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Assessment of bacterial critical control points in chicken meat meals served for students in a university hostel

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ABSTRACT

A grand 75 random samples of chicken meals represented by defrosted chicken meat, recently cooked chicken meat and late served chicken meat (25 of each) were collected from the restaurant in university student hostel in governorate Qalyubia. Thirty swabs from handlers, knives and cutting boards of chicken (10 for each) were collected for bacteriological examination. The average values of the total aerobic count of the different critical bacteriological points for examined chicken samples were $1.8x10^{5a}$ $\pm4.2x10^{4}$ in the defrosted chicken and $1x10^{2b}$ $\pm1.8x10$ in recently cooked chicken and 1.8x105a $\pm4.2x10^{4}$ in the late cooked chicken meat. The incidence of Salmonellae, *E. coli and S. aureus* in examined samples from receiving to serving were 8%, 4% and 2% in defrosted chicken, they failed to be isolated from recently cooked chicken and 0%, 4% and 0% in late served chicken. The incidence of Salmonellae, *S. aureus, and E. coli in* cutting boards swab samples were 10%, 0%,1 0%, in knives swab samples were 10%, 0%, 0% and in workers hands swab samples were 0%, 30%, 20%, respectively. The suggestive hygienic measures to improve the quality of meat meals and methods of prevention of contamination of these meals were discussed.

1. INTRODUCTION

There is no doubt that the main task of meat hygienist is the protection of the consumers from the food borne diseases.
Nowadays microbiological food safety considered a dilemma of developing societies. Current food safety issues are deleteriously reshaping the lifestyle of the population in the developing world. Prevalence of food borne illness in developing world is the most neglected area to control disease. *E. coli*, *Salmonella* and *Staphylococcus aureus* infection are extensively prevalent and pose a major threat to human health in underdeveloped communities (Akhtar et al., 2014).
The risk of bacterial food borne diseases increases when meat meals were prepared in kitchens, as in hospitals, students' accommodation, youth hotels and shared homes. This increases the risk due to the high number of individuals using the kitchen, the lack of responsibility and the difference in the hygienic standard for the users of these kitchens (Sharp and Walker, 2003).
The bacterial contamination and hygienic measures during meat production can be measured using the aerobic plate count and three Gram negative indicator groups viz: Total Enterobacteriaceae, total Coliforms and Escherichia coli biotype 1, which is the most important indicator for faecal contamination (Paulsen et al., 2006).
E. coli is commonly non-virulent, but some strains have adopted pathogenic or toxigenic virulence factors that make them virulent to human and animals. It has become recognized as a serious food borne pathogen and has been associated with numerous outbreaks of disease resulting from contaminated meat products (Gi et al., 2009).
Salmonella is the second most common of foodborne illness. It is responsible for millions of cases of food borne illness a year (HGIC, 2000).
Staphylococcus aureus is considered the third most important cause of disease in the world amongst the reported food-borne illnesses, (Tamarapu et al., 2001).
Food poisoning bacteria grow most rapidly in the danger zone (between 5°C and 60°C), so food handlers are advised to never leave food out of refrigeration for longer than two hours. If the temperature above 32°C, food should not be left out more than one hour (FSIS, 2008).
Due to the increasing incidence of food borne infections, there is an urgent need for control and/or prophylaxis for food poisoning outbreaks associated with meat meals through assessment of bacterial critical control points in preparation and serving of meat meals. Therefore, this study was conducted to evaluate the extent of bacterial contamination of meat meals in a university student hostel.

2. MATERIAL AND METHODS

Seventy-five random samples of chicken meals represented by defrosted chicken, recently cooked chicken meat, late cooked chicken meat (25 of each) was collected from the restaurant in university student hostel. 30 swabs from handlers, knives and cutting boards of chicken (10 for

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each) were collected. The samples were kept in a separated sterile plastic bag inside an ice box and transferred to the laboratory under complete aseptic conditions without undue delay for the following examination

1- Determination of aerobic plate count (APC) *(ICMSF, 1996).*
2- Determination of total *Enterobacteriaceae* (ISO, 2004).
3- Determination of Coliform count by ICMSF *(*1996*).*
4- Isolation and identification of *Salmonella* (ISO, 2002).
5- Isolation and identification of *S. aureus* ICMSF, 1996).
6- Isolation and identification of *E. coli* **(**ISO, 2007).

3. RESULTS

Table 1 Statistical analytical results of APC (cfu/g) at different critical bacteriological points for chicken meat samples (n=25)

Points	Min.	Max.	mean± SE
Defrosted chicken	$1.3x10^4$	$6.5x10^5$	$1.8x10^{5a} \pm 4.2x10^4$
Recently cooked chicken meat	1x10	$2.1x10^2$	$1x10^{2b} \pm 1.8x10$
Late served chicken meat	$2.2x10^3$	$1.4x10^5$	$1.6x10^{4c} \pm 7.4x10^3$

According to Egyptian Organization for Standardization and Quality "EOSQ"(2005) aerobic count APC (cfu/g) should be <105 in defrosted chicken.

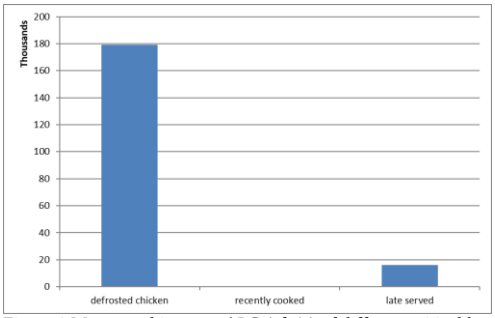

Figure 1 Mean aerobic count APC (cfu/g) of different critical bacteriological points for chicken meat samples (n=25).

As shown in table (1) results showed that the average APC of the different critical bacteriological points for examined chicken $1.8x10^{5a} \pm 4.2x10^4$ in the defrosted chicken and $1x10^{2b} \pm 1.8x10$ in recently cooked chicken and $1.6x10^{4a} \pm 7.4x10^3$in the late served chicken meat. The differences associated with APC from receiving to serving were of high significant (P<0.01).

Table 2 Statistical analytical results of total Enterobacteriacae count (cfu/g) of different critical bacteriological points for chicken meat samples (n=25)

Points	Min.	Max.	mean± SE
Defrosted chicken	$1.5x10^3$	$8.5x10^3$	$4.1x10^{3a} \pm 7.1x10^2$
Recently cooked chicken meat	1x10	3.2x10	$2x10^b \pm 0.4x10$
Late served chicken meat	1.8x10	$2x10^2$	$8.8x10^c \pm 2.5x10$

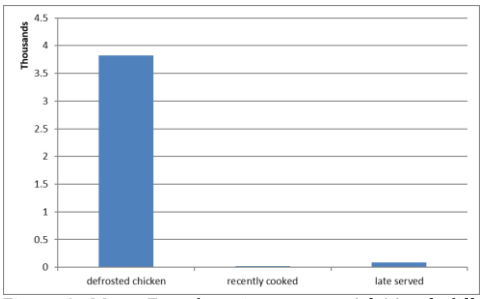

Figure 2 Mean Enterobacteriacae count (cfu/g) of different critical bacteriological points for chicken meat samples (n=25).

Also, the mean value of Enterobacteriaceae count (cfu/g) as shown in Table (2) and Figure (2) was $4.1x10^{3a} \pm 7.1x10^2$ in defrosted chicken, $2x10^b \pm 0.4x101$in recently cooked chicken meat and $8.8x10^c \pm 2.5x10$ I in late served chicken meat. The differences associated with Enterobacteriaceae count from receiving to serving were of high significant (P<0.01).

Table 3 Statistical analytical results of total coliform count (cfu/g) of different critical bacteriological points for chicken meat samples (n=25)

Points	Min.	Max.	mean± SE
Defrosted chicken	$1x10^2$	$4.2x10^3$	$1.8x10^{3a} \pm 5.2x10^2$
Recently cooked chicken meat	0.3x10	1x10	$0.5x10^b \pm 0.1x10$
Late served chicken meat	2.4x10	$1.5x10^2$	$7x10^c \pm 1.8x10$

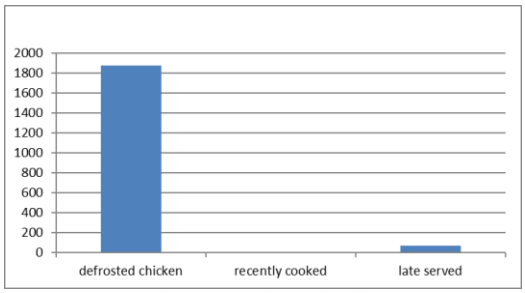

Figure 3 Mean coliform count (cfu/g) of different critical bacteriological points for chicken meat samples (n=25).

The mean value Coliforms count (cfu/g) as viewed in table (3) and figure (3) was $1.8x10^{3a} \pm 5.2x10^2$ in defrosted chicken ,$0.5x10^b \pm 0.1x10$ in recently cooked chicken and $7x10^c \pm 1.8x10$ in late served chicken meat. The differences associated with the Coliforms count from receiving to serving were of high significant (P<0.01).

Table 4 Mean values of bacterial counts (cfu/g) in the examined swabs taken from chicken meals contact surface and food handlers (n=10)

Item	Cutting boards	Knives	Handlers
APC	$2.7x10^{5a} \pm 1x10^4$	$1.3x10^{5a} \pm 2.7x10^3$	$7.1x10^{5a} \pm 3.5x10^3$
Enterobacteriacae count	$3x10^{4a} \pm 7.2x10^3$	$2.6x10^4$ a $\pm 2.1x102$	$3.4x10^{4a} \pm 6.3x10^3$
Coliform count	$2x10^4$ a $\pm 5.2x10^2$	$1.3x10^4$ a $\pm 2.7x10^3$	$1x10^{4a} \pm 2.2x10^2$

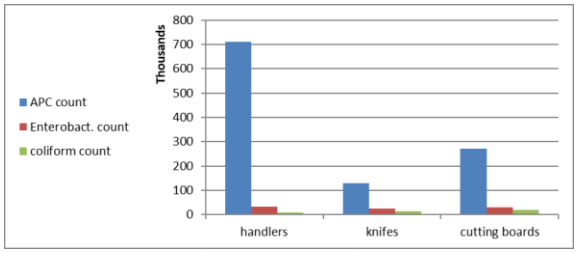

Figure 4 Mean values of bacterial counts (cfu/g) in the examined swabs taken from chicken meals contact surface and food handlers (n=10).

Results in Table (4) the mean values of APC (cfu/g) in swab samples of cutting boards, knives and handlers were$2.7x10^{5a} \pm 1x10^4$,$1.3x10^{5a} \pm 2.7x10^3$and$7.1x10^{5a} \pm 3.5x10^3$. The differences associated with APC from receiving to serving were of no significant (P>0.01) Also, the mean values of Enterobacteriaceae count (cfu/g) in contact-surface swab samples were$3x10^{4a} \pm 7.2x10^3$, $2.6x10^4$ a $\pm 2.1x10^2$ and $3.4x10^{4a} \pm 6.3x10^3$ in cutting boards, knives and handlers swab samples, respectively. The differences associated with of Enterobacteriaceae count from receiving to serving were of no significant (P>0.01)

Moreover, the mean values of Coliforms count (cfu/g) were$2x10^4$ [a] $\pm 5.2x10^2$, $1.3x10^4$ [a] $\pm 2.7x10^3$. and $1x10^{4a}\pm 2.2x10^2$ in cutting boards, knives and handlers swab samples, respectively. The differences associated with of coliforms count from receiving to serving were of no significant (P>0.01).

Table 5 Incidence of food poisoning microorganisms isolated from chicken meat samples (n=25)

Points	Salmonellae		*E. coli*		*Staph. aureus*	
	No.	%	No.	%	No.	%
Defrosted chicken	2	8	1	4	2	8
Recently cooked chicken meat	0	0	0	0	0	0
Late served chicken meat	0	0	1	4	0	0

Results in Table (5) The incidence of Salmonellae, , *E.coli and S. aureus* in examined samples from receiving to serving were 8%, 4% and 2% in defrosted chicken, 0%, 0% and 0% in recently chicken and 0%, 4% and 0% in late served chicken meat.

Table 6 Incidence of food poisoning microorganisms isolated from contact surface and food handlers (n=10)

Micro-organism	Cutting boards		Knives		Worker hands	
	No.	%	No.	%	N0.	%
Salmonellae	1	10	1	10	0	0
E.coli	0	0	0	0	3	30
Staph. Aureus	1	10	0	0	2	20

As shown in Table (6) declared that the incidence of Salmonellae, *S. aureus, and E. coli in* cutting boards swab samples were 10%, 0%,1 0%, in knives swab samples were 10%, 0%, 0% and in workers hands swab samples were 0%, 30%, 20% respectively.

Table 7 Acceptability of examined samples of chicken meat meals based on incidence of Salmonella(n=25)

Sample	APC/g	Accepted samples		Unaccepted samples	
		NO	%	NO	%
Defrosted Chicken	Nil	23	92	2	8
Recently cooked Chicken meat	Nil	25	100	0	0
Late served Chicken meat	Nil	25	100	0	0

According to Egyptian Organization for Standardization and Quality "EOSQ"(2005)

Table 8 Acceptability of examined samples of chicken meat meals based on incidence of E. coli (n=25)

Sample	APC/g	Accepted samples		Unaccepted samples	
		NO	%	NO	%
Defrosted Chicken	Nil	24	96	1	4
Recently cooked Chicken meat	Nil	25	100	0	0
Late served Chicken meat	Nil	24	96	0	0

Table 9 Acceptability of examined samples of chicken meat meals based on incidence of Staph. Aureus (n=25)

Sample	APC/g	Accepted samples		Unaccepted samples	
		NO	%	NO	%
Defrosted Chicken	Nil	23	92	2	8
Recently cooked Chicken meat	Nil	25	100	0	0
Late served Chicken meat	Nil	25	100	0	0

4. DISCUSSION

Preparation of meat meals in university student hostels should be subjected to strict hygienic measures to ensure food safety so application of periodical examination of these meals before and after cooking help in the evaluation of these meals from the microbiological side.

The obtained results in Table (1) showed that total aerobic plate count of the different critical bacteriological points for examined chicken meat samples (1) were nearly similar to those reported by ELTaher (2009) which were from $1.6xl0^5$ to $3.6x10^s$ (cfu/g) and Abdelhakim (2018) which ranged from $1.8xl0^5$to $3.4xlO^5$ with a mean value of $2.6x10^5\pm 8xl0^4$ in defrosted chicken, and lower than those reported by Abbas (2011) who found that APC in defrosted chicken ranged from $8.5x\ 10^5$ to $9.1\ x\ 10^7$ (cfu/g) and higher than those reported by Hashem (2015) which ranged from $2.3x\ 10^3$ to $2.6x\ 10^4$ (cfu/g) while in cooked chicken meat samples the results are lower than those recorded by El - taher Amna (2009) and El meligy-Asmaa (2015).

The highest APC was in defrosted chicken which reflects that the thawing process may occur under the temperature of danger zone which suitable for microbial growth.

Holding of cooked foods at ambient temperature for several hours is the primary contributing factor for the growth and multiplication of such organism. Contamination occurred through different stages of handling and preparation until serving and consumption. The risk of excess contamination increased when these meals prepared in kitchens with high number of individuals and workers dealing with them and this appear in our study in late served chicken meals.

The results in Table (2) of Enterobacteriaceae count were nearly similar to those reported by Nur Yukesk et al (2009) who reported results ranged from $Ix10^2$ to 3.7x10 (cfu/g) and lower than those reported by Abdel Hakim (2018).

The highest Enterobacteriaceae count was in defrosted chicken which declares improper sanitary conditions during defrosting process (thawing process) may occur under the temperature of danger zone which suitable for microbial growth.

The increasing in Enterobacteriaceae count in late served chicken meals than recently cooked meals is due to keeping this food in improper temperature leading to growth and proliferation of pathogenic organism including Enterobacteriaceae group members.

The results in Table (3) about coliforms count were similar to those reported by Nur Yukesk et al. (2009) who reported results ranged from $2.1>x10^4$ to $3.2xl0^5$ (cfu/g) and Arab (2010) who obtained results ranged from $2.6x\ 10^3$ to $6.6x\ 10^4$ (cfu/g)) but lower than those reported by Abdel Hakim (2018) who reported results ranged from $2.1\ x\ 10^4$ to $2.4x\ 10^5$ with a mean value of $1.3xl0^5\pm\ lxl0^5$ in defrosted chicken,

The highest Coliforms count was in defrosted chicken which indicate fecal matter contamination which may be due to bad personal hygiene during defrosting process.

The results of APC (cfu/g) in swab samples of cutting boards, knives and workers hands in Table(4) were nearly similar to those reported by Isis (2002) which reported mean values of $2.8xl0^5\pm 2.3xl0^4$, $2.2xl0^6\pm 1.7xl0^6$ and $3.6xl0^4\pm 2.6xl0^4$ in cutting boards, knives and workers hands, respectively, Vural (2006) recorded $2.7xl0^5\pm 2.3xl0^4$, $2xl0^6\pm 1.6xl0^6$ and $3.4xl0^4\pm 2.8xl0^4$ in cutting boards, knives and workers hands, respectively , Ghanem (2009) recorded

3.Ixl0^5±2.1xl0^4, 2xl0^6±1.9xl0^6 and 3.5xl0^4±2.9xl0^4 in cutting boards, knives and workers hands, respectively while Abdel Hakim (2018) recorded results lower than Khallaf (2014) who reported mean values (cfu/g) of 2.9xl0^5±2.2xl0^4, 2.1xl0^6±1.8xl0^{6}and3.6xl0^4±2.8xl0^{4}in cutting boards, knives and workers hands, respectively.

The results were lower than reported by Khallaf (2014) who reported mean values of 2.5xl0^5±1.8x 10^s, 8.8xl0^5±2.8xl0^4 and 9.4xl0^5±1.4xl0^5 in cutting boards, knives and workers hands swabs, respectively and AbdelHakim (2018) who reported that the mean values of 1.5xl0^5±l.lxl0^5, 8.8xl0^4±1.4xl0^{4}and 9.4x 10^4±1.4x 10^4 in cutting boards, knives and workers hands swab samples, respectively ,but nearly similar to those reported by Ghanem (2009) who recorded 1.5x10^5±1.3x10^s, 8.5xl0^4±1.3xl0^4 and 9.5x 10^4±1.6x I0^4.

The level of *Enterobacteriaceae* count in food can be routinely used as an indicator for improper hygiene and handling during processing which can lead to proliferation of pathogens (Zweifel et al, 2005).

The high *Enterobacteriaceae* count was in cutting boards and this indicates improper handling and lack of sanitary conditions for food equipment.

The results were nearly similar to those reported by Khallaf (2014) which were Ixl0^4±1.3xl0^7.2xl0^4±2.4xl0^4 and 6.2xl0^3±2.2 x10^3 in cutting boards, knives and workers hands swab samples, respectively and lower than those reported by Isis (2002) who reported mean values of 1.2xl0^5±1.3xl0^4, 9.4xl0^4±1.3xl0^4 and 8.2xl0^3±2.2xl0^3 in cutting boards, knives and workers hands swab samples, respectively, Vural (2006) obtained results of I.lx104±1.4xl0^4, 5.9xl0^4±1.6xl0^4 and 8 x10^3±l.lxl0^3 in cutting boards, knives and workers hands swab samples, respectively , Ghanem (2009) who found mean values of 1.3xl0^5± l.l x 10^4, 9.4xl0^4±1.2xl0^4 and 8.2xl0^3±1.3xl0^3 in cutting boards, knives and workers hands swab samples, respectively and Abed Elhakim (2018) who found mean values of Ixl0^5±1.3xl0^4, 9.6xl0^4±1.4xl0^4 and 8.1xl0^3±1.2xl0^3 in cutting boards, knives and workers hands swab samples, respectively.

The highest mean value of Coliforms count (cfu/g) was in cutting boards swab samples.

The results in Table (5) were lower than those reported by Arab (2010) who obtained 10% *S. aureus* in raw chicken and Abbas (2011) who obtained 24% *S. aureus* in raw chicken and 16% in grilled chicken and Adel Hakim (2018) who found that the incidence of *Salmonellae*, *S. aureus*, *E.coli* of examined samples from receiving to serving were 40%, 40%, 40% and 0% in raw chicken, 60%, 20%, 20% in defrosted chicken, 40%, 20%,40% in marinated chicken, 0%, 40%, 20% and in frozen chicken, 20%, 80%, 0% and in defrosted chicken and 0%, 40%, 0% and 40% in end product with total incidence of 26.6%, 40%, 20% .

These results in Table (4) are lower than those reported by Abdel Hakim (2018) that the incidence of *Salmonellae*, *S. aureus*, *E. coli* in cutting boards swab samples were 33.3%, 0%, 0% in knives swab samples were 33.3%, 66.6%, 0% and in workers hands swab samples were 0%, 33.3%, 66.6% respectively.

Foodborne illnesses caused by *Salmonella* species and represented a major public health problem worldwide. These pathogens are transmitted mainly through consumption of contaminated food and the presence of these organisms in meat has relevant public health implications (Sousa, 2008).

In order to minimize or prevent contamination of chicken meat and chicken products by *Salmonella* and improve the sanitary status of chicken cut and chicken products, some recommendations should be carried out such as application of good Hygienic Practices, GHPs Good Manufacturing Practices, GMPs, and Hazard Analysis and Critical Control Point HACCP system in the poultry processing operation (Saad et al., 2015).

Members of Gram-negative bacteria e.g., *E. coli* are widely distributed in the environment contaminated food and water (the major sources by which the bacteria are spread). *E. coli* is commonly used as surrogate indicator, its presence in food generally indicates direct and indirect fecal contamination (Clarence et al., 2009).

Staphylococcus aureus is the most incident bacteria especially in defrosted chicken which indicate lack of sanitary condition arid improper handling during thawing.

Staphylococcus aureus grows without change in the odor and taste with production of heat stable enterotoxins which lead to food poisoning. *Staphylococcus aureus* cells can be destroyed by subsequent cooking of chicken products however the elaborated enterotoxins by the pathogens are heat stable. They can resist cooking process and subsequently lead to food intoxication if ingested (Wabeck, 2002).

Contamination with *S. aureus* is important risk index in evaluation of safety and hygienic quality of chicken meat (Jyhshiun et al., 2009). The presence of *S. aureus* in heat treated food may be due to its contamination from food handlers and inadequate cleaned equipment or post processing contamination (Duffy et al., 2000).

S. aureus produce thermo stable toxins. The toxic levels of SEs are produced in the food when Staph aureus concentration exceeds 10 ^{5} cfu/ml. Less than 1.0ug of toxin in food will induce symptoms of staphylococcal intoxication (Pexara et al., 2010).

Hinton et al. (2007) stated that the mechanical pickers have been implicated as a major source of broiler carcasses contamination as the fecal matters being forced out of the cloaca can adhere to the rubber and carcasses surface and this is in agreement with what recorded by Nde et al. (2008) who mentioned that the scalding water act as a source of cross contamination during defeathering.

Pathogenic microorganisms can spread from the raw chicken to hands and surfaces of kitchens during the domestic preparation of the meals (Gorman et al., 2002, and Haysom and Sharp, 2004).

5. CONCLUSION

Cooking especially boiling play a great role in killing of most of these microorganisms but not all. presence of heat resistance toxins from some of these bacteria represent a great public health hazard especially in places with great groups of people receiving this food. Also, post cooking recontamination when holding of such meals for a period until serving in unhygienic condition especially at room temperature or insufficient reheating represent of major public health hazard.

From the previous data in our study, we can say that there are some bacterial critical points in preparation of chicken meals in a university student hostel such as defrosting operation, late serving and chicken meat contact surface (knives, cutting boards and handler's).

Generally, Application and implementation of Hazard Analysis and Critical control point (HACCP) system may

be the appropriate solution to ensure quality and safety of chicken meat products especially during preparation, processing, storage and serving.

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