.3% but unfortunately personal hygiene was given the lowest score percentages ranging from 34.5% to 46.9%. Moreover, there were no significant differences among different zones concerning the mean score percentages of different sanitation checklist parameters. Bacteriological analysis of 198 samples; 135 chicken carcass's washes, 45 scalding water samples and 18 defeathering machine washes revealed that washes collected after defeathering had the worst bacteriological profile regarding the counts of aerobic mesophiles (3.7×10^7 CFU/100 ml) and coliforms (8.0×10^4 MPN/100 ml). Carcass washes collected after evisceration and washing from most zones were contaminated with lower bacterial loads than either after scalding or defeathering, but they showed higher contamination with coagulase positive staphylococci. Within the same zone, the defeathering machine washes were usually of worse bacteriological quality than scalding water.

KEY WORDS: Chicken Shops; Hygienic Condition; Sanitation-Checklist; Aerobic Mesophilic Counts; Staphylococci; Coliform; Fecal Coliforms; Carcass Handling; Personal Hygiene

INTRODUCTION

Consumption of chicken meat has risen remarkably over the last two decades due to the perception that it is "healthier" alternative to red meat.¹ There are two kinds of poultry slaughtering, one is an automated whereby automated systems are used for processing of carcasses. The second is the traditional slaughtering, which is commonly practiced in small scale slaughtering shops under poor hygienic conditions that are favorable for contamination by various pathogens.^{2,3}

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Live chickens are hosts of a large number of different microorganisms. During slaughtering, most of these microorganisms are eliminated, but subsequent contamination from the environment, equipment and operators' hands is possible at any stage of the production process.⁴ Contamination of poultry meat with foodborne pathogens remains an important public health issue, because it can lead to illness if there are malpractices in handling. Foodborne illness causes human suffering and loss of productivity, and adds significantly to the costs of food production and healthcare.⁵ The aim of this work was to assess the sanitary conditions of chicken shops in different zones of Alexandria and to determine the bacteriological profile of chicken carcasses washes collected after different processing steps.

MATERIAL AND METHODS

A total of 15 chicken shops were selected from five zones of Alexandria

(three shops from each zone). Each chicken shop was visited three times where a total of 198 samples were collected; 135 chicken carcass's washes (45 after each of scalding, defeathering as well as after evisceration and washing step) in addition to 45 scalding water samples and 18 defeathering machine washes that were collected only from six shops where the automatic defeathering machines were used. After each step, each chicken carcass was rinsed in 500- ml sterile peptone saline then 100 ml portion was transferred into a sterile plastic container. A samples of 100-ml of the scalding water was collected from the scalding tank immediately after scalding of the chicken. The internal surface of defeathering machine was washed with 500 ml of sterile peptone saline after defeathering then a 100 ml portion was transferred into a sterile plastic container.⁶ All containers were transported refrigerated immediately to the laboratory for investigating the

following bacteriological parameters:

- 1- Determination of aerobic mesophilic plate counts according to the ISO procedures⁷ where the standard plate count agar was drop plated and incubated at 30°C for 72 hours.
- 2- Enumeration of staphylococci using Baird Parker agar base with potassium tellurite (1%) that was incubated at 37°C for 48 hours according to the ISO procedures.⁸ The suspected colonies were subjected to tube coagulase test.⁹
- 3- Determination of coliform counts according to the most probable number (MPN); multiple tube technique using MacConkey broth and incubation at 35-37°C for 24-48 hours.¹⁰
- 4- Enumeration of fecal coliforms where all positive MacConkey tubes used in enumeration of coliforms were sub-cultured into brilliant green lactose bile (BGLB) broth tubes and incubated at

44.0 ±0.1°C for 24-48 hours.¹⁰

The hygienic condition of each shop was assessed using a pre-designed sanitation-checklist composed of several items within the following four parameters.¹¹

- 1- Building and facilities.
- 2- Utensils and equipment.
- 3- Personal hygiene.
- 4- Carcass handling.

Every question in the checklist was scored and the score of each parameter and items as well as the total score of the whole checklist were calculated and converted into percentages. Shops with ≥ 50% score percentages were considered acceptable for their sanitation while those with <50% were unacceptable.¹²

RESULTS

Table (1) shows that although carcass washes collected after evisceration and washing from most zones were contaminated with lower bacterial loads than either scalding or defeathering, they

showed higher percentages of contamination with coagulase positive staphylococci ranging from 44.4% in El-Montazah to 66.6% in each of El-Gomrouk, East and West. Within the same zone. There were insignificant variations among the three processing steps concerning bacterial load of carcass washes collected thereafter except in case of coagulase positive staphylococci in East zone. Within the same processing step, carcass washes collected from El-Gomrouk were contaminated with the highest counts in most of the studied bacteriological parameters. The lowest counts of aerobic mesophiles, coliforms and staphylococci were in washes collected after the three processing steps from East, West and El-Montazah zones; respectively. The lowest fecal coliforms counts were in washes collected after scalding and evisceration from West zone (1.4×10^1 and 3.8 MPN/100 ml) and after defeathering from East zone (3.6 MPN/100 ml), moreover, there were

significant variations among different zones concerning mean aerobic mesophilic and staphylococci counts after the three steps and in case of coliforms and fecal coliforms after defeathering.

Table (2) illustrates that within the same zone, the defeathering machine washes were usually of worse bacteriological quality than scalding water. Scalding water collected from West zone had the highest aerobic mesophilic and staphylococci counts while the highest coliform count was in El-Gomrouk. Fecal coliforms and coagulase positive staphylococci were not detected in any scalding water samples. Defeathering machine washes collected from El-Gomrouk showed the highest counts of aerobic mesophiles, (2.5×10^8 CFU/100 ml), staphylococci (4.5×10^6 CFU/100 ml), and coagulase positive staphylococci percentage (33.3%) while those collected from El-Montazah had the highest coliform

(2.7×10^5 MPN/100 ml) and fecal coliform counts (7.4 MPN/100 ml). There were no significant variations among different zones concerning the bacterial loads of either the scalding water or defeathering machine washes except in case of aerobic mesophilic count in the defeathering machine washes.

Table (3) illustrates that the carcass handling parameter had the highest mean score percentages in all zones while the personal hygiene parameter had the lowest. Moreover, there were no significant differences among different zones concerning the mean score percentages of different sanitation checklist parameters. In all zones, the items of health certificates, slaughtering, and scalding were given the highest score percentages while pest control, preparation surfaces, avoidance of bad habits, hands and display items were given the lowest. There were no significant differences among different zones concerning any checklist item.

DISCUSSION

Chicken industry becomes highly competitive since chickens are not subjected to any religious restriction and consumers recognize them as a relatively cheap protein source.¹³

1. Bacteriological profile of the carcasses' washes collected after different processing steps

Live chickens carry many different kinds of microorganisms on the skin, among feathers and in the alimentary tract. Many of these organisms may ultimately become contaminants of carcasses at any stage of their processing.¹⁴ Prevention of microbial contamination involves careful regulation and monitoring of the slaughtering process, proper handling and storage.^{15,16}

1. Scalding step

The bacterial load of scalding water is important because of the possibility that some chickens could inhale water, which

may contaminate the blood and respiratory system. Also there is an opportunity for cross contamination between carcasses during the scalding process.¹⁷ In the present study, washes collected after scalding had poor bacteriological profile with mean counts of aerobic mesophiles, coliforms, fecal coliforms and staphylococci of 3.4×10^7 CFU/100 ml, 7.0×10^4 MPN/100 ml, 2.4×10^2 MPN/100 ml and 1.0×10^6 CFU/100 ml (table 1) that can be attributed to using highly contaminated scalding water with a mean aerobic mesophilic count of 6.5×10^5 CFU/100 ml, coliform count of 2.1×10^1 MPN/100 ml and staphylococci count of 3.9×10^4 CFU/100 ml (table 2). This noticeable scalding water contamination can be attributed to using dirty scalding tanks made of pitted aluminum, which were not usually properly

cleaned or disinfected in most shops. Moreover, the dirty scalding water was not changed until the end of the working day. Finally, topping off the dirty scalding water

with tap water that consequently lowering the temperature of scalding water and creating favorable conditions for growth of the contaminating bacteria. An other study reported lower aerobic mesophilic and coliform counts (1.0×10^7 CFU/100 ml and 7.9×10^3 MPN/100 ml, respectively) in washes collected after scalding that may be attributed to using multistage scalding and cleaner chickens before slaughtering.¹⁸ Temperature of scalding water is usually maintained at 50-53°C to loosen the feathers and to prevent subsequent discoloration of the skin. Under these conditions there is a minimal destruction of any pathogen present.¹⁹ In the present study, temperatures of scalding water were ranging from 50°C to 55°C.

2. Defeathering step

Defeathering of chicken usually occurs either mechanical or manual. During mechanical defeathering, microbial contamination occurs through the

contaminated flexible rubber fingers. Also, warm and moist conditions inside the machine are favorable for microbial growth.²⁰ In the present study, washes collected after defeathering had the worst bacteriological profile among different processing steps regarding the counts of aerobic mesophiles (3.7×10^7 CFU/100 ml) and coliforms (8.0×10^4 MPN/100 ml) (table 1). The deteriorating status of the most used defeathering machines that were usually not properly cleaned or sanitized was reflected on the bacteriological profile of the machines washes that were contaminated with high counts of aerobic mesophiles (6.5×10^7 CFU/100 ml), coliforms (1.4×10^4 MPN/100 ml), fecal coliforms (3.4 MPN/100 ml), and staphylococci (1.1×10^6 CFU/100 ml). Moreover, 24.4% were contaminated with coagulase positive staphylococci (table 2). Another study reported that the slight reduction in the aerobic mesophilic count may be attributed to better cleaning and

disinfection of the defeathering machine, regular replacement of worn fingers and avoidance of excessive feather accumulation in the machine.²¹

3. Evisceration and washing step

In the present study, although washes collected after evisceration and washing were of better bacteriological profile than the other two processing steps, they were contaminated with mean counts of aerobic mesophiles, coliforms, fecal coliforms, and staphylococci of 2.1×10^7 CFU/100 ml, 2.7×10^4 MPN/100 ml, 3.6×10^1 MPN/100 ml and 8.5×10^5 CFU/100 ml, respectively, (table 1). This can be attributed to the improperly cleaned evisceration area, using unclean water without disinfectants in the final washing of the eviscerated carcasses. Unclean eviscerating surfaces favor the accumulation of microorganisms that would contaminate the eviscerated carcasses. Adequate washing of carcasses is important to minimize

microbial contamination of the carcasses.¹⁹

2. The hygienic condition of chicken shops

2.1. Building and facilities

The chicken shop must be of sound construction, kept in good repair, and be of sufficient size to allow processing, handling, and storage of the slaughtered carcasses in a manner that does not result in carcasses contamination.²² Although building and facilities were acceptable

West, East, and Middle zones, they were given mean score percentages ranging from 61.3 ± 26.1 in West zone to 65.3 ± 15.0 in Middle zone. Moreover, El-Gomrouk and El-Montazah zones were unacceptable with $<50\%$ mean score percentages (table 3). This poor scoring can be attributed to the deteriorating status of floors, walls and ceiling that were not usually properly cleaned in most shops. Also; wastes were disposed using uncovered waste receptacles, and this in addition to the uncovered sewers constitute pitfalls in the

pest control that was unfortunately given very low scores in all zones ranging from 13.7% in each of El-Gomrouk and Middle to 27.5% in East zone. Ventilation was inadequate in most shops that were manifested by elevated temperatures and accumulation of bad odor that also indicates improper cleaning and sanitization.

2.2. Utensils and equipment

Utensils and equipment must be of acceptable materials and construction to be easily cleaned and sanitized. They must be made of materials resistant to corrosion and their surfaces should be smooth and free from pits and crevices.²³ Although West and East zones were acceptable in the utensils and equipment parameter, their mean score percentages ranged from 57.6 ± 12.7 in West zone to 58.6 ± 10.7 in East zone. Moreover, El-Gomrouk, El-Montazah, and Middle zones were unacceptable with mean score

percentages of less than 50% (table 3). This can be attributed to the unsanitary conditions of scalding tanks and defeathering machines that were made of worn and pitted aluminum in most shops. Evisceration and preparation surfaces were made of poor quality marble or wood, moreover, utensils and equipment were usually used for different carcasses without adequate cleaning and sanitization in-between. Poorly repaired and maintained equipment and utensils may harbor food residues which serve as media in which bacteria can multiply. All utensils must be washed in warm water containing adequate amount of suitable detergents and then disinfected.²³

2.3. Personal hygiene

All persons working at poultry processing shops must adhere to hygienic practices while on duty to prevent carcass contamination.²³ In the present study, unfortunately personal hygiene was given the lowest score percentages ranging from

34.5±8.5 in El-Montazah zone to 46.9±5.6 in West zone (table 3). This poor unacceptable scoring can be attributed to lack of uniform and hair covers in addition to bad habits (i.e., sneezing and smoking) that were unfortunately practiced by some workers. Hand washing was carried out using tap water without any detergent and was not followed after each practice that could contaminate the hands. Wounds on the hands of some workers were covered with a piece of gauze. Among different items of this parameter, health certificate and health status items were given the highest score since most workers had valid health certificates and were in good health.

2.4. Carcass handling

Chicken carcasses should be handled properly during their processing since errors during handling were reported to be responsible for a lot of foodborne diseases outbreaks.²⁴ Although evisceration and displaying items were unacceptable most zones of Alexandria,

carcass handling was the parameter with the highest mean score percentages ranging from 69.7 ± 11.6 in Middle zone to 83.3 ± 14.6 in West zone (table 3). This can be attributed to accurate bleeding time and holding time in scalding water. The poor scoring of evisceration and displaying items can be attributed to conducting manual defeathering and evisceration of the carcasses at the same place, washing of carcasses in unclean containers using unclean water without disinfectant and displaying carcass parts neither covered nor refrigerated outside the chicken shops.

RECOMMENDATIONS

Improvement of the bacteriological

profile of chicken carcasses through using two scalders rotating them as one reaches the correct temperature. Continuous cleaning and disinfection of various utensils and equipment and evisceration on clean surface followed by washing with tap water and if possible, using a suitable food grade disinfectant. Improvement of the sanitary condition of the chicken shops and installing of pest control. Food safety training programs should be launched to all workers and bacteriological profile of the carcass parts displayed outside the shops should be evaluated.

Table (1): Bacteriological profile of chickens' carcass washes collected after different processing steps from chicken shops in different zones of Alexandria.

Bacteriological parameters	Zones	Processing steps			Kruskal Wallis Test
		Scalding	Defeathering	Evisceration and washing	
Aerobic mesophilic counts ^a (CFU/100 ml)	EL-Gomrouk	2.9×10 ⁸	3.9×10 ⁸	2.2×10 ⁸	0.30
	West	9.0×10 ⁶	3.1×10 ⁷	6.5×10 ⁶	4.75
	Middle	1.0×10 ⁸	4.7×10 ⁷	2.1×10 ⁷	1.39
	East	3.9×10 ⁶	6.5×10 ⁶	4.9×10 ⁶	2.73
	EL-Montazah	4.6×10 ⁷	1.9×10 ⁷	2.9×10 ⁷	0.79
	All zones	3.4×10⁷	3.7×10⁷	2.1×10⁷	
Kruskal Wallis Test^b		18.69*	13.64*	12.97*	
Coliform counts ^a (MPN/100 ml)	EL-Gomrouk	1.0×10 ⁵	2.9×10 ⁵	4.6×10 ⁴	4.77
	West	1.8×10 ⁴	3.2×10 ⁴	8.0×10 ³	1.46
	Middle	8.5×10 ⁴	6.5×10 ⁴	3.2×10 ⁴	3.28
	East	5.5×10 ⁴	3.6×10 ⁴	2.0×10 ⁴	1.92
	EL-Montazah	2.2×10 ⁵	1.4×10 ⁵	5.5×10 ⁴	4.40
	All zones	7.0×10⁴	8.0×10⁴	2.7×10⁴	
Kruskal Wallis Test^b		9.78*	14.25*	6.37	
Fecal coliform counts ^a (MPN/100 ml)	EL-Gomrouk	8.3×10 ²	4.1×10 ²	2.3×10 ²	2.44
	West	1.4×10 ¹	1.7×10 ¹	3.8	1.03
	Middle	9.7×10 ²	1.7×10 ²	4.0×10 ¹	3.74
	East	6.3×10 ¹	3.6	7.5×10 ¹	3.94
	EL-Montazah	1.0×10 ³	1.4×10 ²	2.4×10 ¹	4.24
	All zones	2.4×10²	5.8×10¹	3.6×10¹	
Kruskal Wallis Test^b		8.96	10.25*	5.32	
Staphylococci counts ^a (CFU/100 ml)	EL-Gomrouk	7.0×10 ⁶	2.7×10 ⁷	4.0×10 ⁷	1.34
	West	5.5×10 ⁵	9.5×10 ⁵	4.3×10 ⁵	1.35
	Middle	1.6×10 ⁶	7.5×10 ⁵	6.5×10 ⁵	1.37
	East	7.5×10 ⁵	4.6×10 ⁵	3.2×10 ⁵	0.70
	EL-Montazah	2.4×10 ⁵	1.2×10 ⁵	1.2×10 ⁵	1.12
	All zones	1.0×10⁶	1.0×10⁶	8.5×10⁵	
Kruskal Wallis Test^b		10.14*	15.68*	11.46*	
Coagulase positive staphylococci (%)	EL-Gomrouk	33.3	44.4	66.6	2.00
	West	11.1	33.3	66.6	5.81
	Middle	44.4	11.1	55.5	3.98
	East	11.1	0.0	66.6	11.51*
	EL-Montazah	11.1	33.3	44.4	2.39
	All zones	22.2%	24.4%	60%	
Monte Carlo proportion^b		5.02	6.35	1.45	

*P<0.05

a: Geometric mean

b: among different zones

Table (2): Bacteriological profile of scalding water and defeathering machine washes collected from chicken shops in different zones of Alexandria.

Bacteriological parameters	Zones	Scalding water	Defeathering machine washes
Aerobic mesophilic counts^a (CFU/100 ml)	EL-Gomrouk	4.1×10 ⁵	2.5×10 ⁸
	West	2.6×10 ⁶	NA
	Middle	4.5×10 ⁵	1.4×10 ⁸
	East	1.0×10 ⁶	6.0×10 ⁶
	EL Montazah	2.8×10 ⁵	2.3×10 ⁸
	All zones	6.5×10⁵	6.5×10⁷
Kruskal Wallis Test^b		5.42	8.81*
Coliform counts^a (MPN/100 ml)	EL-Gomrouk	1.7×10 ²	6.6×10 ³
	West	3.3×10 ¹	NA
	Middle	1.3×10 ¹	3.3×10 ⁴
	East	1.4×10 ¹	6.7×10 ³
	EL Montazah	3.9	2.7×10 ⁵
	All zones	2.1×10¹	1.4×10⁴
Kruskal Wallis Test^b		8.56	7.42
Fecal coliform counts^a (MPN/100 ml)	EL-Gomrouk	<3	<3
	West	<3	NA
	Middle	<3	3.4
	East	<3	2.6
	EL Montazah	<3	7.4
	All zones	<3	3.4
Kruskal Wallis Test^b		0.00	3.36
Staphylococci counts^a (CFU/100 ml)	EL-Gomrouk	5.0×10 ⁴	4.5×10 ⁶
	West	7.5×10 ⁴	NA
	Middle	3.7×10 ⁴	4.7×10 ⁵
	East	2.7×10 ⁴	4.8×10 ⁵
	EL Montazah	2.2×10 ⁴	1.0×10 ⁶
	All zones	3.9×10⁴	1.1×10⁶
Kruskal Wallis Test^b		2.44	1.15
Coagulase positive staphylococci (%)	EL-Gomrouk	0%	33.3%
	West	0%	NA
	Middle	0%	22.2%
	East	0%	8.3%
	EL Montazah	0%	22.2%
	All zones	0%	24.4%
Monte Carlo proportion^b		0.00	4.42

*P<0.05

a: Geometric mean

b: among different zones

NA: not applicable

Table (3): Mean score percentages of different sanitation checklist parameter and items of chicken shops in different zones of Alexandria.

Parameters and items	Mean score percentage					K W Test
	Ei-Gomrouk	West	Middle	East	Ei-Montazah	
Building and facilities	46.6±25.4	61.3±26.1	65.3±15.0	63.3±16.2	45.3±7.5	2.86
Sanitary design	44.9±21.2	69.2±20.4	76.9±10.2	70.5±22.5	57.7±20.4	4.57
Cleaning & waste disposal	54.9±24.5	49.0±29.6	60.8±18.0	60.0±12.2	29.4±11.8	4.20
Pest control	13.7±18.9	25.5±17.0	13.7±12.2	27.5±7.0	15.7±3.4	3.07
Utensils and equipment	43.3±8.5	57.6±12.7	42.3±17.2	58.6±10.7	43.0±1.7	5.77
Slaughtering knives	42.0±15.4	48.9±13.9	37.8±7.7	75.8±13.7	35.6±3.8	5.24
Scalding tank	42.2±10.2	42.2±15.4	35.6±21.4	48.9±3.8	40.0±6.7	2.04
Defeathering machine	50.0±0.0	NA	31.3	56.3±0.0	50.0	5.00
Preparation surfaces	37.3±19.0	49.0±6.8	33.3±22.3	49.0±17.0	35.3±10.2	2.92
Displaying surfaces	47.2±4.0	58.3±27.5	42.6±8.5	58.3±27.5	NA	0.62
Personal hygiene	38.2±4.2	46.9±5.6	39.5±16.7	40.7±13.3	34.5±8.5	2.44
Health certificate	83.3±28.9	100.0±0.0	100.0±0.0	83.3±28.9	66.7±28.9	4.45
Health status	66.7±33.3	88.9±19.2	66.7±33.3	77.8±19.2	55.6±38.5	2.27
Habits	27.8±9.6	33.3±0.0	38.9±19.2	22.2±9.6	22.2±9.6	4.11
Hands	31.3±10.8	37.5±6.3	27.1±15.7	31.3±9.6	31.3±6.3	1.80
Carcass handling	69.7±13.3	83.3±14.6	69.7±11.6	71.0±9.8	73.0±6.9	2.09
Slaughtering	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0	0.00
Scalding	100.0±0.0	91.7±14.4	100.0±0.0	91.7±14.4	100.0±0.0	3.23
Defeathering	75.0±43.3	25.0±0.0	50.0±50.0	75.0±43.3	50.0±50.0	3.63
Evisceration	27.8±25.5	88.9±9.6	50.0±50.0	44.4±48.1	16.7±16.7	4.90
Displaying	22.2±19.2	33.3±33.3	33.3±0.0	27.8±25.5	0.0±0.0	4.99
whole checklist	46.0±12.1	57.3±14.6	50.3±13.6	56.3±9.0	44.0±4.4	3.64

NA: not applicable

K W test: Kruskal Wallis test

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