

**Reducing The Microbial Of Chicken Meat by Improving Grill  
Machine Design**

Muna Turkey Mossa Al-Mossawei \*

Abdulrazzak Abdullatif Jasim \*\*

Khalid Zemam Amer\*\*\*

\* College of Science for Women - Department of Biology -University of Baghdad-  
Republic of Iraq

\*\* College of Agriculture - Department of Agricultural Machines and Equipment –  
University of Baghdad - Republic of Iraq

\*\*\* University of Mustansiriya - Republic of Iraq

[monatyf2005@yahoo.com](mailto:monatyf2005@yahoo.com)

[raz55iq@yahoo.com](mailto:raz55iq@yahoo.com)

[khalid\\_zeemam@yahoo.com](mailto:khalid_zeemam@yahoo.com)

**Abstract**

The experiment was conducted to improve the microbial load and sensory characteristics of chicken meat using locally designed and manufactured an improved grill and compared it with traditional grill in the department of Agricultural Machines and Equipment/College of Agriculture, University of Baghdad in 2017. The study included test of complete roasted chicken samples that ready for sale consumption from the top and bottom rows of improved grill, also included incomplete roasted chicken samples from the top row in addition to complete roasted chicken that ready for sale and consumption from the bottom row of the traditional grill, as well as a control sample that was roasted chicken by putting it in traditional grill alone. Bacteriological included total number of aerobic bacteria (Aerobic Plate Count APC), total number Coliform, fecal *E. coli*, *Staphylococcus aureus* and *Salmonella* Spp, In addition to Molds and Yeasts were tested in this study. Despite the lack of microbial limits for roasted chicken in Iraqi standard specifications, the results showed that absence of all study samples, including control from the presence of *Salmonella*, but it showed the

superiority of improved grill to reduce the mean of APC, coliform, yeasts and molds, which they are free of fecal coliform and *Staphylococcus aureus*, and recorded significant reducing. Also, high microbial load in complete roasted chicken samples that taken from the bottom row from traditional grill compared with improved grill demonstrates that the exudates fluids from the top row chicken on the bottom row chicken of the traditional grill has contributed to the rise of these microbial load, also demonstrates the erroneous practice adopted in the roasted method of chicken in the traditional grill, when the worker puts the chicken intended for roasting in the top rows of the grill and put the complete roasted chicken that ready for sale or consumption in the bottom of the grill, which contributes in contamination by exudates fluids that fall out of the raw and incomplete roasted chicken in the top row. The results of the current study also showed superiority of the improved grill to register the highest average in sensory evaluation scores of complete grilled chicken by the evaluators experts in a number of sensory qualities of odor, flavor, palatability and juiciness, it recorded significant differences compared with traditional grill, as well as it hood to get to complete roasting compared with samples of traditional grill and control.

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Keywords: chicken meat, grill, APC, Coliform, *E. coli*, *Staphylococcus aureus*, sensory characteristics.

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## **Introduction**

Chicken meat is contaminated with bacteria directly or indirectly by the surfaces that laid on it during preparation, tools and workers' hands (28). Air is also an important factor in the transport the microorganisms and contamination to chicken meat in different stages of processing (10). Also contaminate of carcasses by chicken feces during slaughter, cleaning and manufacturing has a big role in the transfer of pollution in the slaughter erhouses (25).

Food preparation, cooking, and street foods practices contribute in non-acceptance of the microbial quality, therefore, it is necessary to develop food preparation methods and train food hygiene vendors to improve their microbial quality (15). Different reports have identified the risks associated with the consumption of contaminated foods sold on the streets that have high level of pathogenic bacteria such as *Escherichia coli*, *Salmonella* spp, *Staphylococcus*

*aureus*, *Bacillus cereus* , *Clostridium perfringens*, and *Vibrio cholera* . (7, 11 and 16).

As well as the spreading of restaurants and concerned shops for sailing roasted chicken in an innovative way to add taste and palatability, which increased the demand for consumption of chicken meat , thus increase the production (6). The increased demand for animal products and fast food seeks World Health Organization (WHO) to stimulate a deep work and discussion on global food safety, highlight the best practices in building food safety around the world, and also look for new ways to ensure that people have access to food, with safe food supplies. Mohamed(17) and Tavakoli and Majid(27) pointed out the percentage of pollution in chicken sold in Europe reached 75% ,while in the United States of America 60%. These indicate the size of high pollution of poultry meat and if not cooked well, will transmitted these

contaminations to the human. Odu and Akano (18) and Olayinka *et.al.*(19) pointed out that pollution may be the result of poor manufacturing practices used by food vendors, and the conditions in which street vendors work and are often not suitable for the preparation and sale of meat foods, which raises many concerns and makes them a source on a public health concern due to the presence of food borne disease and incidence of food poisoning.

The phenomenon of selling grilled chicken meat using traditional vertical grills that the simplest conditions of cleanliness, and put of these grills outside the restaurants and on the sidewalks, leading to the contamination of grilled chicken, as well as the unhealthy method that used in grilling, when the worker puts a ready to sell or consumption chicken in the bottom row of the grilled and non grill or incomplete grilling chicken in the upper row of the grill. These processes leads to

the revelation their exudation fluids on the bottom row and contaminate the full grilling chicken ready for sale and consumption, as these exudation fluids containing microbial load as well as melted fat as a result of grilling temperature which will affect the sensory quality of the final product.

Many studies were conducted on grilled chicken for detection of contamination level and their results varied. In the study which was conducted at the restaurants in one of faculties of Tehran University found that APC was  $6.23 \times 10^4$  and coliform was  $1.05 \times 10^2$ , while none of the samples were contaminated with Salmonella and *S. aureus*, (26). In assessing the microbiological quality of roasted chicken samples from several cities in the Philippines, several samples contained high levels of the total number of APC, coliform, fecal coliform and *S.aureus*, that

indicating unhealthy and poor sanitation practices, (15).

Another study indicated that there is a high significance differences ( $P < 0.01$ ) between examined samples of half cooked chicken meat products for APC and total staphylococci count as a result of product type, Awadallah(1), Saad and Sabra(22) and Sharaf and Sabra(24) and recorded that *E.coli* was isolated from(1, 7 and 3) of examined samples of chicken nuggets, chicken hot wings and frozen chicken shawerma, respectively.

Our results were agree with World Health Organization(WHO)(29) as results who concluded that when these products cooked not properly and contaminated post processing, the diseases can also result.

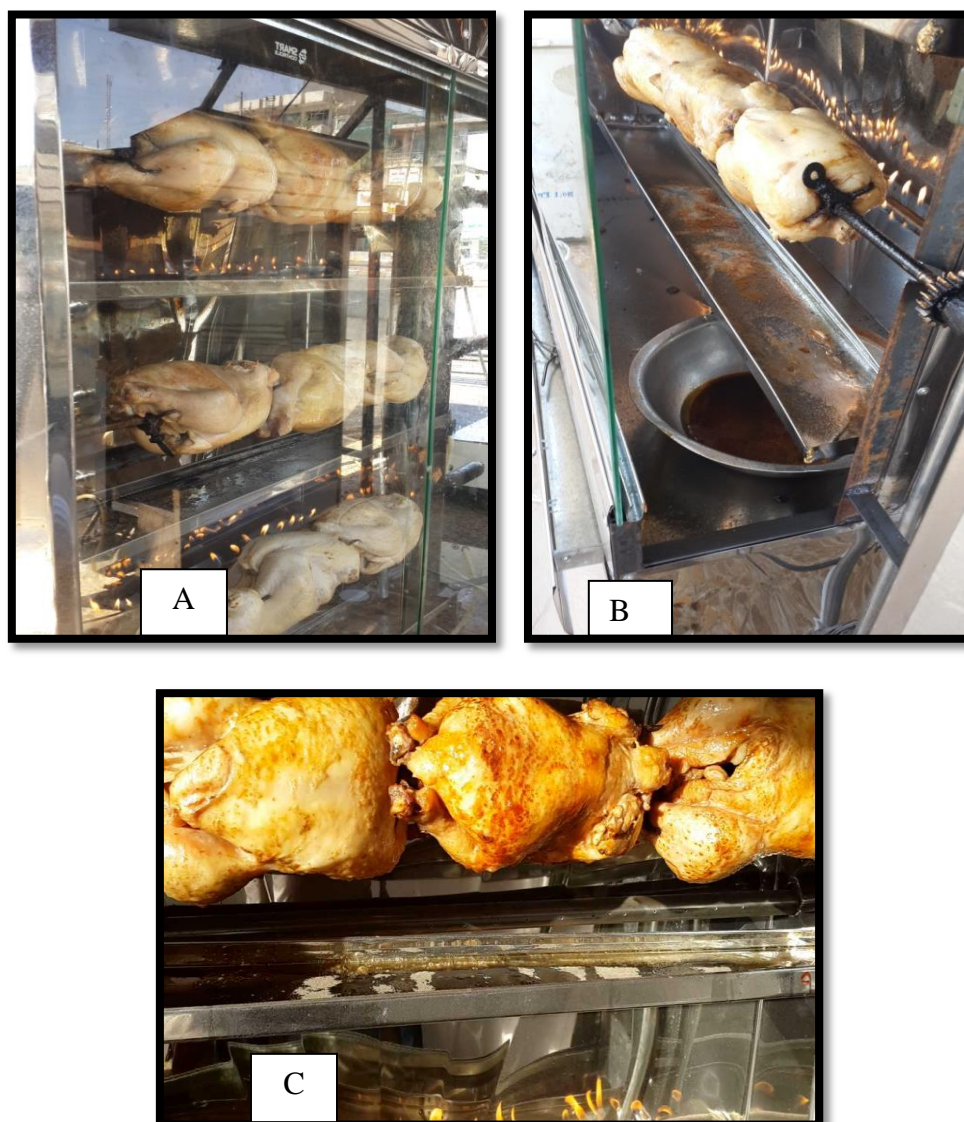
The aim of this study was to improved grill machine for chicken meat, compared the microbial load and sensory characteristics of complete grilled chicken meat that ready for sale and consumption in

both grills (traditional and improved).

## **Materials and Methods**

### **1. Design and assembling the improved grill**

It has designed and assembling an improved grill for whole chicken meat in the department of Agricultural Machines and Equipment /College of Agriculture/ University of Baghdad, using an iron metal structure and stainless steel metal sheets , so put slanting sheets separating between a row and another of the grill rows to prevent exudates fluids falls from chicken to chicken in another rows, and assembly of exudates fluids of each row side lateral by pipeline joint between the grill rows , then the pipeline finished into a metal container. Figure (1-A,B,C) showed the grill process in the improved grill and descent of exudates fluids on the separates and assembled in the container through the lateral pipeline.



**Figure (1-A,B,C): The grill process in the improved grill machine while Figures (2-A,B) showed grill process in the traditional grill and the descent of exudates fluids from the top row on the chicken in the lower rows. Also, grilled chicken by putting it in traditional grill alone as control sample.**

2. Preparing complete chicken meat and operate both grill machine (the traditional and improved) It was prepared amount of spiced whole chicken meat (local production at weight 1200g) and operate both grill machine (traditional and improved) at one time

### 3. Chicken meat samples

Complete grilled whole chicken meat samples that were ready for sale and consumption was taken from top and bottom row of the improved grill machine, also taken incomplete grilled chicken meat samples from the top row, as well as complete grilled chicken meat samples ready for sale and consumption from the bottom row of the traditional grill, in addition of control sample .All samples were placed in sterile polyethylene bags and tightly closed, then placed in a Cooler Box contain Ice powder in order to avoid the occurrence of any changes that affect the results of microbial load compared to

samples of chicken, and then transferred to the Central public Health Laboratory /Ministry of Health to conduct microbial testing after their arrival directly.

### 4. Microbial tests

Bacteriological tests were conducted of the samples, depending on (3) included total number of aerobic bacteria (Aerobic Plate Count APC) , total number of Coliform , fecal *E. coli* , *Staphylococcus aureus* and *Salmonella* Spp., In addition to Mold and Yeast . The agricultural media were prepared in the Central Public Health Laboratory as instructed processed companies and appropriate pH , then sterilized by autoclave at a temperature of 121<sup>0</sup>C(15 Ib/Inch<sup>2</sup>) for 15 min., unless otherwise provided for it.

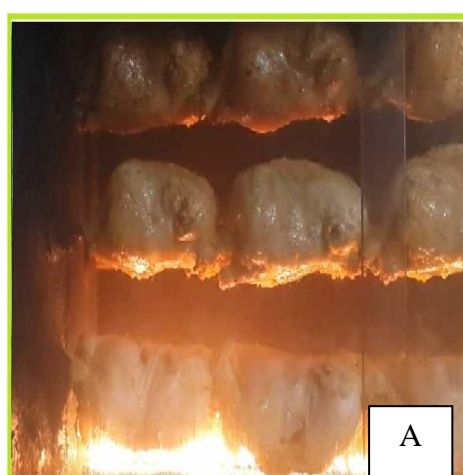
### 5. Sensory evaluation

The sensory evaluation was conducted to the final products of complete grilled chicken meat ready for sale and consumption taken from both grill machine (improved and traditional)

according to the method recommended by American Meat Science Association(AMSA)(2) and Cross and Berry(8) sensory scores included a number of characteristics including general appearance, odor, flavor, tenderness, juiciness and palatability. Evaluation scores estimated using an acceptability scale ranging from 1 to 5. 10 peoples Participated in evaluation scores (nutrition experts from departments of food microbiology, food chemistry and food health/Central Public Health Laboratory and professors from college of agriculture and college of science for girl / University of

Baghdad, whose sensory taste specifications apply to them, according to the special form and focus on the acceptance scores and in order to avoid differences that may affect evaluation scores have been taking the time of testing at the eleventh hour before noon, degree of grill temperature, duration of grilling , piece size that submitted for evaluation and water drink at room temperature between the test and the another by the evaluators, according to Lee and Williams(13), as well as unification of the region which the piece of chicken (breast or thigh) taking for evaluation.

Statistical analysis



**Figure (2-A,B): The grill process in the traditional grill machine**



The statistical program (23) was used in the analysis the data in order to study the effect of the different treatments (machine and location) in the studied traits

## Results

### 1. Microbiological tests

Table (1) shown that presence of total aerobic bacteria (APC) in the study samples. The APC was

1.2 ×10<sup>4</sup> cfu/g in the control, and superiority of improved grill to Decrease of APC in samples in both top and bottom rows compared with the traditional grill reach (1×10<sup>4</sup> and 1.1×10<sup>4</sup>), (2.7×<sup>4</sup> 10 and 8.9×10<sup>3</sup>) cfu/g, respectively and recorded significant difference at (P≤0.01).

**Table(1): mean of total number of aerobic bacteria in study samples**

Grilled chicken samples	Mean of Total No. aerobic bacteria		P-value
	CFU/g		
	Position of the row		
	Top	Bottom	
Traditional grill machine	$2.7 \times 10^4$	$8.9 \times 10^3$	0.0016 **
Improved grill machine	$1.0 \times 10$	$1.1 \times 10$	0.319 NS
Control	$1.2 \times 10$	$1.2 \times 10$	1.00 NS
P-value	0.0021**	0.0001**	---

\*\* (P≤0.01), NS: Non-significant

Table(2) showed that presence of coliform bacteria in the study samples, including control, reach 7.5 cfu/g ,with a decrease mean in the samples of improved grill at top and bottom rows, compared with the traditional grill machine which reach to (6.3 and 6.7) ,(5.5 x 10<sup>2</sup> and 1.9 × 10<sup>2</sup>) cfu/g, respectively. Significant differences were recorded at (P≤0.01).

**Table(2): mean of coliform bacteria in study samples**

Grilled chicken samples	Mean of Coliform CFU/g		P-value
	Position of the row		
	Top	Bottom	
Traditional grill machine	5.5×10 <sup>2</sup>	1.9× 10 <sup>2</sup>	0.0001 **
Improved grill machine	6.3	6.3	0.2071 NS
Control	7.5	7.5	1.00 NS
P-value	0.0001*	0.0001**	---

\*\* (P≤0.01), NS: Non-significant

While Table (3) shown that the superiority of the improved grill machine was without *E.coli* and failure of traditional grill samples and control due to the presence of this bacteria. There was a significant difference between (P≤0.05).

**Table(3): mean of *E. coli* in study samples**

Grilled chicken samples	Mean of <i>E. coli</i> CFU/g		P-value
	Position of the row		
	Top	Bottom	
Traditional grill machine	3.4× 10	2.2× 10	0.0993 NS
Improved grill machine	0	0	0.2166 NS
Control	2.5	2.5	1.00 NS
P-value	0.0476*	0.0511*	---

\* (P≤0.05), NS: Non-significant

Also Table (4) shown the superiority of the improved grill which did without *S. aureus* and failure of traditional grill samples and control due to the significant difference at (P≤0.01).

**Table(4): effect of grill Type on *staph. aureus* in study samples**

Grilled chicken samples	Mean of <i>Staph. aureus</i> CFU/g		P-value
	Position of the row		
	Top	Bottom	
Traditional grill machine	2.1×10 <sup>2</sup>	9.8× 10	0.0031 **
Improved grill machine	0	0	0.2141 NS
Control	3.6	3.6	1.00 NS
P-value	0.0025**	0.0109**	---

\*\* (P≤0.01), NS: Non-significant

Table (5) indicates that all samples of the study were absent from Salmonella, as well as control,. No significant difference was recorded.

**Table(5): mean of salmonella in study samples**

Grilled chicken samples	Mean of Salmonella CFU/g		P-value
	Position of the row		
	Top	Bottom	
Traditional grill	0.0	0.0	NS
Improved grill	0.0	0.0	NS
Control	0.0	0.0	NS
P-value	NS	NS	---

NS: Non-significant

The presence of molds and yeasts in the study samples, including control (7.2 cfu/g) , with a decrease the mean in samples of the improved grill at top and bottom rows compared with the traditional grill machine which reached (3.2 and 2.8) , (2.7×10 and 2.3×10)cfu/g, respectively. Significant differences were recorded at ( $P \leq 0.05$ ).

**Table(6): Effect of grill type on molds and yeasts in study samples**

Grilled chicken samples	Mean of Mold and Yeast CFU/g		
	Position of the row		P-value
	Top	Bottom	
Traditional grill machine	2.7×10	2.3× 10	0.459 NS
Improved grill machine	3.2	2.8	0.783 NS
Control	7.2	7.2	1.00 NS
P-value	0.0218 *	0.0264 *	---

\*\* (P≤0.05), NS: Non-significant

## 2. Sensory taste evaluation

Table (7) shows that superiority of the improved grill machine on the traditional grill and compared with the control treatment in recording the highest mean of sensory evaluation for the grilled whole chicken meat in the characteristics of Odor, flavor and palatability which reached to 5 score for each of them, and showed significant differences at (P≤0.01).

**Table(7):Effect of grill machine type on sensory evaluation mean of full roasted chicken samples**

Grilled chicken samples	overall shape	odor	Flavor	tenderness	juiciness	palatability
Traditional grill machine	4.6	2.1	2.2	4.7	3.8	2.2
Improved grill machine	4.4	5.0	5.0	4.4	4.4	5.0
Control	4.4	3.8	3.8	4.5	3.2	3.9
p-value	0.4291NS	0.0027 **	0.0049 **	0.3177 NS	0.0198 *	0.0017 **

\* ( $P \leq 0.05$ ), \*\* ( $P \leq 0.01$ ), NS: Non-significant.

The juiciness score for improved machine was 4.4 and showed a significant difference at ( $P \leq 0.05$ ). While there were no significant differences in overall shape and tenderness compared with traditional grill samples and control. (table 7)

We were observed that the chicken samples in the top grill had taken less time to reach full roast compared with the traditional grill samples.

## **Discussion**

Although there is non-microbial limit for the roasted chicken in the specification of Iraqi standard, the results of current study showed the absence of *Salmonella* in all study samples, including control. But it shown the superiority of improved grill on the traditional grill machine to reduce the mean of APC, coliform, molds and yeasts, they are free of *E.coli* and *S. aureus*, that recorded significantly differences.

In the current study the high microbial load in complete roasted samples for sale and consumption that taken from bottom row of the traditional grill compared to the improved grill demonstrates that chicken exudate fluids on the bottom row chicken of the traditional grill contributed to the rise of this microbial load, while the presence of metal plates between the rows of the improved grill have a role in preventing drop of fluids on the bottom row. As evidenced by the wrong practice adopted in method of roasting chickens in traditional grills when the worker put the chicken that prepared for roasting in the top rows of grills and put the chicken that ready for sale or consumption at the bottom of the grill, contributing to contamination by fluid droppings from raw chicken and not complete roasting that located in top rows of grill.

The results of the present study also showed superiority of the improved grill on the traditional

grill and also the control in recording the highest mean of sensory evaluation for the grilled whole chicken in many characteristics (Odor, flavor, juiciness and palatability) and showed significant differences higher than traditional grill. It also need to reach full roast compared with traditional grill samples and control.

Consumer rejects or accepts meat according to the feelings experimented, when observing or eating it , therefore evaluating food sensory quality was do. These sensory characteristics are perceived by senses resulting from food /consumer interaction. These perceptions will influence consumer decisions . Nevertheless, despite meat cooking methods and organoleptic characteristics can be important factors(4) .Thus was agree with Pizato *et.al.* (20) that changes in temperatures used in the grill and cooking of chicken meat have a greater effect on microbial growth, cutting strength,

color changes, store life, and sensory changes. We also agree with results Ba *et.al.*(5) that cooking conditions such as temperature, taken time and cooking methods play an important role in determining the composition of volatile compounds for flavor. In general, it has been shown that cooked meat at a high temperature grill will produce better flavor characteristics and odor as well as spicing, and suggested that slow cooking which takes longer time can allow volatile compounds for unwanted flavor appearing, therefor reduce the access to a favorite flavor. Flavor was the most important factor that determines the degree of palatable meat by the consumer through which the consumer will judge the quality of meat. (12).

As a result, there is a need to develop guidelines for producers and consumers and to promote a multidisciplinary education campaign to provide information on cooking safety and time-



temperature that can maintain the sensory characteristics of meat.

Finally, we recommend adopting the model of the improved grill machine to be used on a commercial use. The Central Agency for Standardization and Quality Control must establish a microbial limit for grilled chicken meat and the health control teams should take their actions in accounting for the grills and apply the approved health requirements and health of consumers.

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