A MICROBIOLOGICAL STUDY OF SOME MICROWAVE COOKED FOODS

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ABSTRACT

A total of 150 fresh samples of fish, beef and chicken (50 samples for each) were collected from different retail stores in Alexandria. Samples were examined microbiologically in it s fresh state (prior cooking) and after microwave cooking (immediately and after 6 hours of cooking). Results indicated that the mean (log CFU/gm) total aerobic bacterial counts of uncooked fish, beef and chicken samples were as follows: 5.700 log10, 5.627 log10, 5.863 log10; respectively. However, the total aerobic bacterial counts of post microwave cooked fish, beef and chicken samples (immediately after cooking and after 6 hours cooking) were 3.651 log10, 3.066 log10, 2.978 log10 and 4.870 log10, 5.011 log10, 4.159 log10 for immediately and after 6 hours; respectively with a significant difference between total aerobic bacterial counts of uncooked and post microwave cooked samples. Moreover, in fish samples, there was a decrease in the percent of bacterial survival from 100% for uncooked to 14% for immediately and 6% for after 6 hours after cooking, respectively.The percent of bacterial survival of beef and chicken samples was decreased from 100% of uncooked samples to 14%, 10% in beef and 20%, 8% in chicken samples for immediately after cooking and after 6 hours cooking. It was also reported that the mean values (mean log cfu/gm) of total yeast and mould counts of fish samples were 4.995 log10 for uncooked, 3.075 log10 for immediately after cooking and 4.100 log10 for after 6 hours cooking, with a significant difference between total yeast and mould counts of them. The percent of survival was decreased from 98% in uncooked fish samples to 28% and 16% in post microwave cooked samples (immediately and after 6 hours cooking). Concerning beef samples, the mean total yeast and mould counts were found in uncooked (5.327 log10) followed by after 6 hours cooking (4.279 log10) and immediately after cooking (2.945 log10). Moreover, 24% of beef samples showed yeast, mould survival, immediately after cooking but after 6 hours cooking, 22% of beef samples showed yeast and mould survival. In case of chicken samples, the mean levels of total yeast and mould counts were 4.479 log10,

3.238 log10 and 4.509 log10 for uncooked and post microwave cooked (immediately and after 6 hours cooking; respectively). At the same time, yeast and mould survival was decreased after microwave cooking (immediately and after 6 hours) from 96% for uncooked to 14% and 12% for immediately and after 6 hours microwave cooking.

Our results also indicated that the percent of survival of Salmonella, Shigella, Staph aureus isolated from uncooked fish samples were: 10%, 4% and 28%; respectively, while after microwave cooking (immediately and after 6 hours cooking), no survival were obtained except in case of Staph aureus, where the percent of survival was 4% for immediately and 2% for after 6 hours. Both uncooked and post microwave cooked fish samples showed no survival of listeria monocytogenes. IT was found that, the uncooked beef samples showed Salmonella, Shigella, and Staph aureus survival with a percent of 6%, 2% and 24%; respectively. While after 6 hours microwave cooking, the percent of survival were decreased to 2%, 0% (non survival), 2%. In case of listeria monocytogenes, no survival were observed in both uncooked, post microwave cooked beef samples. Regarding chicken samples, the isolated Salmonella, Shigella, Staph aureus showed survival of 4%, 4% and 16%; respectively. After microwave cooking (immediately after cooking) the percent of survival decreased to 2%, 0%, 6% and to 2%, 0%, 2% after 6 hours for Salmonella, Shigella and Staph aureus. In general our results indicated that microwave cooking of the examined fish, beef and chicken samples were effective in significant decreasing the total aerobic bacterial counts, and total yeast and mould counts. The survival of bacteria, yeast and mould decreased after microwave cooking and the percent of survival of isolated Salmonella, Shigella, Staph aureus organisms were also decreased after microwave cooking, while listeria monocytogenes could not be isolated.

INTRODUCTION

One of the primary objectives of the cooking process is the thermal destruction of microorganisms, thus food are usually heated in such a manner that they can be consumed with a high degree of safety. It has been reported that conventional cooking reduces the usual microbiological contamination in food to levels that represent little food poisoning danger to the consumer. One of the new methods of food cooking include microwave cooking. It is gaining acceptance because it is fast and convenient and also, saves energy. The heating of food in a microwave oven results from molecular friction between water molecules under an oscillating electric field of specific frequency. The question has arisen whether, microwaving is effective in

killing micro-organisms. Concerns based on the starter time employed in microwave cooking and in the known heterogeneous nature of food heating process **(Evans et al., 1995 . Allison Hill, 1998).**

Numerous studies address the effect of micro-wave heating on pathogenic microorganisms in foods. Bacteria reported to be inactivated by microwave heating of foods include listeria monocytogenes, Staphylococcus aureus, and Salmonella **(Rosenberg and Boglw 1987, Knutson etal.,1987,Heddleson and Doores ,1994).**

The non uniform heating by microwave may lead to survival of food borne pathogens including Salmonella, listeria monocytogenes **(Gessener and Beller, 1994 , Lundetal.,1989).**

It was reported that bacteria were more resistant to thermal inactivation by microwave heating than yeast and moulds and bacterial spores were more resistant than vegetative cells **(Imsunwoo etal., 2000) .**

Two mechanisms are proposed for inactivation of microorganisms by microwave cooking. The first state, microwave cooking inactivate microorganisms entirly by heat through mechanisms comparable to other biophysical process induced by heat such as denaturation of enzymes, proteins, nucleic acid or other vital components as well as disruption of membranes **(Heddleson and Doores 1994).** There is no question as to the validity of this mechanisms. A second proposed mechanism for inactivation involving non thermal effects. Four predominant theories have been used to explain non thermal inactivation by microwaves: selective heating, electroporation, cell membrane rupture and magnetic field coupling **(Mudgett 1989) .**

The selective heating theory states that micro-organisms are heated more effectively by microwaves than the surrounding medium and thus kill more readily. Electroporation is caused when pores related in the voltage drop across the membrane cause it to rupture. In the fourth theory, cell lysis occurs due to coupling of electromagnetic energy with critical molecules within the cells, disrupting internal components of the cell. **(Kozempel etal ., 2000).**

It was found that food borne pathogens such as listeria monocytogenes, Staphylococcus and Salmonella spp. Have been the focus of most studies of microwavable food safety, primarily because of their uliquitous nature and prevalence in causing food borne illness **(Heddleson and Doores 1994).**

As foodborne illness have substantial impact on public health **(Todd 1990)** and destruction of various pathogens in meat by microwaves has generated considerable interest. So the aim of the current study was focussed on the microbiological status of some microwave cooked foods as beef, fish and chicken meats.

MATERIAL AND METHODS

Sampling :

A total of 150 fresh samples (50 of each of fish, beef and chicken meats) were collected from different retail stores in Alexandria. The samples were transported to the laboratory in an insulated ice box with a minimum of delay, then they were examined in its fresh state (prior cooking).

Microwave cooking :

The samples were covered and subjected to cooking in a microwave oven of 970 MHz frequency at full power (600 W), and according to the manufacturer's instructions. Then they were examined immediately and after a standing period of 6 hours (post microwave cooking).

Microbiological procedures

*** Total aerobic bacterial counts**

Decimal dilutions of the sample (25 grams) were made with buffered peptone water and 0.1 ml of each dilution was spread on the surface of duplicate plate count agar (Oxoid CM 463) plates. After incubation at 30°C for 48 h, colonies were counted and the counts were multiplied by the dilution factor as CFU/g **(Iso refercnce method 2293, 1976).**

*** Total yeast and mould counts**

Sample dilutions were spread on Sabouraud dextrose agar plates (Oxoid), incubated at 25°C for 5 days and counted as previously mentioned. Doubtful colonies were stained with lactophenol cotton blue and examined microscopically **(American Public Health Association 1992).**

* Isolation and identification of Salmonella species (U.S. FDA 2003).

* Isolation and identification of Shigella species (U.S. FDA 2003).

* Isolation and identification of Staphylococcus aureus (U.S. FDA 2003).

* Isolation and identification of Listeria monocytogenes (U.S. FDA 2003).

Identification was done as described by **Harvey and Glimour (1992).**

RESULTS

Table (1) presented the effect of microwave cooking of the examined food samples (fish, beef and chicken) on total aerobic bacterial counts. Concerning fish samples, the mean (log cfu/gm) total aerobic bacterial counts was found in uncooked samples (5.7 log cfu/gm) followed by Immediately after cooking (3.651 log cfu/gm) and after 6 hours microwave cooking (4.870 log cfu gm) with a significant difference between the total aerobic bacterial counts of them. The per-

cent of survival was reduced from 100% in uncooked samples to 14% and 6% in post microwave cooked samples (immediately and after 6 hours).

In case of beef samples, there was a reduction in total aerobic bacterial counts immediately after cooking and after 6 hours cooking than uncooked samples (mean values: 5.627 log cfu/gm, 3.066 log cfu/gm, 5.011 log cfu/gm for uncooked, immediely after cooking and after 6 hours cooking; respectively) with a significant difference between the total aerobic bacterial counts of them. Moreover, bacterial survival was decreased after microwave cooking (100% in uncooked, 14% and 10% in post microwave cooked).

Regarding chicken samples, the mean values of total aerobic bacterial counts for uncooked, immediately and after 6 hours microwave cooking were: 5.863 log cfu/gm, 2.978 log cfu/gm and 4.159 log cfu/gm; respectively.

Moreover, in chicken samples there was a decrease in bacterial survival in post microwave cooked (20%, 8% for immediately and after 6 hours cooking) than uncooked samples (100%).

Table (2) illustrated the effect of microwave cooking of food samples (fish, beef and chicken) on total yeast and mould counts.

Regarding fish samples, the mean values of total yeast and mould counts were 4.995 log cfu/gm for uncooked, 3.075 log cfu/gm for immediately cooked and 4.100 log cfu/gm for after 6 hours cooking with a significant difference between total yeast and mould counts of them. There was a reduction in the percent of bacterial survival from 98% for uncooked to 28% for immediately after and 16% for after 16 hours.

Concerning beef samples, the mean total yeast and mould counts was found in uncooked (5.327 log cfu/gm) followed by after 6 hours (4.279 log cfu/gm) and immediately after cooking (2.945 log cfu/gm). Moreover, 24% of samples showed bacterial survival, immediately after microwave cooking but after 6 hours cooking, 22% of samples showed bacterial survival.

In case of chicken samples, the mean levels of total mould and yeast counts were 4.479 log cfu/gm, 3.238 log cfu/gm and 4.509 log cfu/gm for uncooked and post microwave cooked samples (immediately and after 6 hours cooking; respectively). At the same time, the bacterial survival was decreased after microwave cooking (immediately and after 6 hours) from 96% for uncooked to 14% and 12% for immediately and after 6 hours microwave cooking.

Table (3) Presented the percent of survival of food poisoning micro-organisms isolated from uncooked and post microwave cooked fish samples. The percent of survival of isolated Salmonella species was 10% for uncooked fish samples, while, after microwave cooking, there was no survival. There was also a reduction in Shigella species survival from 4% for uncooked samples to

no survival after microwave cooking. In case of Staphylococcus aureus, the percent of survival was 28% for uncooked fish samples, 4% of samples is showed survival after microwave cooking (immediately) and 2% showed survival after 6 hours. Listeria monocytogenes showed no survival in uncooked fish samples and after microwave cooking.

Table (4) illustrated the percent of survival of food poisoning micro-organisms isolated from uncooked and post microwave cooked beef samples. The percent of survival of isolated bacteria from uncooked beef samples were 6%, 2%, 24%, 0% (no survival) for Salmonella species, Shigella species, Staphylococcus aureus and Listeria monocytogenes; respectively. While immediately after microwave cooking, the percent of survival were 2%, 2%, 10%, 0% (no survival); for Salmonella species, Shigella species, Staphylococcus aureus, Listeria monocytogenes; respectively. After 6 hours microwave cooking, there were no survival of Shigella species and Listeria monocytogenes.

Table (5) presented the percent of survival of food poisoning micro-organisms isolated from uncooked and post microwave cooked chicken samples. The percent of survival of isolated bacteria were reduced immediately after microwave cooking, to 2%, 0% (no survival), 6%, for salmonella species , Shigella species, Staphylococcus aureus; respectively and after 6 hours of microwave cooking, Shigella and Staphylococcus aureus showed 0%, 2% survival. Listeria monocytogenes could not be isolated from uncooked and post microwave cooked samples .

DISCUSSION

Several studies have examined variables that influence temp's and bacterial destruction achieved in foods heated by microwave energy. Factors of primary importance include both physical and chemical (product mass, density, specific heat, ionic content, dielectric properties) parameters. The majority of evidence indicates that microwaves inactivate microbs by thermal effects alone **(Fung and cunningham 1980, Heddleson and Doores 1994)** Our results showed that microwave cooking of the examined fish, beef and chicken samples were effective in significant decreasing of the total aerobic bacterial counts and total yeast and mould counts. The survival of bacteria, yeast and mould decreased after microwave cooking and the percent of survival of isolated Salmonella, Shigella, Staph aureus organisms were also decreased after microwave cooking.

It was reported that conventional boiling plus microwave and microwave alone cooking of fish fillets were all successful in reducing bacterial counts to a non detectable level **(Daniely, 1980).**

Goksoy et al (1999) found that microwave energy has the potential to raise the surface tem-

perature of meat rapidly for short period of time sufficient to reduce bacterial numbers significantly without causing physical changes to meat. Microwave ovens can play an important role at meal time, but special care must be taken when cooking or reheating meat to make sure that they are prepared safety **(Food Safety and Inspection Service FSIS, 2000)**.

Abd-El Aziz A.S (2002) reported that the mean values of aerobic plate count, Staph aureus in beef burger were: 3×10^5, 6×10^2, cfu/gm; respectively after microwave cooking, while in case of Kofta, the mean values were 9×10^5, 7×10^2 cfu/gm; respectively. At the mean time, Salmonella could not be isolated from all samples examined (Beef Burger, Kofta), whereas, Staph aureus can be isolated from Kofta cooked by microwave with 5% percentage.

It was stated that some of the microbial flora survive in all minced meat samples cooked by microwaves with standing periods **(Hollywood et al 1991)**.

It was found that the microbial flow of raw meat balls was as follows: total bacteria, $6.0^2 \times 10^6$ cfu/gm, psychrophilic bacteria 1.3×10^5 cfu/gm, yeast and mould, 2.4×10^5 cfu/gm, Staph. aureus 85 cfu/gm, while salmonella was found in only one sample. The cooking by microwave decreased the microbial flora (3 4 log cycles in microwave at 97 degrees C heating) of the meat balls. It is advised to use slightly highest temp's than used in the conventional cooking to increase the microbial quality of meat balls **(Yilma etal.,, 2002)**.

The survival of salmonella cells is of greater public health concern than is the survival of L.monocytogenes given that the minimum human infectious dose for salmonella spp. Can be as low as 1 to 10 cells **(D Aoust 1985, D Aoust 1989)**.

The efficiency of microwave ovens in destruction of some pathogenic micro-organisms was studied by **Aries et al (1997)**, who found that despite the cooking level used, the time required for elimination of Staph. aureus, Salmonella is greater than the one in which meat is considered enzymatically, and organoleptically cooked. **(Aries et al 1997)**.

It was illustrated that in the microwave cooking of poultry, there were inability to provide uniform heating temp's. This limitation can lead to the survival of food borne pathogens such as listeria spp in broilers, roasters cooked in microwave ovens. This is especially relevant since an epidemiological association has been made between undercooked chicken and sporadic cases of human listeriosis **(Schwart etal., 1988)**.

Lund et al (1989) showed that microwave cooking of whole chickens according to recommended cooking and standing times results in a 10^6 fold reduction in numbers of L.monocytogenes placed on the surface of the skin.

It was reported that no significant difference between conventional cooking and microwave

cooking of chicken products in reducing micro-organisms in those products. **(Daniely 1980)**

It was stated that microwave cooking were effective in reducing micro-organisms in chicken to in significant levels and that exposure time needed to be correlated with size and type of food **(Madson etal., 1971).**

Daniely (1980) compared bacterial counts of chicken cooked either by microwaves plus steam or a steam process alone. He showed that lower total counts, salmonella/ proteus counts were obtained with microwave process in contrast, **Chen et al, (1973)** claimed that microwave processing of chicken parts was not effective as a hot water processing in reducing surface bacteria. They postulated the higher count obtained in microwave cooking was due to non uniform exposure of all surfaces in the microwave treatment.

The following practices should be taken to obtain safe microwave cooked food:

1- Foods reheated in a microwave ovens should be "piping hot" with an internal temp exceeding 74°C in all areas.

2- Frozen foods should be completely defrosted because microwave cooking of partially thawed food enhances uneven heating .

3- To improve the efficiency of microwave ovens, cover poultry with wax paper during microwave cooking and check the internal temp of the product at best three different site.

4- In the absence of rotating microwave pad, rotate foods manually several times during microwave cooking.

5- Place thicken portions of foods towards the exterior of the microwave dish.

6- Microwave cooking instructions on the label of prepackaged foods may not guarantee appropriate cooking for every make and model of microwave oven.

7- Make sure that products are thoroughly cooked. In addition, microwave manufacturers should improve on the clarity of cooking instructions as some were found to be confusing and/or misleading.

Table (1): Effect of microwave cooking of food samples (Fish, Beef and Chicken) on total aerobic bacterial counts

Food sample	Uncooked samples (n=50)						Post-microwave cooked samples (n=50)												$F_{5\%}$	LSD
							Immediately						After 6 hours							
	+ve	%	Min log CFU/g	Max log CFU/g	mean log CFU/g	SD ± SE	+ve	%	Min log CFU/g	Max log CFU/g	mean log CFU/g	SD ± SE	+ve	%	Min log CFU/g	Max log CFU/g	mean log CFU/g	SD ± SE		
Fish	50	100	2.602	8.973	5.700	1.438 ± 0.203	7	14	2.699	4.892	3.651	0.659 ± 0.249	3	6	4.505	5.491	4.870	0.541 ± 0.312	7.269*	1.832
Meat	50	100	3.301	8.602	5.627	1.320 ± 0.187	7	14	2.176	4.813	3.066	0.998 ± 0.377	5	10	3.716	5.914	5.011	0.833 ± 0.372	12.750*	1.440
Chicken	50	100	3.663	7.898	5.863	1.108 ± 0.157	10	20	1.903	3.845	2.978	0.614 ± 0.194	4	8	3.954	4.279	4.159	0.148 ± 0.074	35.926*	0.750

n = Number of examined samples.
+ve = Number of samples showing growth.
SD = Standard deviation.
SE = Standard error.

Table (2): Effect of microwave cooking of food samples (Fish, Beef, and Chicken) on total yeast and mould counts

Food sample	Uncooked samples (n=50)						Post-microwave cooked samples (n=50)												$F_{5\%}$	LSD
							Immediately						After 6 hours							
	+ve	%	Min log CFU/g	Max log CFU/g	mean log CFU/g	SD ± SE	+ve	%	Min log CFU/g	Max log CFU/g	mean log CFU/g	SD ± SE	+ve	%	Min log CFU/g	Max log CFU/g	mean log CFU/g	SD ± SE		
Fish	49	98	1.954	7.505	4.995	1.348 ± 0.193	14	28	2.041	4.322	3.075	0.750 ± 0.200	8	16	1.954	5.690	4.100	1.183 ± 0.418	13.584*	1.076
Meat	50	100	2.447	7.978	5.327	1.385 ± 0.196	12	24	1.477	4.322	2.945	0.798 ± 0.230	11	22	1.699	5.959	4.279	1.250 ± 0.377	17.426*	1.056
Chicken	48	96	1.845	7.041	4.479	1.394 ± 0.201	7	14	2.146	4.204	3.238	0.714 ± 0.270	6	12	3.699	6.602	4.509	1.183 ± 0.483	2.748	1.442

n = Number of examined samples.
+ve = Number of samples showing growth.
SD = Standard deviation.
SE = Standard error.

Table (3): The percent of survival of food poisoning micro-organisms isolated from uncooked and post microwave cooked fish samples

Organism	Un cooked samples		Post microwave cooked samples			
			Immediately		After of hours	
	+ve	%	+ve	%	+ve	%
Salmonella	5	10	-	-	-	-
Shigella	2	4	-	-	-	-
Staphylococcus aureus	14	28	2	4	1	2-
Listeria monocytogenes	-	-	-	-	-	-

Table (4): The percent of survival of food poisoning micro-organisms isolated from uncooked and post microwave cooked beef samples

Organism	Un cooked samples		Post microwave cooked samples			
			Immediately		After of hours	
	+ve	%	+ve	%	+ve	%
Salmonella	3	6	1	2	1	2
Shigella	1	2	1	2	-	-
Staphylococcus aureus	12	24	5	10	1	2
Listeria monocytogenes	-	-	-	-	-	-

Table (5): The percent of survival of food poisoning micro-organisms isolated from uncooked and post microwave cooked chicken samples

Organism	Un cooked samples		Post microwave cooked samples			
			Immediately		After of hours	
	+ve	%	+ve	%	+ve	%
Salmonella	2	4	1	2	1	2
Shigella	2	4	-	-	-	-
Staphylococcus aureus	8	16	3	6	1	2
Listeria monocytogenes	-	-	-	-	-	-

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الملخص العربى

دراسة ميكروبيولوجية على بعض الأطعمة المطهية بالميكروويف

د/ مرفت كمال إبراهيم د/ نبيله فؤاد السيد

قسم صحة الأغذية بمعهد بحوث صحة الحيوان - الإسكندرية

لقد تم جمع ١٥٠ عينة من اللحوم الطازجة المختلفة وتشمل ٥٠ عينة من لحوم الأسماك، ٥٠ عينة من اللحوم الحمراء، ٥٠ عينة لحوم الدواجن من أسواق الإسكندرية المختلفة وقد أجرى على جميع العينات الفحص الميكروبيرلوجى وهى فى الحالة الطازجة قبل الطهى، كذلك بعد الطهى بالميكروويف مباشرة، وبعد الطهى بالميكروويف بست ساعات وقد أوضحت النتائج مايلى :

- متوسط العدد الكلى الهوائى البكتيرى للحوم الأسماك الغير مطهية، كذلك اللحوم الحمراء، كذلك لحوم الدواجن : لوغاريتم 5.7 ، لوغاريتم 5.627 ، لوغاريتم 5.863 خلية / جم على التوالى.
- العد الكلى الهوائى البكتيرى للحوم الأسماك واللحوم الحمراء، ولحوم الدواجن المطهية بالميكروويف بعده مباشرة، بعد ٦ ساعات من الطهى : لوغاريتم 3.65، لو3.066، لوغاريتم 2.978 خلية / جم على التوالى، وبالإضافة إلى ذلك وجد أن نسبة الميكروبات فى لحوم الأسماك سواءاً المطهية بالميكروويف بعدها مباشرة أو بعد الطهى بست ساعات هى 14%، 6% على التوالى.
- نسبة الميكروبات فى اللحوم الحمراء المطهية بالميكروويف بعد الطهى مباشرة تقل من 100% فى اللحوم الغير مطهية إلى 14% و10% ، حالة لحوم الدواجن تقل إلى 20% المطهية بعد الميكروويف مباشرة و 8% بعد الطهى بست ساعات.
- لوحظ أن متوسط قيم العد الكلى للفطريات والخمائر فى لحوم الأسماك لو 4.995 جم/خلية للأسماك الغير مطهية، لوغاريتم 3.075 بعد الطهى مباشرة، 4.100 بعد الطهى بست ساعات.
- وفى حالة اللحوم الحمراء، وجد أن أعلى قيمة لمتوسط العد الكلى للفطريات والخمائر (لوغاريتم 5.327 جم / خلية) يليه بعد الطهى مباشرة (لوغاريتم 2.945 جم / خلية) ثم بعد الطهى بست ساعات. (لو4.279جم/خلية). وجد أن 28% من عينات لحوم الأسماك بعد الطهى مباشرة بها نمو للفطريات والخمائر، ولكن بعد الطهى بست ساعات كانت النسبة 16%.
- لوحظ 24% من عينات اللحوم الحمراء بعد الطهى مباشرة بها نمو للفطريات والخمائر ولكن كانت النسبة بعد الطهى بست ساعات 22%.
- فى حالة لحوم الدواجن فإن متوسط العد الكلى للفطريات والخمائر كالآتى : لو 4.479،3.238،4.509 قبل الطهى، بعد الطهى مباشرة، بعد الطهى بست ساعات على التوالى.
- نسبة نمو الفطريات والخمائر يقل فى لحوم الدواجن بعد الطهى بالميكروويف من 96% فى اللحوم الغير مطهية إلى 14% بعد الطهى مباشرة، 12% بعد الطهى بست ساعات.
- وقد أوضحت الدراسة أيضاً أن نسبة نمو السالمونيلا، الشيجيلا والمكور العنقودى المعزولة من عينات الأسماك الغير مطهية كالآتى : 10%، 4%، 28% على التوالى ولكن بعد الطهى بالميكروويف مباشرة كانت النسبة 0%، 0%، 4% ، بعد

الطهى بست ساعات كانت 0%, 0%, 2% على التوالى.

- كما وجد أن عينات اللحوم الحمراء الغير مطهية تم عزل ميكروبات السالمونيلا والشيجيلا، المكور العنقودى وكانت النسبة كالآتى : 6%, 2%, 24% على التوالى ولكن بعد الطهى بالميكروويف قلت النسبة إلى 2%, 0%, 2% .
- لايوجد ميكروب الليستيريا قبل أو بعد الطهى بالميكروويف فى اللحوم.
- فى حالة لحوم الدواجن، لقد تم عزل ميكروبات السالمونيلا، الشيجيلا، المكور العنقودى وكانت النسبة 4%, 4%, 16% على التوالى فى حالة لحوم الدواجن الغير مطهية، قلت إلى 0%, 6%, 2% على التوالى فى حالة بعد الطهى مباشرة، فى حالة بعد الطهى بست ساعات كانت النسبة 2%, 0%, 2% على التوالى.
- لقد أوضحت هذه الدراسة بصفة عامة مدى تأثير أفران الميكروويف المستخدمة فى طهى الأطعمة على تقليل العد الكلى البكتيرى الهوائى والعد الكلى للفطريات والخمائر وكذلك نسبة الميكروبات الممرضة تقل بعد الطهى بالميكروويف مثل ميكروب السالمونيلا، الشيجيلا والمكور العنقودى والليسيريا لم يتم عزلها سواء قبل أو بعد الطهى الميكروويف.