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Bacteriological Quality of Retailed Chicken Meat Products in Zagazig City, Egypt

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Abstract

Chicken meat products have a high biological value; they are good sources of amino acids, vitamins, and minerals. Despite this high biological value, these products act as a good substrate for different types of bacteria and have been implicated in many foodborne disease outbreaks. Therefore, a total of 60 random samples of chicken meat products (nuggets, luncheon and pane, 20 of each) were collected from Zagazig City, Sharkia Governorate, Egypt for bacteriological examination (Aerobic Plate Count, Staphylococci count, *Pseudomonas* count, determination of most probable number of Coliform and *E. coli*.). The obtained results revealed that the mean aerobic plate counts were 5.18±0.19, 4.88±0.20 and 4.73±0.29 $\log_{10}$ CFU/g; Staphylococci counts were 2.96±0.20, 3.14±0.21 and 3.32±0.16 $\log_{10}$ CFU/g; *Pseudomonas* counts were 2.17±0.30, 2±0.28 and 2.34±0.21 $\log_{10}$ CFU/g; most probable numbers of Coliforms were 3.37±0.11, 3.83±0.27 and 3.64±0.30 $\log_{10}$ CFU/g; and most probable numbers of *E. coli* were 2.14±0.17, 2.56±0.30 and 2.64±0.25 $\log_{10}$ CFU/g in the examined nuggets, luncheon and pane, respectively. According to the Egyptian Organization for Standardization and Quality (EOS), the examined chicken product samples were 10(21.67%), 9(15%), 28(46.67%), 49(81.67%), 31(51.67%) and 30(50%) accepted for aerobic plate count, Staphylococci count, *S. aureus*, *Pseudomonas* count, Coliform and *E. coli*, respectively. In conclusion, the examined chicken meat products revealed unsatisfactory hygienic measures. Therefore, strict hygienic practices should be adopted during processing of chicken meat products to improve the bacteriological quality of such products.

KEYWORDS
Chicken products, Coliform, *E. coli*, Food poisoning, *Pseudomonas*.

INTRODUCTION

In the last decades, chicken meat products are considered one of the most popular foods in both developed and developing countries; these products can solve the problem of animal meat shortage. They have many health benefits as a good supply of easily digested, high quality protein, good source of minerals and vitamins including riboflavin thiamine and niacin which are essential for maintaining life and promoting growth. Despite this high biological value, chicken meat products are subjected to contamination by different types of food spoilage and poisoning microorganism because of an abundance of all nutrients required for the growth and multiplication of most microorganisms (Samaha *et al*. 2012; Morshdy *et al*., 2021). Different sources can contaminate chicken meat products by many pathogens starting from de-feathering, evisceration and the subsequent during processing in plant (Morshdy *et al*., 2018b; Saleh *et al*., 2020; Yar *et al*., 2021). These pathogens may be endogenous from the gastrointestinal tract of the bird or from the surrounding environment in farm and/ or slaughterhouse (Akbar and Anal, 2014). Also, unhygienic practices, use of contaminated instruments and materials in food processing are mainly associated with food-borne diseases (Morshdy *et al*., 2018bc; Wilfred *et al*., 2012). Bacterial growth is the main cause of food spoilage and foodborne illness in humans, resulting in severe health and economic losses.

Pseudomonas spp. is an aerobic Gram-negative psychrotrophic bacterium, which is found in soil. It can produce proteinases that hydrolyze chicken protein causing meat spoilage (Nowak *et al*., 2012). *Pseudomonas* spp. can be found everywhere (human beings, drinking water and plants) and isolated from various sources including foods (Hassan *et al*., 2020). In a temperature range from 2 to 35 °C, *Pseudomonas* spp. can grow well (Ercolini *et al*., 2010), therefore, it can be found in chilled meat products and at room temperature prepared food (Caldera *et al*., 2016).

Staphylococcus aureus and *E. coli* are the most frequent and common pathogens that cause food infections and food poisoning (Pires *et al*., 2012). All over the world, Staphylococcal food poisoning (SFP) is one of the most common food-borne diseases; resulting from ingestion of preformed staphylococcal enterotoxins in food by enterotoxigenic strains of *S. aureus* (Lika *et al*., 2021). It occurs within 30 minutes to 8 hours after ingestion leading to many symptoms including nausea, vomiting, diarrhea, abdominal cramp, chills, sweating and decrease in the body tem-

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perature (FDA, 2012; Morshdy *et al*., 2018c).

E. coli is one of the major components of the normal intestinal micro-flora of human and mammals; it is harmless to the host and can cause diseases only in the immune-compromised host or when it breaches the gastrointestinal barriers (Ibrahim *et al*., 2018). Meanwhile, some *E. coli* strains can acquire specific virulence and represent primary pathogens with enhanced potential to cause many disease conditions (Li *et al*., 2005; Morshdy *et al*., 2018b). Therefore, the present study was planned out to evaluate to what degree chicken meat products in Sharkia Governorate are contaminated bacteriologically by food poisoning and food spoilage microorganisms.

MATERIALS AND METHODS

Collection of samples

A total of 60 chicken meat product samples (Nuggets, luncheon, and Pane, 20 of each) were collected randomly from different outlets at Zagazig City, Sharkia Governorate, Egypt. The samples were aseptically transferred as soon as possible in an ice box to the Meat Hygiene Laboratory, Faculty of Veterinary Medicine, Zagazig University to be examined bacteriologically.

Preparation of samples

Twenty-five grams of each sample were homogenized in a sterile homogenizer with 225 ml sterile buffered peptone water (BPW) 0.1% at 2500 rpm. for 3 minutes to produce a homogenate of 1/10 initial dilution. From this initial dilution (1/10), 1 ml was transferred into tube containing 9 ml sterile BPW 0.1% to be diluted in subsequent manner by ten – fold dilution (APHA, 2001).

Determination of Aerobic Plate Counts (APC)

From the initial dilution, 1 ml was aseptically poured into two separate sterile petri dishes and approximately 15 ml of sterile melted and tempered plate count agar (MERCK UM1401630150) was poured. After thorough mixing, the dishes were allowed to solidify at room temperature, and then incubated at 37ºC for 24-48 h in an inverted position. Total APC /g was calculated on plates containing 25-250 colonies (ISO, 2003).

Determination of Staphylococci count and S. aureus

From each previously prepared serial dilution 0.1 ml was spread over the surface of prepared Petri dishes with Barid-Parker agar medium using a spreader. The plates were retained in upright position until the inoculums were absorbed by agar about 10 min. The inoculated and control plates were inverted and incubated at 37 ºC for 24– 48 h. Black shiny convex colonies surrounded by area with a zone of opacity are the morphological ideal colonies of *S. aureus* were recorded and total Staphylococci count was calculated was carried out according to FDA (2001).

Determination of Pseudomonas count

From the previously prepared homogenate, 0.1 ml of each sample was inoculated separately into *Pseudomonas* selective agar medium base (HiMedia) which is supplemented with glycerol. After evenly spread, the plates were incubated at 25 °C for 48 hours then all developed colonies which were greenish yellow colonies were enumerated (ISO, 2004).

Determination of most probable number (MPN) of Coliform

One ml of the previously prepared dilution was inoculated separately into each of three MacConkey broth tubes (HiMedia, Mumbai) with inverted Durham's tubes. These inoculated tubes were incubated at 37 ºC, and then examined after 24 hours and 48 hours. Positive tubes showing acid and gas productions in inverted Durham's tubes were recorded (ICMSF, 1978).

Determination of most probable number (MPN) of E. coli

One ml from the previously positive MPN of Coliform tubes (showing acid and gas productions) were inoculated into a previously warmed tubes containing 7 ml *E. coli* (EC) broth (Himedia, Mumbai) and incubated at 44.5 °C for 24 to 48 hours. Positive tubes (showing gas production) were used to calculate the MPN of *E. coli* (FDA, 2002).

Statistical analysis

Results were converted to $\log_{10}$ CFU/g and reported as mean values ± standard error (S.E). Statistical analysis of data was done by using the statistical package for social sciences (SPSS-21.; Chicago, IL, USA) software. Differences among individual means were compared by Duncan Multiple Range test, at 95% level of confidence, $P<0.05$ was considered as significant.

RESULTS

Aerobic plate counts (APC)

Chicken meat products are subjected to many contamination risks with different pathogens from various sources. Results illustrated in Table 1, declared that APC ranged from 3.41 to 6.94, 3.50 to 6.41 and 2.04 to 6.99 $\log_{10}$ CFU/g, with mean counts of 5.18±0.19, 4.88±0.20 and 4.73±0.29 $\log_{10}$ CFU/g in the examined nuggets, luncheon, and pane, respectively.

Table 1. Aerobic plate count ($\log_{10}$ CFU/g) in chicken products (N=20, of each).

Samples	Minimum	Maximum	Mean± S.E.
Nuggets	3.41	6.94	5.18±0.19
Luncheon	3.5	6.41	4.88±0.20
Pane	2.04	6.99	4.73±0.29

S.E. Standard error of mean
Means are not significantly different (P> 0.05) according to Duncan significant difference test.
N: Number of examined samples.
CFU/g: Colony Forming Unit per gram

Staphylococci count and S. aureus

As recorded in Table 2, the examined nuggets, luncheon and pane were 19 (95%), 20 (100%) and 18 (90%), respectively contaminated by Staphylococci with a total prevalence of 57 (95%). The total Staphylococci counts in the examined nuggets, luncheon and pane were 2.96±0.20, 3.14±0.21 and 3.32±0.16 $\log_{10}$ CFU/g, respectively; with minimum counts of 1.39, 1.90 and 1.81 $\log_{10}$ CFU/g, respectively and maximum counts of 4.12, 5.98 and 4.39 $\log_{10}$ CFU/g, respectively (Table 3). As illustrated in Table 2, the prevalence of *S. aureus* in the examined chicken product samples was 32 (53.33%). *S. aureus* was detected in 13 (65%), 11 (55%) and 8 (40%) of the examined nuggets, luncheon, and pane, respectively.

Table 2. Prevalence of Staphylococci and *S. aureus* in chicken products (N=20, of each).

Samples	*Staphylococci*		*S. aureus*	
	No.	%	No.	%
Nuggets	19	95	13	65
Luncheon	20	100	11	55
Pane	18	90	8	40
Total	57	95	32	53.33

N: Number of examined samples; No.: Number of positive samples

Table 3. Total staphylococci count (log_{10} CFU/g) in chicken products (N=20, of each).

Samples	Minimum	Maximum	Mean± S.E
Nuggets	1.39	4.12	2.96±0.20
Luncheon	1.9	5.98	3.14±0.21
Pane	1.81	4.39	3.32±0.16

S.E. Standard error of mean
Means are not significantly different (P> 0.05) according to Duncan significant difference test.
N: Number of examined samples.
CFU/g: Colony Forming Unit per gram

Determination of Pseudomonas count

The examined chicken product samples were 22 (36.67%) contaminated by *Pseudomonas* spp.; its prevalence was 8 (40%), 5 (25%) and 9 (45%) in the examined nuggets, luncheon and Pane, respectively (Table 4). The mean count of *Pseudomonas* spp. in the examined nuggets, luncheon and pane was 2.17±0.30, 2±0.28 and 2.34±0.21log_{10} CFU/g, respectively; with minimum counts of 1.04, 1.32 and 1.64 log_{10} CFU/g, respectively and maximum counts of 3.66, 2.99 and 2.99 log_{10} CFU/g, respectively.

Table 4. Total *Pseudomonas* count (log_{10} CFU/g) in chicken products (N=20, of each).

Samples	Prevalence	Minimum	Maximum	Mean± S.E
Nuggets	8 (40%)	1.04	3.66	2.17±0.30
Luncheon	5 (25%)	1.32	2.99	2±0.28
Pane	9 (45%)	1.64	2.99	2.34±0.21

S.E. Standard error of mean
Means are not significantly different (P> 0.05) according to Duncan significant difference test.
N: Number of examined samples.
CFU/g: Colony Forming Unit per gram

Most probable number (MPN) of Coliform

Results illustrated in Table 5 declared that the prevalence of Coliform in the examined nuggets, luncheon and pane was 13 (65%), 7 (35%) and 10 (50%), respectively; with a total prevalence of 30 (50%). The MPN of Coliform ranged from 2.41 to 4.04, 2.55 to 4.66 and1.99 to 4.99 log_{10} CFU/g, with mean values of 3.37±0.11, 3.83±0.27 and 3.64±0.30 log_{10} CFU/g in the examined nuggets, luncheon and pane, respectively (Table 5).

Table 5. Most probable number of Coliform (log_{10} CFU/g) in chicken products (N=20, of each).

Samples	Prevalence	Minimum	Maximum	Mean± S.E
Nuggets	13 (65%)	2.41	4.04	3.37±0.11
Luncheon	7 (35%)	2.55	4.66	3.83±0.27
Pane	10 (50%)	1.99	4.99	3.64±0.30

S.E. Standard error of mean
Means are not significantly different (P> 0.05) according to Duncan significant difference test.
N: Number of examined samples.
CFU/g: Colony Forming Unit per gram

Most probable number (MPN) of E. coli

The prevalence of *E. coli* in the examined chicken product samples was 30 (50%); it was isolated from 13 (65%) of nuggets, 7 (35%) of luncheon and 10 (50%) of pane (Table 6).

As recorded in Table 6, the mean values of MPN of *E. coli* was 2.14±0.17, 2.56±0.30 and 2.64±0.25 log_{10} CFU/g, with minimum values of 1.39, 1.50 and 1.07 log_{10} CFU/g and maximum values of 3.11, 3.56 and 3.98 log_{10} CFU/g in the examined nuggets, luncheon, and pane, respectively.

Table 6. Most probable number of *E. coli* (log_{10} CFU/g) in chicken products (N=20, of each).

Samples	Prevalence	Minimum	Maximum	Mean± S.E
Nuggets	13 (65%)	1.39	3.11	2.14±0.17
Luncheon	7 (35%)	1.5	3.56	2.56±0.30
Pane	10 (50%)	1.07	3.98	2.64±0.25

S.E. Standard error of mean
Means are not significantly different (P> 0.05) according to Duncan significant difference test.
N: Number of examined samples.
CFU/g: Colony Forming Unit per gram

DISCUSSION

Different pathogens from many sources can contaminate chicken meat products starting from pre-processing, processing steps and post-processing during packaging, marketing, and storage. These pathogenic microorganisms render the chicken products harmful to consumers and unfit for human consumption. Many indicators can be used to evaluate the hygienic status of chicken products; APC, total staphylococcal count, *Pseudomonas* count and coliform are commonly used to evaluate the hygiene of chicken meat and its products production process (Hassanin *et al.*, 2017).

Aerobic plate count is an indicator on the quality of chicken meat, bacterial contamination, and the hygienic measures during

Table 7. Acceptability of the examined chicken product samples based on the bacteriological examination.

Samples	Aerobic plate count		*Staphylococci*		*S. aureus*		*Pseudomonas*		Coliform		*E. coli*	
	MPL	Acceptable	MPL	Acceptable	MPL	Acceptable	MPL	Acceptable	MPL	Acceptable	MPL	Acceptable
Nuggets	4	3(15%)	< 2	5(25%)	Free	7(35%)	< 2	15(75%)	< 2	7(35%)	Free	7(35%)
Luncheon		6(30%)		1(5%)		9(45%)		18(90%)		13(65%)		13(65%)
Pane		4(20%)		3(15%)		12(60%)		16(80%)		11(55%)		10(50%)
Total		10(21.67%)		9(15%)		28(46.67%)		49(81.67%)		31(51.67%)		30(50%)

MPL: Maximum Permissible Limit according to EOS (2005) for poultry products.

processing, in addition to keeping quality evaluation. The highest APC was found in the examined nuggets, while the lowest APC was found in the examined pane. According to the Egyptian Organization for Standardization and Quality (EOS, 2005), the examined chicken product samples were 10 (21.67%) accepted for APC; the acceptability was 3(15%), 6(30%) and 4(20%) for the examined nuggets, luncheon, and pane, respectively (Table 7). These results were in accordance with those reported by Bkheet *et al*. (2007) (5 $\log_{10}$ CFU/g in chicken luncheon) and Shanab (2014) (5.6 $\log_{10}$ CFU/g for chicken nuggets), Ibrahim *et al*. (2014) (4.7, 4.3, 4.5 $\log_{10}$ CFU/g for nuggets, luncheon and pane, respectively) and Ibrahim *et al*. (2018) (5.9 and 5.3 $\log_{10}$ CFU/g for nuggets and luncheon). Meanwhile, higher results were recorded by Ahmed (2004) (6.3 and 6.8 $\log_{10}$ CFU/g for chicken luncheon and chicken nuggets). The high result of APC may be attributed to contamination of chicken products from many sources as well as unsatisfactory processing and unsuitable condition during storage (Zahran, 2004). Lower APC (3.9 $\log_{10}$ CFU/g) was obtained by Sharaf and Sabra (2012) in chicken luncheon.

Total staphylococci count is considered as an important indicator on improper processing and sanitation in addition to presence of enterotoxin producing strains especially *S. aureus*. The examined chicken product samples were contaminated by staphylococci; the highest count was recorded in chicken pane, while the lowest count was in chicken nuggets. According to the EOS (2005), the examined chicken product samples were 9(15%) accepted for Staphylococci count; the acceptability was 5(25%), 1(5%) and 3(15%) for the examined nuggets, luncheon, and pane, respectively (Table 7). Nearly similar results were reported by EL-Hoti, el al. (2011); Moustafa *et al*. (2016) and Ibrahim *et al*. (2018) for nuggets and luncheon. Higher staphylococci count was obtained by Shawish (2011) and Al-Ghamdi (2012) who found that the mean count of staphylococci was 4.2 and 6.2 $\log_{10}$ CFU/g in chicken luncheon. While lower staphylococci count (2.5 $\log_{10}$ CFU/g) was reported by Edris (2015). The high incidence of staphylococci in chicken products gives an indication on unacceptable level of contamination during handling and processing as well as post processing contamination.

The prevalence of *S. aureus* in this study was higher than what had been obtained by Sharaf and Sabra (2012) as they isolated *S. aureus* from 10% of chicken luncheon, Edris (2015) who isolated *S. aureus* from 5% and 15% of chicken luncheon and chicken nuggets and Ibrahim *et al*. (2018) who isolated *S. aureus* from 23.3% and 30% in chicken luncheon and nuggets. Meanwhile, our result disagreed with Shanab (2014) who failed to detect *S. aureus* in the examined chicken product samples. The examined chicken product samples were 28(46.67%) accepted for *S. aureus*; the acceptability was 7(35%), 9(45%) and 12(60%) for the examined nuggets, luncheon, and pane, respectively According to the EOS (2005) (Table 7). Contamination of chicken product samples by *S. aureus* indicated its contamination from inadequately cleaned equipment and food handlers.

Pseudomonas spp. are found everywhere and can be isolated from different sources including foods. Under aerobic conditions, *Pseudomonas* spp. can cause putrefaction of ice-cold meat; it has the ability to withstand the difficult environmental conditions that prevent the growth of other microorganisms (Elbehiry *et al*., 2022). The examined chicken pane samples were the most contaminated samples by *Pseudomonas* spp. followed by chicken nuggets and luncheon. The examined chicken product samples were 49(81.67%) accepted for *Pseudomonas* count; the acceptability was 15(75%), 18(90%) and 16(80%) for the examined nuggets, luncheon, and pane, respectively According to the EOS (2005) (Table 7). Other studies conducted by Bruckner *et al*. (2012), Abd El-Aziz (2015), Morshdy *et al*. (2018a), Hassan *et al*. (2020) and Elbehiry *et al*. (2022) reported higher *Pseudomonas* counts (3.8, 4.4, 3.6, 3.9 and 3.6 $\log_{10}$ CFU/g) for nuggets.

Comparing the obtained results of MPN of coliform, nearly similar results were reported by Ibrahim *et al*. (2018). Meanwhile, higher Coliform count was obtained by Bkheet *et al*. (2007) (4.6 and 4.4 $\log_{10}$ CFU/g) in chicken nuggets and chicken luncheon. Moreover, lower Coliform count obtained by El-Kewaiey (2012) (2.4 and 1.7 $\log_{10}$ CFU/g in chicken nugget and chicken luncheon). According to the EOS (2005), the examined chicken product samples were 31(51.67%) accepted for Coliform count; the acceptability was 7(35%), 13(65%) and 11(55%) for the examined nuggets, luncheon and pane, respectively (Table 7). The high results of MPN of coliform in chicken products indicate poor hygienic quality of the product. Contamination of chicken meat products with Coliforms can occur from different sources including contaminated hands, shopping blocks, knives and contaminated water (Yadav *et al*., 2006).

E. coli is a naturally inhabitant of the intestinal tracts of warm-blooded animals and humans, its presence in chicken meat products reflects fecal contamination of meat, in addition to a possible contamination by other enteric pathogens. In humans, the pathogenic strains of *E. coli* have been implicated in many cases of foodborne infections (Adzitey *et al*., 2020). According to the EOS (2005), the examined chicken product samples were 30(50%) accepted for *E. coli*; the acceptability was 7(35%), 13(65%) and 10(50%) for the examined nuggets, luncheon, and pane, respectively (Table 7). *E. coli* was previously isolated from chicken meat products by Ahmed (2004); Awadallah *et al*. (2014) and Sobieh (2014) who isolated *E. coli* a in a percent of 26.67% from the examined chicken products; Edris (2015) who isolated *E. coli* in a percent of 25% of chicken nuggets and Ibrahim *et al*. (2018) who isolated *E. coli* in a percent of 13.3% and 16.6% of chicken luncheon and nuggets. Nearly similar results in Table (5) were obtained by Sharaf and Sabra (2012) and Edris (2015) who found the mean MPN of *E. coli* 2.6 and 2.3 $\log_{10}$ CFU/g in chicken luncheon and chicken nuggets. Meanwhile, higher result (4.5 for pane) was reported by Ibrahim *et al*. (2014), but lower result was recorded by Wardhana *et al*. (2021). Raw foodstuffs and undercooked or gets contamination either during primary production as slaughtering or further processing and handling e.g. cross contamination during processing, human-to-food contamination by food handlers (Adeyanju and Ishola, 2014).

CONCLUSION

The achieved results in the present study prove that most of the examined chicken product samples are contaminated with food spoilage and food poisoning microorganisms this regarded objectionable, not only because they render meat of inferior quality and unfit for human consumption but also, they indicate fecal contamination and improper handling during meat processing. Therefore, it is recommended to adopt strict hygienic measures during handling till consumer consumption.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

REFERENCES

Abd El-Aziz, D.M., 2015. Detection of *Pseudomonas* spp. in chicken and fish sold in markets of Assiut City, Egypt. J. Food Quality and Hazards Cont. 2, 86-89.

Adeyanju, G.T., Ishola, O., 2014. *Salmonella* and *Escherichia coli* contamination of poultry meat from a processing plant and retail markets in Ibadan, Oyo State, Nigeria. Springer Plus 3, 139-147.

Adzitey, F., Assoah-Peprah, P., Teye, G.A., Somboro, A.M., Kumalo, H.M., Amoako, D.G., 2020. Prevalence and antimicrobial resistance of *Escherichia coli* isolated from various meat types in the Tamale Metropolis of Ghana. Int. J. Food Sci. 8877196.

Ahmed, A.F., 2004. Studies on cooked meat and chicken products. PhD., Thesis (Meat Hygiene), Fac. Vet. Med., Zagazig Univ., Benha

Branch, Egypt.
Akbar, A., Anal, K.A., 2014. Occurrence of *Staphylococcus aureus* and evaluation of anti-staphylococcal activity of *Lactococcus lactis* subsp. lactis in ready-to-eat poultry meat. Annals Microbiol. 64,131-138.
Al-Ghamdi, A.Y., 2012. Incidence of *Staphylococcus aureus* contamination of marketed processed chicken products with special reference to its antibiotics sensitivity collected from Al Baha city markets, Saudi Arabia. Pak J Food Sci. 22, 168-170.
American Public Health Association (APHA), 2001. Compendium of Methods for the Microbiological Examination of Foods Fourth edition. F.P. Downes and K. Ito (editors), American Public Health Association, Washington, D.C.
Awadallah, M.A.I., Ahmed, H.A., Merwad, A.M., 2014. Prevalence of non-O157 shiga toxin-producing *Escherichia coli* and Enterotoxigenic staphylococci in ready-to-eat meat products, handlers and consumers in Cairo, Egypt. Global Vet. 12, 692-699.
Bkheet, A.A., Rezk, M.S.H., Mousa, M.M., 2007. Study on the microbiological content of local manufactured poultry meat products in El-Bohira governorate. Assiut Vet Med J. 53, 115-125.
Bruckner, S., Albrecht, A., Petersen, B., Kreyenschmidt, J., 2012. Influence of cold chain interruptions on the shelf life of fresh pork and poultry. Int. J. Food Sci. and Technol. 47, 1639-1646.
Caldera, L., Franzetti, L., Van-Coillie, E., 2016. Identification, enzymatic spoilage characterization and proteolytic activity quantification of *Pseudomonas* spp. isolated from different foods. Food Microbiol. 54, 142-53.
Edris, S.N., 2015. Bacterial and chemical investigation of some heat-treated chickens meat products with special references to recent techniques. Ph.D. Thesis (Meat Hygiene), Fac. Vet. Med., Benha Univ., Egypt.
EOS (Egyptian Organization for Standardization and Quality), 2005. Egyptian Organization for Standardization and Quality for Chilled poultry and rabbit, 1651.
Elbehiry, A., Marzouk, E., Aldubaib, M., Moussa, I., Abalkhail, A., Ibrahem, M., Sindi, W., Alzaben, F., Almuzaini, A., Algammal, A., Rawway, M., 2022. *Pseudomonas* species prevalence, protein analysis, and antibiotic resistance: an evolving public health challenge. AMB Express. 12, 53.
ELHoti, F.A.I., 2011. Effect of batter formulations on the quality of coated chicken meat products. Ph.D. Thesis (Meat Hygiene) Vet. Sc. Fact., of Vet. Med. Cairo Univ., Egypt.
El-Kewaiey, I.A., 2012. Quality assessment of some ready to eat and locally produced chicken meat products. Assiut Vet. Med. J. 58, 40-45.
Ercolini, D., Casaburi, A., Nasi, A., 2010. Different molecular types of *Pseudomonas* fragi have the same overall behavior as meat spoilers. Int. J. Food Microbiol. 142,120-31.
FDA (Food and Drug Administration), 2001. BAM (Bacteriological Analytical Manual) Chapter 23 Microbiological Methods for Cosmetics.
FDA (Food and Drug Administration), 2002. BAM (Bacteriological Analytical Manual) Chapter4: Enumeration of *Escherichia coli* and the Coliform Bacteria.
FDA (Food and Drug Administration), 2012. Bad bug book: Foodborne pathogenic microorganisms and natural toxins handbook, 2nd ed. US Food and Drug Administration, Silver Spring, pp. 87-92.
Hassan, M.A., Ibrahim, H.M., Shawky, N.A., Sheir, S.H., 2020. Incidence of Psychotropic bacteria in frozen chicken meat products with special reference to *Pseudomonas* species. Benha Vet, Med, J. 39, 165-168.
Hassanin, F.S., Hassan, M.A., Shaltouta, F.A., Shawqyb, N.A., Abd-Elhameed, G.A., 2017. Bacteriological criteria of chicken giblets Benha Vet, Med. J. 33, 447-456.
Ibrahim, H.M., Amin, R.A., Ibrahem, I.A., Yunis, O.F., 2014. Isolation of Enterobacteriacaea from poultry products in El-Behera and Alexandria governorates. Benha Vet. Med. J. 27, 109-117.
Ibrahim, H.M., Hassan, M.A., Amin, R.A., Shawqy, N.A., Elkoly, R.L., 2018. The bacteriological quality 0f some chicken meat products. Benha Vet. Med. J. 35, 50-57.
International Commission on Microbiological Specification for Foods (ICMSF), 1978. Microorganisms in foods. 1. Their significance and methods of enumeration. 2nd Ed. Toronto, Univ. of Toronto Press.
ISO (International Standards Organization), 2004. Microbiology of food and animal feeding stuffs. Horizontal method for detection and enumeration of Enterobacteriaceae, Part 2: colony count method. International Standards Organization, Geneva.
ISO, 4833 (International Organization for Standardization), 2003. Microbiology of food and animal feeding stuffs — Horizontal method for the enumeration of microorganisms — Colonycount technique at 30 degrees C. https://www.iso.org/standard/34524.html
Li, Y., Zhuang, S., Mustapha, A., 2005. Application of a multiplex PCR for the simultaneous detection of *Escherichia coli* O157:H7, *Salmonella* and *Shigella* in raw and ready-to-eat meat products. Meat Sci. 71, 402–406.
Lika, E., Puvaca, N., Jeremic, D., Stanojevic, S., Shtylla, T., Cocoli, S., Frutos, R., 2021. Antibiotic susceptibility of *Staphylococcus* species isolated in raw chicken meat from retail stores. Antibiotics. 10,904.
Morshdy, A.M., Hussein, M.A., El-Arabay, A.E. 2018a. Chemical and Microbial Profile of Some Chicken Products. 5th International Food Safety Conference Damanhour University, Egypt.
Morshdy, A.E., Hussein, M.A., Tharwat, A.E., Moustafa, N.A., Hussein, O.K., 2018b. Prevalence of shiga toxigenic and multi drug resistant *Escherichia coli* in ready to eat chicken products' sandwiches. Slov. Vet. Res. 55, 349-356.
Morshdy, A.E., Hussein, M.A., Tharwat, A.E., Fakhry, B.A., 2018c. Prevalence of enterotoxigenic and multi-drug-resistant *Staphylococcus aureus* in ready to eat meat sandwiches. Slov. Vet. Res. 55, 367-374.
Morshdy, A.E.M.A., Nahla, B.M., Shafik, S., Hussein, M.A., 2021. Antimicrobial effect of essential oils on multidrug-resistant *Salmonella typhimurium* in chicken fillets. Pak. Vet. J. 41, 545-551.
Moustafa, N.Y., Tolba, K.S., EL-Shehawy, R.H., 2016. Bacteriological quality of halfcocked chicken meat products. Kafrelsheikh Vet. Med. J. 4th Sci. Congress. pp. 1-20.
Nowak, A., Rygala, A., Oltuszak-Walczak, E., Walczak, P., 2012. The prevalence and some metabolic traits of Brochothrix thermosphacta in meat and meat products packaged in different ways. J. Sci. Food Agric. 92, 1304- 1310.
Pires, S.M., Vieira, A.R., Perez, E., Wong, D.L.F., Hald, T., 2012. Attributing human foodborne illness to food sources and water in Latin America and the Caribbean using data from outbreak investigations. Int. J. Food Microbiol. 152, 129-38.
Saleh, E., Morshdy, A.E., El-Manakhly, E., Al-Rashed, S., F. Hetta, H., Jeandet, P., Yahia, R., El-Saber Batiha, G., Ali, E., 2020. Effects of olive leaf extracts as natural preservative on retailed poultry meat quality. Foods, 9(8), p.1017.
Samaha, I.A., Ibrahim, H.A.A., Hamada, M.O., 2012. Isolation of some Enteropathogens from retailed poultry meat in Alexandria Province ISSN 110-2047 Alex. J. Vet. Sci. 37, 17-22.
Shanab, M.S.M., 2014. Quality of some locally manufactured chicken meat products. M.VSC. Thesis (Meat Hygiene), Fac. Vet Med Benha Univ., Egypt.
Sharaf, E.M., Sabra, S.M., 2012. Microbiological loads for some type of cooked chicken meat products at AL-Taif Governorate, K.S.A. World Appl. Sci J. 17, 593-597.
Shawish, R.R.M., 2011. Microbial evaluation of some retailed cut-up chicken and poultry meat products. M.V.Sc.Thesis (Meat Hygiene), Fac Vet Med Menufia Univ., Egypt
Sobieh, A.S.A., 2014. Fast meat meals safety at restaurants level in Cairo Governorate. M.VSC. Thesis (Meat Hygiene),, Fac. Vet. Med., Meat Hygiene, Benha Univ., Egypt
Wardhana, D.K., Haskito, A.E., Purnama, M.T., Safitri, D.A., Annisa, S., 2021. Detection of microbial contamination in chicken meat from local markets in Surabaya, East Java, Indonesia. Vet. World. 14, 3138–3143.
Wilfred R.S., Nithin P.K., Naveen K.G.S., 2012. Prevalence of food borne pathogens in market samples of chicken meat in Bangalore. Int. Food Res. J. 19, 1763-1765.
Yadav, M.M. Tale, S. Sharda, R. Sharma, V. Tiwari, S., Garg, U.K., 2006. Bacteriological quality of sheep meat in Mhow town of India. Int J Food Sci Technol. 41: 1234–1238.
Yar, D., William, K.J., Zanu, W.K., Balali, G.I., Adepa, E.K., Francis, G., 2021. Microbial quality of frozen chicken parts from three import countries into the Kumasi Metropolis of Ghana. Microbiol. Res. J. Inter., 31, 43-53.
Zahran, D.A., 2004. Using gamma irradiation as an option for controlling bacteria contaminating some foods of animal origin. Ph.D. Thesis (Meat Hygiene), Fac Vet Med. Zagazig Univ. (Benha Branch), Egypt.