Received: 15 March 2023, Accepted: 21 April 2023

Original Research

Journal of Advanced Veterinary Research
(2023) Volume 13, Issue 6, 865-870

Incidence of Some Foodborne Pathogens in Retailed Beef Luncheon and Kofta at El-Gharbia Governorate, Egypt

Zakaria H. Elbayoumi[1], Abo Bakr M. Edris[2], Dina S. Taha[3*], Reyad R. Shawish[1]

[1]Department of Food Hygiene and Control, Faculty of Veterinary Medicine, University of Sadat City, Egypt.

[2]Department of Food Hygiene, Faculty of Veterinary Medicine Benha University, Egypt.

[3]Directorate of Veterinary Medicine, El Gharbia Governorate, Egypt.

***Correspondence**
Corresponding author: Dina S. Taha
E-mail address: reyad.rabea@vet.usc.edu.eg

Abstract

This study was conducted to evaluate the microbial aspect of some meat products by performing *S. aureus* count, detection of *S. aureus* enterotoxins as well as isolation and identification of some food poisoning bacteria. Therefore, fifty random samples of beef luncheon and kofta (25 of each) were equally collected from different localities in Gharbia governorate, then bacteriologically examined, where values of *S. aureus* count were $7.61\times10^{2}\pm0.54\times10^{2}$ in beef luncheon, $2.82\times10^{3}\pm0.39\times10^{3}$ (cfu/g) in kofta samples. Meanwhile, in beef luncheon enterotoxin B and enterotoxin (A&D) were detected with a percentage of 4% of each, while in kofta samples enterotoxin A, enterotoxin D, and enterotoxin (A&C) were detected with a percentage of 8%, 4%, and 4%, respectively. Moreover, *Salmonella*e, *E. coli*, *Klebsiella pneumoniae*, and *Listeria* were detected at 16%, 20%, 20%, and 20% in the examined beef luncheon. while, in kofta samples 24 %, 36%, 28% and 16%, respectively. Meanwhile, *E. coli* identified as O26 : H11, O44 : H18, O78, O91 : H21, O103 : H2, O111 : H4, O127 : H6, O146 : H21 and O159 with various percentages. *Salmonella* spp. identified as *S.* Enteritidis, *S.* Typhimurium, *S.* Labadi, *S.* Infantis, and *S.* Molade. On the other side, *Listeria* species serologically identified as *L. monocytogenes*, *L. ivanovii*, *L. innocuai*, and *L. welshimeri*. Moreover, isolated serotypes of *K. pneumonia* as K1 and K2 were 16%, and 4% in luncheon samples. While 16% and 12% were in kofta samples. Furthermore, high virulent *K. pneumonia* (HVKP) and classic *K. pneumonia* (CKP) were 12% and 8% in luncheon, while were 20% and 8% in kofta samples, respectively. Achieved results in the current study proved that most of the examined meat products were contaminated with *E. coli*, *Salmonella* spp., *S. aureus*, *Listeria* spp. and *K. pneumonia*, this considered objectionable, as they render the product of inferior quality and unfit for consumption

KEYWORDS
Luncheon, Kofta, APC, *Salmonella*e, *E. coli*, *S. aureus*, *K. pneumonia*e, *Listeria*.

INTRODUCTION

Bacteria such as *S. aureus*, *Salmonella*, *L. monocytogenes*, and *E. coli* are the major zoonotic bacterial pathogens that associated with the consumption of the contaminated animal products, and are the causative agents of foodborne illness and death in the world. Most of these microbes have zoonotic importance, as they can significantly impact both public health and economic sectors (Abebe *et al*., 2020). Because of the high levels of moisture, nitrogenous substances, minerals, a few fermentable carbohydrates like glycogen, and perfect pH that promotes the growth of most bacteria, meat products can serve as an effective culture medium for the growth of various organisms (Alahakoon *et al*., 2015).

Coliform microorganisms are related to the digestive systems of human beings and animals. Presence outside the intestines can be a contaminant demonstrated with fecal discharges (Park *et al*., 1999). Fecal contamination of food can occur at the time of slaughter or during processing (Dsani *et al*., 2020). Pneumonia, encephalitis, infections of the urinary system, and diarrhea all have been linked to pathogenic *E. coli* (Elbayoumi *et al*., 2018b).

Coliform bacteria (*E. coli* and *Klebsiella* spp.) are of great importance in food microbiology. They are vital biosanitary indicators that emphasize hygiene in the processing and handling of food products (Filimon *et al*., 2010). *K. pneumonia*e is an important opportunistic pathogen that spreads through contaminated food materials and is often considered an agent of foodborne illness. The pathogen can be found in frozen foods and fresh meat that causes a variety of infectious diseases in humans, including septicemia, liver abscesses, diarrhea, and pneumonia (Guo *et al*., 2017). It is the primary reason for the hospitalization of immunocompromised patients and individuals with severe diseases (Russo and Marr, 2019).

Staphylococcus aureus was in contaminated foods causing human illness; linked to food poisoning. Furthermore, *S. aureus* can develop and convey virulence in a wide range of foods, including meat and meat products. Heat-stable enterotoxins of *S. aureus* strains can cause staphylococcal food poisoning, a common cause of gastroenteritis worldwide (Shaltout *et al*., 2019).

Salmonella is an important foodborne zoonotic pathogen with relevance to global public health (Gomes *et al*., 2022). *Salmonella* serovars continue to pose a threat to the public's health even if they don't always result in fatal illness, it is mainly located within the intestinal tract leading to gastroenteritis (Mohammed-

ISSN: 2090-6277/2090-6269/

and Cormican, 2016). Diarrhea, cramping in the abdomen, and fever within 8 to 72 hours are the most common characteristics of salmonellosis (Elbayoumi *et al*., 2018a).

Listeriosis is an important bacterial food-borne zoonotic disease caused by *Listeria monocytogenes*. The pathogenic strains of *Listeria* can cause severe illness in men by ingestion of contaminated food products, especially meat (Deka *et al*., 2022).

Serious symptoms of invasive listeriosis, such as sepsis, encephalitis, and meningitis, are common. which affects mainly pregnant women, immunocompromised people, and newborns (Cherifi *et al*., 2020). Because of the severity of the symptoms and the high case fatality rate, *L. monocytogenes* research and control are critical for food safety worldwide (Thomas *et al*., 2015). As the contamination of meat products such as luncheon and kofta with different food-borne pathogens constitute dangerous problems for consumers. So, this study was done to evaluate the pathogenic microorganisms and bacteriological quality of these products.

MATERIALS AND METHODS

Collection of samples

Fifty random samples of meat products were equally collected from different localities in Gharbia governorate, Egypt from February to August 2022. Samples were luncheon and kofta (25 of each). Samples were kept in separate sterile plastic bags and preserved in an ice box then transferred to the laboratory quickly for bacteriological examination.

Preparation of samples (ISO, 2008)

In aseptic conditions, 25 grams of each sample were collected and transferred to a sterile homogenizer flask containing 225 ml of sterile peptone water (0.1%). homogenized for 3 minutes at 14000 rpm then allowed for 5 minutes at room temperature. One ml of the homogenate was added to a tube containing 9 ml of sterile peptone water (0.1%) tenfold serial dilutions were prepared for bacteriological examination.

Bacteriological examination

S. aureus was detected according to Mac Faddin (2000) and counted according to FDA (2001). Enterotoxin was detected based on the method described by Shingaki *et al.* (1981). Samples were examined for E coli according to ISO (2013) and serologically based on Kok *et al.* (1996). Detection of *Salmonella*e was done according to ISO (2013) and serologically to Kauffman (1974). Detection of *Listeria* spp. based on the methods of Mac Faddin (2000) and serologically according to Pagotto *et al*. (2001). *Klebsiella pneumonia* was detected as described in ISO (2004), and serologically based on Edmondson and Cooke (1979).

Statistical Analysis

Using the SPSS tool, the collected results were statistically evaluated (Statistical Package for Social Sciences, version IBM 23). Statistical analysis was made using one way analysis of variance (ANOVA) for determinations of the minimum, maximum and means of the different organisms isolated from the meat samples products according to Feldman *et al*., (2003).

RESULTS

In Table 1, the incidence of *S. aureus* in beef luncheon and kofta samples were 40% and 52% with mean values of $7.61\times10^2\pm0.54\times10^2$ and $2.82\times10^3\pm0.39\times10^3$ Cfu/g, respectively. Also, enterotoxin B and enterotoxin A and D with a percentage of 4% in beef luncheon, while enterotoxin A (8%), enterotoxin D (4%), and enterotoxin A and C (4%) in kofta samples, respectively (Table 2).

Moreover, *E. coli* was detected with a percentage of 20 % and 36% in beef luncheon and kofta samples as follows O26: H11(4%), O91: H21 (8%), O111: H4(4%) and O146: H21(4%) in beef luncheon. While in kofta O26 : H11(12%), O44 : H18 (4%), O78(4%), O103 : H2(4%), O127 : H6(8%) and O159 (4%),(table 3).Furthermore, *Salmonella* was detected with a percentage of 16 % and 24% in beef luncheon and kofta samples, respectively as followed by *S.* Infantis (8%) in luncheon and (4%) in kofta, also, *S.* Enteritidis (4%) in luncheon and (8%) in kofta, *S.* Typhimurium (4%of each), S . Labadi and *S.* Molade 4% in kofta samples only (Table 4).

Listeria spp. were 20% and 16% in luncheon and kofta samples, respectively. In beef luncheon, *L. ivanovii* with a percentage of 12%, *L. monocytogenes* and L. innocua (4% of each). Meanwhile, in kofta samples, *L. monocytogenes* with a percentage of 8%, *L. ivanovii* and *L. welshimeri* (4% of each) (Table 5).

*K. pneumonia*e with a percentage of 20% and 28% in beef luncheon and kofta, respectively as K1 and K2 percent were

Table 1. Count of *S. aureus* in the examined samples of meat products (n = 25).

	No. of affected samples		Min	Max	Mean±S.E*
	No.	%			
Beef luncheon	10	40	$< 10^2$	2.0×10^3	$7.61\times10^2\pm0.54\times10^2$
Kofta	13	52	$< 10^2$	7.0×10^3	$2.82\times10^3\pm0.39\times10^3$

S.E* = Standard error

Table 2. Incidence of *S. aureus* enterotoxins isolated from samples of meat products (n=25).

Enterotoxins	Meat luncheon		Kofta	
	No	%	No	%
A	-	-	2	8
B	1	4	-	-
D	-	-	1	4
A+C	-	-	1	4
A+D	1	4	-	-
Total	2	4	4	8

16%& 4% in beef luncheon samples. While 16% &12% were in kofta samples, respectively. High virulent *K. pneumonia*e (HVKP) with a percentage of 12% and 20% in luncheon and kofta. Furthermore, classic *K. pneumonia*e (CKP) with a percentage (of 8% of each) (Table 6).

DISCUSSION

Accomplishing food safety is a worldwide health objective and food-borne manifestations that have attracted major attention in global health. Hence, the determination of microbial pathogens in food is the key to the identification and prevention of problems related to well-being and safety (Gokulakrishnan and Vergis, 2015).

Concerning luncheon samples, *S. aureus* count were nearly similar to results obtained by Abuelnaga *et al.* (2021) ($5.20\times10^2\pm0.41\times10^2$) and Saad *et al.* (2023) ($8.2\times10^2\pm3.6\times10^2$) Cfu/g, lower level reported by Hassanien *et al.* (2018) ($0.1x10^2$) Cfu/g and Shaltout *et al.* (2022) ($6.3X10^2\pm1.6X10$) Cfu/g, and higher value obtained by Tarabees *et al.* (2016) ($3.09x10^5$ cfu/g). On the other side, a lower incidence of *S. aureus* by Abuelnaga *et*

Table 3. Incidence of *E. coli* serotyping of samples of meat products (n=25).

Products / *E. coli* strains	Meat luncheon		Kofta		Strain Characteristics
	No.	%	No.	%	
O17: H18	-	-	-	-	EPEC
O26: H11	1	4	3	12	EHE C
O44: H18	-	-	1	4	EAEC
O78	-	-	1	4	ETEC
O91: H21	2	8	-	-	EHEC
O103: H2	-	-	1	4	EHEC
O111: H4	1	4	-	-	EHEC
O121: H7	-	-	-	-	EPEC
O127: H6	-	-	2	8	ETEC
O146: H21	1	4	-	-	EPEC
O159	-	-	1	4	EIEC
Total	5	20	9	36	

Table 4. Incidence of *Salmonella*e and serotyping isolated from samples of meat products (n=25).

Products	Beef luncheon		Kofta		Antigenic structure	
Serotypes	No.	%	No.	%	O	H
S. Enteritidis	1	4	2	8	1,9,12	g,m: -
S. Kentuckey	-	-	-	-	8,20	i: Z6
S. Infantis	2	8	1	4	6,7,14	r: 1,5
S. Labadi	-	-	1	4	8,20	d: Z6
S. Molade	-	-	1	4	8,20	Z10: Z6
S. Papuana	-	-	-	-	6.7	r: e,n,Z15
S. Typhimurium	1	4	1	4	1,4,5,12	i: 1,2
S. Wingrove	-	-	-	-	6,8	c: 1,2
Total	4	16	6	24	-	-

Table 5. Incidence of *Listeria* species and serotyping isolated from samples of meat products (n=25).

Products	Beef luncheon		Kofta	
*Listeria*e	No.	%	No.	%
L. monocytogenes	1	4	2	8
L. ivanovii	3	12	1	4
L. innocua	1	4	-	-
L. grayi	-	-	-	-
L. welshimeri	-	-	1	4
Total	5	20	4	16

Table 6. Incidence of *K. pneumonia*e and serotyping of samples of meat products (n=25).

Products	Positive samples		Serotypes							
	No.	%	K1		K2		HVKP		CKP	
			No.	%	No.	%	No.	%	No.	%
Luncheon	5	20	4	16	1	4	3	12	2	8
Kofta	7	28	4	16	3	12	5	20	2	8

al. (2021) 30% and Saad *et al.* (2023) 20% in luncheon samples. The presence of *S. aureus* in heat-treated food is a pointer to largely poor personal hygiene, improper storage, and an unhygienic environment (Achi and Madubuike, 2007).

Regarding kofta samples, *S. aureus* count was nearly similar to the result obtained by Hassan *et al.* (2018) ($3.72x10^3 \pm 0.51x10^3$) and Hassanin *et al.*, (2018) ($3.10\times10^3 \pm 0.74\times10^3$), lower result obtained by Abd El Satter (2016) ($4.3\times10^2 \pm 2.06\times10^2$) (cfu/g), Abuelnaga *et al.* (2021) ($4.4\times10^2 \pm 9.5\times10$) and Shaltout *et al.* (2022) ($8.7X10^2 \pm 1.5X10^2$). Lower incidence of *S. aureus* was recorded by Abuelnaga *et al.* (2021) (20%), Hassanin *et al.* (2018) (46.67%), and Shaltout *et al.* (2022) (40%) in kofta samples. The high *S. aureus* count could be due to the neglected hygienic practices of the workers and the technique used for evisceration (Cohen *et al.*, 2007). Moreover, the existence of *S. aureus* in meat products is considered a trustworthy index of improper handling during processing (Nadim, 2016).

S. aureus strains that produce sea are known to be the most frequent in food poisoning outbreaks. The sea is an extremely potent gastrointestinal toxin, with a low infective dose of 100 ng sufficient to cause toxicity (Balaban and Rasooly, 2000).

In luncheon samples, a high rate of *E. coli* was obtained by Mosbah (2017) (24%); Abuelnaga *et al.* (2021) (55%) and Shaltout *et al.* (2022) (30 %). Lower results were reported by Saad *et al.* (2018) (12%) Similar results were recorded by Tarabees *et al.* (2015) (20%).

Meanwhile, in kofta samples high rate of *E. coli* obtained by Hassan *et al.* (2018) (46.67%) and Shaltout *et al.* (2022) (40%), lower results reported by Younes *et al.* (2019) (12%) and Abuelnaga *et al.* (2021) (25%).

The presence of *E. coli* in food is considered an indicator of faults during preparation, handling, storage, or service (Shaltout *et al.*, 2016). Fecal contamination of carcass and contamination of raw food is common source of *E. coli* infection (Roberts, 1990).

The isolated serotypes agree with Hassan *et al.* (2018) who isolated O26:H11 (6.67%) & O111: H4 (EHEC) (6.67 %) and Abuelnaga (2021) O26, O126, O111, O158, O146 from luncheon samples. While Hassan *et al.* (2018) O26:H11 (13.33%), Saad *et al.* (2018) O127: H6 (ETEC) (4%), and Abuelnaga (2021) O26 from kofta agree with the obtained results.

Regarding the detection of *Salmonella* in the examined beef luncheon, a lower rate of *Salmonella* was reported by Saad *et al.* (2018) 8% and Abuelnaga *et al.* (2021) 15% and Elbayoumi *et al.* (2021) 7.5%, a similar result was recorded by Essa *et al.* (2009) (16.7%). While others did not detect *Salmonella* (Sharaf-and Sabra- 2012; Saad *et al.* (2018); Armany *et al.* 2021; Saad *et al.* 2023). Comparing the obtained findings for detection of *Salmonella* in the examined kofta samples, high results were obtained by Hassan *et al.* (2018) (26.67%) and Elbayoumi *et al.* (2021) (27.5%), lower results were obtained by Saad *et al.* (2018) (16%) and Abuelnaga *et al.*, (2021) (15%) and Elbayoumi *et al.* (2021) (27.5%). While Younes *et al.* (2019) did not detect *Salmonella*.

The transmission of salmonellosis occurs when feed and water are contaminated by *Salmonella*-contaminated stools or fecal-oral routes making feces important reservoirs of *Salmonella* serovars (Atlaw, 2022). As well as poor hygiene conditions, the temperature of storage, equipment, and personal hygiene (Stevens *et al.*, 2006). More than 2500 *Salmonella* serotypes are recognized, of which, *S.* Enteritidis, *S.* Typhimurium, and S. Kentucky are identified as the most frequent causative agents causing disease burden on consumers (Bugarel, 2017).

The isolated serotypes of *Salmonella* agree with Eldesouky *et al.* (2016) isolated *S.* Enteritidis (47%), *S.* Typhimurium (23.52%), and Elbayoumi *et al.* (2021) *S.* Enteritidis 2.5% and *S.* Typhimurium 5% from luncheon samples. While Hassan *et al.* (2018) isolated *S.* Enteritidis 6.67 % (1), *S.* Typhimurium 13.33 % (2), and Elbayoumi *et al.* (2021) isolated *S.* Enteritidis 12.5% (5), *S.* Infantis 7.5% (3)

Listeria causes contamination of various processed meat in any stage of processing and storage (Zanette, 2015). High incidence of *Listeria* spp. obtained by Mahmoud *et al.* (2019) 40% from luncheon. While Eldaly *et al.* (2013) could not isolate *Listeria* spp. from luncheon but in examined kofta samples high incidence of *Listeria* spp. obtained by Ahmed (2001) (22.5%), Eldaly *et al.* (2013) (35%), and Mahmoud *et al.* (2019) (70%).

Concerning *L. monocytogenes* in luncheon samples, lower results were obtained by Abdel-Aziz and Hassanien (2022) (3.1%), while Armany *et al.* (2021) failed to find *L. monocytogenes* and higher results were reported by Saad *et al.* (2001) (7.5%) and Mahmoud *et al.* (2019) (10%) in luncheon samples.

The capability of *L. monocytogenes* to reproduce at the refrigeration zone of temperature a risk of processed cooked meat like luncheon (Schuchat *et al.*, 1992). Therefore, the presence of *L. monocytogenes* reflects bad hygienic measures (Marinšek and Grebenc, 2002). While in examined kofta samples lower results of *L. monocytogenes* were obtained by Eldaly *et al.* (2013) (5%) and higher results were obtained by Mahmoud *et al.* (2019) (20%) in kofta samples. Contamination of kofta by *L. monocytogenes* may occur during animal slaughtering, transportation, workers' hands, and equipment used such as mincing machines, knives, and packaging tools.

Recently, the number of foodborne illness outbreaks caused by *K. pneumonia*e increased. However, characteristics of *K. pneumonia*e isolated from foods now, are not detected (Zhang *et al.*, 2018).

Lower result (12.6%) for *K. pneumonia*e in beef luncheon was reported by Abdel-Rhman (2020), while (HVKP) and (CKP) (26 and 18 isolates, respectively) and Meshaal *et al.* (2021) detected *K. pneumonia*e in 4 of 12 beef luncheon samples. Moreover, Chepkemei *et al.* (2022) isolated *Klebsiella* spp. (7%) from raw meat. A relatively high prevalence of *Klebsiella* spp. may be attributable to the employment of conventional food preparation techniques, improper temperatures, and improper hygiene (Barro *et al.*, 2006).

CONCLUSION

The contamination of meat products with such serious pathogens not only renders these meals of inferior quality and unfit for human consumption but is also considered an indication of fecal contamination. It demonstrated that there is a high bacterial load besides a relatively high rate of pathogens of public health importance and this may be due to mishandling and the negligence of hygienic aspects either at production levels or product selling.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

REFERENCES

Abdel-Aziz, N., Hassanien, A., 2022. The impact of Clove and thyme essential oils on *Listeria monocytogenes* isolated from meat and poultry products. SVU-Internat J. Vet. Sci, 5, 104-111.

Abdel-Rhman, S.H., 2020. Characterization of β-lactam resistance in *K. pneumonia*e associated with ready-to-eat processed meat in Egypt. Plos one, 15, e0238747.

Abdel Satter, A.M., 2016. Incidence and importance of some pathogenic microorganisms contaminating meat product. M. V. Sc. Thesis (Meat Hygiene), Fac of Vet. Med. Benha Univ, Egypt.

Abebe, E., Gugsa, G., Ahmed, M., 2020. Review on major foodborne zoonotic bacterial pathogens. J. Trop. Med., 2020, 4674235.

Abuelnaga, A.S., El-Razik, K.A., Soliman, M.M., Ibrahim, H.S., Abd-Elaziz, M.M., Elgohary, A.H., Elgabry, E.A., 2021. Microbial Contamination and Adulteration Detection of Meat Products in Egypt. World Vet. J. 11, 735-744.

Achi, O.K., Madubuike, C.N., 2007. Prevalence and antimicrobial resistance of *S. aureus* isolated from retail ready to eat foods in Nigeria. Res. J. Microbiol., 2, 516-523.

Ahmed, S., 2001. Prevalence of *Listeria monocytogenes* in meat and some meat products. PhD.V.Sc Thesis, (Meat Hygiene), Fac of Vet. Med., Assiut University, Egypt.

Alahakoon, A. U., Jayasena, D. D., Ramachandra, S., Jo, C., 2015. Alternatives to nitrite in processed meat: Up to date. Trends in Food Science and Technology 45, 37-49.

Atlaw, N. A., Keelara, S., Correa, M., Foster, D., Gebreyes, W., Aidara-Kane, A., Fedorka-Cray, P. J., 2022. Evidence of sheep and abattoir environment as important reservoirs of multidrug resistant *Salmonella* and extended-spectrum beta-lactamase *Escherichia coli*. Inter.J. Food Micro. 363, 109516.

Armany, G., Ibrahim, H.M., Amin, R., Hagag, N.H., 2021. Detection of *Salmonella* in Meat Products by Polymerase Chain Reaction. Benha Vet. Med. J. 41, 103-105.

Balaban, N., Rasooly, A., 2000. Staphylococcal enterotoxin. Int. J. Food Microbiol. 61, 1-10.

Barro, N., Bello. A., Aly. S., Ouattara, C., Ilboudo. A., Traoré, A., 2006. Hygienic status assessment of dishwashing waters, utensils, hands and pieces of money from street food processing sites in Ouagadougou; Burkina Faso. African J. Bio. 5, 1107-1112.

Bugarel, M., Tudor, A., Loneragan, G.H., Nightingale, K.K., 2017. Molecular detection assay of five *Salmonella* serotypes of public interest: Typhimurium, Enteritidis, Newport, Heidelberg, and Hadar. J. Microbiol Methods 134, 14-20.

Chepkemei, A., Mwaniki, J., Nyerere, A., Kiiru, J., 2022. Phenotypic and Genotypic Characterisation of Antibiotic Resistance in *Escherichia coli*, *Klebsiella* spp. and *Listeria monocytogenes* Isolates from Raw Meat Sold in Nairobi. Advances in Microbiology 12, 603-620.

Cherifi, T., Arsenault, J., Pagotto, F., Quessy, S., Côté, J. C., Neira, K., Fravalo, P., 2020. Distribution, diversity and persistence of *Listeria monocytogenes* in swine slaughterhouses and their association with food and human listeriosis strains. PLoS One 15, e0236807.

Cohen, N., Ennaji, H., Bouchrif, B., Hassar, M., Karib, H., 2007. Comparative study of microbiological quality of raw poultry meat at various seasons and for different slaughtering processes in Casablanca (Morocco). J. Appl. Poult. Res. 16, 502-508.

Deka, A., Hazarika, R.A., Barua, A.G., Saikia, G.K., Borah, P., Shakuntala, I., Bora, D. P., 2022. Prevalence of *Listeria monocytogenes* in Foods of Animal Origin: Study from Assam, A North-Eastern State of India. Eur. J. Vet. Med. 2, 20-25.

Dsani, E., Afari, E.A., Danso-Appiah, A., Kenu, E., Kaburi, B.B., Egyir, B., 2020. Antimicrobial Resistance and Molecular Detection of Extended Spectrum β-Lactamase Producing *Escherichia coli* Isolates from Raw Meat in Greater Accra Region, Ghana. BMC Microbiology 20, 1-8.

Edmondson, A., Cooke, E., 1979. The production of antisera to the *Klebsiella* capsular antigens. J. Appl. Bacteriol. 46, 579–584.

Elbayoumi, Z.H., Shawish, R.R., Esmail, H.R., 2018a. Incidence and Characterization of *Salmonella* Isolated from Poultry Meat and its Products. Alex.J. Vet. Sci., 56,114-122.

Elbayoumi, Z.H., Shawish, R.R., Hamada, M., Esmail, H.R., 2018b. Molecular Characterization of *Escherichia coli* Isolated from Poultry Meat and its Products. Alex. J. Vet. Sci. 56, 39-47.

Elbayoumi, Z.H., Zahran, R.N., Shawish, R., 2021. Isolation and Molecular Characterization of *Salmonella*e Isolated from Some Meat Products. J. Cur. Vet. Res. 3, 63-69.

Eldaly, E.A., Saleh, E.A., Moustafa, A.H., Atya, O., 2013. Prevalence Of *Listeria* Organisms in Meat And Some Meat Products. Zagazig Vet. J. 41, 57-68.

Eldesouky, I.E., Eissa, M.O., Nada, H.S., Satar, A.A., 2016. Molecular characterization of *Salmonella* species isolated from some meat products. J. Nat. Sci. 14, 83-89.

Essa, H.H., Manaa, A.M., Makar, N.H., Sayed, S.M., 2009. Studies on *Salmonella* and *E. coli* in some meat products (beef burgers and luncheon) sold in Assiut city. Assiut Vet. Med. J. 55, 126-135.

Feldman, D., Ganon, J., Haffman, R., Simpson, J., 2003. The solution for data analysis and presentation graphics. 2nd Ed., Abacus Lancripts, Inc., Berkeley, USA.

Filimon, M. N., Borozan, A., Bordean, D., Radu, F., Popescu, R., 2010. Microorganisms, qualitative indicators for meat products. Scientific Papers. J. Animal Sci. Biotechnol. 43, 346-349.

FDA (Food and Drug Administration), 2001. *Staphylococcus aureus*. Bacteriological analytical manual. 8th Ed. Chapter12. Academic Press, Gaithersburg, UK.

Gokulakrishnan, P., Vergis, J., 2015. Molecular methods for microbiological quality control of meat and meat products: A review. Critical Reviews in Food Science and Nutrition 55, 1315-1319.

Gomes, V.T., Moreno, L.Z., Silva, A.P.S., Thakur, S., La Ragione, R.M., Mather, A.E., Moreno, A.M., 2022. Characterization of *Salmonella* enterica contamination in pork and poultry meat from São Paulo/Brazil: Serotypes, genotypes and antimicrobial resistance profiles. Pathogens 11, 358.

Guo, Y., Wang, S., Zhan, L., Jin, Y., Duan, J., Hao, Z., 2017. Microbiological and clinical characteristics of hypermucoviscous *Klebsiella pneumoniae* isolates associated with invasive infections in China. Front. Cell. Infect. Microbiol. 7, 1-9.

Hassan, M.A., Amin, R.A., Eleiwa, N.Z., Gaafar, H.W., 2018. Detection of *Staphylococcus aureus* in some meat products using PCR technique. Benha Vet. Med. J., 34, 392-403.

Hassanien, F., Fahim, S., Mohammed, H., Lotfy, L., El-Nagar, H., 2018. Quality assurance of some locally processed meat products. Benha Vet. Med. J. 34, 41-47.

ISO (International Standards Organization), 2004. Microbiology of food and animal feeding stuffs. Horizontal method for detection of *L. monocytogenes*. International Standards Organization, Geneva, Switzerland.

ISO (International Standards Organization), 2008. Microbiology of food and animal feeding stuffs-Preparation of test samples, initial suspension and decimal dilutions for microbiological examination.

ISO (International Standards Organization), 2013. Microbiology of food chain- Horizontal method for the enumeration of microorganisms. Part I; Colony count at 30°C by the pour plate technique. International Standards Organization, Geneva, Switzerland.

Kauffman, G., 1974. Kauffmann white scheme. J. Acta. Path. Microbiol. Sci. 61,385.

Kok, T., Worswich, D., 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.

Mac Faddin, J.F., 2000. Biochemical tests for identification medical bacteria. Warery Press, INC. Baltimore, Md. 21202 USA.

Mahmoud, H., Karmi, M., Maky, M., 2019. Occurrence and Characterization of *Listeria* Species Isolated from Processed Meat in Qena, Egypt. Zagazig Vet. J. 47, 267-276.

Marinšek. J., Grebenc, S, 2002. *Listeria monocytogenes* in minced meat and thermally untreated meat products in Slovenia. Slovenian Vet. Res. 39, 131–136.

Meshaal, A.K., Hetta, H.F., Yahia, R., Abualnaja, K.M., Mansour, A.T., Al-Kadmy, I.M., El-Kazzaz, W., 2021. In Vitro Antimicrobial Activity of Medicinal Plant Extracts against Some Bacterial Pathogens Isolated from Raw and Processed Meat. Life (Basel, Switzerland) 11, 1178.

Mohammed, M., Cormican, M., 2016. Whole genome sequencing provides insights into the genetic determinants of invasiveness in *Salmonella* Dublin. Epidemiol. Infect. 144, 2430-2439.

Mosbah, M., 2017. Incidence of some pathogenic bacteria in meat products. M.V.Sc ., Thesis, (Meat Hygiene) Fac. Vet. Med., Alex. Univ., Egypt.

Nadim, S. S.A., 2016. A comparative study on application of PCR and ELISA for detection of pathogens in some meat products with special references to public health. PhD.V. Sc. Thesis (Meat Hygiene) Fac. Vet. Med. Benha Univ., Egypt.

Pagotto, F., Daley, E., Farber, J., Warburton, D., 2001. Isolation of *Listeria monocytogenes* from all foods and environmental samples (MFHPB-30). Health products and food branch, HPB Method, Ottawa, Canada.

Park, S., Worobo, R. W., Durst, R. A., 1999. *Escherichia coli* O157: H7 as an emerging foodborne pathogen: a literature review. Critical reviews in Food Science and Nutrition 39, 481-502.

Roberts, D., 1990. Sources of infection: food. Lancet (British edition) 336, 859-861.

Russo, T.A., Marr, C.M., 2019 Hypervirulent *Klebsiella pneumoniae*. Clin. Microbiol. Rev. 32, 1–19.

Saad, M.S., Ibrahim, H.M., Niazi, Z.M., El Lawandy, H.M., 2001. Prevalence of *Listeria* species in meat and meat products. Cairo Univ. Vet. Med. J. 49, 543-552.

Saad, M.S., Hassanin, F.S., Salem, A.M., Shawqy, N.A., Gomaa, W.M., 2018. Bacterial Quality of Some Meat Products. Benha Vet. Med. J. 34, 344-352.

Saad, S.A., El-Sayed, A.M., Abdelgawad, M.H., Batiha, G.E.S., Simal-Gandara, J., 2023. Food born pathogen contamination of some meat products in Damanhur City, Egypt. Stem Cell Res. Int. 7, 08-18.

Schuchat, A., Deaver, K.A., Wenger, J.D., Plikaytis, B.D., Mascola, L., Pinner, R. W., Lefkowitz, L., 1992. Role of foods in sporadic listeriosis: I. Case-control study of dietary risk factors. Jama 267, 2041-2045.

Shaltout, F.A.E., Barr, A.A.H., Abdelaziz, M.E., 2022. Pathogenic Microorganisms in Meat Products. Biomed. J. Sci. Tech. Res. 41, 32836-32843.

Shaltout, F.A, Saad, M., Abo El-Roos, N., Saber, E., 2019. Incidence of Staphylococci and *E. coli* in Meat and Some Meat Products. EC Nutrition 4,171-179.

Shaltout, F.A., Salem, A.M., Khater, D.F., Lela, R.A., 2016. Studies on bacteriological Profile of some meat products. Benha Vet. Med. J. 31, 43-49.

Sharaf, E.M., Sabra, S.M., 2012. Microbiological load for some types of cooked chicken meat product at Al-Taif governorate KSA. World

Applied Sci. J. 17, 593-597

Shingaki, M., Igarashi, H., Fujikawa, H., Ushioda, H., Terayrna, T., Sakai, S., 1981. Study on Reversed Passive Latex Agglutination for detection of staphylococcal enterotoxins A, B, and C. Res. Lab. Public Health 32, 128-131.

Stevens, A., Kaboré, Y., Perrier-Gros-Claude, J.D., Millemann, Y., Brisabois, A., Catteau, M., Dufour, B., 2006. Prevalence and antibiotic-resistance of *Salmonella* isolated from beef sampled from the slaughterhouse and from retailers in Dakar (Senegal). Inter. J. Food Micro. 110, 178– 186.

Tarabees, R.Z., Hassanin, Z.H., El Bagoury, M.A., 2015. Polymerase chain reaction (PCR): An alternative rapid method for detection of some microbial contamination of meat products. Alex. J. Vet. Sci. 45, 91-98.

Tarabees, R.Z., Hassanin, Z.H., Sakr, M.A., Zidan S.A., 2016. Molecular screening of some virulence factors associated with *S. aureus* isolated from some meat products. Alex. J. Vet. Sci. 48, 12- 19

Thomas, K., Vriezen, R., Farber, M., Currie, A., Schlech, W., Fazil, A., 2015. Economic cost of a *Listeria monocytogenes* outbreak in Canada, 2008. Foodborne Pathogens and Disease 12, 966-971

Younes, O., Ibrahim, H., Hassan, M., Amin, R., 2019. Demonstration of some food borne pathogens in different meat products: a comparison between conventional and innovative methods. Benha Vet. Med. J. 36, 219-228.

Zanette, C.M., Santa, O.R., Bersot, L.S., 2015. Effect of Lactobacillus plantarum starter cultures on the behavior of *Listeria monocytogenes* during sausage maturation. Int. Food Res. J. 22, 844- 848.

Zhang, S., Yang, G., Ye, Q., Wu, Q., Zhang, J., Huang Y., 2018. Phenotypic and Genotypic Characterization of *Klebsiella pneumoniae* Isolated From Retail Foods in China. Front Microbiol. 9, 289.