IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS)
e-ISSN: 2319-2380, p-ISSN: 2319-2372. Volume 14, Issue 8 Ser. I (August 2021), PP 33-38
www.iosrjournals.org

Assessment of the bacteriological quality of meat meals servedat University hostel in Egypt

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Abstract
Background: *Consumption of healthy food is very helpful in the building of healthy bodies, so it is very important to make sever supervision and control for all meat and chicken meals which served for students in university students' hostel.*
Material and methods: *A grand total 75 random samples of different processing stages meat meals represented by raw received meat, recently cooked meat (boiled) (after 1-2h), and late cooked meat (boiled) (over 4h) (25 of each) were collected from restaurant in an university student hostel in Egypt; as well as 30 swabs from cutting boards, knives and food handlers from the same hostel (10 for each) were collected to investigate their bacteriological and hygienic quality.*
Result:*As a hygienic indicators, total aerobic bacterial count (APC), Enterobacteriaceae (EC) and coliform counts (CC) were investigated, and revealed that the raw meat samples showed the highest bacterial counts, followed by late served meat samples and recently cooked meat samples, respectively; also, the bacterial counts of the swab samples revealed that the food handlers were the main source of contamination where they revealed the highest counts followed by cutting boards and knife samples, respectively. Referring to the detection of some pathogenic bacteria, Salmonella species could be detected in 4 and 10 % of the raw meat samples and cutting bords, respectively; while E. coli was detected in 12 and 30% of raw meats and knives swab samples, respectively. on the other hand, S. aureus was detected in 4 and 4% of the raw, late cooked meat samples, respectively; moreover, it was detected in 20% of cutting boards, knives and handler's swabs of each, respectively.*
Conclusion: *Referring to the obtained results, improper cooking and storage measures appeared to significantly affect the bacterial count of the cooked meat meals and their quality also; surrounding closely contact food surfaces like cutting boards and food handlers represent the most critical point between in cross contamination of raw and cooked meat. So, application of strict hygienic measures during receiving, cooking, storage and handling of each food item is significant for wholesome of meat meals and keeping consumer's health.*
Keywords*: Bacteriological quality, Student's Hostel, Meat meal, Egypt.*

Date of Submission: 03-08-2021 Date of Acceptance: 17-08-2021

I. Introduction

Meat is considered the most important part of our diet which acts as a good source of first high-quality proteins as it contains the essential amino acids for human life. On the other hand, it is considered as an ideal culture medium for growth of many organisms because of its high moisture content, high percentage of nitrogenous compounds, plentiful supply of minerals, some fermentable carbohydrates (glycogen) and favorable pH for most microorganisms[1].

The preparation and handling of foods may constitute the most direct and harmful source of bacterial contamination. The risk of contamination increased by storage of food at ambient temperature, using insufficiently high temperature for reheating food, as well as adding contaminated ingredients at stages with no further heat treatment[2].

The most important bacterial pathogens in beef that is responsible for foodborne infections include *E.coli, Salmonellae* and coagulase positive *S. aureus*[3].

Escherichia coli is commonly a commensal non-pathogenicmicroorganism, but some strains have adopted pathogenic and/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[4].In addition, *Salmonella* species remains a leading cause of food poisoning in the developed world, resulting in multiple cases of gastroenteritis, illness, hospitalization and death each year[5]. Moreover, *S. aureus* is one of the most causative agents of food-borne disease outbreaks causing gastroenteritis mostly due to excessive handling or post-cooking contamination of meat meals[6].

Most people carry harmful bacteria on their bodies and can unwittingly transport them to food. Touching your mouth, nose, hair or even your clothing can spread bacteria and cause contamination. Even healthy people are not immune and must practice good personal hygiene to minimize this risk.Poor personal hygiene can cause serious problems in the kitchen, food poisoning being the most serious, and cause irreparable damage to a food business's reputation.

As a food handler it is important for you to practice good personal hygiene to ensure a safe working environment and prevent the spread of foodborne illnesses[7].

So, this work was planned out to assess the bacteriological quality of different points of meat processing system and swabs of food handlers and the used equipment and tools in a University student hostel in Egypt.

II. Material and methods

2.1. Collection of samples

2.1.1. Collection of meat samples

A total of seventy-five random samples represented by raw received meat, recently cooked meat(after 1-2 hours), late cooked meat(boiled) (over 4 hours) (25 of each) were collected fromrestaurant in a University student hostel.The weight of each sample was approximately 100g.

2.1.2. Collection of swab samples

Thirty swabs from different cutting boards, knives andfood handlers of meat (10 for each) were collected.Swabs were taken from the inner side of 10cm^2 sterilized template.

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 bacteriological examinations

2.2. Preparation of samples

2.2.1. Preparation of meat samplesaccording to **ISO[8].**

To 25 gof each sample, 225 ml of sterile peptone water (0.1%) were added and thoroughly mixed using sterile blender for 1.5 minutes, from which ten-fold serial dilutions were prepared.

2.2.2. Preparation of swabsaccording to**ISO[8]**.

Cotton swabswere aseptically retained into the rinsing fluid screw capped tubes containing 10 ml buffered peptone water (0.1%) from which ten-fold serial dilution were prepared.

2.3. Bacteriological examinations

2.3.1. Aerobic plate count (APC) was performed following **ISO[9]:**1 ml from the previously prepared serial dilution was cultured in APC agar by pour-plate technique, and incubated at 30^o C for 72 hours. Colonies were counted recorded.

2.3.2. Enterobacteriaceae count (EC) was performed following **ISO[10]:** 1 ml from the previously prepared serial dilution was cultured in Violet Red Bile Glucose (VRBG) agar by pour-plate technique, and incubated at 37^o C for 24 hours. Suspected colonies were counted and recorded.

2.3.3. Coliform count (CC)was performed following **ISO[11]:** 1 ml from the previously prepared serial dilution was cultured in Violet Red Bile (VRB) agar by pour-plate technique, and incubated at 37^o C for 24 hours. Suspected colonies were counted recorded.

2.3.4. Detection of *Escherichia coli* was performed according to **ISO[12]**: 1 ml from the previously prepared serial dilution was cultured in TBX agar by pour-plate technique, and incubated at 44^o C for 24 hours. Positive samples with suspected colonies were recorded.

2.3.5. Detection of Salmonella species was performed according to **ISO[13]:** Prepared sample was incubated in buffered peptone water broth at 37°C ± 1°C for 18 ± 2 hours, then transferred to Rappaport Vassilidis broth (RV broth) and incubated at 43°C\ 24hr. one ml of enriched sample was plated on selective XLD agar and Brilliant Green agar, and incubated at 37°C\24hrs, plates were examined for suspected Salmonella colonies, positive samples with suspected colonies were recorded.

2.3.6. Detection of *Staphylococcus aureus* was performed according to was performed following**ISO[14]:** 0.1 ml from the previously prepared serial dilution was spreaded over Baird-Parker agar plates, and incubated at 35±2^{o}C for 24-48 hours. Positive samples with suspected colonies were recorded.

2.4. Statistical Analysis:the obtained results were statistically evaluated by application of Analysis of Variance (ANOVA) test according to **Feldman[15].**

III. Results

Results of the aerobic plate count (APC), Enterobacteriaceae count (EC) and Coliform count (CC) in **Table (1)** revealed that the raw examined meat samples had the highest bacterial counts with significant difference with the other examined meat samples ($P \leq 0.05$), followed by late served meat samples and recently cooked samples, respectively. Referring to swab samples, food handler swab samples had the highest bacterial counts which indicated that improper personal hygiene was the main source of meat meals contamination without significance difference in relation to other swab samples when ($P \leq 0.05$).

Table no.1.Mean values of APC, EC and CC (CFU/g) of meat and swab samples

Points	APC	EC	CC
Meat samples (n=25)			
Raw received meat	$3.2x10^5 \pm 0.7x10^{5a}$	$2.3x10^4 \pm 0.6x10^{4a}$	$1.8x10^3 \pm 0.1x10^{3a}$
Recently cooked meat meal	$1.8x10^2 \pm 0.09x10^{2c}$	$1.1x10^2 \pm 0.2x10^{2c}$	$9.0x10 \pm 0.6x10^{c}$
Late served meat meal	$1.7x10^4 \pm 0.3x10^{4b}$	$1.3x10^3 \pm 0.15x10^{2b}$	$3.4x10^2 \pm 0.4x10^{2b}$
Swab samples (n=10)			
Cutting boards	$3.4x10^5 \pm 0.02x10^{5a}$	$3.2x10^4 \pm 0.07x10^{4a}$	$2.0x10^4 \pm 0.1x10^{4a}$
Knives	$2.4x10^5 \pm 0.1x10^{5a}$	$2.7x10^4 \pm 0.02x10^{4a}$	$2.1x10^4 \pm 0.2x10^{4a}$
Handlers	$6.5x10^5 \pm 0.02x10^{5a}$	$3.9x10^4 \pm 0.04x10^{4a}$	$2.4x10^4 \pm 0.08x10^{4a}$

[abc] Different litters indicate significant variation when $P \leq 0.05$.
statistical analysis of variance was calculated between meat samples and swab samples separately.

Concerning with the prevalence of some food poisoning bacteria in the examined swab samples, the recorded results in **Table (2)** indicated that the raw meat samples were the most contaminated with Salmonella sp., *E. coli* and *S. aureus* with prevalence of 4, 12 and 4%, respectively; in addition, 4% of the examined late served meat samples was contaminated with S. aureus indicated improper storage and/or handling practices, while recently cooked meat samples was free from pathogenic bacteria. Referring to the obtained results of swab samples, Salmonella sp. and *E. coli* were detected in 10 and 30% of the examined cutting board and knife swab samples, respectively; while *S. aureus* was detected in 20% of the examined cutting board, knives and handler's swab samples of each.

Table no. 2.Incidence of food poisoning bacteria isolated from the examined meat and swab samples

Points	*Salmonellae*		*E.coli*		*S. aureus*	
	No.	%	No.	%	No.	%
Meat samples (n=25)						
Raw received meat	1	4	3	12	1	4
Recently cooked meat meal	0	0	0	0	0	0
Late served meat meal	0	0	0	0	1	4
Swab samples (n=10)						
Cutting boards	1	10	0	0	2	20
Knifes	0	0	3	30	2	20
Handlers	0	0	0	0	2	20

IV. Discussion

Food security is a complex issue, where animal proteins such as meats, is generally regarded as high-risk commodity in respect of pathogen contents, natural toxins and other possible contaminants[16].

The risk of contamination increases by storage of cooked meat at ambient temperature as well as insufficient high temperature for reheating of cooked meat**;**so,it is essential to control time and temperature to ensure food quality and safety in hospitals as these pathogens can multiply if food is not maintained at an appropriate temperature and if there are delays between food preparation and distribution[17].

A. Meat samples

The obtained results of APC, EC and CC counts were recorded in **Table(1).**The obtained results of APCof the different points of examined meat sampleswere in line with those reported by**Hassan**[18](5.07x10^5 CFU/g in cooked meat samples), while higher than those reported by**AbdEl-Hakim**[19](5.4x10^4 CFU/gfor raw meat samples), and **Jaja**[20] (1.5x10^4 CFU/g for raw meat); but lower than those recorded by**Ragab**[21] (1.6x10^6 and 4.9x10^9 CFU/g for cooked and raw meat samples, respectively).

The highest APC was in raw meat which reflects the unhygienic and improper handling of meat during slaughter, dressing and evisceration.

Concerning withEC, they were nearly similar to those reported by **Ghanem**[22] (ranged from 4.5x10^3 to 6.1x10^3 CFU/g in cooked meat samples), and **AbdEl-Hakim**[19](2.1xl0^3 CFU/g in raw meat samples), while were lower than those recorded by **Hassan**[18](7.48x10^4 CFU/g in cooked meat samples).

The highest Enterobacteriaceae count was in the raw received meat which may reveal lack of sanitary conditions and improper handling during preparation, handling and storage.

Concerning withCC, they were higher than those reported by **Kim and Yim**[23](0.2x10CFU/g in raw meat samples), and **Ragab**[21](2.3x10^2 and 6.4x10^2 CFU/g for processed and raw meat samples, respectively); while lower than those recorded by **Hassan**[18](5.67x10^3 CFU/g in cooked meat samples), and **Jaja**[20] (1x10^5 CFU/g in raw meat samples); but **Zafar**[24]recorded negative coliforms in their examined raw meat samples.

The highest coliforms count was in raw meat indicates improper handling and unhygienic conditions during transportation, as well aspoor hygienic quality of meat. The contamination with coliforms may occur during slaughtering,cutting or dressing of carcasses, contaminated hands, cutting boards or knives in addition to contaminated water are considered as an important source of coliforms in meat processing[25].

Holding of cooked foods at ambient temperature for several hours is the primary contributing factor for the growth and multiplication of such organisms. Contamination occurred through different stages of handling and preparation until serving and consumption[26]. 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 meat meals.

The results recorded in **Table (2)** about the incidence of Salmonellasp., *E.coli* and *S.aureus* in the examined meat samples from receiving to serving were lower than reported by **El-melegy**[27](*S. aureus* was found in 20 and 13% of raw meat and cooked meat samples, respectively; while Salmonella sp.was detected in 6.67% of the raw meat samples); while higher than those reported by **Abd El-Hakim**[19](*Salmonellae, S.aureus and E.coli* of the examined meat samples were 60%, 40% and 40% in raw meat).

The highest incidence in raw meat which may due till improper handling during slaughtering, evisceration and receiving.

Salmonellosis is a great problem and one of the important foodborne diseases, as mishandling in preparation of food of animal origin was the major cause of human gastroenteritis[5].

Members of Gram-negative bacteria as *E.coli* is widely distributed in the environment contaminated food and water.*Escherichia coli* is commonly used as surrogate indicator, its presence in food generally indicate direct and indirect fecal contamination[28].

The presence of *S. aureus* may be from hands of food handlers or from raw meat itself. Food handlers contaminate food via skin, nose and mouth; therefore, proper hygiene is essential. Cross contamination should be avoided and food must be maintained at proper temperature (either refrigerated or heated) to prevent multiplication of the organism and production of heat-stable enterotoxins[29].

Staphylococcus aureus was recovered from received meat and late served meat meals and this one's may be due to that the cocci usually more heat resistant than rods and could be used as target microorganism in designing mild thermal treatments for foods**,**or may be attributed to the lack of hand hygiene since such infection occurs when cooked foods are handled by persons who carry the pathogen in their nails or their skin[30].

B. Swab samples

The results of APC (CFU/g) in swab samples of cutting boards, knives and workers hands in **Table(1)**were lower than reported by**Saikia and Joshi**[31](1.2x10^6, 2.3xl0^6 and 7xl0^5 CFU/g in cutting boards, knives and workers hands, respectively).

The highest mean value of APC was in worker's hands swab samples. The high APC indicates lack of sanitary condition and personal hygiene for food handlers.

Moreover, the mean values of CC (CFU/g) were higher than those reported by**Nawar**[32](5xl0^3,2xl$0^3$and 3.2xl0^3 CFU/g in cutting boards, knives and workers hands swab samples, respectively), while were in line with those recorded by**Abd El-Hakim**[19](9.5xl0^4,2xl0^5 and 1.7xl0^4 in cutting boards, knives and workers hands swab samples, respectively).

The highest counts of APC, EC and CC were in swab samples offood handlers and cutting boards that indicated lack of sanitary condition for food equipment and bad personal hygiene through handling of food and food equipment which must be scoped and corrected to decrease the contamination in the product.

Referring to the detected food poisoning bacteria in swab samples in **Table (2),** Salmonella could be detected in 10% of the examined cutting board swab samples; *E. coli* was detected in 30% of the examined knife swab samples, while *S. aureus* was detected in 20% of the examined swab samples. The obtained results were in agree with those reported by **Abd El-Hakim**[19]who detected Salmonellae in 33.3% of the examined cutting board swabs; *S. aureus* in 33.3% of the examined knife swabs; while, Salmonella, *S. aureus* and *E. coli* were detected in 33.3%, 33.3% and 66.6% of food handler's swabs, respectively.

The above-mentioned results revealed that bacterial contamination of the examined raw meat samplesoccurred during slaughtering, transportation and preparation of them,from the workers hands and/or

equipment and tools as knivesand cutting boards.While in the cooked samples it may be due to post cooking contamination or may be due to holding of them until to be served to students in an ambient temperature.

V. Conclusion

Referring to the obtained results, improper cooking and storage measures appeared to significantly affect the bacterial count of the cooked meat meals and their quality also; surrounding closely contact food surfaces like cutting boards and food handlers represent the most critical point between in cross contamination of raw and cooked meat. So, application of strict hygienic measures during receiving, cooking, storage and handling of each food item is significant for wholesome of meat meals and keeping consumer's health.

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Amira. K. Abd-Alla, et. al. "Assessment of the bacteriologicalquality of meat meals servedat University hostel in Egypt." *IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS)*, 14(8), 2021, pp. 33-38.