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Research Article

Incidence of *Staphylococci* and *E. coli* in Meat and Some Meat Products

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Abstract

Meat products are liable to harbour different types of micro-organisms during long chain of handling, processing, distribution and storage as well as preparation .A total of 100 random samples of locally manufactured meat products represented by frozen minced meat, Kofta ,sausage and beef burger (25 of each) were randomly collected from different shops in El-Menoufia governorate, Egypt. All the examined samples were positive for *Staphylococci* and *E. coli*. *Staphylococcus aureus* detected in (40%), (68%), (72%) and (52%) in examined samples of Frozen minced meat, Kofta, sausage and beef burger, respectively. *Escherichia coli* strains isolated from Frozen minced meat were O26:H11 (4%) and O119:H4 (4%). While O86 (8%) and O127:H6 (4%) were isolated from Kofta. The present study revealed that meat and some of meat products were contaminated with *E. coli* and *S. aureus* especially (beef burger, kofta and sausage). The unhygienic and poor sanitary conditions under which these meat products were handled and processed act as the causes of the high count of *Staphylococci*, *S. aureus* and *E. coli* in this study. The contamination can be reduced by application of good manufacture practices.

Keywords: *Staphylococci; S. aureus; E. coli; Kofta; Sausage; Beef Burger*

Introduction

Microorganisms control in meat products is a major concern in the preparation of high quality foods. During slaughtering process, the meat is exposed to many sources of contamination including; environment, equipment and workers' hands [1]. The hygienic state of animals prior, during and after slaughter can be critical to the finished product quality [2]. Also, during deboning process, the meat undergoes extensive handling and is susceptible to bacterial contamination resulting in decomposition, discoloration and development of off odors pigment [3].

Staphylococcus aureus can contaminate foods and cause illness in humans when ingested [4], so it is frequently implicated in food borne illness [5]. Convenience food offers a suitable growth environment for *S. aureus*, which is able to grow and express virulence in a wide variety of foods such as mixed foods, meat and meat products [6] and ready-to-eat foods [7]. Particular relevance to the food processing industry, the ability of some *S. aureus* strains to produce heat stable enterotoxins that cause staphylococcal food poisoning which ranks as one of the most prevalent causes of gastroenteritis worldwide [8].

The native habitat for *E. coli* is the intestinal tract of man and animals; therefore its presence in food generally indicates direct or indirect pollution of faecal origin. *Escherichia coli* is the classical indicator of the possible presence of enteric pathogens in food [9]. The incidence of human *E. coli* infection is one of the major outbreaks resulting from contaminated beef products [10].

Therefore, this work was performed to study the bacteriological contamination in meat and some locally manufactured meat products from different local commercial shops in Menoufia government, Egypt.

Materials and Methods

Collection of samples

One hundred random samples of meat and locally manufactured meat products represented by frozen minced meat, Kofta, sausage and beef burger (25 samples of each) were collected from different shops supermarkets in Menoufia government, Egypt. All collected samples were separately kept in sterile plastic bag and transferred in an ice box to the laboratory under complete aseptic conditions without undue delay. The samples were subjected to the bacteriological examination for detection of *Staphylococcus aureus* and *E. coli* in such products.

Preparation of samples [11]

25 grams of each examined sample were aseptically transferred to aseptic blender jar and 225 ml of sterile buffered peptone water (0.1%) were added to the content of the jar. Then homogenized 1500 - 2000 rpm for 2 minutes to provide a homogenate (1:10) from which decimal serial dilutions was prepared. The prepared samples were subjected to the following examinations.

Determination of *Staphylococci* and *S. aureus* counts [12]

The developed colonies appeared on Baired Parker agar plate after incubation at 37°C for 48 hours were suspect to be *S. aureus* appear which as black, shiny, circular, smooth, convex with narrow white margin and surrounded by a clear zone extending into opaque medium and enumerated as *Staphylococcus aureus* count/g and recorded. Also, the suspected colonies were picked up and purified on nutrient agar slopes for further morphological, biochemical and serological identification.

Detection of enteropathogenic *E. coli*

It was identified and isolated morphologically, biochemically and serologically according to ICMSF (1996).

Statistical analysis

It was done according to Feldman., *et al* [13].

Results

It is evident from the results recorded in table 1 that all the examined samples of frozen minced meat, kofta, sausage and beef burger were positive for *staphylococci* with a mean value of $2.11 \times 10^3 \pm 1.45 \times 10^3$, $5.41 \times 10^3 \pm 0.95 \times 10^3$, $6.23 \times 10^3 \pm 0.31 \times 10^3$ and $6.16 \times 10^3 \pm 0.82 \times 10^3$ (cfu/g) for the examined samples, respectively and 60%, 28%, 48% and 32% of the same samples, respectively were accepted according to "EOS" for *Staphylococci* count as recorded in table 2.

Products	Min	Max	Mean ± S.E*
Frozen minced meat	3.0×10^2	2.5×10^4	$2.11 \times 10^3 \pm 1.45 \times 10^3$
Kofta	4.0×10^2	3.0×10^4	$5.41 \times 10^3 \pm 0.95 \times 10^3$
Sausage	6.0×10^2	9.0×10^4	$6.23 \times 10^3 \pm 0.31 \times 10^3$
Beef burger	5.0×10^2	6.0×10^4	$6.16 \times 10^3 \pm 0.82 \times 10^3$

Table 1: *Statistical analytical results of total Staphylococci count/g in the examined samples of meat and meat products (n = 25). S.E* = Standard Error of Mean.*

Products	Staphylococci count /g*	Accepted samples		Unaccepted samples	
		No.	%	No.	%
Frozen minced meat	$>10^2$	15	60	10	40
Kofta	$>10^2$	7	28	18	72
Sausage	$>10^2$	12	48	13	52
Beef burger	$>10^2$	8	32	17	68
Total		42	42	58	58

Table 2: *Acceptability of the examined samples of meat and meat products based on their Staphylococci counts/g (n = 25).*

Egyptian Organization for Standardization "EOS" (2005).

No 1688-2005 for beef burger.

No 1973-2005 for kofta.

No 1972-2005 for sausage.

S. aureus detected in 10 (40%) , 17 (68%), 18 (72%) and 13 (52%) in examined samples of frozen minced meat, kofta, sausage and beef burger, respectively with mean value of $4.28 \times 10^3 \pm 0.86 \times 10^3$, $8.13 \times 10^3 \pm 2.04 \times 10^3$, $1.96 \times 10^3 \pm 0.37 \times 10^3$ and $7.54 \times 10^3 \pm 1.60 \times 10^3$ for the same examined samples, respectively as recorded in table 3.

Products	+ve Samples		Min	Max	Mean ± S.E*
	No.	%			
Frozen minced meat	10	40	2.3×10^2	2.0×10^4	$4.28 \times 10^3 \pm 0.86 \times 10^3$
Kofta	17	68	3.7×10^2	2.4×10^4	$8.13 \times 10^3 \pm 2.04 \times 10^3$
Sausage	18	72	4.7×10^2	5.0×10^4	$1.96 \times 10^3 \pm 0.37 \times 10^3$
Beef burger	13	52	4.1×10^2	5.2×10^4	$7.54 \times 10^3 \pm 1.60 \times 10^3$

Table 3: *Statistical analytical results of total S. aureus count/g in the examined samples of meat and meat products (n = 25).*

The incidence of *Staphylococcus* species from examined samples of meat and meat products is 28%, 8%, 4%, 4%, 4% and 8% for *Staphylococcus aureus*, *Staphylococcus epidermidis, Staphylococcus saprophyticus*, *Staphylococcus intermedius, Staphylococcus capitis and Micrococci spp.,* respectively isolated from frozen minced meat, 28%, 12%, 8%, 4%, 8% and 16% for *S. aureus, S. epidermidis, S. saprophyticus, S. intermedius, S. capitis and Micrococci spp.,* respectively isolated from kofta, 36%, 12%, 4%, 8% and 16% for *S. aureus, S. epidermidis, S. saprophyticus, S. intermedius and Micrococci spp.,* respectively isolated from sausage and 32%, 28%, 12%, 4%, 8% and 4% for *S. aureus*, *S. epidermidis, S. saprophyticus, S. intermedius, S. capitis and Micrococci spp.,* respectively isolated from beef burger samples as recorded in table 4.

Meat Products Gram + ve cocci	Frozen minced meat		Kofta		Sausage		Beef burger		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%
Staphylococcus aureus	7	28	7	28	9	36	8	32	31	31
Staphylococcus epidermidis	2	8	3	12	3	12	7	28	17	17
Staphylococcus saprophytics	1	4	2	8	1	4	3	12	7	7
Staphylococcus intermedius	1	4	1	4	2	8	1	4	5	5
Staphylococcus capitis	1	4	2	8	----	----	2	8	5	5
Micrococci spp.	2	8	4	16	4	16	1	4	12	12

Table 4: *Incidence of Gram positive cocci isolated from the examined samples of meat and meat products (n = 25).*

The data recorded in table 5 indicated that the incidence of *E. coli* serotypes in the examined samples were O26:H11 and O119:H4 (4%) of each in frozen minced meat, O86 (8%) and O127:H6 4% in Kofta, O26:H11 (4%), O55:H7 (4%), O86 (8%), O111:H4 (8%) and O124 (8%) in sausage and O26:H11 (8%), O55:H7 4%, O86 (4%), O111:H4 (4%) and O124 (4%) in beef Burger.

Product *E. coli* Strains	Frozen minced meat		Kofta		Sausage		Beef Burger		Strain characteristics
	No.	%	No.	%	No.	%	No.	%	
O26:H11	1	4	-	-	1	4	2	8	EHEC
O55:H7	-	-	-	-	1	4	1	4	EPEC
O86	-	-	2	8	2	8	1	4	EPEC
O111:H4	-	-	-		2	8	1	4	EHEC
O119:H4	1	4	-	-	-	-	-	-	EPEC
O124	-	-	-	-	2	8	1	4	EIEC
O127:H6	-	-	1	4	-	-	-	-	ETEC
Total	2	8	3	12	8	32	6	24	

Table 5: *Incidence and serotyping of E. coli Strains isolated from the examined samples meat and meat products (n = 25).*

EPEC: Enteropathogenic E. coli; EIEC: Enteroinvasive E. coli; ETEC: Enterotoxigenic E. coli; EHEC: Enterohaemorrhagic E. coli.

Table 6 declared that 8%, 12%, 32% and 24% of the examined samples of frozen minced meat, kofta, sausage and beef burger, respectively were unaccepted samples based on presence of *E. coli*. According to Egyptian Organization for Standardization "EOS" (2005).

Meat Products	*E. coli* /g*	Accepted samples		Unaccepted samples	
		No.	%	No.	%
Frozen minced meat	Free	23	92	2	8
Kofta	Free	22	88	3	12
Sausage	Free	17	68	8	32
Beef burger	Free	19	76	6	24
Total (100)	Free	81	81	19	19

Table 6: *Acceptability of the examined samples of meat and meat products based on their contamination with E. coli (n = 25).*

Egyptian Organization for Standardization "EOS" (2005).

Discussion

Meat products are gaining popularity because they represent quick easily prepared meals of low price from one side and render the processors to convert the various types of meat into unified products from the other side. Also, raw foods can transmit pathogens to utensils and equipment which they contact to them as well as workers who handled raw food can transfer microorganisms from raw foods to cooked one Emam-Neveen [14].

According to table 1, lower results were reported by Badr-Sarah [15] who found that the mean *Staphylococci* count in sausage and beef burger samples was $2.38 \times 10^4 \pm 0.51 \times 10^4$, $4.07 \times 10^3 \pm 0.69 \times 10^3$ (cfu/g), respectively, but higher results was reported in kofta $9.52 \times 10^3 \pm 2.14 \times 10^3$ (cfu/g).

Higher results were reported by Abou Hussein-Reham [16] who found that the *Staphylococcal* count (cfu/g) ranged from 4×10^4 to 2×10^6 with a mean value of $5.38 \times 10^5 \pm 9.7 \times 10^4$ for sausage and from 2×10^4 to 4.7×10^6 with a mean value of $9.6 \times 10^5 \pm 2.1 \times 10^5$ for beef burger, while the mean value of examined sausage and beef burger samples was $1.04 \times 10^7 \pm 4.3 \times 10^6$ for sausage, $1.46 \times 10^6 \pm 5.33 \times 10^5$ for beef burger as recorded by Talaat-Nagwa [17] and 100% of examined sausage and beef burger were positive for *staphylococci* with counts (cfu/g) ranged from 5.00×10^2 to 2.80×10^6 and 2.00×10^3 to 2.52×10^6 with a mean value of $1.97 \times 10^5 \pm 6.49 \times 10^4$ and $2.08 \times 10^5 \pm 5.56 \times 10^4$ for examined sausage and beef burger, respectively as recorded by Ibrahim–Shimaa [18]. While lower results of staphylococcal count (cfu/g) ranged from 2×10^2 to 7.5×10^3 with a mean value of $3.05 \times 10^3 \pm 0.97 \times 10^3$ for kofta samples as recorded by Abd El Satter-Alla [19].

Concerning the results of table 3 higher results revealed that 15 (37.5%) of the examined minced meat samples was positive for the suspected *S. aureus* and the count (cfu/g) was ranged from 1.00×10^2 to 5.00×10^5 with a mean value of $7.10 \times 10^4 \pm 2.88 \times 10^4$ as recorded by Ibrahim-Shimaa [18]. Lower results recorded by Hassanien-Faten [20] 24% as positive samples for *S. aureus* and the count (cfu/g) was ranged from 2.00×10^2 to 7.00×10^3 with a mean value of $2.51 \times 10^3 \pm 0.31 \times 10^3$. The total *S. aureus* count (cfu/g) for examined kofta samples was ranged from 1×10^2 to 9×10^2 with a mean value of $4.3 \times 10^2 \pm 2.06 \times 10^2$ as recorded by Abd El Satter- Alla [19] and 46.67% as positive samples for *S. aureus* with a mean value of $3.10 \times 10^3 \pm 0.74 \times 10^3$ (cfu/g) as recorded by Badr-Sarah [15].

Nearly similar result had been recorded by Hassanien-Faten [20] 52% as positive samples with *S. aureus* count ranged from 4.00×10^2 to 2.81×10^3 with a mean value of $1.12 \times 10^3 \pm 0.17 \times 10^3$/g, while higher results revealed that 11 (22%) of the examined sausage samples was positive for *S. aureus* and the count (cfu/g) was ranged from 1.00×10^2 to 1.00×10^4 with a mean value of $3.03 \times 10^3 \pm 6.33 \times 10^2$ as recorded by Ibrahim-Shimaa [18], with an incidence of 20% positive sausage samples and a mean value of $2.1 \times 10^4 \pm 0.5 \times 10^4$ as recorded by Eldaly., *et al*. [21], with an incidence of 63.33% positive sausage samples and a mean value of $5.96 \times 10^3 \pm 0.88 \times 10^3$ (cfu/g) as recorded by Badr-Sarah [15].

Nearly similar results revealed that 15 (30%) of the examined beef burger samples was positive for *S. aureus* and the count (cfu/g) was ranged from 2.00×10^2 to 7.00×10^4 with a mean value of $1.02 \times 10^4 \pm 2.53 \times 10^3$ as recorded by Ibrahim-Shimaa [18], 36% positive samples and the *S. aureus* count ranged from 3×10^2 to 5.40×10^4 with a mean value of $6.34 \times 10^3 \pm 1.02 \times 10^3$/g Hassanien-Faten [20], lower result 40% positive samples for *S. aureus* and the count (cfu/g) was ranged from 1.0×10^2 to 2.0×10^3 with a mean value of $8.71 \times 10^2 \pm 1.49 \times 10^2$ as recorded by Badr-Sarah [15].

Ahmed-Neveen [22] could isolate *E. coli* serotypes of O_{126}:H_{11} 2%, O_{55}:H_7 2%, O_{111}:H_4 2%, O_{125}:H_{21} (one *ETEC* strain) 2%, and O_{127}:H_6 4% from kofta, respectively.

On the other hand, *Badr-Sarah* [15] could isolate were O_{26}:H_{11} 10%, O_{44}:H_{18} 3.33%, O_{91}:H_{21} 3.33% and O_{124} 3.33% and O_{163}:H_2 3.33% from sausage, respectively.

Staphylococcus aureus intoxication is a worldwide problem where several food poisoning outbreaks were reported due to consumption of meat products contaminated with this organism. Accordingly, the *S. aureus* count can be taken as an index of sanitary conditions under which meat and its products are manufactured and handled [23]. The symptoms of staphylococcal food poisoning are abdominal cramps, nausea, vomiting, sometimes followed by diarrhea (never diarrhea alone). The onset of symptoms remission is observed after 24 hrs [24].

Escherichia coli was associated with human and animal infections as well as the most common cause of urinary tract infections in human; also it was found in suppurative lesions, neonatal septicemia and meningitis [25].

Infection due to *E. coli* O_{26} have increased over the past 5 years Kaper and O'Brien [26], Locking., *et al*. [27] and the O_{26} serogroup was the most common cause of HUS in the United States between 1983 and 2002 [28]. On the other hand, Willshaw., *et al.* [29] concluded that *E. coli* O_{113}, O_{163}, O_{165} and O_{172}, have been associated with human infection [30].

Conclusion

The present study revealed that meat and some of meat products were contaminated with *E. coli* and *S. aureus* especially (beef burger, kofta and sausage). The unhygienic and poor sanitary conditions under which these meat products were handled and processed act as the causes of the high count of *staphylococci*, *S*. *aureus* and *E. coli* in this study. The contamination can be reduced by application of good manufacture practices.

Bibliography

1. Cheorun Jo. "Inactivation of food borne pathogens in marinated beef rib by ionizing radiation". *Journal of Food Microbiology* 21.5 (2004): 543-548.

2. Satin M. "Use of irradiation for microbial decontamination of meat: situation and perspectives". *Meat Science* 6.3 2(2002): 277-283.

3. Nel S., *et al*. "Bacterial populations associated with meat from the deboning room of a high through put red meat abattoir". *Meat Science* 66.3 (2004): 667-674.

4. Kroll D. "The growing food testing business: Highlighting pathogens, pesticides and GMOs. Business communications company (INC.)". Food and Beverage publications (2005).

5. Prange A., *et al*. "Investigation of different human pathogenic and food contaminating bacteria and mould grown on Selenite/ Selenate and Tellurite/Tellurate by-x ray absorption spectroscopy". *Food Control* 16.8 (2005): 713-728.

6. Guven K., *et al*. "Occurrence and characterization of S.aureus isolated from meat and dairy products consumed in Turkey". *Journal of Food Safety* 30.1 (2010): 196-212.

7. Aydin A., *et al*. "Prevalence of staphylococcal enterotoxins, toxin genes and genetic-relatedness of foodborne S. aureus strains isolated in the Marmara Region of Turkey". *International Journal of Food Microbiology* 148.2 (2011): 99-106.

8. Hejazi M A. "Microbial changes in cattle carcasses stored at chilling condition". M. V. Sc. (Meat hygiene) Faculty of Veterinary Medicine, Alexandria University (2013).

9. Zaki E and El- Mahrouk AM. "Rapid detection of Enterotoxigenic *E. coli* recovered from buffalo meat products using PCR". *Assiut Veterinary Medical Journal* 51.104 (2005): 35-49.

10. Madden R H., *et al*. "Occurrence of Escherichia coli O157: H7, Listeria monocytogenes, Salmonella and Campylobacter Spp. on beef carcasses in Northern Ireland". *Meat Science* 58.4 (2001): 343-346.

11. International commission of Microbiological Specification for Foods "ICMSF". Microorganisms in Food. I-Their Significance and methods of enumeration. 3rd Edition. University of Toronto, Canada (1996).

12. Food and Drug Administration "FDA". Staphylococcus aureus. Bacteriological analytical manual. 8th Edition. Chapter 12. Academic Press, Gaithersburg, UK (2001).

13. Feldman D., *et al*. "The solution for data analysis and presentation graphics". 2nd Edition, Abacus Lancripts, Inc., Berkeley, USA (2003).

14. Emam-Neveen H. "Microbilogical investigation of meat serving establishements". Ph.D. Thesis meat Hygiene, Faculty of Veterinary Medicine, Zagazig University, Egypt (2002).

15. Badr-Sarah. "Follow up of *E. coli* and Staphylococcus aureus in some locally manufactured meat products". M.V.Sc., Thesis (Meat Hygeine), Faculty of Veterinary Medicine, Benha University, Egypt (2018).

16. Abou Hussien-Reham AA. "Microbial evaluation of some meat products". M. V. Sc. Thesis (Meat hygiene), Faculty of Veterinary Medicine, Moshtohor, Zagazig University, (Benha branch). Egypt (2004).

17. Talaat - Nagwa W. "Bacteriological and histological evaluation of some meat products". M. V. Sc. (Meat Hygiene), Faculty of Veterinary Medicine, Kafr El-Sheikh University, Egypt (2009).

18. Ibrahim-Shimaa. "Detectionof S.aureus classic enterotoxin genes in some meat products using multiplex PCR". M. V. Sc. Thesis (Meat Hygiene), Faculty of Veterinary Medicine, Benha University, Egypt (2016).

19. Abd El Satter-Alaa M. "Incidence and importance of some pathogenic microorganisms contaminating meat product". M.V.Sc. Thesis (Meat Hygiene), Faculty of Veterinary Medicine, Benha University, Egypt (2016).

20. Hassanien-Fatin S. "Bacterial hazards associated with consumption of some meat products". *Benha Veterinary Medical Journal* 15.2 (2004): 41-54.

21. Eldaly EA., *et al*. "Detection of enterotoxigenic *S. aureus* genes prevalent in some meat products using Multiplex PCR". The 1st International Conference on the Impact of environmental Hazards On Food Safety, Zagazig University, Egypt (2014): 162-168.

22. Ahmed-Neven M. "Traceability Diarrheogenic *E. coli* in meat products with special reference to Enterohemorrhagic Srtains". PhD, Thesis (Meat Hygiene), Faculty of Veterinary Medicine, Benha University, Egypt (2016).

23. Potter N. "Food Science".4th Edition, The AVI publishing Co., Inc., New York, USA (2001).

24. Le Loir Y., *et al*. "Staphylococcus aureus and food poisoning". *Genetics and Molecular Research* 2.1 (2003): 63-76.

25. Collins CH., *et al*. "Microbiological methods". Butter worth, London, Boston, Toronto (1991).

26. Kaper JB and O'Brien AD. "*Escherichia Coli* O157:H7and Other Shiga Toxin-producing *E. coli* Strains". ASM Press, Washington, DC (1998).

27. Locking M., *et al*. "VTEC in Scotland 2003". *SCIEH Weekly Report* 38.49 (2004): 294-297.

28. Brooks JT., *et al*. "Non- 0157 shiga toxin producing *E. coli* infection in united states, 1983- 2002". *The Journal of Infectious Diseases* 192.8 (2005): 1422-1429.

29. Willshaw GA., *et al*. "Verocytotoxin producing *E. coli* in a herd of dairy cattle". *Veterinary Record* 132.4 (1993): 196.

30. Ahmed MN. "Incidence and occurance of salmonella and *E. coli* organisms in impacted meat products in Assiut". M.V.Sc. Thesis (meat Hygiene), Faculty of Veterinary Medicine, Assiut University, Egypt (1992).

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