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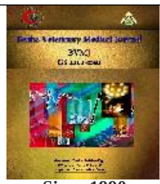

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Effect of cooking methods on bacteriological quality of meat

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ABSTRACT

A total of 100 random samples of fresh meat (50gm) collected from different supermarkets and shops from Menoufia governorate, Egypt. The collected samples were divided into four groups; the first was raw and the other three groups were treated by boiling, frying, and roasting to evaluate their bacteriological aspects (total APC, coliform count, Staphylococcal count and *S. aureus counts*). The bacteriological examination revealed that the mean values of APC of the raw ,boiled ,fried and roasted meat samples were $2.28x10^7±6.16x10^6$, $1.19x 10^{3-}±2.92x10^2$, $1.50x10^4± 4.24x10^3$, $2.70x10^{3-} ±1.55x10^3$ cfu/g, respectively. The mean values of coliform count (cfu/g) of such examined samples were $1.35x10^5 ±5.06x10^4$, 9.2x10 ±3.00x10, $2.78x10^2±8.90x10$, $4.41x10^2±2.08x10^2$, respectively. The mean value of Staphylococci count (cfu/g) of raw ,boiled , fried , roasted samples were $7.75x10^3±2.42x10^3$. $3.48x10±0.11x10^2$, $0.60x10^2 ±0.17x10^2$, $0.92x10^2±0.27x10^2$ with average counts for *S. aureus* of count of the raw ,boiled ,fried ,roasted meat samples were $5.12x10^3± 1.46x10^3$, 2.62x10±0.80x10, $0.33x10^2±0.10x10^2$, $068x10^2±0.20x10^2$. Methods of heat treatment of meat have acceptable killing effect on reduction of the bacterial load of raw samples. The boiling method is the first method for reduction of bacterial load of raw meat followed by frying method then roasting method.

1. INTRODUCTION

Meat is perishable food so act as a vehicle for microbial growth which may lead to its spoilage and public health hazard. Cooking of meat is very important for reduction of bacterial contamination and obtaining safe food for human health. food poisoning increased in recent years because of bad handling of food and improperly cooked food. Methods of thermal treatment such as boiling, frying and roasting decrease the microbial level and increase the shelf life of food. So, meat must be subjected to temperature range exceeding the danger zone (5 ^{0}C- 65^{0}C) since the bacteria grow rapidly between these range. The quality characteristics of meat are affected by the composition of muscle and cooking method, and time as well as temperature (Lee et al., 2005). Meat is an important source of both trace elements and B-vitamins and greatly contributes to daily intake of these micronutrients in the diet (Lombordi-Boccia et al., 2005). Contamination of meat by pathogenic microorganisms is one of the most important challenges faced by producers of processed meat production resulting in a range of human health problems as well as economic losses to producers due to recalls from market places (Sofos2008).Cooking of meat is important in order to have a delicious and safe product (Sayas-Barbera et al., 2010). The purpose of cooking is to make meat palatable, digestible and microbiologically safe. (Moro et al., 2011).The number of Staphylococcus must exceed 10^5 per gram of food for SEs production and the number can be lowered depending on the strain ,condition of food and environment.(Ostyn et al., 2011). The cooking methods are boiling, convective oven, grilling, microwave, superheated steam. The cooking treatment ended when the meat reached 75 °C at their thermal center which is generally recognized safe temperature for chicken (Kim et., 2013). Cooking is represented the only wide spread and most effective methods to prevent food borne diseases caused by vegetative pathogenic microorganisms from contaminated meat.(Roccato et al., 2015).Therefore ,the aim of this subject is to evaluate the effect of different cooking methods (boiling, frying, roasting) on the bacteriological aspect of meat including of APC coliform, Staphylococcus and *S. aureus* count in addition to their identification.

2. MATERIAL AND METHODS

2.1. Collection of samples

One hundred random samples of fresh meat and then divided into four groups 1st group was raw samples, 2nd was boiled samples, 3rd group was roasted samples and 4th group was fried samples (each group of 25 sample of 50 grams in weight, 7 cm In length).

Application of different cooking methods;

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1. Boiling; It was performed according to Choi et al. (2016). The standard temperature for boiling is 100 °C.
2.Frying; It was applied according to Yousif et al. (2013) the standard temperature for frying is 190-200 °C.
3.Roasting;The method adopted by Hollywood et al. (1991) was carried out where the standard temperature for roasting is 175°C.

2.2. Bacteriological examination;

2.2.1. Preparation of the samples (ISO6887-1; 2017)

Twenty-five grams of the examined samples were taken using sterile scissors and forceps after surface sterilization by hot spatula, transferred to sterile polyethylene bags, to which 225 ml of 0.1% of sterile buffered peptone water were aseptically added .Then samples were homogenized in sterile homogenizer for 2 minutes at 2500 RPM to provide a homogenate of 1/10 dilution. The mixture was allowed to stand for 15 minute at room temperature then one ml from such dilution was transferred to another sterile tube containing 9 ml sterile buffered peptone water and mixed well to make the next dilution, from which further decimal serial dilutions were prepared .the prepared dilutions were prepared. The prepared dilutions were subjected to the following examinations.
1. *Determination of aerobic plate count* According to (Iso4833-1;2013(E)
2. *Determination of total coliform count* According to (ISO4832;2006).
3. *Isolation of Staphylococcus aureus* according to (ISO6888-1;1999).

3. RESULTS AND DISCUSSION

3.1. APC count

It is evident from the current results recorded in table (1) The mean value of APC count(cfu/g) of the examined raw, boiled, fried, roasted meat samples were $2.82x10^7±6.16x10^6$,$1.19x10^3±2.92x10^2$,$1.50x10^4±4.24x10^3$ ^{b}, $2.70x10^3±1.55x10^3$ cfu/g. Also, table (1) revealed significance differences between raw , boiled ,fried and roasted meat as a result of all used cooking methods had the largest destructive effect on contaminating bacteria that achieved the highest reduction on bacterial load of raw samples but raw meat were highly bacterial level due to contamination from bad slaughtering technique ,unhygienic abattoir ,mishandling of the animal. The result recorded in table (2) revealed that the acceptability of APC(cfu/g) of the examined raw meat samples according to EOS (2005) permissible limit not more than 10^6cfu/g.the acceptable meat samples were 7 samples and the ratio of it were 28% and the unaccepted samples were 18 and the ratio of it were 72%. Nearly similar results were recorded by Abdel Aal-Asmaa et al. (2015), who evaluated the effect of boiling and frying on different meat products from agovernmental hospital at various times in Kalyobia governorate ,Egypt.The results conducted that bacterial load with mean APC of $5.07x10^4$ $±1.12x10^4$,8.31x $10^3±2.05x10^3$.Also these results are similar to those obtained by EL melegy- Asmaa et al. (2015), who evaluated the microbial status of raw and cooked meat product serviced to university students that conducted the mean value of APC of raw meat ,cooked meat were $5.4x10^4$ $±7.9x10^3$,$3.6x10^4$ $±2.1x10^3$cfu/g. also these results were similar to those revealed by Mohamed (2017), who reported that the bacterial load of the fresh and frozen ground beef samples purchased from local butchers and supermarkets in Alexandria and conducted that the APC and coliform count were $4.1x10^6±7.2x10^6$ and $1.02x10^4±2.2x10^4$CFU/g ,respectively.These results were nearly similar with results obtained by Khirrala (2007), who reported that APC and coliform counts of examined cooked meat meals selected from Tanta University restaurants were $9.40x10^4$±o.$32x10^3$cfu/g and $4x10^2±2.23$CFU/g.

Table 1 Statistical analytical results of different cooking methods on APC (cfu/g) of the examined meat samples (n = 25)

Meat Samples	Min.	Max.	Mean ± S.E
Raw Meat	$3.4x10^5$	$9.5x10^7$	$2.28x10^7 ± 6.16x10^{6a}$
Boiling	$1.2x10^2$	$5.2x10^3$	$1.19x10^3 ± 2.92x10^{2b}$
Frying	$2.1x10^2$	$7.2x10^4$	$1.50x10^4±4.24x10^{3b}$
Roasting	3.2x10	$3.9x10^4$	$2.70x10^3± 1.55x10^{3b}$
Total	3.2x10	$9.5x10^7$	$5.70x10^6± 1.81x10^6$

Means within a column followed by different letters showed significant difference ($P < 0.05$).

Table 2 Acceptability of the examined meat samples according to their APC/g (n = 25)

Meat Samples	Permissible Limit* (not more than)	Accepted samples		Unaccepted samples	
		No.	%	No.	%
Raw Meat	10^6	7	28	18	72

Permissible Limit according to E.S (2005)

3.2. Coliform count

In table (3)the results revealed the mean value of coliform count (cfu/g) of the raw, boiled , fried and roasted meat samples were ; $5.12x10^3±5.06x10^4$, 9.2x10±3.00x10, $2.78x10^2$± 8.90 x10 , $4.4x10^2 ± 2.08x10^2$ cfu/g. From table (2) it is noted that from the obtained results there were significance differences between raw ,boiled ,fried meat samples in which raw meat samples were highly contaminated due to bad hygiene in the slaughterhouse, mishandling, unhygienic transportation. While boiled , fried, roasted meat samples showed lower level of coliform count (cfu/g) due to thermal treatment has very good effect on the bacteriological quality of the meat because of it have greatest lowering on the bacterial level on meat. The permissible limit not more than10^2 CFU/g. In table (4) showed that the acceptability of coliform (cfu/g) of the examined raw meat samples according to the codex alimentairis (2005) which conducted 5 acceptable samples (20%) and 20 unaccepted samples (80%).This results were nearly similar to the results obtained by Adel Aaal-Asmaa et al. (2015), who reported that various meat products represented by boiled beef meat, fried beef meat ,boiled chicken meat and fried chicken meat from governmental hospital at different times in Kalyobia governorate , Egypt The conducted result evaluated bacterial load with mean APC of $5.07X10^4±1.12$ $X10^4$,$8.31X10^3±$ $2.05X10^2$and $7.18X10±1.44x10^4$ CFU/G and mean coliform count of $5.67x10^3$ $±0.87x10^3$, $2.01x10^3$ $±0.33x10^3$, $1.06x10^4±$ $0.17x10^4$ and $6.40x10^3±1.23x10^3$CFU/g, respectively. These results were relatively similar to the results obtained by Tavakoli and Riazipour (2008), who reported that the microbial load of cooked meat in Tehran university restaurants conducted that the mean value of total bacterial and coliform counts were $1.14x10^5$cfu/g and $1.98x10^2$.

3.3. Staphylococci count

Table 3 Effect of different cooking methods on coliform count (cfu/g) of the examined meat samples (n=25)

Meat Samples	Min.	Max.	Mean ± S.E

Raw Meat	< 10	$8.4x10^{5}$	$1.35x10^{5} \pm 5.06x10^{4a}$
Boiling	< 10	$5.2x10^{2}$	$9.2x10 \pm 3.00x10^{b}$
Frying	< 10	$2.1x10^{3}$	$2.78x10^{2}\pm8.90x10^{b}$
Roasting	< 10	$5.3x10^{3}$	$4.41x10^{2}\pm 2.08x10^{2b}$
Total	< 10	$8.4x10^{5}$	$3.39x10^{4}\pm 1.38x10^{4}$

Means within a column followed by different letters showed significant difference (P < 0.05).

Table 4 Acceptability of the examined meat samples based on their coliform count/g (n = 25)

Meat Samples	Permissible Limit (not more than)	Accepted samples		Unaccepted samples	
		No.	%	No.	%
Raw Meat	10^{2}	5	20	20	80

Permissible Limit according to Codex Alimentarius (2005)

Table (5) indicated that the mean value of Staphylococci count (cfu/g)of the examined raw, boiled, fried and roasted meat samples were 7.75x $10^{3}\pm2.42x10^{3a}$, $3.48x10\pm 0.11x10^{2b}$, $0.60x10^{2}\pm0.17x10^{2b}$, $0.92x10\pm 0.27x10^{2b}$cfu/g. These results showed significant difference ($p<0.05$). Permissible limit according to EOS (2005) must be free. The number of acceptable samples and ratio of raw, boiled, fried , roasted meat were as 6 samples in raw meat and were constituted 24% but unacceptable samples were 19 and equal 76% in boiling meat the acceptable were 11 samples and represented 44%whilethe unacceptable were constituted 14samples and constituted 56%while in frying meat the acceptable samples were 8 samples and were constituted 32% but unacceptable samples were 17 samples and represented 68%.while in roasting meat were 8 samples and represented 32% and unacceptable samples 17 samples and constituted 68%.These results were agree with the results obtained by Montanari et al. (2015), who reported that complete destruction of *Staphylococcus aureus* isolated from fermented sausages cannot be achieved during processing temperature of 80 °C for 20 min.

The results in table (7) showed that the mean values of S. aureus count(cfu/g) in raw ,boiled ,fried , roasted meat samples were $5.12x10^{3}$ $\pm1.46x10^{3}$ $2.26x10\pm0.80$ $x10^{b}$ 0.33x $10^{2}\pm10x10^{2b}$,0.68 $x10^{2}\pm$ $0.20x10^{2b}$cfu/g. These results showed non-significant difference ($p<0.05$).The permissible limit according to EOS (2005) must be free in the meat samples. The number of acceptable samples in raw meat samples were 6 samples and represented 24%of the acceptable samples but the unacceptable samples were 19 and constituted 76%while in boiled meat were 11 and equal 44% of the acceptable samples while the unacceptable samples were 14 and represented 56%.but in fried meat the acceptable samples were 8 and constituted 32%and the unacceptable samples were17 and equal 68%whereas the acceptable samples in roasting meat were 8 and represented 32%while the unacceptable samples were 17 and constituted 68%.These results were nearly similar to the results obtained by Saad et al. (2011) $1.85x10^{3}$cfu/g)for RTE beef –burger while the lower result were recorded by Masoad-Nagwa (2013) (3.8x10 cfu/g) for street vended kofta. Moreover, the higher results were obtained by Adam(2009) ($1.24x10^{5}$cfu/g) for street vended kofta. These results were nearly similar to the results obtained by Zaki-Eman (2003) who reported that the Staphylococcus aureus were $9x10^{2}$cfu/g. Also ,the obtained results of S. aureus were nearly similar to the results obtained by Morshdy et al. (2013) ($4.3x10^{2}$)/g in minced meat), Hassanein-Fatin (2004) ($7.01x10^{2}$ in luncheon).

Table 5 Effect of different cooking methods on staphylococci count (cfu/g) of the examined meat samples (n = 25)

Meat Samples	Min.	Max.	Mean ± S.E
Raw Meat	< 10	$3.7x10^{4}$	$7.75x10^{3} \pm 2.42x10^{3a}$
Boiling	< 10	$1.9x10^{2}$	$3.48x10 \pm 0.11x10^{2b}$
Frying	< 10	$2.5x10^{2}$	$0.60x10^{2}\pm0.17x10^{2b}$
Roasting	< 10	$3.8x10^{2}$	$0.92x10^{2}\pm 0.27x10^{2b}$
Total	< 10	$3.7x10^{4}$	$1.99x10^{3}\pm 6.84x10^{2}$

Means within a column followed by different letters showed significant difference (P < 0.05).

Table 6 Acceptability of staphylococci count (cfu/g) of the examined meat samples

Meat Samples	Permissible Limit	Accepted samples		Unaccepted samples	
		No.	%	No.	%
Raw Meat	Free	6	24	19	76
Boiling	Free	11	44	14	56
Frying	Free	8	32	17	68
Roasting	Free	8	32	17	68

Permissible Limit according to EOS (2005)

Table 7 Statistical analytical results of different cooking methods on *S. aureus* count (cfu/g) of the examined frozen meat samples (n = 25)

Meat Samples	Min.	Max.	Mean ± S.E
Raw Meat	< 10	$2.5x10^{4}$	$5.12x10^{3} \pm 1.46x10^{3a}$
Boiling	< 10	$1.1x10^{2}$	$2.26x10 \pm 0.80x10^{b}$
Frying	< 10	$1.4x10^{2}$	$0.33x10^{2}\pm0.10x10^{2b}$
Roasting	< 10	$3.1x10^{2}$	$0.6810^{2}\pm 0.20x10^{2b}$
Total	< 10	$2.5x10^{4}$	$1.31x10^{3}\pm 4.22x10^{2}$

Means within a column followed by same letters showed nonsignificant difference (P < 0.05)

Table 8 Acceptability of the examined meat samples based on their *S. aureus* (n = 25)

Meat Samples	Permissible Limit	Accepted samples		Unaccepted samples	
		No.	%	No.	%
Raw Meat	Free	6	24	19	76
Boiling	Free	11	44	14	56
Frying	Free	8	32	17	68
Roasting	Free	8	32	17	68

Permissible Limit according to E.S (2005)

4. CONCULOSIONS

From the obtained results it was concluded that raw meat was highly contaminated due to bad hygienic slaughtering, mishandling, bad transportation of meat. .Thermal treatment to the meat lead to lowering and destruction of large number of the microorganisms and so improvement of the quality and shelf lifetime of the meat. Boiling method is the best method to cooking of meat from bacteriological view .then frying and finally the roasting method. The boiling was the best due to the internal thermal temperature of the core of the meat reached to 72-75 °C during boiling in which the food were well done and boiling destroy a large number of the microorganism so, food become safe for consumption but the frying, roasting methods the cooking temperature not penetrate the core of the meat but act on the superficial part of the meat so, do not affect the microorganism in the internal part of meat so the cooked meat not well done so, represent health hazard on the human health.

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