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THE INFLUENCE OF MICROWAVE AND FRYING COOKING ON NUTRITIVE VALUE AND BACTERIOLOGICAL STATUS OF SOME FAST MEAT PRODUCTS

(With 3 Tables)

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تأثير الطهى بالميكروويف والقلى على القيمة الغذائية والحالة البكتيريولوجية لبعض منتجات اللحوم سريعة التحضير

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تعتبر اللحوم من الاغذية التى تجمع بين القيمة الغذائية والفائدة الصحية وعلى الرغم من ذلك فقد تعتبر مصدرا لبعض الميكروبات اذا تم تصنيعها تحت ظروف غير صحية. وهذه الدراسة صممت لتوضيح تأثير طريقة الطهى بالقلى وطريقة الطهى بالميكروويف على القيمة الغذائية والحالة البكتيريولوجية لبعض منتجات اللحوم السريعة الطهى (همبورجر اللحم ،السجق والكفتة). وقد تبين من النتائج ان الطهى بالميكروويف أسفرعن زيادة نسبة فقد الرطوبة بالمقارنة بطريقة الطهى بالقلى مع انخفاض طفيف فى نسبة البروتين والدهون والكربوهيدرات والرماد فى العينات التى خضعت للاختبارات الكيميائية. وأسفرت النتائج ايضا أنة لا يوجد اختلافات ملحوظة فى القيم الغذائية فى العينات التى تم طهيها بالقلى او بطريقة الميكروويف. وعلى الجانب الاخرفقد أسفرت نتائج الاختبارات البكتريولوجية التى أجريت على العينات المختبرة عن كفاءة الميكروويف فى تدمير بعض الميكروبات المسببة للتسمم الغذائى وانخفاض العدد الكلى البكتيرى بدون احداث تغيرات فيزيائية لمنتجات اللحوم. هذا وقد تم مناقشة تأثير كل من الطهى بالقلى والطهى بالميكروويف على القيمة الغذائية وعلى العدد الكلى لبعض الميكروبات المسببة للامراض ومناقشة بعض التوصيات التى يجب اتباعها للتأكد من جودة وأمان بعض منتجات اللحوم التى تم طهيها بهذه الطرق وأهميتها الصحية.

SUMMARY

This study was designed to investigate the effect of conventional and microwave cooking methods on nutritive value and bacteriological status of some fast meat products (beef burger, sausage and kofta). The microwave cooking method resulted in higher moisture losses compared with conventional method with minimal nutritional effect on protein, lipid, carbohydrate and ash in the examined samples subjected to chemical examinations. There were no nutritional differences between food prepared by conventional and microwave methods. Bacteriological examination revealed the efficiency of microwave oven in the destruction of some pathogenic micro-organisms and reduction of bacterial numbers without causing physical changes to meat. The public health significance and the recommendations to ensure safety and quality of some meat Products were discussed.

Key words: *Fast meat products, nutritive value, microwave and frying cooking, bacteriology.*

INTRODUCTION

Meat is well known as an excellent protein and energy source for our daily diets and after digestion provides excellent nutrition (Chang and Huang, 1991). In most countries, meat consumption increases as economic development improves (Fuller, 1996). In the last two decades, there are noticeable changes in the behaviour of Egyptian consumer which was due to social and economic consideration; many people eat fast food giving the consumer many choices over the food which can eat. Meat products such as burgers, sausages and kofta are widely accepted and consumed by all ethanic groups at home as well as in the fast food restaurants.

Cooking is a heat treatment of food to make it more palatable digestible and safe. It breaks down connective tissues in meat making it tender and soft. The method of cooking can be classified according to the method of heat transfer to the food. Conduction of heat is used when cooking in a liquid medium, boiling, stewing and pot- roasting and pressure cooking are most suitable for food that requires the penetration of water to soften or tenderize the structure of food such as meat. Convection of heat is used in steaming and is most suitable for tender foods that will cook by heat transmitted. Radiant heat is used in grilling,

roasting, these methods being best suited to tender foods and microwave cooking (Williams, 2007). Due to the rapid and continuous increase in the number of peoples that eat fast food, the need to change the conventional method of cooking to another faster method seems to be urgent.

The microwave oven is one of the great inventions of the 20th century; over 90% of homes have at least one. Microwave ovens can play an important role at mealtime. Microwave cooking has gained considerable importance as an energy saving, convenient and time saving cooking method. Microwaves are electromagnetic waves of radiant energy differing from such other electromagnetic radiant as light and radio waves only in wavelength and frequency (Noverman and Joseph, 1995). The primary advantage of microwave heating is the reduction in cooking time to one fourth or less time than in a conventional oven, but using microwave with high power to be more faster may cause increase cooking losses in meat, but one disadvantage of microwave is that surface browing doesn't occur to produce a flavorful browned exterior (Food Theory and Application, 1992).

The significant expansion of the fast food industry and the increased consumption of processed meat products make it necessary for a re-evaluation of the nutritional and bacteriological quality of popular meat products currently available in the market. Therefore, the present study was undertaken to investigate the effect of frying method (Conventional method of cooking) and microwave cooking on the nutritive value and bacteriological status of some fast meat products (beef burger, sausage and kofta) and discuss the recommendation which must be follow to prevent food borne illness.

MATERIALS and METHODS

Meat samples:

A total of one hundred and thirty five random samples (45 of each beef burger, sausage and kofta) were purchased from different supermarkets in Port-Said governorate. Samples were transferred in an ice box to the lab to be analyzed chemically and bacteriologically.

Equipment:

Microwave irradiation was performed in a household microwave oven (Clatronic, type MWG-748, with a rotating glass plate, a frequency of 2, 450 MHZ, and power of 850W).

Heat treatment of samples:

Each type of sample was divided into 3 portions. The first 2portions were cooked by conventional (frying) and microwave methods and the 3rd portion remained uncooked (raw). Samples were subjected to the following examinations:

1- Chemical examinations:

Moisture content: Samples were ground using mortar and the atmospheric oven method was used to determine the moisture content according to AOAC (1990).

Carbohydrate content was done according to AOAC (1990).

Protein content was done according to AOAC (1990).

Fat content was done according to AOAC (1986).

Ash was determined according to the Person's chemical analysis of food (Quasem *et al.*, 2009).

2 - Bacteriological examinations:

All samples were subjected to the following examinations according to the relevant methods.

1- Total aerobic bacterial count:

The count was carried out by pouring plate method as recommended by ISO 4833-1(2003).

2- *Staphylococcus aureus* count: Technique using Baired Parker agar medium according to ISO 6888(2003) was followed.

3- Detection and isolation of S*almonella*: was dome as recommended by ISO 6579 (2002) .

4- Isolation and identification of *E.coli* Using Eosine methylen Blue medium according to ISO 7251(2005). Colonies on plates were manually counted as colony forming units per gram of samples (cfu/g). The minimum, maximum and mean of these records were tabulated and statistically analyzed to calculate the standard deviation and standard error using Microsoft excel 2003.

On the other hand colonies suspected to be *Salmonella* or *E.coli* were identified biochemically and serologically according to the methods outlined by ISO 6579(2002) and ISO 7251(2005).

RESULTS

Table 1: Chemical examination of some raw meat products and cooked either by conventional or microwave method (15 each).

Content		Beef burger			Sausage			Kofta		
		R	C	M	R	C	M	R	C	M
Protein%	Min	16.69	14.03	10.32	10.09	11.8	9.19	16.86	16.70	16.60
	Max	18.90	15.86	14.0	19.25	20.12	18.55	18.30	18.20	18.15
	Mean	17.8o	14.59	11.64	24.86	15.12	12.45	17.84	17.73	16.89
	SE ±	0.87	0.77	0.22	1.03	1.40	1.18	0.84	0.82	0.78
Fat %	Min	14.72	17.22	16.90	19.50	18.75	15.15	16.26	14.60	13.42
	Max	20.62	27.08	22.70	27.45	25.75	19.75	18.56	16.24	18.38
	Mean	20.25	22.77	18.44	20.58	22.64	18.00	16.25	18.07	15.40
	SE ±	0.17	1.40	0.54	0.95	1.03	0.44	0.40	0.86	0.81
Moisture loss	Min	40.88	47.25	52.64	38.31	39.90	43.13	51.54	55.17	57.98
	Max	47.07	58.00	63.54	59.50	59.96	63.61	60.07	62.26	64.11
	Mean	43.13	53.60	57.27	52.79	55.25	58.04	55.58	58.49	61.93
	SE ±	0.66	0.78	0.76	3.43	3.48	4.97	0.48	0.87	1.35
Ash%	Min	2.10	3.20	3.40	2.10	2.50	2.00	2.40	3.10	3.30
	Max	3.50	4.60	4.60	3.50	4.40	5.40	3.50	3.70	3.70
	Mean	2.89	3.80	3.80	2.60	3.16	3.00	2.94	3.38	3.48
	SE ±	0.62	0.81	0.37	0.50	0.18	0.48	0.32	0.38	0.40
Carbohydrate%	Min	8.13	8.15	7.58	7.83	7.80	7.50	7.80	7.50	7.20
	Max	18.00	17.00	14.24	18.50	16.20	16.00	18.50	18.00	18.20
	Mean	11.83	11.63	11.03	11.61	11.02	11.06	11.75	11.70	11.80
	SE ±	1.41	1.30	0.84	1.31	1.32	1.31	0.65	0.63	0.60

Sample key
R: Raw material **C:** Conventional method **M:** Microwave
Mean: Mean value **Min.:** Minimum **Max.:** Maximum
SE: Standard Error

Table 2: Statistical values for bacteriological quality of some raw meat products and cooked either by frying or microwave method (15 each).

Count		Beef burger			Sausage			Kofta		
		R	C	M	R	C	M	R	C	M
A.P.C	Min	3×10^3	2×10^3	2×10^3	9×10^4	6×10^4	6×10^4	8×10^4	5×10^4	3×10^4
	Max	22×10^4	4×10^4	3×10^4	6×10^6	4×10^6	2×10^6	6×10^8	4×10^8	2×10^8
	Mean	8×10^3	4×10^3	3×10^3	99×10^4	6×10^4	2×10^4	2×10^6	1×10^6	1×10^6
	SE±	9×10^3	6×10^3	2×10^3	9×10^4	5×10^4	4×10^4	2×10^4	1×10^4	1×10^4
Staph. aureus	Min	4×10^2	3.6×10^2	3×10^2	3×10^3	2×10^3	1×10^3	7×10^2	5×10^2	4×10^2
	Max	4×10^3	3×10^3	2×10^3	7×10^4	3×10^4	1×10^4	6×10^3	4×10^3	3×10^3
	Mean	8×10^2	7×10^2	6×10^2	7×10^2	4×10^2	3×10^2	6×10^2	5×10^2	3×10^2
	SE±	2×10^2	1×10^2	1×10^2	1×10^2	1×10^2	1×10^2	2×10^2	1×10^2	1×10^2

Sample key
R: Raw material **C**: Conventional method **M**: Microwave
Mean: Mean value **Min.**: Minimum **Max.**: Maximum
SE: Standard Error

Table 3: Incidence of some food poisoning micro-organisms isolated from some meat products either raw or cooked by conventional and microwave method (15 each).

Organism	Beef burger						Sausage						Kofta					
	R		C		M		R		C		M		R		C		M	
	No	%	No	%	No	%	No	%	No	%	No	%	No	%	N0	%	N0	%
Salmonella	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
E.coli	0	0	0	0	0	0	0	0	0	0	0	0	1	6.7	0	0	0	0

Sample key
R: Raw material **C**: Conventional method **M**: Microwave

DISCUSSION

1- Chemical examinations:

Table 1 shows protein, fat, moisture loss, and ash and carbohydrate contents of beef burger, sausage and kofta. The mean values of protein in beef burger were17.80±o.87, 14.59±0.77 and11.64±0.22 for raw burger and for conventional and microwave cooked burger respectively, and were 24.86±1.03, 15.12±1.40 and 12.45±1.18 in raw, fried and microwave cooked sausage respectively. The mean values of protein were 17.84±0.84; 17.73±0.82 and 16.89±0.78 in raw, fried and microwave cooked kofta respectively. This slight reduction may be attributed to destruction of the nutritive value of nucleoproteins in meats. Concerning fat % the mean values were 20.25±0.17 in raw beef burger and 22.77±1.40 and 18.44±0.54 in beef burger cooked by frying and microwave method respectively. In sausage samples, the mean values of fat% were 20.98±0.95, 22.64±1.03 and 18.00±0.44 in raw, fried and microwave cooked sausage respectively. But the mean values of fat% were 16.25±0.40, 18.07±0.86 and15.40± 0.81for raw, fried and microwave cooked kofta respectively.

Moisture loss in beef burger varied according to the used methods of cooking where the mean values 43.13±0.66, 53.60±0.78 and 57.27±0.76 for raw, fried and microwave cooked burger respectively. Whereas they were 52.79±3.43, and 55.25±3.48 and 58.04± 4.97 for raw, fried and microwave cooked sausage respectively, but in kofta, the mean values of moisture loss were 55.58±0.48 and 58.49±0.87 and 61.93±1.35, for the tested meat products respectively. As for ash the mean values were 2.98±0.62, 3.8±0.81 and 3.8±0.37 in raw, fried and microwave burger respectively, while in sausage they were 2.6±0.5, 3.16±0.18 and 3±0.48 in the same manner as before. The corresponding values for kofta were 2.94±0.32, 3.38±0.38 and 3.48±0.40 in raw, conventional and microwave cooked kofta respectively.

On the other hand, the mean values of carbohydrates in raw burger, raw sausage and raw kofta were 11.83 ± 1.41, 11.61±1.31 and 11.75±o.65. Whereas they were 11.63±1.30, 11.02±1.32 and 11.70±0.63 in burger, sausage and kofta samples cooked by frying respectively. Furthermore 11.03±0.84, 11.06±1.31 and 11.80±0.60mean carbohydrates content of burger, sausage and kofta samples cooked by microwave respectively.

From the achieved results, we noticed slight decrease in protein % in burger, sausage and kofta cooked by microwave with higher moisture loss in burger, sausage and kofta compared with conventional method. Also our results showed that the ash % in beef burger, sausage and kofta cooked by microwave is slightly high as compared with that cooked by conventional method but the fat % in our results was elevated in the samples cooked by frying as compared with cooked by microwave. While the carbohydrate % showed no changes in all meat product samples either cooked by conventional or microwave method. These obtained results agreed with that of Juarez *et al.* (2007). They investigated that, the influence of boiling, grilling and frying cooking method on the chemical and lipid composition of meat product caused reduction of protein%, elevation of moisture loss, ash and fat content which increased after frying. This may be attributed to the incorporation of fat from olive oil, then the lipid fraction proportions were affected by frying in which glycerides increased. Also the obtained results were coincide with Noverman and Joseph (1995) who reported that, the nutritional effects of microwaves on protein and lipid were minimal and there were no effects of microwave on carbohydrate fraction in mean value foods. Moreover, the present results were in line with the findings of Abd–Elaziz (2002) and Gross and Fung (1982) who reported that microwave cooking resulted in higher moisture losses compared with conventional method and the nutritional effect of microwave on protein, lipid and minerals were low and there were no nutritional differences exist between food prepared by conventional and microwave method. Meanwhile, Dahi and Mattheus (1980) noticed that, the moisture and fat content of food decreased as the time of microwave heating increased.

Bacteriological examinations:

Bacteriological examinations of all the examined samples were tabulated in Table 2. The mean values of APC in beef burger were $8 \times 10^3 \pm 9 \times 10^4$, $4 \times 10^3 \pm 6 \times 10^3$ and $3 \times 10^3 \pm 2 \times 10^3$ in raw burger and cooked either by conventional and microwave method respectively while that of *S. aureus* were $8 \times 10^2 \pm 2 \times 10^2$, $7 \times 10^2 \pm 1 \times 10^2$ and $6 \times 10^2 \pm 1 \times 10^2$ for raw, fried and microwaved burger respectively. As for sausage, the mean values of APC were $99 \times 10^4 \pm 9 \times 10^4$, $6 \times 10^4 \pm 5 \times 10^4$ and $2 \times 10^4 \pm 4 \times 10^4$ for raw, fried and microwave cooked sausage and were $7 \times 10^2 \pm 1 \times 10^2$, $4 \times 10^2 \pm 1 \times 10^2$ and $3 \times 10^2 \pm 1 \times 10^2$ for Staph. aureus count respectively. On the other hand, the mean value of APCand Staph. aureus count for kofta were $2 \times 10^6 \pm 2 \times 10^4$, $1 \times 10^6 \pm 1 \times 10^4$ and $1 \times 10^6 \pm 1 \times 10^4$ and $6 \times 10^2 \pm 2 \times 10^2$, $5 \times 10^2 \pm 1 \times 10^2$ and $3 \times 10^2 \pm 1 \times 10^2$ for raw, fried and micro waved cooked

kofta respectively. These results agree with that obtained by Abd-ELaziz (2002). The achieved results in Table 3 revealed that, *Salmonella* could not be isolated from the examined samples but *E.coli* can be isolated from raw kofta at an incidence of 6.75% which is considered higher than those reported by Abd-ELaziz (2002) and lower than those reported by *Roushdy* (1971) and EL-Fekey (1982). The presence of *Staph. aureus* in some meat products may be originated from staphylococcal infections in meat (W.H.O, 1957), Also presence of *Staph. aureus* in some examined meat products indicates its contamination from skin, mouth or nose of food handlers. From the zoonotic point of view the consumption of kofta contaminated with *E.coli* can lead to food poisoning in the form of vomition ,diarrhea and sever enteritis in man (Betty and Richard, 1978).

On the other hand *E.coli* could not be isolated from all samples cooked by both methods of cooking, this attributed to the effect of microwave and conventional cooking on the temperature profiles and microbial flora of minced meat. These results agreed with Arias *et al.* (1997) who studied the efficiency of microwave oven in the destruction of some pathogenic micro-organisms, bacteriological analysis showed that, despite the cooking level used the time required for elimination of *Staph. aureus* and *Salmonella* was greater than that in which the meat was considered enzymatically and organolyptically cooked. In this concern, *Goksoy et al.* (1999) found microwave energy had the potential to raise the surface temperature of meat rapidly for short period of time sufficient to reduce bacterial numbers significantly without causing physical changes to meat.

Also Hollywood *et al.* (1991) studied the effect of microwave and conventional cooking on the temperature profiles and microbial flora of minced meat. They found that some of the microbial flora survives in all samples cooked by microwaves with standing period and samples cooked to rare and medium by conventional oven. Meanwhile Gessner and Beller (1994) stated that comparing with conventional methods of cooking, microwave ovens had no protective effecting preventing illness.

FSIS (2000) mentioned that, microwave ovens can play an important role at meal time, but special care must be taken when cooking or re-heating meat to make sure that they were prepared safely. Microwave ovens can cook unevenly and leave "cold spots" where harmful bacteria can survive. For this reason, Food Science Nutrition

(1982) recommended that it is important to use the following safe microwaving steps to prevent food borne illness.

1- Bacteria will be destroyed during microwave cooking just as in other types of ovens, so food is safe cooked in microwave oven; however the food can cook less evenly than in a conventional oven. Microwave cooking can be uneven just as with frying and grilling. For that reason, it is important to use a food thermometer and test food in several places to be sure it has reached the recommended temperature (160Ċ for red meat to destroy bacteria and other pathogenic that could cause food borne illness.

2- Microwave oven are safe to use for destroy, reheating, and cooking. However cold spots can occur in microwaved foods because of the irregular way the microwaves enter the ovens and are absorbed by the food if food doesn't cook evenly, bacteria may survive and cause food-borne illness. Simple techniques to minimize the cold or twice during microwaving, arranging food uniformly in a covered dish (plastic wrap or a lid which doesn't touch the food loosen the wrap to allow steam to vent. the moist heat that is created will help destroy harmful bacteria and ensure uniform cooking), and turning large foods upside down during cooking.

3- Arrange food items evently in a covered dish and add some liquid if needed. Cover the dish with a lid and loosen the lid to let steam escape. The created moist heat will help the destruction of harmful bacteria and ensure uniform cooking.

4- Don't cook large cuts of meat on high power. Large cuts of meat should be cooked on medium power for longer periods. This allows heat to reach the center without over cooking outer areas.

5- Stire or rotate food midway through the microwaving time to eliminate cold spots where harmful bacteria can survive.

6- Only use cook wave that is specially manufactured for use in the microwave oven.

7- Never use thin plastic storage bags, newspapers or aluminum foil in the microwave oven.

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