Benha Veterinary Medical Journal 41 (2022) 32-37

Official Journal Issued by Faculty of Veterinary Medicine

Benha Veterinary Medical Journal

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

Since 1990

Original Paper

Enterotoxigenic Staphylococci as potential hazards in meat meals prepared at restaurant level

Marwa Gewely[1], Faten Hasanine[1], Amani Salem[1], Nahla Shawky[2]

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

[2]*Department of Food Hygiene, Animal Health Research Institute, shebin El –Kom branch, Egypt*

ARTICLE INFO

Keywords

Meat meals
Ready to eat (RTE)
Staphylococcus count
S. aureus count

Received 27/09/2021
Accepted 24/10/2021
Available On-Line 01/01/2022

ABSTRACT

Enterotoxigenic staphylococci are associated with food poisoning infection especially in ready to eat meals ingestion causing serious health hazards. A total of 150 random samples of prepared meat meals represented by beef kofta, hawawshi, chicken shawarma, chicken pane, fish fillet and fried tilapia (25 of each) were gathered from several restaurants in Egypt's Menoufia governorate and analyzed bacteriologically for detection of enterotoxigenic staphylococci. The obtained results showed that, the mean values of staphylococci count (CFU/g) were $2.3\times10^3 \pm 0.35\times10^3$ in beef kofta, $2.5\times10^3 \pm 0.1\times10^3$ in hawawshi, $8.1\times10^3\pm0.21\times10^4$ in chicken shawarma, $2.1\times10^3\pm0.45\times10^3$ in chicken pane, $3.8x10^3\pm0.06x10^3$ in fish fillet, $7.6x10^3\pm0.13x10^3$ in fried tilapia. Also, *Stahphylococcus aureus* had mean values of $1.3\times10^3\pm 0.23\times10^3$, $1.5\times10^3 \pm 0.21\times10^3$, $4.5\times10^3 \pm 0.01\times10^3$, $1.5\times10^3 \pm 0.31\times10^3$, $2.2x10^3\pm0.05x10^3$, $3.0x10^3\pm0.03x10^3$ (CFU/g) and with incidences of 24%, 20 %, 24 %, 12 %, 16 % and 12% in the examined samples of beef kofta, hawawshi, chicken shawarma, chicken pane, fish fillet and fried tilapia, respectively. Restrict hygienic measures should be applied to prevent food contamination.

1. INTRODUCTION

Food either raw or cooked, hot or chilled that are ready for immediate consumption at the point of sale without further treatment are generally described as "ready-to-eat (Tsang, 2002). Due to their biological value, affordable price, and acceptable flavor, ready-to-eat meat products are in high demand; they also represent quick, easy-to-prepare meals and alleviate the problem of fresh meat shortages that are out of reach for many low-income households (Samapundo *et al.*, 2015). Ready-to-eat meat and meat products are of special concern since they may be ingested without further cooking and are known to be a good growth medium for certain microorganism. Furthermore, lack of knowledge about foodborne illnesses is a major risk factor for food contamination and the presence of germs that can cause significant health issues in human (Derbew *et al.*, 2013). In Egypt, street-vended meat products may pose a health risk due to poor hygienic conditions such as using low-quality raw materials, poor personal hygiene, and post-cooking holding for long periods of time, which encourages heavy bacterial loads in foods containing pathogenic microorganism; such contamination may render the product of inferior quality or unfit for human consumption (El-Ziqaty *et al.*, 2016). Staphylococcal food poisoning is one of the most common food-borne diseases worldwide resulting from contamination of food with *S. aureus* enterotoxins causing economic losses and losses in human productivity (Kadariya *et al.*, 2014). Staphylococci are responsible for a wide range of tissue infections and illnesses. More than 30 different kinds of staphylococci strains have been confirmed to be human-infectious, with symptoms and disorders ranging from mild to severe. *Staphylococcus aureus*, a prominent human and zoonotic pathogen implicated in both clinical care and food safety, is responsible for the majority of these infections (Xu *et al.*, 2011). Because of its pathogenicity and zoonotic significance, the presence of *S. aureus* in ready-to-eat meat poses a public health risk and raises food safety issues (Razmyar *et al.*, 2017). *Staphylococcus aureus* poisoning usually occurs after eating various foods, especially processed meat due to poor handling and subsequent storage at a high temperature (Argudin *et al.*, 2010). The contamination of food by *S. aureus* may directly occur due to skin lesions of food handlers or sneezing and coughing (Hanson *et al.*, 2011). It can grow and produce SEs under a wide range of conditions, including temperature, pH, sodium chloride concentration as well as water activity (Adams and Moss, 2008). Accordingly, the number of *S. aureus* bacteria can be used as an indicator of the hygienic circumstances under which meat and its products are cooked and handled (Potter, 2001). Therefore, this study was performed for assessment of staphylococci and *S. aureus* prevalence in various ready to eat beef, chicken and fish meals.

2. MATERIAL AND METHODS

2.1. Collection of Samples:

One hundred and fifty random samples of ready to eat meat meals of beef kofta, hawawshi, chicken shawarma, chicken

* Corresponding author: marwagewely91

pane, fish fillet and fried tilapia (25 of each) were collected from several restaurants in Menoufia governorate, Egypt. All samples were transferred in ice box as rapidly as possible to the laboratory under possible aseptic conditions without undue delay and examined as quickly as possible.

2.2. Preparation of samples (APHA, 2001):

Twenty-five grams from each sample were homogenized with 225 ml sterile 0.1 % peptone solution in a sterile polyethylene bag for 1.5 minutes using stomacher (Lab-blender 400). One ml from the sample original homogenate was added to a test tube containing 9 ml 0.1% sterile peptone water to provide a dilution of 10^2. Similarly, a tenfold serial dilution was prepared, and the following bacteriological investigations were performed.

2.3. Staphylococci and S. aureus counts (FDA, 2001).

2.4. Identification of Staphylococci:

2.4.1. Morphological and cultures character (Cruickshank et al. 1975)

2.4.2. Motility test (ICMSF, 1996)

2.4.3. Biochemical identification (MacFaddin, 2000) :

2.4.3.1. Catalase activity test

2.4.3.2. Oxidase test

2.4.3.3. Growth at 10% NaCl

2.4.3.4. Detection of Arginine decarboxylase (ADH)

2.4.3.5. Bile esculin test

2.4.3.6. Mannitol test

2.4.3.7. Detection of hemolysis

2.4.3.8. Coagulase test

2.4.3.9. Thermostable nuclease test "D-Nase activity" (Lachia et al. 1971)

2.4.3.10. Fermentation of sugars.

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

3. RESULTS

From the results given in Table (1) it was obvious that, staphylococci count of the examined meat samples (CFU/g) was varied from 6.2×10^2 to 8.9×10^3 with mean of $8.1\times10^3 \pm 0.21\times10^4$ in chicken shawarma, $2.7x10^3$ to $5.1x10^4$ with mean of $7.6x10^3\pm0.13x10^3$ in fried tilapia, $5.3x10^2$ to $6.7x10^3$ with mean of $3.8x10^3\pm 0.06x10^3$ in fish fillet, 3.2×10^2 to 4.7×10^3 with mean of $2.5\times10^3\pm0.1\times10^3$ in hawawshi, 4.5×10^2 to 5.8×10^3 with mean of $2.3\times10^3\pm0.35\times10^3$ in beef kofta and 4.5×10^2 to 3.5×10^3 with mean of $2.1\times10^3\pm0.45\times10^3$ in chicken pane.

Although chicken shawarma exposed to heat treatment the statistical analysis of variance of staphylococci counts among the examined meat product samples indicated a significant difference ($P<0.0001$) between examined chicken shawarma samples and the other product samples

Moreover, the average of staphylococci count in case of beef kofta samples was significantly different ($P<0.0001$) compared to chicken pane samples and fried tilapia samples). However, it was not significantly different compared to hawawshi, and fillet samples. There was no significance difference between chicken pane and fried tilapia samples.

Table 1 Statistical analytical results of staphylococci count (CFU/g) in the examined samples of ready to eat meat meals (n=25)

Product	Positive samples				
	No.	%	Min.	Max.	Mean values
Beef kofta	15	60	4.5×10^2	5.8×10^3	$2.3\times10^3 \pm 0.35\times10^{3b}$
Hawawshi	16	64	3.2×10^2	4.7×10^3	$2.5\times10^3 \pm 0.1\times10^{3bc}$
Chicken shawarma	17	68	6.2×10^2	8.9×10^3	$8.1\times10^3 \pm 0.21\times10^{4a}$
Chicken pane	12	48	4.5×10^2	3.5×10^3	$2.1\times10^3 \pm 0.45\times10^{3c}$
Fish fillet	14	56	5.3×10^2	6.7×10^3	$3.8\times10^3\pm 0.06 \times 10^{3bc}$
Fried Tilapia	13	52	7.2×10^3	5.1×10^4	$7.6\times10^3\pm 0.13 \times10^{3c}$

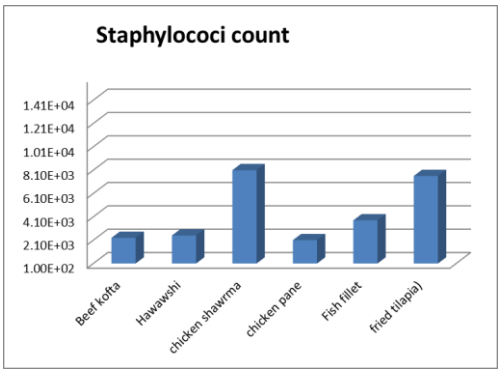

Figure 1 Mean values of Staphylococci count (CFU/g) in the examined samples (n=25).

Tables (2 and 3) indicated that *S. aureus* count (CFU/g) of the examined meat samples was 2.5×10^2 to 3.8×10^3 with mean of $1.3\times10^3\pm0.23\times10^3$ for beef kofta, 2.6×10^2 to 3.7×10^3 with mean of $1.5\times10^3\pm0.21\times10^3$ for hawawshi, 3.5×10^2 to 6.2×10^3 with mean of $4.5\times10^3\pm0.01\times10^3$ for chicken shawarma, 3.1×10^2 to 2.8×10^3 with mean of $1.5\times10^3\pm0.31\times10^3$ for Chicken pane, $2.4x10^2$ to $4.5x10^3$ with mean of $2.2x10^3\pm0.05x10^3$ for fish fillet and $2.6x10^3$ to $3.1x10^4$ with mean of $3.0x10^3\pm0.03x10^3$ for fried tilapia. The incidence of *Staphylococcus aureus* isolated from the examined product samples was 24%, 20%, 24%, 12%, 16% and 12% in beef kofta, hawawshi, chicken shawarma, chicken pane, Fish fillet and fried tilapia, respectively.

There is a significant difference ($P<0.0001$) between examined shawerma samples and other examined samples. However, there is no significant difference between the other examined samples (beef kofta, hawawshi, chicken pane, fish fillet and fried tilapia).

Table 2 Statistical analytical results of S. aureus count (CFU/g) in the examined samples of ready to eat meat meals (n=25)

Product	No. of examined samples	Suspected S. aureus positive samples				
		No.	%	Min.	Max.	Mean values
Beef kofta	25	6	24	2.5×10^2	3.8×10^3	$1.3\times10^3 \pm 0.23\times10^{3b}$
Hawawshi	25	5	20	2.6×10^2	3.7×10^3	$1.5\times10^3 \pm 0.21\times10^{3b}$
Chicken shawarma	25	6	24	3.5×10^2	6.2×10^3	$4.5\times10^3 \pm 0.01\times10^{3a}$
Chicken pane	25	3	12	3.1×10^2	2.8×10^3	$1.5\times10^3 \pm 0.31\times10^{3bc}$
Fish fillet	25	4	16	2.4×10^2	4.5×10^3	$2.2\times10^3\pm 0.05 \times 10^{3bc}$
fried tilapia)	25	3	12	2.6×10^3	3.1×10^4	$3.0\times10^3\pm 0.03 \times10^{3bc}$

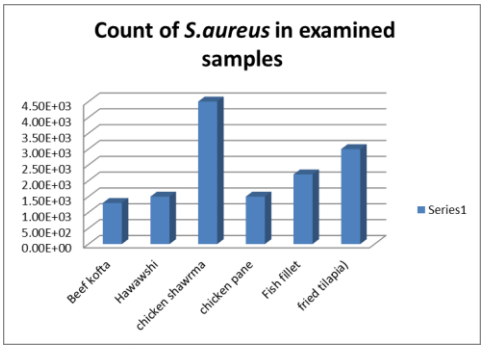

Figure 2 Mean values of S. aureus count (CFU/g) in the examined samples.

Results obtained in Table (3) and Fig. (3) revealed that 24%, 20%, 24%, 12%, 16% and 12% of the examined samples of beef kofta, hawawshi, chicken shawarma, chicken pane, fish fillet and fried tilapia were unaccepted where they exceeded the safe permissible limit recommended by Egyptian Organization for Standardization and Quality "EOSQ" (2005) which stated that *S. aureus* count /g should be free. Consequently, the samples exceeding the permissible limit represent a potential health hazard if stored under unfavorable condition where *S. aureus* can proliferate and produce enterotoxin causing SFP.

Table 3 Acceptability of the examined samples of ready to eat meat meals based on their S. aureus counts (n=25)

Type of the sample	Accepted samples		Unaccepted samples	
	No	%	No	%
Beef kofta	19	76	6	24
Hawawshi	20	80	5	20
Chicken shawarma	19	76	6	24
Chicken pane	22	88	3	12
Fish fillet	21	84	4	16
Fried Tilapia	22	88	3	12

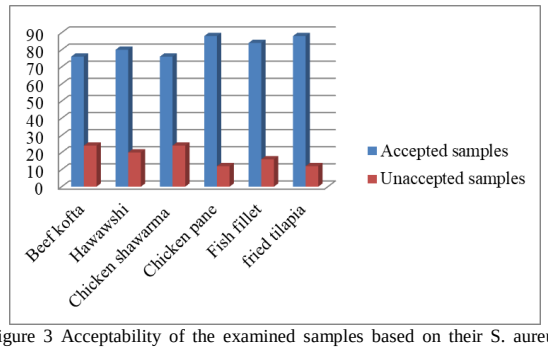

Figure 3 Acceptability of the examined samples based on their S. aureus counts.

Results given in Table (4) declared that the incidence of *S. aureus, S. epidermidis, S. intermedius, S. saprophyticus* and *S. capitis* were 24%, 16%, 8%, 8% and 4% from beef kofta, 20%, 12%, 16%, 8%, and 8% from hawawshi, 24%, 6%, 16%, 16% and 4% from chicken shawarma and 12%, 8%, 12%, 16 %and 4% from fried tilapia samples. While *S. aureus, S. epidermidis* S. *intermedius* and S. saprophyticus were isolated as 12%, 16%, 12% and 8% from chicken pane and 16%, 12%, 16% and 12% from examined fish fillet samples.

Table 4 Serotyping of Staphylococci isolated from the examined samples (n=25)

Staphylococci	Beef kofta		Hawawshi		Chicken shawarma		Chicken pane		Fish fillet		fried tilapia	
	No.		No.		No.	%	No.	%	No.	%	No.	%
S. aureus	6	24	5	20	6	24	3	12	4	16	3	12
S. epidermidis	4	16	3	12	2	8	4	16	3	12	2	8
S. intermedius	2	8	4	16	4	16	3	12	4	16	3	12
S. saprophyticus	2	8	2	8	4	16	2	8	3	12	4	16
S. capitis	1	4	2	8	1	4	-	-	-	-	1	4
Total	15	60	16	64	17	68	12	48	14	56	13	52

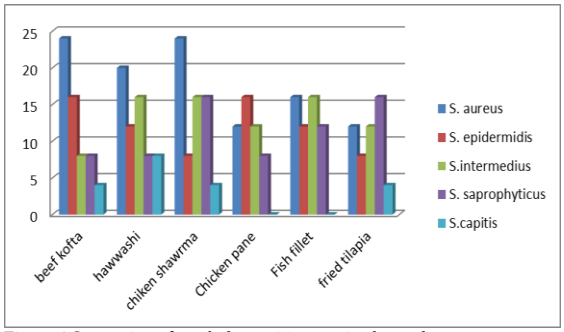

Figure 4 Serotyping of staphylococci in examined samples.

4. DISCUSSION

Over the past decade ready to eat meat meals have gained wide popularity due to their low price compared to fresh meat and their delicious taste. On the other hand, ready to eat meat products can be contaminated by food poisoning microorganisms and become unacceptable for human consumption. The majority of foodborne disease outbreaks are caused by food handler contamination and the development of heat stable toxins in food (FSIS, 2003). Food storage at potentially unsafe temperatures, unsanitary food handling practices and food contamination with uncooked meat were the main sources of contamination of street vended food (Burt *et al.*, 2003).

A high staphylococci count indicates poor sanitation and processing, as well as the presence of enterotoxin-producing strains such as *S. aureus* (ICMSF, 1996). Therefore, staphylococcus remains an important problem for food processors, food service companies and consumers. The most common way for food contamination with staphylococcus is through contact with food workers who carry the bacteria (CDC, 2006).

The results showed that the highest incidence of staphylococci in the examined samples were recorded in chicken shawarma followed by hawawshi, beef kofta and fish fillet. However, the lowest incidence of such bacteria was recorded in chicken pane and fried tilapia samples.

High incidence of staphylococci in examined chicken shawarma samples may be due to inadequate heat treatment, unhygienic handling practices through the workers who can transfer staphylococci on their hands, using dirty equipment for slicing and leaving the skewer of shawarma in unsuitable temperature along the day. In restaurants and food outlets, food handlers are a major

source of staphylococcal food contamination (Colombari *et al.*, 2007).

Although chicken shawarma exposed to heat treatment, the statistical analysis of variance of staphylococci count among the examined meat product samples indicated a significant difference (P<0.0001) between examined Chicken shawarma samples and the other product samples and this may be attributed to inadequate heat treatment, unhygienic handling practices through the workers who can transfer staphylococci on their hands, leaving the skewer of shawerma in unsuitable temperature along the day and using dirty knifes for slicing.

Moreover, the average of Staphylococci count in case of beef kofta samples was significantly different (P<0.0001) compared to chicken pane samples and fried tilapia samples). However, it was not significantly different compared to hawawshi, and fillet samples. There was no significance difference between chicken pane and fried tilapia samples.

According to the results recorded for beef kofta they came in agreement with those obtained by Hassanien et al. (2015); EL- Hanafy (2016); Badr (2018) and EL-Maghraby (2018) but lower results were recorded by Shafik (2013); Sobieh (2014); Ragab et al. (2016) and Saad et al. (2018) but higher results recorded by Mohammed (2020) who found the average count of staphylococci $10.3x10^4$ CFU/g in samples of beef kofta.

Meanwhile, the present results of hawawshi samples were similar to those obtained by Saad et al. (2018) but higher results were recorded by Ahmed - Wafaa (2015).

Moreover, the obtained results of examined chicken shawarma samples are relatively agree, to some extent, with those obtained by Hassanien et al. (2015) who found the mean count $9.42x10^3 \pm 2.23x10^3$, while lower incidence recorded by Salem-Nehad et al. (2016) (68%).

The obtained results of examined fish fillet are lower than those recorded by mohammed-Rehab (2020) who found the mean count of staphylococci $9.6x10^4$ CFU/g.

Intoxication with *Staphylococcus aureus* is a worldwide concern, with many food poisoning outbreaks linked to the eating of infected meat and meat products. As a result, the total number of *S. aureus* can be used as a measure of the hygienic circumstances under which meat and its products are produced and handled (Potter, 2001).

The results indicated that the highest incidence of *S. aureus* in the examined samples were recorded in the examined chicken shawarma and beef kofta, hawawshi, fish fillet While, the lowest incidence was recorded in both chicken pane and fried tilapia.

The presence of *S. aureus* in heat treated food is a pointer to largely poor personal hygiene, improper storage facilities, and unhygienic environment (Achi and Madubuike, 2007). *Staphylococcus aureus* is regarded as a good sign of inefficient thermal processing, poor sanitary conditions during food manufacturing, preparation, or chilling. (Melheiros *et al.*, 2010). The presence of *S. aureus* in meat products might be due to direct contact with employees who have *S. aureus* -related hand or arm sores, or coughing and sneezing, both of which are prevalent during respiratory illnesses. In staphylococcal outbreaks, food workers are usually the cause of food contamination (Jennifer Hait, 2012). As it may be found on the skin and nose, it can be spread to foods as a result of human contamination, either through filthy hands or coughing or sneezing into RTE meals (Koo, 2008).

The results of beef kofta were relatively similar to some extent, with those obtained by Hassanein - Fatin (2004) who found the mean value of *S. aureus* $2.51\times10^3 \pm 0.31\times10^3$ (CFU/g). While higher results were recorded by Baz - Amany (2016) who found mean value $1.63\times10^4\pm0.60\times10^4$ (CFU/g) and an incidence of 46.7%; Nadim-Samaa (2016) (28%); EL-Maghraby- Marwa (2018) who found mean value $3.51\times10^3 \pm 4.6 x10^2$ (CFU/g) and an incidence 40% and Sabry et al. (2019) who found mean value $4.59x10^3 \pm 0.73x10^3$ (CFU/g) and an incidence 46. 67%.

In hawawshi, higher incidence was recorded by Sabry et al. (2019) (60%); Morshdy et al. (2018) (65%) and Hassan et al (2016) (31. 4%).

Meanwhile, lower results of isolated *S. aureus* in chicken shawarma were reported by Samir et al. (2019) (5%). On the other hand, higher results obtained by Salem-Nehad et al. (2016) (26%) and Hassanien et al. (2015) (53. 33%).

Higher results of isolated *S. aureus* in chicken pane were recorded by Shaltout-Fahim (2020) (26. 6%) and Eman et al. (2013) (25%).

Moreover, higher results of isolated *S. aureus* in fish fillet were recorded by mohammed-Rehab (2020) (33. 3%), but lower results recorded by Daniel et al. (2012) who found the incidence of *S. aureus* in ready to eat fish products were 10%.

Abdominal pains, nausea, vomiting, and diarrhea are all symptoms of S. aureus food poisoning. Shijia et al. (2016), which occur 2-6 hours from eating contaminated food. The severity of the disease is determined by the victim's susceptibility to infection, the amount of contaminated consumed food, the amount of toxin present in the food consumed, and the victim's overall health (U.S.FDA, 2012).

The statistical analysis of variance of *S. aureus* count among shawerma samples and other examined samples and this could be attributed to the same reasons for significant increase in staphylococci in shawerma samples compared to other product samples in addition coughing and sneezing of workers or vendors, because *S. aureus* is frequently found in the nose and respiratory tract.

The most accepted examined samples were chicken pane and fried tilapia followed by fish fillet, hawawshi then beef kofta and chicken shawarma according to the safe permissible limit recommended by Egyptian Organization for Standardization and Quality (EOSQ., 2005) which stated that *S. aureus* count /g should be free. So, samples that were exceeding the permissible limit represent a potential health hazard.

Finally, it was obvious that Incidence of Gram-positive cocci isolated from the examined samples was highest at chicken shawarma followed by hawawshi beef kofta, Fish fillet, fried tilapia and chicken pane.

5. CONCLUSION

The obtained results indicated that the beef, chicken and fish meat meals were prepared and handled under poor sanitary and hygienic conditions which were the main cause of high count of Staphylococci. It was considered that the most contaminated meat meals were chicken shawarma and beef kofta followed by hawawshi and fish fillet then finally chicken pane and fried tilapia. Finally, RTE meat products still represent health issues for consumers so more restrict hygienic measures should be applied over ready to eat food restaurants.

6. REFERENCES

1. Achi, O. K. And Madubuike, C. N. (2007): Prevalence and antimicrobial Resistance of Staphylococcus aureus isolated from Retail ready to eat foods in Nigeria. Res. J. Microbiol., 2 (6): 516-523.
2. Adams, M. R. and Moss, M. O. (2008): Bacterial agents of food borne illness- *S. aureus.* Food Microbiol., Royal Society of Chemistry, Cambridge.
3. Ahmed-Wafaa, M. A. (2015): Bacterial hazards associated with consumption of street vended meat products in Kalyobia governorate. M. V. Sc. Thesis (Meat Hygiene), Fac. Vet. Med., Benha Univ., Egypt.
4. Alaa Eldin M. A. Morshdy, Mohamed A. Hussein, Ahmed E. Tharwat, Basma A. Fakhry (2018): Prevalence of enterotoxigenic and multi-DRUGRESISTANT *Staphylococcus aureus* in ready to eat meat sandwiches, Slov. Vet. Res., 55 (Suppl 20): 367–74 Original Research Article DOI 10. 26873/SVR-664-2018.
5. American Public Health Association & quot; APH & quot; (2001): Compendium of Methods for the Microbial Examination of Foods. 4 th Edition 365-366-800. 1 st, NW Washington DC2000 1-3710.
6. Argudin, M. Á.; Mendoza, M. C. and Rodicio, M. R. (2010): Food poisoning and *S. aureus* enterotoxins. Toxins, 2: 1751-1773.
7. Badr - Sarah, M. M. (2018): Follow up of *E. coli* and *Staphylococcus aureus* in some locally manufactured meat products. M. V. Sc. Thesis (Meat hygiene), Fac. Vet. Med., Benha Univ. Egypt.
8. Baz-Amany, H. A. (2016): Risk Assessment of Ready-to-Eat Meats. M. V. Sc. Thesis (Meat hygiene), Fac. Vet. Med., Zagazig Univ., Egypt.
9. Burt, B. J. V. I., Volel, C. and Finkel, M. (2003): Safety of vendor-prepared foods: evaluation of 10 processing mobile food vendors in Manhattan. J. Public Health Reports, 118 (5): 470-476.
10. Centers for disease control and prevention (CDC) (2006): Staphylococcal Food Poisoning. Available on http: //www. cdc. gov/dbmd/diseaseinfo/staphylococcusfoodg. htm.
11. Colombari, V.; Mayer, M. D. B. and Laicini, Z. M. (2007): Foodborne Outbreak Caused by Staphylococcus aureus: Phenotypic and Genotypic Characterization of Strains of Food and Human Sources. Journal of Food Protection. 70: 489–493.
12. Cruickshank, R.; Duguid, J.; Marmion, B. and Swain, R. H. (1975): Medical 12th Ed., Edinburg, London and New York. Microbiology.
13. Derbew, G.; Sahle, S. and Endris, M. (2013): Bacteriological Assessment of Some Street Vended Foods in Gondar, Ethiopia. Internet J. of Food Safety, 15: 33 - 38.
14. Egyptian Organization for Standardization "EOS" (2005): Reports related to No 1972-2005 for sausage, No 1688-2005 for beef burger & No 1973-2005 for kofta. Egyptian Standards, Ministry of Industry, Egypt.
15. EL- Hanafy-Asmaa, R. A. (2016): Bacteriological Quality Indices of Some Meat Sandwiches. M. V. Sc. Thesis (Meat Hygiene), Fac. Vet. med., Benha Univ. Egypt.
16. EL-Maghraby, Marwa S. M. (2018): Detection of enterotoxigenic staphylococcal aureus in some street vended meat products, (Ph.D. Thesis, Meat Hygiene), Fac. Vet. Med., Benha Univ.
17. El-Ziqaty, A. A. (2016): Microbial evaluation of some street vended meat meals. Thesis, Master of Veterinary Medicine, Alexandria University, Egypt.
18. Eman M Farid, Dalia A Salim and Amany N Dapgh (2013): Occurrence of Enterotoxigenic *S. aureus* in Half-Cooked Chicken Products. *Zag. Vet. J. (ISSN. 1110-1458), 41(2):140-151.*
19. Feldman, D.; Hoffman, R. and Simpson, J. (2003): The solution for data analysis and presentation graphics. 2 nd Ed. Abacus Landcripts, Inc., Barkeley, CA, USA.
20. Food and Drug Administration "FDA" (2001): *Staphylococcus aureus*. Bacteriological analytical manual. 8th Ed. Chapter12. Academic Press,
21. Food Safety and Inspection Service "FSIS" (2003): Meat preparation: Beef from farm to table. Washington. DC. 20250-3700.
22. Hanson, B. M.; Dressler, A. E.; Harper, A. L.; Scheibel, R. P.; Wardyn, S. E. L K Roberts, J S Kroeger, T C Smith (2011): Prevalence of Staphylococcus aureus and methicillin-resistant Staphylococcus aureus (MRSA) on retail meat in Iowa. J infect Public Health; 4(4):169-74.
23. Hassan, M. A.; Marionette, Z. N. and Mona A. I. (2016): Incidence of *Staphylococcus aureus* in meat products with special reference to enterotoxins. Benha Vet. Med. J-30 (2): 23-27.
24. Hassanien, F. S.; El-Shater, M. A. H. and Abd El-Fatah, R. R. (2015): Bacteriological aspect of meat and poultry meat meals. Benha Vet. Med. J., 28 (2): 91-97.
25. Hassanien-Fatin, S. (2004): Bacterial hazards associated with consumption of some meat products. Benha Vet. Med. J., 15(2): 41-54.
26. International commission of Microbiological Specification for Foods "ICMSF" (1996): Microorganisms in Food. I-Their Significance and methods of enumeration. 3rd Ed. Univ. of Toronto, Canada.
27. Jennifer Hait, B. S. (2012): Handbook of Foodborne Pathogenic Microorganisms and Natural Toxins. *Staphylococcus aureus*. In Bad Bug Book, (ed. 2).
28. Kadariya, J.; Smith, T. C. and Thapaliya, D. (2014): *Staphylococcus aureus* and Staphylococcal Food-Borne Disease: An Ongoing Challenge in Public Health. Biomed Res Int., 827965.
29. Koo, I. C. (2008): Food Poisoning *Staphylococcus aureus* in Food. Com Medical Review Board.
30. MacFaddin, J. F. (2000): Biochemical tests for identification medical bacteria. Warery Press Inc, Baltimore, Md. 21202 USA.
31. Malheiros, P. S., Passos, C. T., Casorin, L. S., Serraglia, l. and Tondo, E. C. (2010): Evaluation of growth and transfere of *S. aureus* from poultry meat to surfaces of stainless steel and polyethylene and their disinfection of control, 21: 298- 301.
32. Mohammed, Rehab G. A. (2020): Prevalence of some food poisoning bacteria in some ready to eat sandwiches, (Ph.D. Thesis, Meat Hygiene), Fac. Vet. Med., Benha Univ.
33. Nadim-Samaa, 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. Ph. D., Thesis (Meat Hygiene), Fac. Vet. Med., Benha Univ., Egypt.
34. Ragab, W. S.; Ehsan A. B. H.; Al-Geddawy, M. A. and Albie, A. A. (2016): Bacteriological Quality of some Meat Products in the Egyptian Retail Markets. Assiut J. Agric. Sci., 47 (6-2): 422-429.
35. Razmyar, J., Jamshidi, A., Khanzadi, S. and Kalidari, G. (2017): Toxigenic *Clostridium difcile* in retail packed chicken meat and broiler in northeastern Iran. Iran. J. Vet. Res., 18(4): 271-274.
36. Roberts, L. K.; Kroeger, J. S. and Smith, T. C. (2011): Prevalence of *S. aureus* and MRSA on retail meat in Iowa. J. Infect. Public Health, 4(4): 169-174.
37. Saad, M. Saad, Nahla, A. Shawky Abouel- Roos and Enas, Abd El- Mohsein El-Shazly (2018): Food Poisoning Bacteria in Meat-Based Sandwiches, Benha Veterinary Medical journal, 35 (1): 228-235.
38. Sabry, Reham, Hassan Ahmed Mohamed, Zaghloul marionette and Ibrahim, Hemmat Mostafa (2019): indices of some ready-to-eat meat products, Benha Veterinary Medical Journal, 37, 37-40.
39. Salem-Nehad, I. E., EL-Gamel, A. M., Khalifa-Amel, M. A., Abd-EL Hady-Hala, A. M. and Abou Zeid-Mayada, A. M. (2016): Microbial Status of Shawerma Sandwiches in Kafr El-Sheikh. Alex. J. Vet. Sinc., 51(2): 303-309.
40. Samapundo, S., Climat, R., Xhaferi, R. and Devlieghere, F. (2015): Food safety knowledge, attitudes and practices of street food vendors and consumers in Port-au-Prince, Haiti. Food Control, 50: 457-466.
41. Samir A. Alharbi, Mamdouh H. Abdel-Ghaffar and Kadher Nivas R (2019): Isolation and identification of pathogenic bacteria from ready-to -eat fast foods in al-quwayiyah, kingdom of saudi arabia, Department of Medical Laboratory Science, College of Applied Medical Sciences, Al Quwayiyah, Shaqra University, Riyadh, Kingdom of Saudi Arabia, DOI: 10. 18697/ajfand. 86. 17840.
42. Shafik-Nagwa, M. (2013): Staphylococcal food poisoning associated with Egypt. fast foods. M. V. Sc. (Meat Hygiene), Fac. Vet. Med., Benha Univ. Egypt.
43. Shaltout, Fahim & Shaltout, Fahim. (2020): Prevalence of some food poisoning bacteria in semi cooked chicken meat products at Qaliubiya governorate by recent Vitek 2 compact and PCR techniques. Benha Vet. Med. J., 38:88-92.
44. Shijia, W.; Nuo, D.; Huajie, G.; Lilong, H.; Hua, Y.; Wenhui, G. and Zhouping, W. (2016): A review of the methods for detection of *S. aureus* enterotoxin. Toxins, 8, 176; doi: 10. 3390/ toxins 8070176.
45. Sobieh, A. S. A. (2014): Fast meat meals safety at restaurants level in Cairo governorate. M. V. Sc. (Meat Hygiene), Fac. Vet. Med., Benha Univ.
46. Tsang (2002): Microbiological Guidelines for ready to eat foods, Road and Environmental Hygiene Department, Hong Kong: 115- 116.
47. U.S. Food and Drug administration (2012): Bad bug book: food borne pathogenic microorganisms and natural toxins handbook *Staphylococcus aureus*. 10903 New Hampshire Avenue Silver Spring, MD 20993.
48. Vázquez-Sánchez, Daniel, López-Cabo, Marta, Ibusquiza, Paula and Rodríguez Herrera, Juan José. (2012): Incidence and characterization of *Staphylococcus aureus* in fishery products marketed in Galicia (Northwest Spain). International journal of Food Microbiology, 157:286-296.
49. Xu Z, Li L, Zhao X. (2011): Development and application of a novel multiplex polymerase chain reaction (PCR) assay for rapid detection of various types of staphylococci strains. Afr. J. Microbiol. Res., 5:1869–1873.