Bacteriological and Chemical Evaluation of Meat Meals in Some Egyptian Hotels

Hassan, M. A.[1.] and Reham A. Amin[1.] and El-Salhy, M. S.[2.]

[1.] *Food Control Dept., Faculty of Veterinary Medicine, Benha University*
[2.] *Food Safety and Water Control Specialist*

A B S T R A C T

Total of 90 random samples of meat meals represented by beef steaks, beef kofta and beef filets (30 of each, 90 gm for each sample) were collected from two different Egyptian hotels at Cairo governorate named A and B (45 of each). The collected samples were examined bacteriologically and chemically to determine their hygienic and keeping quality by counting APC, total Enterobacteriacae count, total coliform count and total Staphylococcal count, Salmonella count, as well as measuring pH, TVN and TBA. The mean values of APC(cfu/g), total *Enterobacteriaceae* counts(cfu/g), total coliform counts (cfu/g) and total *Staph. aureus* count (cfu/g)of the examined samples of meat meals from hotel (A) were $2.17\times10^5\pm0.27\times10^5$, $1.06\times10^4\pm 0.43\times10^4$, $1.06\times10^4\pm 0.43\times10^4$and $8.26\times10^3\pm1.49\times10^3$,respectively for beef steak, $8.84\times10^4\pm2.13\times10^4$, $8.84\times10^4\pm2.13\times10^4$, $6.52\times10^3\pm 1.18\times10^3$, $1.76\times10^3\pm 0.37\times10^3$and $3.64\times10^3\pm0.71\times10^3$,respectively for beef kofta and $5.02\times10^4\pm0.71\times10^4$, $5.02\times10^4\pm0.71\times10^4$ $2.31\times10^3\pm 0.69\times10^3$, $8.14\times10^2\pm 2.46\times10^2$ and $1.51\times10^3\pm0.23\times10^3$, respectively for beef fillet, while for hotel (B), they were $7.15\times10^4\pm1.44\times10^4$, $4.46\times10^3\pm 0.88\times10^3$, $1.27\times10^3\pm 0.19\times10^3$ and $3.82\times10^3\pm 0.90\times10^3$, respectively for beef steak, $2.67\times10^4\pm0.63\times10^4$, $1.09\times10^3\pm 0.31\times10^3$, $6.82\times10^2\pm 1.04\times10^2$ and $1.75\times10^3\pm0.31\times10^3$, respectively for beef kofta and $6.96\times10^3\pm1.20\times10^3$, $5.94\times10^2\pm 1.25\times10^2$, $2.35\times10^2\pm 0.60\times10^2$ and $7.33\times10^2\pm1.24\times10^2$, respectively for beef fillet. From the present study, we concluded that meat meals can be contaminated by several ways such as incorrect thawing, inadequate cleaning and sanitation for utensils or post cooking contamination resulting in higher contamination with microorganisms and lower keeping quality measures, which leading to severe public health hazards.

Key words: Meat meal, Bacteriological status, keeping quality.

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1. INTRODUCTION

Red meat provides animal protein of high biological value for consumers at all ages, where they contain all the essential amino acids required for human growth, higher proportion of unsaturated fatty acids and less in cholesterol value. Moreover, meat is good source of different types of vitamins and minerals. Meat meals can be exposed to several ways of contamination through improper preparation and handling of foods which constitute the most direct and harmful source of microbiological contamination. The risk of contamination is increased by storage of food at ambient temperature, by using insufficiently high temperature to reheating the food, and adding contaminated ingredients at stage which no further heat treatment was applied (Ehirl *et al*., 2001). Aerobic plate count (APC) is the most reliable index of meat quality, sanitary processing and storage life of meat products (ICMSF, 1980). High APC of mesophilic bacteria, for example, when applied to raw products, often consists of the normal microflora, or perhaps indicate incipient spoilage, rather than any potential health hazard (ICMSF, 1978). *Enterobacteriaceae* group has an epidemiological interest as some of its members are pathogenic and may result in serious infections and food poisoning.

Moreover, the total number of *Enterobacteriaceae* can be taken as an indication of possible enteric contamination in the absence of coliforms (Mercuri et al., 1978). Presence of coliform in meat meals indicates inadequate processing and post processing contamination (most probably from worker, dirty utensils and other contact surfaces) or from the raw ingredient which may lead to contamination from various sources as polluted water, soil and manure (Tabbutt, 1989). *Staph.aureus* is a pathogenic bacterium that causes abscesses, pneumonia, endocariditis, and food poisoning. *Staphylococcus aureus*is also one of the resident flora of the endotherm and colonizes the host by skillfully evading its defense mechanism. Identification of attenuated mutants of *Staphylococcus aureus* in an animal infection model is useful for investigating its adaptability and pathogenesis (Kurokawa*et al.* (2007). Enteropathogenic*E.coli* constitute public health hazards as it may give rise to sever diarrhea in infants and young children as well as food poisoning and gastroenteritis among adult consumers (Miskimin*et al*., 1976). Salmonellosis is one of the most common bacterial food- borne illnesses. *Salmonella* infections can be life-threatening, especially to those with weak immune systems, such as infants, the elderly and persons with infection or undergoing chemotherapy. The most common manifestations of salmonellosis are diarrhea, abdominal cramps, and fever within eight to72 hours. Additional symptoms may be chills, headache, nausea and vomiting that can last up to seven days (FSIS 2008). *Staph.aureus* plays a great role in bacterial contamination of cooked food, Staphylococcus can be carried on human hands, nasal passage or throats, so workers play as major role of *Staph. aureus*contamination during preparation, processing, or even through post cooking contamination by touching cooked foods that are usually eaten without further cooking or heating. Most food borne illnesses of *Staph.aureus*outbreaks are a result of production of heat stable toxins in the food which may lead to severe food poisoning outbreaks(Ahmed 1991 and FSIS 2003). The pH value of meat has been related chemical characters of meat, so the early detection of meat spoilage is obtained by direct measurement of their pH. The total Volatile nitrogen (TVN) could be widely used as an indication of protein decomposition by microorganisms and tissue enzyme during storage (Greer and Murray, 1991). Therefore, the present study was planned out to evaluate the bacteriological quality and chemical quality of some meat meals in the two of Egyptian hotels through: Determination of Aerobic Plate Count (APC), total *Enterobacteriaceae* counts, total Coliform counts and Staphylococci counts and Measurement of pH, Total Volatile Nitrogen (TVN) and Thiobarbituric Acid number (TBA).

2. Materials and methods

2.1. Collection of samples:

A total of 90 random samples of meat meals represented by beef steaks, beef kofta and beef filets (30 of each) were collected from two different Egyptian hotels at Cairo namely A and B (45 of each). Each meat meal was represented by 15 samples related to the hotel A and 15 ones related to the hotel B.

2.2. Bacteriological examination:

Preparation of samples following ICMSF (1996). 3.2.2. Aerobic Plate Count following (ICMSF, 1996). Total Enterobacteriaceae count (Gork, 1976). Confirmatory test (ICMSF, 1996). Identification of family Enterobacteriacea(Cowan and Steel, 1974). Total coliform count (ICMSF,1996). Determination of total Staphylococci count (ICMSF, 1996). Isolation and identification of Enteropathogenic Escherichia coli (ICMSF, 1996). Isolation and identification of *Salmonellae*.

2.3. Chemical examinations:

Determination of pH (Pearson, 1984). Determination of Total Volatile Nitrogen (TVN) following Food and Agriculture Organization (FAO, 1980). Determination of Thiobarbituric acid number (TBA) following Vyncke (1970).

3. RESULTS

Results achieved in Table (1) declared that, the mean values of APC (cfu/g) of the examined samples of RTE meat meals from hotel (A) were$2.17\times10^5\pm0.27\times10^5$for beef steak, $8.84\times10^4\pm2.13\times10^4$for beef kofta and $5.02\times10^4\pm0.71\times10^4$for beef fillet, while for hotel (B) they were $7.15\times10^4\pm1.44\times10^4$ for beef steak, $2.67\times10^4\pm0.63\times10^4$for beef kofta and $6.96\times10^3\pm1.20\times10^3$ for beef fillet. Table (2) declared the acceptability percentage of examined meat meals in Egyptian hotels based on their APC/ g according to Center for Food Safety (2014). Consequently, 53% for beef steak, 40% for beef kofta and 33.33% for beef fillet for Hotel A, there for, beef steak samples were not accepted. While 33.33% for beef steak, 26.67% for beef kofta and 20% for beef fillet for Hotel B, based on that beef steak, beef kofta and beef fillet meals were accepted. Results achieved in Table (3) declared that, the mean values of total *Enterobacteriaceae* counts(cfu/g) in the examined samples of meat meals for hotel (A) were $1.06\times10^4\pm 0.43\times10^4$ for grilled beef steak, $6.52\times10^3\pm 1.18\times10^3$ for beef kofta, $2.31\times10^3\pm 0.69\times10^3$ for grilled beef fillet, respectively. While samples of hotel (B) recorded that, $4.46\times10^3\pm 0.88\times10^3$for grilled beef steak, $1.09\times10^3\pm 0.31\times10^3$for beef kofta and $5.94\times10^2\pm 1.25\times10^2$ for beef fillet, respectively. Acceptability percentage based on Center for Food Safety (2014) of *Enterobacteriaceae* isolated from examined meat meals was shown in Table (4). Consequently, 46.67% for beef steak and26.67% for beef kofta and at Hotel A which is accepted. At the same time 20% for beef steak at Hotel B which is accepted. Incidence of *Enterobacteriaceae* isolated from examined samples of hotel (A) meat meals was shown in Table (5). Consequently, *Proteus vulgaris* was isolated at highest level (73%) from beef steak followed by *Proteus mirabilis* (60%), *Enterobacter aerogenes* (53%) then *Citrobacter freundii* (46%). From beef kofta, *Proteus vulgaris* was isolated at highest level (60%) followed by *Klebsiella ozaenae* (46%), *Proteus mirabilis* and *Citrobacter freundii* with the same ratio (33%). Concerning beef fillet, *Proteus mirabilis* was isolated at highest level (53%), followed by *Proteus vulgaris* (40%) then *Citrobacter freundii* (20%). Table (6) showed *Enterobacteriacaea* strains from hotel (B) in the examined samples as shown in table (6). Consequently, *Proteus vulgaris* was isolated at highest level (66.67%) from beef steak followed by *Klebsiella pneumonia* (53.33%) then *Enterobacter aerogenes* (46.67%). From beef kofta, *Proteus mirabilis* was isolated at highest level (60%) followed by *Proteus vulgaris* (53%) then *Klebsiella ozaenae* (40%). Concerning to beef fillet, *Proteus vulgaris* was isolated at highest level (46.67%), followed by *Proteus mirabilis* (33.33%) then *Klebsiella ozaenae* (26.26%).

From the results given in Table (7), it is obvious that the mean values of total coliform counts (cfu/g) in the examined samples of meat meals of hotel (A) samples were $1.06\times10^4\pm 0.43\times10^4$ for grilled beef steak, $6.52\times10^3\pm 1.18\times10^3$for beef kofta, $2.31\times10^3\pm 0.69\times10^3$ for beef fillet, while in hotel (B) samples were$4.46\times10^3\pm 0.88\times10^3$for beef steak, $1.09\times10^3\pm 0.31\times10^3$ for beef kofta and $5.94\times10^2\pm 1.25\times10^2$ for beef fillet. Acceptability percentage based on Center for Food Safety (2014) of Coliform count/g isolated from examined meat meals was shown in Table (8). Consequently,66.67% for beef steak, 60% for beef kofta and 40% for beef fillet at Hotel A, based on that, beef steak and beef fillet meals were not accepted. While 46.67% for beef steak, 33.33% for beef kofta and 20% for beef fillet at Hotel B which is accepted. Table (9) declared that the mean values of total staphylococcal

count (cfu/g) in the examined samples of meat meals of hotel (A) was $8.26\times10^3\pm1.49\times10^3$ for grilled beef steak, $3.64\times10^3\pm0.71\times10^3$ for beef kofta and $1.51\times10^3\pm0.23\times10^3$ for beef fillet, while results recorded for hotel (B) samples with an average of $3.82\times10^3\pm0.90\times10^3$for beef steak, $1.75\times10^3\pm0.31\times10^3$for beef kofta and $7.33\times10^2\pm1.24\times10^2$ for beef fillet. Acceptability percentagebased on Center for Food Safety (2014)of staphylococcal count /g isolated from examined meat meals was shown in Table (10). 26.67% for beef steak and20% for beef kofta at Hotel A which is accepted and 13.33% for beef steak at Hotel B which id accepted.

Table (11) declared that the incidence and serotyping of EnteropathogenicE.coli isolated from the examined samples collected from hotel (A) which were O_{111} : K_{58} (B_9) and O_{26}:K_{60} (B6) EHEC (6.67%, 13.33%, respectively), O_{124} : K_{72} (B_{17}) EIEC (6.67%), O_{127}: K_{63} (B8) ETEC (13.33%), and untypable strain (6.67%) for beef steak. For beef kofta, O_{55} : K_{59} (B_5) EPEC (6.67%), O_{124} : K_{72} (B_{17}) EIEC (6.67%), O_{111}: K58 (B9) EHEC (13.33%) & O_{127}: K63(B8) ETEC (6.67%), but in beef fillet: only O_{26} : K_{60} (B_6) EHEC (6.67%) and O_{111}: K_{58} (B9) EHEC (6.67) was isolated. While strains of E. coli isolated from hotel (B) examined samples which illustrated in table (12) were O_{86} : K_{61}(B_7) EPEC (6.67%), O_{111} : K_{58}(B_9) EHEC (13.33%) and O_{125}: K_{70}(B_{15}) ETEC (6.67%) for beef steak samples, while O_{86} : K_{61}(B_7) EPEC (6.67%) & O_{119} : K_{69}(B_{19}) EPEC (13.33%) for beef kofta samples, and O_{111} : K_{58}(B_9) EHEC was the only E. coli strain isolated from beef fillet samples. Results given in Table (13) revealed that, the incidence and serotyping of *Salmonella* strains isolated from the examined samples of Hotel (A) were as follow: *Salmonella Typhimurium* could be detected by incidence of (20%),followed by *Salmonella Enteritidis* (6.67%), and *Salmonella Chester* (6.67%) from examined beef steaks, *Salmonella Typhimurium* (13.33%) followed by *SalmonellaEnteritidis* (6.67%), and *SalmonellaAnatum* (6.67%) could be detected in Beef kofta; only *Salmonella Typhimurium* (6.67%) could be detected in Beef fillet. *Salmonella* could be identified serologically as *Salmonella Entritidis* $O_{1,9,12}$: $H_{g,m\ :\ 1,7}$, *Salmonella Typhimurium* $O_{1,4,5,12}$: $H_{i:1,2}$, *Salmonella Chester* $O_{1,4,5,12}$: $H_{e,h:e,n,x}$, &*SalmonelolaAnatum* $O_{3,10,15,34}$: $H_{e,h:1,6}$.

Results given in Table (14) revealed that the incidence and serotyping of *Salmonella* organisms isolated from the examined samples of Hotel (B) as follow: *Salmonella* organisms could be detected, *Salmonella Enteritidis*, *Salmonella Typhimurium* and *Salmonella Muenster* by the same incidence (6.67%) of examined Beef steaks, *Salmonella Typhimurium* (6.67%) could be detected in Beef kofta; but failed to be isolated *Salmonellae* from beef fillet samples. In regard to beef fillet *Salmonella* could be identified serologically as *Salmonella Entritidis* $O_{1,9,12}$: $H_{g,m\ :\ 1,7}$, *Salmonella Typhimurium* $O_{1,4,5,12}$: $H_{i:1,2}$&*Salmonella Muenster* $O_{3,10,15,34}$: $H_{e,h:1,5}$.

Incidence of isolated and identified Gram +vecocci from hotel (A) meat meal samples as shown in table (15) revealed the presence of *Staph. aureus*, *Staph. Epidermidis* and *Micrococci* in beef steak, beef kofta and beef steak samples, respectively by percentage of 40%, 26.67%, 20% for *Staph. aureus*. 33.33%, 60%, 47.47% for *Staph. Epidermidis* and 73.33%, 40%, 53.33% for *Micrococci*, respectively. While in table (16) strains of Gram +vecocci isolated and identified from hotel (B) meat meal samples revealed presence of *Staph. aureus*, *Staph. epidermidis* and Micrococci in beef steak, beef kofta and beef steak samples, respectively by percentage of 20%, 13.33%, 13.33% for *Staph. aureus*. 26.67%, 26.67%, 40% for *Staph. epidermidis* and 66.67%, 60%, 33.33% for *Micrococci*, respectively. It is obvious from the results recorded in table (17) that, the mean values of pH in the examined samples of hotel (A) & (B) were $6.96\times10^3\pm1.20\times10^3$, 5.67 ± 0.02 for beef steak, 5.66 ± 0.02 and 5.60 ± 0.01 for beef

kofta, while for beef fillet were 5.57 ± 0.01 and 5.54 ± 0.01for beef fillet. The result recorded in table (18) indicated that, the mean values of TVN (mg%) in the examined samples of meat meals of hotels (A) & (B) were 5.72 ± 0.02 and 5.67 ± 0.02 for beef steak, 5.66 ± 0.02 and 5.60 ± 0.01 for beef kofta, while 5.57 ± 0.01 and 5.54 ± 0.01 for beef fillet, respectively. The results given in table (19) showed that, the TBA values (mg/kg) in the examined samples of hotel (A) & (B) were 0.21 ± 0.01 and 0.17 ± 0.01 for beef steak, 0.14 ± 0.01 and 0.09 ± 0.01 for beef kofta, while 0.06 ± 0.01 and 0.04 ± 0.01 for beef fillet, respectively.

Table (1): Statistical analytical results of Aerobic plate count/g (APC) (cfu/g) in the examined samples of meat meals in Egyptian hotels (n=15).

Hotels	Hotel A			Hotel B		
Meat Meals	Min.	Max.	Mean ± S.E*	Min.	Max.	Mean ± S.E*
Beefsteaks	9.1×10^3	2.2×10^6	$2.17\times10^5\pm0.27\times10^5$	3.8×10^3	8.5×10^5	$7.15\times10^4\pm1.44\times10^4$
Beef kofta	5.7×10^3	1.5×10^6	$8.84\times10^4\pm2.13\times10^4$	1.7×10^3	3.2×10^5	$2.67\times10^4\pm0.63\times10^4$
Beef fillets	1.3×10^3	6.7×10^5	$5.02\times10^4\pm0.71\times10^4$	1.0×10^3	9.4×10^5	$6.96\times10^3\pm1.20\times10^3$

*means significant difference ($P<0.05$)

Table (2): Acceptability of examined samples of meat meals in Egyptian hotels based on their APC/ g (cfu/g) (n=15).

Meat Meals	APC/g*	Unaccepted samples of Hotel A		Unaccepted samples of Hotel B	
		No.	%	No.	%
Beef steaks	$\geq 10^5$	8	53.33	5	33.33
Beef kofta	$\geq 10^5$	6	40.00	4	26.67
Beef fillets	$\geq 10^5$	5	33.33	3	20.00

*Center for Food Safety (2014)

Table (3): Statistical analytical results of *Enterobacteriaceae* counts/g in the examined samples of meat meals in Egyptian hotels (n=15).

Hotels	Hotel A			Hotel B		
Meat Meals	Min.	Max.	Mean± S.E*	Min.	Max.	Mean± S.E*
Beef steaks	7.2×10^2	9.5×10^4	$1.06\times10^4\pm 0.43\times10^4$	4.0×10^2	5.1×10^4	$4.46\times10^3\pm 0.88\times10^3$
Beef kofta	3.8×10^2	4.4×10^4	$6.52\times10^3\pm 1.18\times10^3$	2.7×10^2	9.7×10^3	$1.09\times10^3\pm 0.31\times10^3$
Beef fillets	2.5×10^2	8.0×10^3	$2.31\times10^3\pm 0.69\times10^3$	1.8×10^2	3.4×10^3	$5.94\times10^2\pm 1.25\times10^2$

*means significant difference ($P<0.05$)

Table (4): Acceptability of examined samples of meat meals in Egyptian hotels based on their *Enterobacteriaceae* count (cfu/g) (n=15).

Meat Meals	*Enterobacteriaceae* count /g*	Unaccepted samples of Hotel A		Unaccepted samples of Hotel B	
		No.	%	No.	%
Beef teaks	$> 10^4$	7	46.67	3	20.00
Beef kofta	$> 10^4$	4	26.67	0	0
Beef fillets	$> 10^4$	0	0	0	0

*Center for Food Safety (2014)

Table (5): Incidence of *Enterobacteriaceae* isolated from the examined samples of meat meals in Egyptian Hotel A (n=15).

Isolated Enterobacteria	Beef steaks		Beef kofta		Beef fillets	
	No.	%	No.	%	No.	%
Citrobacterdiversus	3	20.00	2	13.33	2	13.33
Citrobacterfreundii	7	46.67	5	33.33	3	20.00
Enterobacteraerogenes	8	53.33	3	20.00	1	6.67
Enterobacteragglomerans	4	26.67	-	-	-	-
Enterobacter cloacae	1	6.67	2	13.33	1	6.67
Enterobacterhafniae	3	20.00	1	6.67	-	-
Klebriellaozaenae	5	33.33	7	46.67	4	26.67
Klebriellapneumoniae	8	53.33	4	26.67	2	13.33
Proteus mirabilis	9	60.00	5	33.33	8	53.33
Proteus rettgeri	1	6.67	4	26.67	2	13.33
Proteus vulgaris	11	73.33	9	60.00	6	40.00
Providenciaalcalifaciens	4	26.67	-	-	-	-
Serratialiquefaciens	6	40.00	3	20.00	2	13.33
Serratiamarcescens	2	13.33	1	6.67	-	-

% was calculated according to total number of samples

Table (6): Incidence of *Enterobacteriaceae* isolated from the examined samples of meat meals in Egyptian Hotel B (n=15).

Isolated Enterobacteria	Beef steaks		Beef kofta		Beef fillets	
	No.	%	No.	%	No.	%
Citrobacterdiversus	1	6.67	1	6.67	-	-
Citrobacterfreundii	5	33.33	3	20.00	2	13.33
Enterobacteraerogenes	7	46.67	4	26.67	2	13.33
Enterobacter cloacae	3	20.00	1	6.67	3	20.00
Enterobacterhafniae	3	20.00	2	13.33	-	-
Klebriellaozaenae	4	26.26	6	40.00	4	26.26
Klebriellapneumoniae	8	53.33	3	20.00	1	6.67
Proteus mirabilis	6	40.00	9	60.00	5	33.33
Proteus rettgeri	4	26.26	4	26.26	2	13.33
Proteus vulgaris	10	66.67	8	53.33	7	46.67
Serratialiquefaciens	3	20.00	1	6.67	2	13.33
Serratiamarcescens	1	6.67	-	-	-	-

% was calculated according to total number of samples

Table (7): Statistical analytical results of coliform counts (cfu/g) in the examined samples of meat meals in Egyptian hotels (n=15).

Hotels	Hotel A			Hotel B		
Meat Meals	Min.	Max.	Mean ± S.E*	Min.	Max.	Mean ± S.E*
Beef steaks	3.2×10^2	4.1×10^4	$5.31\times10^3\pm 0.82\times10^3$	3.0×10^2	1.1×10^4	$1.27\times10^3\pm 0.19\times10^3$
Beef kofta	2.6×10^2	8.0×10^3	$1.76\times10^3\pm 0.37\times10^3$	1.9×10^2	2.6×10^3	$6.82\times10^2\pm 1.04\times10^2$
Beef fillets	2.1×10^2	5.6×10^3	$8.14\times10^2\pm 2.46\times10^2$	1.0×10^2	9.9×10^2	$2.35\times10^2\pm 0.60\times10^2$

Table (8): Acceptability of examined samples of meat meals in Egyptian hotels based on their coliform count (cfu/g) (n=15).

Meat Meals	Coliform count /g*	Unaccepted samples of Hotel A		Unaccepted samples of Hotel B	
		No.	%	No.	%
Beef steaks	$> 10^2$	10	66.67	7	46.67
Beef kofta	$> 10^2$	9	60.00	5	33.33
Beef fillets	$> 10^2$	6	40.00	3	20.00

*Center for Food Safety (2014)

Table (9): Statistical analytical results of Staphylococci counts (cfu/g) in the examined samples of meat meals in Egyptian hotels (n=15).

Hotels	Hotel A			Hotel B		
Meat Meals	Min.	Max.	Mean ± S.E*	Min.	Max.	Mean ± S.E*
Beef steaks	3.0×10^2	5.0×10^4	$8.26\times10^3\pm1.49\times10^3$	2.0×10^2	1.0×10^4	$3.82\times10^3\pm0.90\times10^3$
Beef kofta	1.0×10^2	2.0×10^4	$3.64\times10^3\pm0.71\times10^3$	1.0×10^2	9.0×10^3	$1.75\times10^3\pm0.31\times10^3$
Beef fillets	1.0×10^2	7.0×10^3	$1.51\times10^3\pm0.23\times10^3$	1.0×10^2	4.0×10^3	$7.33\times10^2\pm1.24\times10^2$

Table (10): Acceptability of examined samples of meat meals in Egyptian hotels based on their Staphylococci count (cfu/g) (n=15).

Meat Meals	Staphylococci count (cfu/g)*	Unaccepted samples of Hotel A		Unaccepted samples of Hotel B	
		No.	%	No.	%
Beef steaks	$> 10^4$	4	26.67	2	13.33
Beef kofta	$> 10^4$	3	20.00	0	0
Beef fillets	$> 10^4$	0	0	0	0

*Center for Food Safety (2014)

Table (11): Incidence and serotyping of Enteropathogenic *E.coli* isolated from the examined samples of meat meals in Egyptian Hotel A (n=15).

E.coli strains	Beef steaks		Beef kofta		Beef fillets		Strain Characteristics
	No.	%	No.	%	No.	%	
$O_{26}:K_{60}(B_6)$	2	13.33	-	-	1	6.67	EHEC
$O_{55}:K_{59}(B_5)$	-	-	1	6.67	-	-	EPEC
$O_{111}:K_{58}(B_9)$	1	6.67	2	13.33	1	6.67	EHEC
$O_{124}:{}_{72}(B_{17})$	1	6.67	1	6.67	-	-	EIEC
$O_{127}:K_{63}(B_8)$	2	13.33	1	6.67	-	-	ETEC
Untypable	1	6.67	-	-	-	-	---------
Total	7	46.67	5	33.33	2	13.33	

% was calculated according to total number of samples

Table (12): Incidence and serotyping of Enteropathogenic *E.coli* isolated from the examined samples of meat meals in Egyptian Hotel B (n=15).

E.coli strains	Beef steaks		Beef kofta		Beef fillets		Strain Characteristics
	No.	%	No.	%	No.	%	
O_{86} : $K_{61}(B_7)$	1	6.67	1	6.67	-	-	EPEC
O_{111} : $K_{58}(B_9)$	2	13.33	-	-	1	6.67	EHEC
O_{119} :$K_{69}(B_{19})$	-	-	2	13.33	-	-	EPEC
O_{125}: $K_{70}(B_{15})$	1	6.67	-	-	-	-	ETEC
Total	4	26.67	3	20.00	1	6.67	

% was calculated according to total number of samples

Table (13): Incidence and serotyping of *Salmonella* organisms isolated from the examined samples of meat meals in Egyptian Hotel A (n=15).

Salmonella serotypes	Beef steaks		Beef kofta		Beef fillets		Antigenic Structure	
	No.	%	No.	%	No.	%	O	H
S. enteritidis	1	6.67	1	6.67	-	-	1,9,12	g, m : 1,7
S. typhimurium	3	20.00	2	13.33	1	6.67	1,4,5,12	i : 1,2
S. chester	1	6.67	-	-	-	-	1,4,5,12	e, h : e, n, x
S. anatum	-	-	1	6.67	-	-	3,10,15,34	e, h : 1,6
Total	5	33.33	4	26.67	1	6.67		

% was calculated according to total number of samples

Table (14): Incidence and serotyping of *Salmonella* organisms isolated from the examined samples of meat meals in Egyptian Hotel B (n=15).

Salmonella serotypes	Beef steaks		Beef kofta		Beef fillets		Antigenic Structure	
	No.	%	No.	%	No.	%	O	H
S. enteritidis	1	6.67	-	-	-	-	1,9,12	g,m : 1,7
S. typhimurium	1	6.67	1	6.67	-	-	1,4,5,12	i : 1,2
S. muenster	1	6.67	-	-	-	-	3,10,15,34	e,h : 1,5
Total	3	20.00	1	6.67	-	-		

% was calculated according to total number of samples

Table (15) Incidence of Gram positive cocci isolated from the examined samples of meat meals in Egyptian Hotel A (n=15).

Gram + vecocci	Beef steaks		Beef kofta		Beef fillets	
	No.	%	No.	%	No.	%
Staphylococcus aureus	6	40.00	4	26.67	3	20.00
Staphylococcus epidermidis	5	33.33	9	60.00	7	47.47
Micrococci	11	73.33	6	40.00	8	53.33

% was calculated according to total number of samples

Table (16): Incidence of Gram positive cocci isolated from the examined samples of meat meals in Egyptian Hotel B (n=15).

Gram + vecocci	Beef steaks		Beef kofta		Beef fillets	
	No.	%	No.	%	No.	%
Staphylococcus aureus	3	20.00	2	13.33	2	13.33
Staphylococcus epidermidis	7	26.67	4	26.67	6	40.00
Micrococci	10	66.67	9	60.00	5	33.33

Table (17): Statistical analytical results of pH values in the examined samples of meat meals in Egyptian hotels (n=15).

Hotels	Hotel A			Hotel B		
Meals	Min.	Max.	Mean ± S.E*	Min.	Max.	Mean ± S.E*
Beef steaks	5.60	5.83	5.72 ± 0.02	5.58	5.79	5.67 ± 0.02
Beef kofta	5.54	5.77	5.66 ± 0.02	5.52	5.74	5.60 ± 0.01
Beef fillets	5.49	5.64	5.57 ± 0.01	5.47	5.59	5.54 ± 0.01

Table (18): Statistical analytical results of Total Volatile Nitrogen (TVN) values "mg %" the examined samples of meat meals in Egyptian hotels (n=15).

Hotels	Hotel A			Hotel B		
Meals	Min.	Max.	Mean ± S.E*	Min.	Max.	Mean ± S.E*
Beef steaks	5.91	16.04	11.96 ± 0.74	3.53	12.57	7.89 ± 0.51
Beef kofta	4.28	13.90	9.17 ± 0.48	3.02	10.22	6.27 ± 0.34
Beef fillets	2.74	9.32	5.49 ± 0.39	1.46	7.15	3.65 ± 0.26

Table (19): Statistical analytical results of Thiobarbituric acid (TBA) values "mg/kg" in the examined samples of meat meals in Egyptian hotels (n=15).

Hotels	Hotel A			Hotel B		
Meals	Min.	Max.	Mean ± S.E*	Min.	Max.	Mean ± S.E*
Beef steaks	0.012	0.30	0.21 ± 0.01	0.08	0.25	0.17 ± 0.01
Beef kofta	0.07	0.23	0.14 ± 0.01	0.04	0.16	0.09 ± 0.01
Beef fillets	0.02	0.11	0.06 ± 0.01	0.01	0.08	0.04 ± 0.01

4. Discussion

Results of total plate count (cfu/g) of the examined samples in reported table (1) were somewhat similar to those of Ibrahim-Hemmat et al. (2014) (1.83×10^4 ± 0.39×10^4in kofta). It is fact that, early preparation of larger quantities of meat products and hold for hours without control can facilitate the growth of microorganisms which contaminated such products from numerous sources during handling, transports, processing, storage and serving (Dawson, 1992). The obtained results of the mean values of total *Enterobacteriaceae* counts (cfu/g) in Table (3) were nearly similar to those reported by Elwi (1994) (15 x 10^3/g and 45 x 10^2/gin the examined samples of cooked meat and cooked kofta respectively)Lotfi *et al.*(1990)(3 x 10^4in samples of cooked meat).While, lower results were recorded by Hassan (1991)(1.7 x 10^2in samples of roasted kofta). However, higher findings were obtained by Hussein (1996) and Al-Mutairi (2011)(1.9 x 10^5 in kofta)(10.14×10^5). The improper handling of raw meats in food service establishment is one of the main reasons for food borne illness caused by consumption of cooked meat (NAS, 1985). The factors associated with outbreaks may be attributed to inadequate temperature control, infected food handlers, contaminated raw ingredients, cross contamination & inadequate heat treatment (Rooney *et al.*, 2004). Addition of certain spices during manufacture of meat products may lead to marked increase in bacterial population (Sharaf, 1999). Bacteria belonging to the family *Enterobacteriaceae* enter the animal feed chain as normal contaminants of raw materials used in the manufacture of animal

feeds (Veldman*et al.* 1995). Incidence of *Enterobacteriaceae*of the examined meat meals of hotels (A) and (B) were shown in Table (5) and (6) respectively, such organisms were previously isolated from fast food by Rafaie and Mostafa (1990), Ahmed (1991), Daif (1996) and Ibrahim-Gahada (2001) who isolated this members of *Enterobacteriaceae* from the examined samples of ready to eat kofta meals as follows:*Citrobacterdiversus* 20% & 4%, *Citrobacterfreundii* 4% & 12%, *Enterobacter cloacae* 12% & 20%, Enterobacterhafniae 8% & 4%, *Klebsiellaozenae* 16% & 16%, *Klebsiellapnemoniae* 0% & 12%, *Proteus mirabilis* 8% & 16% and *Proteus vulgaris* 12% & 4%, respectively. Such variations may be attributed to recontamination of cooked meat by pathogens, such as staphylococci or *Salmonella* coming from the hands of the workers or from the equipment or utensils (Bryan, 1988). Results of total coliform count (cfu/g) illustrated in table (7) were lower than those recorded by Ibrahim-Hemmat*et al.* (2014) ($7.91\times10^2 \pm 1.48\times10^2$ in beef kofta). While, somewhat similar to those recorded by Nassar (1988) (2.5×10^4 in the examined samples of cooked meat). Variations may be attributed to the processing defect and/or post processing contamination from workers, utensils and contact surfaces which indicate inadequate hygiene. Coliform have an epidemiological interest and importance, as some of which were pathogenic and may cause serious intestinal infection and food poisoning. Coliform count was greatly considered to be suitable indicator for fecal contamination (Mousa *et al.*, 2001). Staphylococcus can be carried on hands, nasal passage or throats. Most food borne illness out breaks are result of contamination from food handlers and production of heat stable toxins in food. Sanitary food handling and proper cooking and refrigerating should prevent Staphylococcus food borne illness (FSIS, 2003). The presence of *Staph. aureus* in a food indicates its contamination from food handlers & inadequately cleaned equipment (ICMSF, 1996). The incidence and serotyping of Enteropathogenic *E.coli* isolated from the examined samples collected from hotel (A) and (B) were shown at tables (11) and (12) respectively. Enteropathogenic *E. coli* was previously isolated from different ready – to – eat meat products by Yassien (1992), Soliman and El-Tabiy (2006) who achieved that the incidence of serologically identified *E.coli* isolated from the examined sample of hawawshy was 4 isolates one recorded as O_{86} K_{61} (B_7) EPEC (4%). However, the other two serotypes were O_{128} : K_{67} (B_{12}) ETEC (8%) & one serotype was O_{125} : K_{70} (B_{15}) EPEC (4%),but from the examined samples of kofta were 5 isolates which were serologically identified as one O_{26} : K_{60} (B_6) EHEC (4%) while other two serotype were O_{86} : K_{61} (B_7) EPEC (8%) on the other hand two serotypes were O_{124} : K_{72} (B_{17}) EIEC (8%). According to Al-Mutairi (2011) who examined total of 25 samples of beef kofta, several strains of virulent *E.coli* were isolated from 80% of the examined samples such as (O166, O78, O126, O55, O26, O20, O25: K11, O119, O125: K70, O146, O126) while 20% were un-typable. Results given in Tables (13) and (14) which reveal the incidence and serotyping of salmonella strains isolated from the examined samples of hotel (A) and hotel (B) respectively; *Salmonella*e was previously isolated from ready-to- eat meat products by Al-Kour (2001) Soliman *et al.* (2002) & Richardson and Stevens (2003). Also *Salmonella* failed to be isolated from ready to eat meat products as recorded by El-Hosseiny (1987), Khalafalla (1996) and Kirralla (2007). This variation is attributed tocross contamination from raw meat to cooked meals through improper handling and contaminated utensils. Salmonellosis is a great problem and one of the most important food borne diseases. Mishandling during preparation of food of animal origin was the major reason for the outbreak of salmonellosis (Rachmanin and Koulikouskii, 1990). Results of total

staphylococcal count (cfu/g) illustrated in table (9) were nearly similar to the results obtained by Al-kour (2001)(4.13 x 10^3± 1.25 x 10^3). However, they were higher than those obtained by Kirralla (2007) (2.45 x 10^5). While lower results were recorded by Ibrahim-Hemmat*et al.* (2014) (9.35×10^2 ± 2.08×10^2. Variations may be attributed to bad personal practices, incorrect and inadequate hand washing and post cooking contamination.

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