Rapid Assessment of Spoilage and Food Poisoning Microbes in Common Meat Products

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Abstract

Minced meat, sausage and beef-burger are the common meat products at Egyptian markets which were considered as an excellent source of high biological value protein, minerals and, vitamins. Bacterial contaminants have been shown to be present in a wide variety of meat products, for this reason, this study was conducted to evaluate the incidence of spoilage and food borne microbes in minced meat, sausage and beef-burger meat. The results revealed that these meat products are contaminated with a variety of bacteria at different levels. The positive samples for aerobic bacteria, Enterobacteriaceae, *E. coli*, *S. aureus* and Salmonella in minced meat samples were 30 (100%), 30 (100%), 22 (73%), 26 (87%) and 0 (0%) respectively while The negative samples were 0 (0%), 0 (0%), 8 (27%), 4 (13%) and 30 (100%) for aerobic bacteria, enterobacteriaceae, *E. coli*, *S. aureus* and Salmonella respectively. 3M petrifilm technique for bacteriological evaluation of meat product was used for determination the incidence of foodborn pathogen and spoilage bacteria in the examined samples which is considered a rapid method for inspection the meat products which given realizable results and can interpret the bacteriological quality of traded meat products.

Key words: Minced meat, sausage, beef-burger, enterobacteriaceae, *E. coli*.

Introduction

Meat products are the first-choice for many consumers due to their flavor, juiciness and, tenderness **(*Garmyn,* 2020)**. The transformation of meat into meat products involves several operations: (a) processing of raw materials, (b) transporting and distribution of the meat products, (c) storage at proper temperatures and (d) thawing and final handling **(*Pal1 and Devrani,* 2018 *and Soladoye,* 2021).** Under certain circumstances, poor processing techniques and inadequate hygienic measures in any of these operations will result in reduced meat products quality either by spoilage or carry foodborne pathogens **(*Gaafar et al.,* 2019).**

Minced meat, oriental sausage and hamburger are highly perishable food and assist as substrates for numerous spoilage and pathogenic microorganisms due to their high water activity and richness of nutrients. Spoilage of meat products can be defined as meat product is unfit to the consumer from a sensory point of view. Microbial spoilage of meat products leads to the deteriorative changes as off-flavors, discoloration, texture changes and, slime formation **(*Gram et al.,* 2002 *and Cocolin et al.,* 2004)**. The most frequent spoilage bacteria in the sausages were lactic acid bacteria **(*Dias et al.,* 2013).**

Food poisoning pathogens are the main reason of sickness and demise all over the world and are regularly related with inadequate hygiene measures **(*Adesokan et al.,* 2020)**. Bacterial pathogens associated with meat products are *S. aureus,* Salmonella, *Escherichia coli* O157:H7 and *Listeria monocytogenes*, which result in major disease outbreaks and product recall **(*CDC,* 2014 *and Ijabdeniyi et al.,* 2019)**. The most food poisoning pathogens associated with meat products is *S. aureus. **Armany et al.,*** **(2016)** revealed the prevalence of *S. aureus* in minced meat and, Sausage was 24% and 24% respectively. *S. aureus* is a chief cause of foodborne intoxication and its occurrence in meat products constitute an important safety problem for meat processors, handling and consumers **(*El-Dosoky et al.,* 2013).**

The prevalence of dominant bacterial groups current in meat products can assist in the preference of the most hygienic approach for extending the final product shelf-life. However, there is limited information on the uses of 3M™ Petrifilm™ Plates for determination of spoilage and food poisoning microbes. Therefore, the present work aimed to determine the incidence of ACC, enterobacteriacea count, *Escherichia coli, S. aureus,* lactic acid bacteria, yeast and mould and salmonella in minced meat, oriental sausage and hamburger sold at markets of meat products.

Materials and Methods

1-Sample collection: A total of 90 commercial samples of three different categories (30 minced meats, 30 oriental sausages, 30 bee-burger) were randomly collected at Portsaid city from twenty supermarkets prior retail outlets using sterile bags. Samples were transferred in ice-box to the laboratory where they were subjected to bacteriological analysis.

2-Sample Preparation: All samples were prepared according to the technique recommended by

***APHA* (2001).** The samples were kept in frozen state till performance of analysis and protected in aluminum sheet against sunlight. Defrosting was performed in refrigerator at 4ºC for 12-18 hours. 25g of each sample was transferred into a high duty plastic stomacher bag containing 225mL sterile 0.1 % (w/v) buffered peptone water where it homogenized using a Stomacher 400 Lab Blender (Seward Medical, London, UK) for 2 minutes to obtain a 1:10 dilution. 1mL from original dilution was transferred into a series of sterile test tubes containing 9 ml of 0.1% sterile Buffer Peptone Water to prepare a decimal serial dilution of up to 10^7.

3- Determination of aerobic colony count (*3M,* 2022a): aerobic plate count was determined by3M™ petri film™ technique. The top layer was lifted to expose the plating surface, and with a pipette, 1ml of the diluted sample was added. The top film is then slowly rolled down and the "spreader" was used for even distribution. It took a minute for gelling to occur. Incubation was at 35±2°C for 2-3 days. All plates were counted with the 3M™ Petrifilm™ plate reader, on a standard colony counter. Counted colonies expressed as CFU/g

4-Determination of enterobacteriaceae (*3M,* 2022b): was determined by 3M™ petri film™ technique as described in Aerobic Count Plate.

5- Determination of staphylococcus (*3M,* 2022c): was determined by 3M™ petri film™ technique as described in Aerobic Count Plate.

6- Determination of *E. coli*/Coliform (*3M,* 2022e): was determined by 3M™ petri film™ technique as described in Aerobic Count Plate.

7- Determination of lactic acid bacterial count (*3M,* 2022f): was determined by 3M™ petri film™ technique as described in Aerobic Count Plate.

8-Detection of salmonellae (*3M,* 2022g):The original sample in peptone water was incubated at 37°C ±1°C for 18 ± 2 hours.10 ml of this pre-enrichment sample were transferred into 90 ml Rappaport-Vassiliadis broth, and incubated for 24± 3 hours at 42ºC. Detection of salmonella was carried out by 3M™ petri film™ technique as described in Aerobic Count Plate.

9- Determination of yeast and mould (*3M,* 2022d): was determined by 3M™ petri film™ technique as described in Aerobic Count Plate.

10-Statistical analysis

Data analysis was performed by using SPSS statistical software program ***(SPSS for Windows version 16, Spss Inc., USA).*** Data were expressed as mean ± standard error (SE). Two-way analysis of variance (ANOVA) with Duncan post-hoc multiple comparisons test. Any significant differences ($P<0.05$) were analyzed by the multiple comparisons procedure of LSD (least significant difference), using a level of significance of alpha = 0.05.

Results and Discussion

Minced meat, sausage and beef-burger are liable to harbor various types of pathogens due to handling, processing, transportation and storage. They may represent a public health hazard and linked to major outbreaks of food poisoning all over the world **(*Hassanien,* 2004).** Foodborne pathogens are of public health hazard such as enterobacteriacae, *E. coli*, *S.aureus* and Salmonella were isolated from minced meat, sausage and beef-burger. Their total number reflects the sanitary quality of meat products **(*Erdem et al.*, 2014)**.

The results in tables (1) revealed the incidence of foodborne bacterial pathogens in minced meat, sausage and beef-burger samples where The positive samples for aerobic bacteria, Enterobacteriaceae, *E. coli*, *S.aureus* and Salmonella in minced meat samples were 30 (100%), 30 (100%), 22 (73%), 26 (87%) and 0 (0%) respectively while The negative samples were 0 (0%), 0 (0%), 8 (27%), 4 (13%) and 30 (100%) for aerobic bacteria, enterobacteriaceae, *E. coli*, *S.aureus* and Salmonella respectively.

In sausage samples, the positive samples for aerobic bacteria, Enterobacteriacae, *E. coli*, *Staphylococcus aureus* and salmonella were 30 (100%), 30 (100%), 24 (80%), 21 (70%) and 0 (0%) respectively, while the negative samples were 0 (0%), 0 (0%), 6 (20%), 9 (30%) and 30 (100%) for aerobic bacteria, Enterobacteriacae, *E. coli*, *S.aureus* and Salmonella respectively. The positive samples for aerobic bacteria, enterobacteriacae, *E. coli*, *S. aureus* and Salmonella in beef-burger samples were 30 (100%), 30 (100%), 18 (60%), 24 (80%) and 0 (0%) respectively, while the negative samples were 0 (0%), 0 (0%), 12 (40%), 6 (20%) and 30 (100%) for aerobic bacteria, enterobacteriacae, *E. coli*, *S.aureus* and Salmonella respectively.

The results in tables (2), revealed the incidence for presence of food spoilage bacteria in minced meat, sausage and beef-burger samples, where the positive samples for coliform, *lactic acid bacteria* and yeast &moulds in minced meat samples were 22 (73%), 26 (87%) and 25 (83%) respectively, while the negative samples were 8 (27%), 4 (13%) and 5 (10%) for coliform, *lactic acid bacteria* and yeast &moulds respectively.

In sausage samples, The positive samples coliform, *lactic acid bacteria* and yeast &moulds were 24 (80%), 21(70%) and 30 (100%) respectively while the negative samples were 6 (20%), 9 (30%) and 0 (0%) for coliform, *lactic acid bacteria* and yeast & moulds respectively. The positive samples coliform, *lactic acid bacteria* and yeast &moulds in beef-burger samples were 18 (60%), 28(93%) and 27 (90%) respectively, while the negative samples were 2 (7%) and 3 (10%) for coliform, *lactic acid bacteria* and yeast &moulds respectively.

Food handlers and Poor personal hygiene is the main vehicle for transmission of microbial transmission to food either from human body parts or cross-contamination between different food items **(*Malhotra et al.,* 2008)**.

Indicator microorganisms as aerobic colony counts are widely utilized to detect and estimate the degree of hygienic measures during processing of meat products in routine food safety monitoring. It is evident from the results recorded in tables (3) the **s**tatistical analytical results for total aerobic counts (cfu/g) in minced meat, sausage and beef-burger samples. The mean values of total aerobic counts (cfu/g) in minced meat, sausage and beef-burger samples were $11x10^4$, $8x10^4$ and $14x10^4$ respectively with maximum values were $28x10^4$, $29x10^4$ and $25x10^4$ in minced meat, sausage and beef-burger samples respectively while the minimum values of were $1,7x10^4$, $1x10^4$ and $2x10^4$ in minced meat, sausage and beef-burger samples respectively.

High result may due to contamination of the meat products during preparation or may due to low quality of raw meat use, which leads to spoilage of the meat and economic losses. Meat products at the retail location can introduce more spoilage microorganisms if proper equipment hygiene and handling measures not followed **(*Ragab et al.,* 2016)**.

Nearly similar results obtained by ***Hassanien et al.,* (2015)**, ***Shaltout et al.,* (2017)**, ***Salem et al.,* (2018) and *Albie* (2019)** and ***Younis, et al.,* (2019)** while lower results those recorded by ***Mousa et al.,* (2014)** and higher results recorded by ***Al-Mutairi* (2011), *Shaltout et al.,* (2016b)** and ***Mohamed* (2017)**. The differences in results may attributed to the fact due to mishandling and the negligence of hygienic aspects either at production levels where most workers did not have medical certificates or at selling of meat with expired dates.

Results given in table (5) showed that the number of accepted minced meat samples, sausage samples and beef-burger samples were 30 (100%), 30 (100%) and 24 (80%) respectively, while 0 (0%), 0 (0%) and 6 (20%) of minced meat samples, sausage samples and beef-burger samples were rejected as they exceed the permissible limits (10^6cfu/g) according to ***EOS* (2005**). Lower results recorded by ***Shaltout et al.,* (2016)** and ***Mohamed* (2017)**.

Enterobacteriaceae group has an epidemiological importance as some of its members are pathogenic and may cause serious infections and food poisoning **(*Salem et al.,* 2018)**. Their counts can be taken as an indicator of possible enteric contamination in the absence of coliforms even in low number **(*Abdelrahman et al.,* 2014).**

It is evident from the results recorded in table (1) that enterobacteracae group found in 30(100%) of minced meat, sausage and beef-burger samples. Nearly similar results recorded by ***Abdelrahman et al.,* (2014)**, ***Elhawary et al.,* (2016)** and ***Salem et al.,* (2018)**, while lower results obtained by ***Gaafar et al.,* (2012)**.

Results recorded in table (3) showed that the minimum, maximum and mean value ± standard error of Enterobacteriaceae count were $2×10^3$, $8×10^4$ and $2,6×10^4$ ± $8,7×10^3$cfu/g, respectively in examined minced meat samples, $2×10^3$, $10×10^4$ and $2×10^4$ ± $9×10^3$cfu/g respectively in examined sausage samples and $2×10^3$, $12×10^4$ and $3,3×10^4$ ± $12×10^3$cfu/g, respectively in examined beef-burger samples. The results obtained are nearly similar to those reported by ***Abdelrahman et al.,* (2014), *Elhawary et al.,* (2016)** and ***Salem et al.,* (2018)** while lower results were recorded by ***Gaafar et al.* (2012)**, ***Shaltout et al.,* (2017),** and ***Youness* (2018)**. The presence of high Enterobacteriaceae counts in meat products indicate poor sanitary conditions inside the butcher's shops especially for mincing machines which were used for meat mincing without periodical washing or cleaning and also workers hands which carry heavy contamination and contaminate meat by bad handling **(*El-Gendy et al.* 2014). *EOS* (2005)** does not establish a microbial standard limit for Enterobacteriaceae count.

Escherichia coli have a fecal-oral life style and consider as indicator for environmental fecal contamination **(*Edris and Gafer,* 2013)**. Inadequate cleaning of both equipment and surfaces, poor personal hygiene and use of untrained personnel are the main causes of *Escherichia coli* presence **(*Abd El-Tawab et al.,* 2015**). It is evident from the results recorded in table (1), that the incidence of *Escherichia coli* was 22(73%), 24(80%) and 18(60%) in minced meat, sausage and beef-burger samples respectively. The results obtained were nearly similar to those reported by ***Geoff et al.,* (2008) and *Erdem et al.,* (2014)**while lower results recorded by, **Shaltout *et al*., (2017), Sofy *et al.,* (2017)**, ***Hassan et al.,* (2018)**, ***Abd El- Tawab et al.,* (2019), *Hamad and Saleh* (2019)**, ***Abd El-Tawab et al.,* (2020)** and ***Mokhtar and Karmi* (2021).**

Table (3) showed the statistical analytical results for *Escherichia coli* count in examined minced meat samples were ranged from less than 10 to $5,3×10^4$ with mean value $1,5×10^4$± $5,5×10^3$cfu/g while in sausage samples the statistical analytical results for *Escherichia* *coli* count was ranged from less than 10 to 8×10^4 with mean value $1,6\times10^4\pm$ $7,8\times10^3$cfu/g. For beef-burger samples *Escherichia coli* count was ranged from less than 10 to 6×10^4 with mean value $2,1\times10^4\pm$ $7,2\times10^3$cfu/g. *Escherichia coli* is used as an indicator microorganism, its presence in meat indicates poor hygienic conditions, fecal contamination or poor sanitation during preparation and handling **(*Khater et al.,* 2013).**

Salmonella is one of the microorganisms most frequently associated with foodborne outbreaks of illness. Meat products in general are the common sources of food poisoning by Salmonella **(*Majowicz et al.,* 2010) .**Results given in table (1) revealed that Salmonella failed to be detected in all examined minced meat, sausage and beef-burger samples respectively. The results obtained agreed with ***El-dosoky et al.,* (2013), *Khater et al*., (2013)**, ***Shaltout et al.,* (2017), *Hassanin et al.,* (2018)** and ***Younis et al.,* (2019b)** while disagreed with ***Ed-dra et al.,* (2017)**, ***Hassan et al,.* (2017), *Hassan et al,.* (2018), *Morshdy et al.,* (2018), , *Albie* (2019), *Hamad and Saleh* (2019), *Abd El-Tawab et al.,* (2020)**, ***Al-Thubaiti et al.,* (2021). *EOS* (2005)** stated that minced meat, sausage and beef-burger samples should be free from Salmonella so all samples were accepted.

S. aureus is a public-health zoonotic pathogen that causes significant illness in people and food poisoning outbreaks **(*Mousa et al,* 2017)**. It is evident from the results recorded in table (1) that the incidence of *S. aureus* was 26(87%), 21(70%) and 24(80%) in minced meat, sausage and beef burger samples respectively. The incidence of *S. aureus* agreed with the fact that coughing and sneezing is frequent vehicles in transporting them to meat processing and packaging surfaces **(*Pazlarová et al.,* 2016)**. Higher results was recorded by ***Erdem et al.,* (2014)** and ***Mousa et al.,* (2014)** while lower results recorded by ***El-dosoky et al.,* (2013), *Armany et al.,* (2016), *Shawish and Al-Humam* (2016), *Hassan et al.,* (2018)**, ***Karmi* (2019), *Younis et al.,* (2019)** and ***Abd El-Tawab et al.,* (2020).**

Table (2) showed the statistical analytical results for *S.aureus* count in examined minced meat samples where the count was ranged from less than 10 to 15×10^4 cfu/g with mean value 33×10^3 ± 15×10^3cfu/g. while it was ranged from less than 10 to 1×10^5 cfu/g with mean value 25×10^3 ± 8×10^3cfu/g in examined sausage samples. In beef burger samples the statistical analytical results for *S.aureus* count was ranged from less than 10 to 11×10^4 cfu/g with mean value 46×10^3 ± 10×10^3 cfu/g. The occurrence of *S.auerus* in meat has been linked to poor handling practices. *S.auerus,* a pathogenic bacteria of public health concern and significance, could contaminate meat products during storage.(***Khater et al*., 2013)**.These results were nearly similar to those obtained by ***Shaltot et al.,* (2015)** while lower results were obtained by ***Shaltout et al*., (2016)**, ***Shaltout et al.,* (2017)*, Edris et al.,* (2018), *Hassan et al*., (2018))** and ***Younis et al.,* (2019)** and higher results were obtained by ***Erdem et al.,* (2014)**. The high contamination rate found in this study could be attributed to poor hygiene during handling, transport, processing, and storage of such product.

Table (5) showed the number and percentage of acceptable samples for *S.aureus* count based on Egyptian Standard ***EOS* (2005)** which recorded that the average of *S.aureus* count must not exceed (10^2cfu/g) in minced meat, sausage and beef burger, where in examined minced meat samples, 4 (13%) of the samples were accepted while 26 (87%) of samples were rejected. Meanwhile in examined sausage samples, 9 (30%) of examined samples were accepted while 21 (70%) of samples were rejected based on Egyptian Standard ***EOS* (2005)**. In beef burger samples, 6 (20%) of examined beef burger samples were accepted while 24 (80%) of samples were rejected based on Egyptian Standard ***EOS* (2005)**.

Those results disagreed with ***Younis et al.,* (2019)** who found that 5% of samples were unaccepted as they were exceeded the permissible limit of ***EOS* (2005)**.

Food spoilage is an undesirable process and is a serious problem for humans. The main causes of meat and meat products spoilage after slaughtering and during processing and storage are; microorganisms. Meat and meat products provide excellent growth media for a variety of micro flora (bacteria, yeasts and molds) some of which are pathogens **(*Jay et al*., 2005).**

Coliform is significant organisms in meat as indicator of fecal contamination. Also the presence of coliform in great numbers may be responsible for inferior quality of meat products resulting in economic losses and the possibility of presence of enteric pathogens which constitute public health hazard.Results recorded in table (4) showed that the minimum, maximum and mean value of coliform in examined minced meat, sausage and beef burger samples where they were 0, 5.3×10^2 and 1.5×10^2 cfu/g, respectively in minced meat samples, 0, 8×10^2 and 1.6×10^2 cfu/g respectively in sausage samples and 0 , 6×10^2 and 2.1×10^2 cfu/g respectively in beef-burger samples.

The results obtained were nearly similar to those reported by ***Shaltout et al*.,(2016)*, Ragab et al.,* (2016)** and ***Selim et al*., (2013)**, while lower results recorded by ***Younis et al.,* (2019).** On the other hand, higher results recorded by ***Al-Mutairi* (2011)*, Shawish et al*., (2014), *Abd El-Tawab et al*., (2015), *Shaltot et al.,* (2015).**

Lactic acid bacteria (LAB) are considered useful microorganisms which used mainly in meat fermentation processes. When these organisms spoil meats, they usually cause souring; however, other types of spoilage do occur as well. The presence of lactic acid bacteria in large numbers may be responsible for poor meat quality, resulting in financial losses and public health risks. Results recorded in table (4) showed the minimum, maximum and mean value of lactic acid bacterial count in examined minced meat, sausage and beef burger samples which were 0, 37×10^3 and 11×10^3cfu/g respectively in minced meat samples, 1×10^3, 8×10^4 and 18×10^3cfu/g respectively in examined sausage samples and 0, 8×10^4 and 16×10^3cfu/g, respectively in examined beef-burger samples.

The presence of yeast and mould in the food samples in the form of spores which are abundant in the environment and can be introduced that through dust and soil. Their presence in these food is a serious public health concern as these fungi may be associated with the production of mycotoxins. Results recorded in table (4) showed the minimum, maximum and mean value of mould count in examined minced meat, sausage and beef burger samples, which were 2×10^2, 2×10^3 and 6×10^2cfu/g, respectively in minced meat samples, 300, 3×10^3 and 1×10^3 cfu/g respectively in sausage samples and 2×10^3 and 8×10^2 cfu/g respectively in beef burger samples. On the other hand, higher results recorded by ***Salem et al*., (2018),** and ***Ayten K. et al*., (2014).** The presence of mould in meat product samples may be because of improper storage causing this foods stuff to become humid therefore supporting the growth of these fungi. The minimum, maximum and mean value of yeast count in examined minced meat, sausage and beef burger samples were given in table (4) where they were 2×10^2, 4×10^3 and 1×10^3 cfu/g respectively in minced meat samples, 3×10^2, 6×10^3 and 1.5×10^3 cfu/g, respectively in sausage samples and 3×10^2, 3×10^3 and 6×10^2 cfu/g, respectively in beef burger samples. On the other hand, higher results recorded by ***Salem et al*., (2018),** and ***Ayten K. et al*., (2014).**

Conclusions

In the light of the previous achieved results, it was concluded the poor bacteriological quality of some meat products as minced meat, sausage and beef-burger traded in the markets which are contaminated with a variety of bacteria at different levels. The sources of these contaminations may be due to using of low-quality raw materials or contamination during the manufacturing processes. High incidence of foodborne bacteria in minced meat, sausage and beef-burger constitutes a public health hazard and has an epidemiological interest and importance as they are considered as true indicator of poor sanitation during production, post processing contamination and the extent of fecal contamination where the most important pathogens associated with meat products are *Escherichia coli*, *Salmonella spp.* and *Staphylococcus aureus*.

Table (1): *Incidence of foodborne bacterial pathogens in minced meat, sausage and beef-burger samples (n=30)*

Foodborne Pathogen	Minced meat				Sausage				Beef-burger			
	Positive		Negative		Positive		Negative		Positive		Negative	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Total Aerobic Count	30	100	0	0	30	100	0	0	30	100	0	0
Enterobacteriacae	30	100	0	0	30	100	0	0	30	100	0	0
E. coli	22	73	8	27		80	6	20	18	60	12	40
Salmonella	ND	0	30	100	ND	0	30	100	ND	0	30	100
S. aureus	26	87	4	13	21	70	9	30	24	80	6	20

ND= Non detected

Table (2): *Incidence food spoilage bacteria in in minced meat, sausage and beef-burger samples (n=30)*

Food spoilage bacteria	Minced meat				Sausage				Beef-burger			
	Positive		Negative		Positive		Negative		Positive		Negative	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Coliform	22	73	8	27	24	80	6	20	18	60	12	40
Lactic acid bacteria	26	87	4	13	21	70	9	30	28	93	2	7
Yeast	25	83	5	10	30	100	0	0	27	90	3	10
Moulds	25	83	5	10	30	100	0	0	27	90	3	10

Table (3): *Statistical analytical results for foodborne bacterial pathogens (CFU/g) in minced meat, sausage and beef-burger samples (n=30)*

Foodborne Pathogen	Minced meat			Sausage			Beef-burger		
	Min	Max	Mean ±S.E	Min	Max	Mean ±S.E	Min	Max	Mean ±S.E
Total Aerobic Count	1.7×10^4	28×10^4	11×10^4 $\pm3.1\times10^4$	1×10^4	29×10^4	$8\times10^4\pm$ $2,5\times10^4$	2×10^4	25×10^4	14×10^4 $\pm2,6\times10^4$
Enterobacteriacae	2×10^3	8×10^4	2.6×10^4 $\pm 8.7\times10^3$	2×10^3	10×10^4	2×10^4 $\pm9\times10^3$	2×10^3	12×104	3.3×10^4 $\pm12\times10^3$
E. Coli	<10	5.3×10^4	1.5×10^4 $\pm 5.5\times10^3$	<10	8×10^4	$1,6\times10^4$ $\pm 7,8\times10^3$	<10	6×10^4	2.1×10^4 $\pm7.2\times10^3$
S. aureus	<10	15×10^4	33×10^3 $\pm 15\times10^3$	<10	1×10^5	25×10^3 $\pm 8\times10^3$	<10	11×10^4	46×10^3 $\pm10\times10^3$

S.E. means standard error
Min. = Minimum
Max. = Maximum

Table (4): *Statistical analytical results for food spoilage bacteria (CFU/g) in minced meat, sausage and beef-burger samples (n=30)*

Food spoilage bacteria	Minced meat			Sausage			Beef-burger		
	Min	Max	Mean ±S.E	Min	Max	Mean ±S.E	Min	Max	Mean ±S.E
Coliform	<10	5.3×10^4	1.5×10^4 $\pm5.5\times10^3$	<10	8×10^4	$1,6\times10^4$ $\pm1.2\times10^2$	<10	6×10^4	2.1×10^4 $\pm7.2\times10^3$
Lacticacid bacteria	<10	37×10^3	11×10^3 $\pm4\times10^3$	10×10^2	80×10^3	18×10^3 $\pm10\times10^3$	0	8×10^4	16×10^3 $\pm37\times10^3$
Yeast	2×10^2	4×10^3	1×10^3 $\pm30\times10^3$	3×10^2	6×10^3	1.5×10^3 $\pm6\times10^2$	3×10^2	3×10^3	1.6×10^3 $\pm4\times10^2$
Moulds	2×10^2	2×10^3	6×10^2 $\pm1\times10^2$	2×10^2	3×10^3	1×10^3 $\pm 2\times10^2$	1.5×10^2	2×10^3	8×10^2 $\pm2\times10^2$

S.E. means standard error
Min. = Minimum
Max. = Maximum

Table (5): *Frequency distribution of foodborne bacterial pathogens compared the Egyptian standards*

	Aerobic bacteria		***Staphylococcus aureus***	
Minced Meat samples	**F**	**%**	**F**	**%**
Within the Egyptian standard	30	100	4	13%
Exceed the Egyptian standard	0	0	26	87%
Total	30	100	30	100%
Sausage samples	**F**	**%**	**F**	**%**
Within the Egyptian standard	30	100	9	30%
Exceed the Egyptian standard	0	0	21	70%
Total	30	100	30	100%
Beef-burger samples	**F**	**%**	**F**	**%**
Within the Egyptian standard	24	80	6	20%
Exceed the Egyptian standard	6	20	24	80%
Total	30	100	30	100%

References

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التقييم السريع لميكروبات الفساد والتسمم الغذائي في منتجات اللحوم الشائعة

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الملخص العربي

تعتبر اللحوم المفرومة والسجق ولحم البقر من منتجات اللحوم الشائعة في الأسواق المصرية والتي تعتبر مصدرًا ممتازًا للبروتين الحيواني العالي القيمة الغذائية وكذلك غنية بالمعادن والفيتامينات وفي نفس الوقت قد توجد الملوثات البكتيرية متنوعة في تلك المنتجات بنسب مختلفة ومن مصادر متعددة أثناء عمليات التجهيز والتخزين والتداول. لهذا السبب أجريت هذه الدراسة لتقييم مدي تواجد ميكروبات الفساد والتسمم الغذائي في عينات اللحوم المفرومة والسجق الشرقي والبرجر المتداولة بالاسواق. وأظهرت النتائج المتحصل عليها إيجابية العينات لتواجد ميكروبات المجموعة الهوائية، والمعوية، والإشريكية القولونية، والمكور العنقودي الذهبي والسالمونيلا في عينات اللحم المفروم بعدد 30 (100٪)، 30 (100٪)، 22 (73٪)، 26 (87٪) و 0 (0٪) على التوالي بينما كانت العينات السلبية بعدد 0 (0٪)، 0 (0٪)، 8 (27٪)، 4 (13٪) و 30 (100٪) لتواجد ميكروبات المجموعة الهوائية، والمعوية، والإشريكية القولونية، والمكور العنقودي الذهبي والسالمونيلا على التوالى. وأكدت النتائج المتحصل عليها أن منتجات اللحوم ملوثة بمجموعة متنوعة من البكتيريا بمستويات مختلفة وأن استخدام تقنية 3 أم بتريفيلم للتقييم البكتريولوجي لمنتجات اللحوم تعد تقنية سريعة وبسيطة لتحديد مدي تلوث تلك المنتجات بيمكروبات الفساد والجراثيم المسببة للتسمم الغذائي.