Official Journal Issued by Faculty of Veterinary Medicine

Benha Veterinary Medical Journal

Journal homepage: https://bvmj.journals.ekb.eg/

Since 1990

Original Paper

Bacteriological profile of some raw chicken meat cuts in Ismailia city, Egypt

Fahim A. Shaltout[1], Islam Z. Mohammed[2], El-Sayed A. Afify[3*]

[1.] *Department of Food Hygiene and Control, Faculty of Veterinary Medicine, Benha University.*

[2.] *Animal Health Research Institute, ARC.*

[3*] *Veterinary supervisor*

ARTICLE INFO

Keywords

Bacteriological aspect.
Breast
Chicken meat
Thigh

Received 25/07/2020
Accepted 24/08/2020
Available On-Line 01/10/2020

ABSTRACT

One hundred random samples of raw chicken meat cuts represented by breast and thigh (50 of each) were collected from an automatic poultry slaughtering plant in Ismailia city, Egypt. The samples were examined to investigate their bacteriological aspect, where the mean values of aerobic plate count and Enterobacteriacae were $5.9x10^5$ and $5.1x10^4$ CFU/g for breast samples and $7.1x10^5$ and $6.1x10^4$ CFU/g while for thigh samples as well as the incidence of Enterobacteriacae contaminated the breast and thigh samples were 42 and 54%, respectively. Moreover, *S. aureus*, Salmonellae, *E. coli*, Enterobacter spp., Proteus spp., Shigella spp. and *C. perfringens* were detected in 10, 14, 12, 4, 2, 2 and 16% of the examined breast samples, respectively. Referring to thigh samples, *S. aureus*, Salmonellae, *E. coli*, Klebsiella spp., Enterobacter spp., Proteus spp., and *C. perfringens* were detected in 4, 8, 18, 4, 2, 2 and 10%, respectively. The obtained results indicated that the raw chicken meat cuts may harbor many food poisoning bacteria from different sources, which strongly recommends following strict hygienic measures through slaughtering, handling and cooking processes.

1. INTRODUCTION

Rapid reproductive cycle, high acceptability of chicken meat due to its high biological value, palatability and many production processing variables; made poultry production one of the major worldwide food industry. Selection of broiler chickens has been primarily directed at economic traits which have reduced costs of production as it is the major brand of production and consumption among poultry (Nabil, 2018). Chicken meat is one of the most popular foods worldwide as it contains many essential amino acids, minerals as sodium, potassium, calcium, iron, phosphorous besides traces of vitamins such as vitamin B12 and niacin required for maintaining life and promoting growth (FAO, 2014). Poultry meat is an ideal medium for bacterial growth and known to harbor a large number of bacteria that are pathogenic to human being. Typically, these occur in low sanitation levels, and only pose a threat to the consumer if the product is not handled in a safe manner (Zakaria, 2005). In processing plants, contamination of poultry meat may be recorded throughout initial slaughtering processes, packaging and storage. Heavy bacterial loads enter the processing operations with the living birds or raw materials utilized during processing (Zhang *et al.*, 2001). Regarding to slaughtering abattoirs and processing plants hygiene, the presence of pathogenic and spoilage microorganisms in poultry meat and its products represent a significant concern for suppliers, consumers and public health officials worldwide. Bacterial contamination of food products is undesirable but unavoidable; it depends on the initial bacterial load of the fresh raw materials, hygienic practices during manufacturing and on time/temperature factor (El-Bassuony, 2008). The detection of foodborne pathogens using conventional culture methods have traditionally been considered as the "gold standard" for the isolation and identification of foodborne bacterial pathogens (Jasson *et al.*, 2010). They consist of a series of steps that include nonselective enrichment, selective enrichment, selective/differential plating and, finally, morphological, biochemical, and serological confirmation. This standardized classical culture method is known to be sensitive and inexpensive.

Therefore, the current study aimed to investigate the bacteriological profile of raw chicken breast and thigh samples through bacteriological and serological techniques.

2. MATERIAL AND METHODS

2.1. Collection of samples:

One hundred samples of raw chicken breast and thigh (50 of each), weighed about 250 g/sample, were collected after complete slaughtering, scalding, defeathering, evisceration, and cold washing processes. The samples were obtained from an automatic poultry slaughtering plant in Ismailia city, Egypt. The collected samples were prepared as recommended by ISO 6887-1 (2017), then subjected to the following examinations:

* Corresponding author: Ssmm1806@gmail.com.

- Aerobic plate count "APC" according to ISO 4833-1 (2013).
- Enterobacteriaceae count "EC" according to ISO 21528-2 (2017).
- Identification of Enterobacteriacae isolates was performed following NHS (2013).
- Detection of *E. coli* was performed according to ISO 16649-2 (2001)
- Serological identification of *E. coli* isolates was performed according to Kok *et al.* (1996).
- Detection of Salmonellae was performed according to ISO 6579-1 (2017)
- Serological identification of the isolated Salmonellae was carried out according to Kauffman – White scheme (Kauffman, 1974).
- Detection of *S. aureus* was performed according to ISO 6888-1 (1999), A1 (2003).
- Detection of *C. perfringens* was performed according to ISO 7937 (2004).
- Detection of Shigella was performed according to ISO 21567 (2004).

2.2. Statistical Analysis:
The obtained results were statistically evaluated by application of Analysis of Variance (ANOVA) test according to Feldman *et al.* (2003).

3. RESULTS

Results of the study revealed that fresh chicken thigh samples were more contaminated according to the mean values of APC and Enterobacteriacae.
Results, as mentioned in Table (1), showed that the mean values of APC of raw chicken breast and thigh samples were $5.9x10^5$ and $7.1x10^5$ CFU/g, respectively.

Table 1 Statistical analytical results of aerobic plate count (APC) of the examined chicken meat samples (n =50).

Chicken meat samples	Count (CFU/g)		
	Min.	Max.	Mean ± SE
Chicken breasts	$3.1x10^4$	$8.2x10^6$	$5.9x10^5 \pm 0.97x10^{5a}$
Chicken thighs	$5.4x10^4$	$9.6x10^6$	$7.1x10^5 \pm 0.11x10^{5a}$

The same value within the same column superscript letter indicated absence of significant difference at ($P \leq 0.05$).

Table (2) revealed that the prevalence and the mean values of Enterobacteriacae in the examined breast and thigh samples as $5.1x10^4$ (42%) and $6.1x10^4$ (54%) CFU/g, respectively.

Table 2 Prevalence and count of Enterobacteriaceae of the examined chicken meat samples (n =50).

Chicken meat samples	Positive samples		Count (CFU/g)		
	No.	%	Min.	Max.	Mean ± SE
Chicken breasts	21	42	$3.5x10^3$	$7.2x10^4$	$5.1x10^4 \pm 0.32x10^{4a}$
Chicken thighs	27	54	$4.6x10^4$	$8.8x10^5$	$6.1x10^4 \pm 0.56x10^{4a}$

([a]) The same value within the same column superscript letter indicated absence of significant difference at ($P \leq 0.05$).

Bacteriological classification and identification of Enterobacteriacae isolates revealed detection of Salmonella spp., *E. coli*, Enterobacter spp., Proteus spp. and Shigella spp. with incidence of 14, 12, 4, 2 and 2% in breast samples; while Salmonella spp., *E. coli*, Klebsiella spp., Enterobacter spp. and Proteus spp. with incidence of 8, 18, 4, 2 and 2%, respectively. Furthermore, *S. aureus* and *C. perfringens* were detected by the incidence of 10 and 16% of breast samples; while were 4 and 10% in thigh samples, respectively as recorded in table (3).

Table 3 Prevalence of isolated bacteria from the examined chicken meat samples (n =50).

Identified bacteria	Chicken breasts		Chicken thighs	
	No.	%*	No.	%*
Staphylococcus aureus	5	10	2	4
Salmonella spp.	7	14	4	8
E. coli	6	12	9	18
Klebsiella spp.	0	0	2	4
Enterobacter spp.	2	4	1	2
Proteus spp.	1	2	1	2
Shigella spp.	1	2	0	0
Clostridium perfringens	8	16	5	10

Escherichia coli isolates were serotyped as *E. coli* O_{157}:H_7, O_{114}:H_{21}, O_{127}:H_6 and O_{26} with incidence of 33.3, 16.6, 16.6 and 33.3% in breast samples, while *E. coli* O_{157}:H_7, O_{114}:H_{21}, O_{127}:H_6 and O_{126} were isolated from thigh samples with incidence of 22.2, 11.1, 33.3 and 33.3%, respectively as recorded in table (4).

Table 4 Serotyping of the isolated *E. coli* strains from the examined chicken meat samples.

E. coli	Examined chicken samples (n=50)			
	Chicken breasts isolates (n=6)		Chicken thighs isolates (n=9)	
	No.	%*	No.	%*
O_{157}:H_7 (EHEC)	2	33.3	2	22.2
O_{114}:H_{21}(EPEC)	1	16.6	1	11.1
O_{127}:H_6 (ETEC)	1	16.6	3	33.3
O_{126} (ETEC)	0	0	3	33.3
O_{26} (EHEC)	2	33.3	0	0

*% was calculated according to total number of isolates.

Moreover, table (5) revealed the results of Salmonella serotypes as *S. Typhimurium* and *S. Enteritidis* with the incidence of 14.2 and 71.4% in breast samples; while were 50% for both strains in thigh samples. In addition, *S. Typhi* was detected in breast sample with incidence of 14.2%.

Table 5 Serotyping of Salmonellae isolated from the examined chicken meat cuts.

Salmonella spp.	Examined chicken samples			
	breasts (n=7)		thighs (n=4)	
	No.	%*	No.	%*
S. Typhi	1	14.2	0	0
S. typhimurium	1	14.2	2	50
S. Enteritidis	5	71.4	2	50

*% was calculated according to total number of isolates

4. DISCUSSION

Contamination of fresh chicken meat with different food pathogens may be occurred due to many improper hygiene and personal faults occurred during different slaughtering, storage, transportation and handling processes, such as contaminated water, gastrointestinal contamination, and air, dust, sewage and food or on food equipment, environmental surfaces (USFDA, 2012).
In general, APC gives an idea about the hygienic measures applied during processing and also helps in the determination of the keeping quality of the poultry carcasses. Nearly similar results were reported by Khalifa (2018) ($2.3x10^5$ and $6.9x10^5$ CFU/g in breast and thigh

samples, respectively). On the other hand, higher counts were reported by Wahbah (2019) ($5.5x10^6$ and $6.8x10^6$ CFU/g for breast and thigh samples, respectively). Comparatively, lower counts were reported by Atia (2018) ($9.28x10^3$ and $2.91x10^4$ CFU/g for breast and thigh samples, respectively).

High determination of Enterobacteriacae in fresh meat indicates enteric contamination with intestinal contents and declares the fact that the GIT is common habitat of the enteric bacteria and is considered the main source of contamination with these organisms during slaughtering, dressing, evisceration, handling and transportation to butcher shops (Hassanin *et al.*, 2013).

Enterobacteriaceae count is more frequently used to assess enteric contamination. Nearly similar results were reported by Wahbah (2019) ($3.5x10^4$ and $7.8x10^4$ CFU/g for breast and thigh samples, respectively), Moreover, higher counts were reported by Shaltout *et al.* (2019) ($4.5x10^6$ and $5.7x10^6$ CFU/g in breast and thigh samples, respectively). On the other hand, lower count was reported by Khalifa (2018) ($1.3x10^3$ and $2.0x10^3$ CFU/g for breast and thigh samples, respectively).

The presence of *E. coli* in food of animal origin is considered as an indicator of faults during preparation, handling, storage or service (Tebbut, 1999). Nearly similar results were reported by Ibrahim *et al.* (2015) (13.33% of the examined chicken thigh samples), Shaltout *et al.* (2019) (10% of the examined breast samples). Moreover, higher percentages of *E. coli* were reported by Elsisy (2019) (45 and 30% of the examined breast and thigh samples, respectively), and Arakeeb (2020) (42.8 and 62.5% of thigh and breast samples, respectively). On the other hand, lower incidence of *E. coli* was reported Atia (2018) (8 and 16% of the examined breast and thigh samples, respectively), and Elshora (2019) (8.57%) of the examined breast samples).

Moreover, serological typing revealed detection of various *E. coli* serotypes in different percentages, which is agree with several previous studies as the results recorded by Elboghdady (2019), Elshora (2019), and Elsisy (2019), who recorded detection of several *E. coli* serotypes including O_{114}:H_{21} (EPEC), O_{127}:H_6 (ETEC), O_{126} (ETEC), and O_{26} (EHEC) in their examined fresh breast and thigh samples with different incidences. Furthermore, El-Ramy (2017) and Khalaf (2019) detected *E. coli* O_{157}:H_7 in their examined samples of chicken meat cuts.

Actually, the different strains of *E. coli* are the major cause of many gastric disturbances, where symptoms appear within 12 to 36 hours and characterized by fever, nausea, vomiting and watery stools, which occasionally contain mucous, but without gross blood; therefore, *E. coli* showed to be the first bacterial cause of diarrhea in infants and its proportion may reach 54% (Varnam and Evans., 1991).

Salmonella species is an important food-borne pathogen responsible for disease in animals and humans. It has been the cause of many outbreaks and infections around the world and is considered as one of the major causes of human gastroenteritis worldwide (Rasschaert *et al.*, 2005).

The obtained results of Salmonella detection in fresh chicken meat cuts are in agree with those reported by Kallaf *et al.* (2014) (detected Salmonella in 12.66% of the examined raw chicken meat samples), Hashem (2015) and Ibrahim *et al.* (2015) who found Salmonella in 12% of their examined chicken carcass samples.

Moreover, higher prevalence of Salmonella spp. was reported by Hassanin *et al.* (2017) (24 and 36% of the examined breast and thigh samples, respectively), Elsisy (2019) (20 and 25% of the examined breast and thigh samples, respectively), and Wahbah (2019) (33.3 and 46.6% of breast and thigh samples). Comparatively, low percentages of Salmonella spp. were reported by Colmegna *et al.* (2009) (4.7% of examined chicken meat samples), and Anju *et al.* (2014) (4.44% of the examined chicken carcass samples). In addition, many other studies did not detect Salmonellae in the chicken meat samples as performed by Killinger *et al.* (2010), and Javadi and Safarmashaei (2011).

In addition, Salmonella organisms were isolated by Abd El-Aziz (2013) who detected *S. typhimurium* in 44% of the examined chicken meat samples, and Wahbah (2019), who detected *S. Typhimurium* and *S. Enteritidis* in the examined breast and thigh with incidences of 13.3 and 20%, 13.3 and 6.7%, respectively.

Several numbers salmonellosis were recorded due to serious hygienic deficiency in food technology during processing, production and storage as well as poor hygiene of food handlers (Koutikoysk and Kasijanenka, 1991).

Referring to Shigella spp., the obtained results are in variable compatibility with the reported results of El-Ramy (2017) (60% of the examined fresh chicken carcasses), Hozayn (2018) (24% of fresh chicken carcass samples), and Khalifa (2018) (30 and 42% in breast and thigh samples, respectively). In addition, Saad (2016) detected Shigella, Klebsiella, Enterobacter, and Proteus spp. in incidences of 40%, 18, 25, and 20% in the examined chicken carcasses; while Younes (2014) failed to detect Shigella spp. in the examined thigh samples, but found klebsiella, and Enterobacter spp. in 33.3% and 6.67% of the examined thigh samples, respectively.

In regard to *C. perfringens*, it is considered as foodborne pathogen of public health importance due to its ability to produce many enterotoxins. *Clostridium perfringens* food poisoning may occur after consumption of improper handled, cooked and stored poultry meat; where some heat resistant spores (100^OC for more than 1h) can survive, subsequently spore germination and rapid multiplication leading to food poisoning (Mokhtari and Doosti, 2015).

Nearly similar results were recorded by Afshari *et al.* (2015), who detected *C. perfringens* in 15.5% of examined chicken meat samples; while higher results were recorded by Zakaria (2005) who detected *C. perfringens* in 25 and 35% of the examined breast and thigh samples, and Nabil (2018) revealed detection of *C. perfringens* in 40 and 52% of the examined breast and thigh samples; moreover, lower results were reported by Thangamani and Subramanian (2012) who detected *C. perfringens* in 3.81% of the examined chicken meat samples. Furthermore, reported results were disagreed with Ibrahim *et al.* (2015) who failed to detect *C. perfringens* in any examined chicken meat sample.

In addition, presence of *S. aureus* in food refers to poor personnel, and hygienic conditions with great hazard. Staphylococcus food poisoning is considered as one of the frequent foodborne diseases, where its symptoms usually appear within 30 minutes to 8 hours after consumption of contaminated food by staphylococcal enterotoxins including nausea, vomiting, retching and less frequently diarrhea, headache and weakness in minority of cases (Hashim, 2003).

The obtained results somewhat agreed with those reported by Elshora (2019), who found *S. aureus* in 14.28% and

8.57% from chicken breast and chicken thigh samples, respectively.

Higher results were reported by Atia (2018) (28 and 44% of breast and thigh samples, respectively), El-Sheikh (2018) (30 and 40% of breast and thigh samples, respectively), and Abdelkarim (2020) who detected *S. aureus* in 27.08% of the total examined samples of breast and thigh; while lower result was recorded by Abd El-Fattah-Shereen (2014) who detected *S. aureus* in 4.0% of the examined raw chicken carcasses.

Differences between different authors may be referred to the variation between the source of the examined samples, method of rearing, and the hygienic quality of the slaughterhouse and slaughtering processes.

Detection of such food poisoning bacteria indicated poor hygienic condition during slaughtering, handling and storage. Accordingly, the healthy status of the slaughtered birds, hygienic practices performed during slaughtering and processing; the storage time/ temperature, and distribution conditions are important determinant factors for bacteriological profile of fresh poultry meat. Therefore, regular bacteriological assessment of slaughtered fresh carcasses is essential.

5. CONCULOSIONS

From the obtained results, it can be concluded that commercial chicken meat cuts may be loaded with many food poisoning bacteria rendering it of inferior quality or even possess health hazards to consumers. In addition, isolation of *E. coli* O_{157}:H_7, *S. Typhi*, *S. Typhimurium*, and other food poisoning bacteria from such examined samples may be serious to the human being. As recommendations, strict hygienic measures and personal hygiene should be applied in poultry slaughterhouses especially during slaughtering process to avoid such serious contaminants and to verify human safety.

CONFLICT IF INTEREST

The authors declare no conflict of interest

REFERENCES

1. Abd El-Aziz, D.M. 2013. Detection of S. Typhimurium in retail chicken meat and chicken giblets. Asian Pac. J. Trop. Biomed., 3(9), 678-681.
2. Abd El-Fattah-Shereen, A.Y. 2014. Enteropathogenic bacteria in broiler carcasses and some poultry products. Thesis, Ph.D. of Veterinary Medicine (Bacteriology), Alexandria University, Egypt.
3. Abdelkarim, E.A. 2020. Prevalence of some food poisoning bacteria in marketed poultry carcasses. Thesis, Master of Veterinary Medicine (Meat Hygiene), Zagazig University, Egypt.
4. Afshari, A., Jamshidi, A., Razmyar, J. and Rad, M. 2015. Genotyping of Clostridium perfringens isolated from broiler meat in northeastern of Iran. Veterinary Research Forum, 6(4), 279-284.
5. Anju, P., Lath, C., Sunil, B. and Sethulksmi, C. 2014. Detection of Salmonella and Yersinia spp. in uncooked retail chicken meat by multiplex PCR. International J. of Current Microbiology and Applied Science, 3(6), 1028-1034.
6. Arakeeb, S.M. 2020. Natural preservatives in raw chicken meat. Thesis, Master of Veterinary Medicine (Meat Hygiene), Benha University, Egypt.
7. Atia, G.A.A. 2018. Bacteriological and chemical criteria of chicken carcasses. Thesis, Ph.D. of Veterinary Medicine (Meat Hygiene), Benha University, Egypt.
8. Colmegna, S., Invernizzi, A., Mascher, A.L., Corsale, E., Ferrazzi, V. and Grilli, G. 2009. Microbiological characteristics of poultry meats- results of inspections carried out in the province of Milano, Italy. Italian Animal Sci., 8(4), 765-770.
9. El-Bassuony, R.A. 2008. Bacterial evaluation of frozen poultry and some poultry products in Luxor City. J. Egypt. Vet. Med. Assoc., 68 (4), 295-307.
10. Elboghdady, H.A.M. 2019. Incidence of enteropathogenic Escherichia coli In poultry carcasses marketed at Zagazig city. Thesis, Master of Veterinary Medicine (Meat Hygiene), Zagazig University, Egypt.
11. El-Ramy, R.Y.M. 2017. Incidence of some enteric pathogens in chicken carcasses and products. Thesis, Master of Veterinary Medicine (Meat Hygiene), Alexandria University, Egypt.
12. El-Sheikh, S.H.M. 2018. Prevalence of food poisoning organisms existing in poultry and its products. Thesis, Ph.D. of Veterinary Medicine (Meat Hygiene), Zagazig University, Egypt.
13. Elshora, H.E. 2019. Application of recent techniques for detection of some food borne pathogens isolated from different sources. Thesis, Ph.D. of Veterinary Medicine (Meat Hygiene), Benha University, Egypt.
14. Elsisy, S.E.A. 2019. Enterotoxigenic bacteria as potential hazards threaten the safety of some chilled meat, poultry and fish under the Egyptian marketing conditions. Thesis, Master of Veterinary Medicine (Meat Hygiene), Benha University, Egypt.
15. Feldman, D., Ganon, J., Haffman, R. and Simpson, J. 2003. The solution for data analysis and presentation graphics. 2nd Ed., Abacus Lancripts, Inc., Berkeley, USA.
16. Food and Agriculture Organization "FAO" 2014. The role of poultry in human nutrition. available at: www FAO.org/docrp/013/a1713e/a1713e00.
17. Hashem, S.M.H. 2015. Bacteriological criteria of dressed Poultry with special reference to some microbial decontaminators. Thesis, Ph.D. of Veterinary Medicine, Benha University, Egypt.
18. Hashim, E.S. 2003. Aerobic and anaerobic enterotoxigenic bacteria in ready to eat food. Thesis, Ph.D. of Veterinary Medicine, Zagazig Univ. (Benha Branch), Egypt.
19. Hassanin, F.S., Hassan, M.A., Shaltout, F.A., Abo Elroos, N.S. and Abd-Elhameed, G.A. 2017. Bacteriological criteria of chicken giblets. BVMJ, 33(2), 447-456.
20. Hassanin, F.S., Salem, A.M., Hassan, M.S., Gaafar, M.H. 2013. Enterobacteriacae in edible offal. Benha Veterinary Medical Journal, 25(1), 77-87.
21. Hozayn, A.A.K. 2018. Prevalence of food poisoning bacteria in retailed chicken carcasses in Alexandria province. Thesis, Ph.D. of Veterinary Medicine (Meat Hygiene), Alexandria University, Egypt.
22. Ibrahim, H.M., Amin, R.A., El-Shater, M.A. and Hafez-Salwa, M. 2015. Bacteriological evaluation of freshly slaughtered chicken carcasses. BVMJ, 28 (2), 74-82.
23. ISO "International Organization for Standardization 6887-1, 2017. International Organization for Standardization. No.6887-1. Microbiology of the food chain — Preparation of test samples, initial suspension and decimal dilutions for microbiological examination — Part 1: General rules for the preparation of the initial suspension and decimal dilutions.
24. ISO "International Organization for Standardization" 21567-2, 2004. International Organization for Standardization No. 21567-2. Microbiology of food and animal feeding stuffs — Horizontal method for the detection of Shigella spp.
25. ISO "International Organization for Standardization" 4833-1, 2013. International Organization for Standardization. No. 4833-1. Microbiology of the food chain-Horizontal method for the enumeration of microorganisms-Part 1: Colony count at 30 °C by the pour plate technique.
26. ISO "International Organization for Standardization" 7937, 2004. International Organization for Standardization No.

7937. Microbiology of food and animal feeding stuffs — Horizontal method for the enumeration of Clostridium Perfringens - Colony-count technique.
27. ISO "International Organization for Standardization" 16649-2, 2001. International Organization for Standardization No.16649-2. Microbiology of food and animal feeding stuffs — Horizontal method for the enumeration of glucuronidase-positive Escherichia coli - Part 2: Colony-count technique at 44 °C using 5-bromo-4-chloro-3-indolyl-D-glucuronide.
28. ISO "International Organization for Standardization" 21528-2, 2017. International Organization for Standardization. No.21528-2. Microbiology of the food chain — Horizontal method for the detection and enumeration of Enterobacteriaceae — Part 2: Colony-count technique.
29. ISO "International Organization for Standardization" 6579-1, 2017. International Organization for Standardization No.6579-1. Microbiology of the food chain Horizontal method for the detection, enumeration and serotyping of Salmonella - Part1: Detection of Salmonella spp.
30. ISO "International Organization for Standardization" 6888-1 (1999), Amendment 1 (2003): International Organization for Standardization No. 6888-1:1999, A1:2003. Microbiology of food and animal feeding stuffs — Horizontal method for the enumeration of coagulase-positive staphylococci (Staphylococcus aureus and other species) - Part 1: Technique using Baird-Parker agar medium (includes amendment A1: 2003).
31. Jasson, V., Jacxsens, L., Luning, P., Rajkovic, A. and Uyttendaele, M. 2010. Alternative microbial methods: An overview and selection criteria. Food Microbiol., 27, 710-730.
32. Javadi, A. and Safarmashaei, S. 2011. Microbial Profile of marketed broiler. Meat Middle-East J. Sci. Res., 9(5), 652-656.
33. Kallaf, M., Ameur, N., Terta, M., Lakranbi, M., Senoucil, S. and Ennaji, M.M. 2014. Prevalence and antibiotic resistance of Salmonella isolated from chicken meat marketed in Rabat. Morocco. Int. J. Innovation and Applied Studies, 6(4), 1123-1128.
34. Kauffman, G. 1974. Kauffman white scheme. J. Acta. Path. Microbiol. Sci., 61, 385.
35. Khalaf, F.H.M. 2019. Evaluation of hygienic status of meat meals in some food catering establishments. Thesis, Master of Veterinary Medicine (Meat Hygiene), Benha University, Egypt.
36. Khalifa, A.K.M. 2018. Incidence of some enteropathogens chicken carcasses at Beheira province. Thesis, Master of Veterinary Medicine (Meat Hygiene), Alexandria University, Egypt.
37. Killinger, K.M., Kannan, A., Bary, A.I. and Cogger, C. 2010. Validation of a 2% lactic acid antimicrobial rinse for mobile poultry slaughter operation. J. Food Prot., 73(11), 2079-2083.
38. Kok, T., Worswich, D. and Gowans, E. 1996. Some serological techniques for microbial and viral infections". In: Practical Medical Microbiology (Collee, J.; Fraser, A.; Marmion, B. and Simmons, A., eds.), 14th ed., Edinburgh, Churchill Livingstone, UK.
39. Koutikoysk, A.V. and kasijanenenka, A.I. 1991. Present status of Salmonellosis in the Soviet Union, WHO collaboration center for veterinary sanitation and food hygiene.
40. Mokhtari, F.A. and Doosti, A. 2015. Investigation of antibiotic resistance and frequency of Clostridium difficile tcdA and tcdB genes in feces of calves in Chaharmahal Va Bakhtiari province. Journal of Shahrekord University of Medical Sciences, 17, 35–42.
41. Nabil, M.E. 2018. Prevalence of anaerobic bacteria in some raw and ready to cook chicken meat products with special reference to Clostridium perfringens. Thesis, Ph.D. of Veterinary Medicine (Meat Hygiene), Benha University, Egypt.
42. NHS. 2013. UK Standards for Microbiology Investigations: Identification of Enterobacteriaceae. Crown copyright, p. 1-32. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/521047/ID_16dp_UC.pdf
43. Olaoye, O.A. and Nilude, A.A. 2010. Investigation on the potential use of biological agents in the extension of fresh beef in Nigeria. World Journal of Microbiology and Biotechnology, 26, 1445–1454.
44. Rasschaert, G., Houf, K., Imberechts, H., Grijspeerdt, K., De Zutter, L. and Heyndrickx, M. 2005. Comparison of five repetitive-sequences based PCR typing methods for molecular discrimination of Salmonella enterica isolates. J. Clinic. Microbiol., 43, 3615-3623.
45. Saad, A.M.A. 2016. Enterobacteriaceae in broiler chicken carcasses at Alexandria province. Thesis, Master of Veterinary Medicine (Meat Hygiene), Alexandria University, Egypt.
46. Shaltout, F., Nasief, M.Z., Lotfy, L.M. and Gamil, B.T. 2019. Microbiological status of chicken cuts and its products. BVMJ, 37: 57-63.
47. Tebbut, G.M. 1999. Microbiological contamination of cooked meats and environmental site in premise selling both raw and cooked meat products. Inter. J. Environ. Health Res., 3(4), 209-216.
48. Thangamani, A. and Subramanian, S. 2012. Prevalence of Clostridium perfringens in the chicken meat rendered at retail outlets of Namakkal, Tamilnadu. J. Advanced Veterinary Research, 2, 157-159.
49. USFDA (U.S .Food and Drug Administration) 2012. Bad Bug Book: Foodborne pathogenic Micro-organisms and Natural Toxins Handbook S. aureus. 10903 New Hampshire Avenue Silver Spring, MD 20993.
50. Varnam, A.H. and Evans, M.G. 1991. Foodborne pathogens. Wolfe Publishing Ltd., London, UK.
51. Wahbah, S.F.F. 2019. Prevalence of Salmonella in some chicken meat products. Thesis, Master of Veterinary Medicine (Meat Hygiene), Benha University, Egypt.
52. Younes, O.F.A. 2014. Enterobacteriaceae in chicken meat products. Thesis, Master of Veterinary Medicine (Meat Hygiene), Benha University, Egypt.
53. Zakaria, I.M. 2005. Anaerobic bacteria in chicken meat products. Thesis, Master of Veterinary Medicine (Meat Hygiene), Benha University, Egypt.
54. Zhang, L., Davis, M.A. and Conner, D.E. 2001. Poultry-borne pathogens: plant considerations. Poultry Meat Processing, Chap. 9, ISBN 0 - 8493-0120 - 3, CRC Press LLC, New York, USA.