National Center for Radiation Research and Technology.

THE EFFECT OF SAFE IRRADIATION ON THE BACTERIOLOGICAL AND CHEMICAL STATE OF SOME CAMEL'S MEAT PRODUCTS

(With 4 Tables)

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تاثير تعرض بعض منتجات لحوم الجمال للاشعاع الآمن على الحالة البكتيريولوجية والكيميائية

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أجـرى هـذا البحث على عدد ستون عينة من منتجات لحوم الجمال المعروضة فى أسواق القاهرة والجيزة (٢٠ من كل من خلطه الحواوشى، اللحم المفرى وكفته الارز الجملى) وذلك لتقييمها من الناحيه البكتيريولوجيه والكيميائية وتقييم مدى تلوثها بالميكروبات واستخدام أشعة جامـا كوسـيلة لتقليل الحمل البكتيرى والقضاء على الميكروبات الممرضة بتلك المنتجات واسفرت النتائج عن وجود اعداد مرتفعة من البكتريا الهوائية فى العينات التى فحصت وذلك قـبل معالجتها بالاشعاع وبعض العينات وجدت ايجابية العزل لبعض الميكروبات التى تسبب تسمم غذائى وفساد للمنتجات مثل ميكروب الباسيلس سيرس والسالمونيلا والمكور العنقودى الذهـبى وأدى تعـريض المنتجات لاشعة جاما بجرعات ٢ ، ٣ ، ٣,٥ ، ٤كيلو جراى الى انخفـاض ملحوظ فى الاعداد الكلية للميكروبات التى سبق عزلها بدرجات تتناسب مع مقدار الجرعة المستخدمة. كما ادى استخدام الجرعه الاشعاعية ٣,٥ كيلو جراى الى القضاء تماما على الميكروبات التى سبق عزلها وتقليل العد الكلى للميكروبات ، بينما التعريض للجرعة ٤ كـيلو جـراى كانـت كافية للقضاء على العد الكلى للميكروبات المعزولة سابقا. ووجد ان اسـتخدام اشعة جاما لم يوثر على العينات من ناحية خواصها الكيميائية وايضا لم يسجل اى تغـير فـى الصـفات الطبيعية لتلك المنتجات ومن نتائج هذه الدراسة يتضح انه من الممكن تعـريض المنتجات لجرعات حتى ٣,٥ كيلو جراى وذلك لضمان سلامة المنتج من الناحية الصحية وايضا لاطالة فترة صلاحية المنتج.

SUMMARY

The microbial contents of 60 samples of commercial camel's meat products (20of each hawawshi, minced meat and rice kofta) purchased from retail markets in Cairo and Giza; as well as the effect of gamma irradiation on the microbial population of these products were

investigated, high aerobic plate counts (10^6 cfu/g) were recorded in the samples examined before irradiation, and some samples were contaminated with pathogens such as *Bacillus cereus, Salmonella* and *Staphylococcus aureus*. Irradiation of the products with doses of 2, 3, 3.5 and 4kilogray(KGy) led to reduction in the bacterial counts and pathogens with the different doses. Whereas the use of the dose 3.5kGy was sufficient to reduce the detection of *Bacillus cereus*, *Salmonella and Staphylococcus aureus*, while the exposure to 4 KGy was sufficient to completely eradicate the initial bacterial density from the products. The major chemical constituents of the examined products and their sensory characters did not changed with irradiation at doses up to 4 KGy. On the basis of economic considerations and from the results of this study 3.5 KGy could be recommended for irradiation of the camel's meat products.

Key words: *Irradiation, camel's meat, meat products.*

INTRODUCTION

In Egypt, camel's meat makes up an important part of the dietary proteins especially for the lower income groups (Shalash, 1979). Camel's meat products are new products appear in the Egyptian markets. El-Amin (1979), found that the use of camel's meat for sausage eliminates its toughness, make the meat easily cured, and its high protein content provides good caloric value. They are also cheaper than sausages made from other meat. Processing and packaging of meat and meat products at ambient temperature may lead to biochemical changes due to the microbial growth. As well as deterioration may occur faster because of the high contamination, mincing and the high ambient temperature (Kalalou, 2004), while freezing of these products might act as preserving agent, which keep certain pathogenic organisms in a dormant state, but when the conditions become favorable for their growth they will create a hazardous problem. Hence, the performance of irradiation might be of importance. Since 1976 application of gamma irradiation techniques under specific restrictions approved to be a satisfactory method for shelf life extension by reduction of the microbial load of foods and ensuring the keeping quality of food without changing their nutritive and sensory characters (WHO, 1988 and Patterson *et al.* 1998). In 1985, Food and Drug Administration (FDA) increased the allowed uses of irradiation of foods such as strawberries, poultry, ground beef and pork. Over 30 years of toxicological, carcinogenic and tetratogenic studies covering different

foods revealed that no evidence of significant toxicological compounds with up to 10 KGy dose which make such foods safe (WHO, 1981 and Elias, 1983). The WHO also views food irradiation as a safe and effective process in the fight against food borne diseases and food losses (kaferstein, 1992). Some of the microorganisms such as *Salmonella*, *Staphylococcus auras* and *Bacillus cereus* may contaminate the camel's meat products during their processing but *Salmonella* and *Staphylococcus auras* can be eliminated or greatly reduced in number, depending upon the level of contamination from meat products by gamma radiation doses between 1.5 – 3.0 KGY, while the high dose may result in development of undesirable flavors, odors and colors as well as losses of nutrients (Banwart, 1981).

Therefore, the aim of the present work was to study the effect of different doses of gamma irradiation on the chemical constituents, microbiological patterns and organoleptic assessments of irradiated camel's meat products to establish the least applicable irradiation dose for these products.

MATERIALS and METHODS

A total of 60 samples of camel's meat products, 20each of hawawshi, minced meat and rice kofta were collected from Cairo and Giza markets, then transported to the laboratory in an ice box without delay for sensory, bacteriological and chemical examination. The samples were exposed to different doses of irradiation and re-examined for sensory, bacteriological and chemical changes.

I- Sensory examination:

The samples were examined for the color, odor and texture by single number of panel judger's using 9 – points hedonic scales as the method described by FAO/IAEA (1970).

II- Bacteriological examination:

Preparation of samples: The method recommended by AOAC (1990) was applied for preparation of decimal serial dilutions up to 10^6.

1-Aerobic plate count (ICMSF, 1978): The spread technique was adopted onto standard plate count agar. Incubation at $37^{O}C$ for 24 hours was done.

2- Staphylococcus aureus count and isolation were carried out according to the technique recommended by FAO (1992) using Baired Parker medium incubated at $37^{0}C$ for 48 hours.

3- Enumeration of Bacillus cereus (ISO, 1987) using the spread technique over surface of Bacillus cereus selective agar plates and incubated at 37^0C for 24 hours.

4- Isolation of Salmonella according to Vassiliadis *et al.* (1978) using buffered peptone water 1% and incubated at 37^0C for 24 hours, then transferred to Rappaport`s Vassiliadis as enrichment medium at 43^0C for 48 hours. Xylose-Lysine Desoxycholate (XLD) agar media was used and incubated at 37^OC for 24 hours.

III- Irradiation of Camel's meat samples:-

The irradiation process was carried out using the Cobalt – 60 Egypt's Industrial Mega Gamma -1 Irradiator, located at the National Center for Radiation Research and Technology (NCRRT), Nasr City, Cairo, Egypt. The source was giving a dose rate of irradiation of about 6 KGy / hour at the time of experiments.

Frozen hawawshi, minced meat and rice kofta samples were kept in polyethylene bags marked with the specific dose of irradiation they would be exposed to. They were replaced in one layer inside the cell of irradiation source and then they were turned to the other side after half the time of the irradiation period to give the meat samples the accurate dose of irradiation homogeneously.

The doses of irradiation did not exceed 7 KGys as this was the maximum dose of irradiation that most microorganisms could not survive according to the ICMSF (1980).

Each kilo gray of Gamma irradiation took about 10 minutes of exposure to the source; so 1 KGy took about 10 minutes, 2 KGys took about 20 minutes of exposure to the Gamma source, 3 KGys took about 30 minutes of exposure to the Gamma source.....etc. according to the dose rate of the irradiation source at the time of experiment. Dose levels of 2, 3, 3.5 and 4 KGy were applied to the examined camel meat products.

Each irradiated sample was subjected to the bacteriological examination, biochemical identification and sensory evaluation.

IV-Chemical examinations:

1- Determination of pH value: Hydrogen ion concentration was measured by using digital pH meter according to the technique recommended by AOAC (1990).

2- Determination of moisture content: It was carried out according to AOAC (1990) using hot air oven.

3- Determination of total volatile basic nitrogen (TVB – N): It was carried out according to FAO (1980) using Conway apparatus.

4- Determination of thiobarbituric acid value (TBA): It was carried out according to Vyncke (1970).

RESULTS

Table 1: Effect of gamma irradiation on the initial contamination of camel's meat products.

Dose/KGy	The bacterial count	Hawawshi		Minced meat		Rice kofta	
		Count	Log	Count	Log	Count	Log
0.0	*APC*	$8.6x10^6$	6.9	$4.3x10^6$	6.6	$5.1x10^6$	6.7
	B.cereus	$1x10^3$	3.0	$1.1x10^3$	3.0	$1.8x10^5$	5.3
	Staph.aureus	$1.1x10^3$	3.0	$1x10^3$	3.0	$7.2x10^3$	3.8
2	*APC*	$3.7x10^5$	5.6	$3.7x10^5$	5.6	$1.8x10^5$	5.3
	B.cereus	$1x10^2$	2.0	$2.2x10^2$	2.3	$2.5x10^4$	4.4
	Staph. aureus	$1.6x10^2$	2.2	$1.6x10^2$	2.2	$2.2x10^2$	2.3
3	*APC*	$8.9x10^3$	3.9	$8.9x10^3$	3.9	$1.3x10^4$	4.1
	B.cereus	$<10^2$	<2	$<10^2$	<2	$1x10^3$	3.0
	Staph.aureus	$1x10^2$	2.0	$1x10^2$	2.0	$1x10^2$	2.0
3.5	*APC*	$2.1x10^2$	2.3	$2.1x10^2$	2.3	$1.1x10^3$	3.0
	B.cereus	$<10^2$	<2	$<10^2$	<2	$<10^2$	<2
	Staph. aureus	$<10^2$	<2	$<10^2$	<2	$<10^2$	<2
4	*APC*	$<10^2$	<2	$<10^2$	<2	$<10^2$	<2
	B.cereus	$<10^2$	<2	$<10^2$	<2	$<10^2$	<2
	Staph. aureus	$<10^2$	<2	$<10^2$	<2	$<10^2$	<2

Table 2: Effect of gamma irradiation on the incidence of some pathogenic organisms associated with camel's meat products.

Dose/KGy	The isolated bacteria	Hawawshi		Minced meat		Rice kofta	
		NO.	%	NO.	%	NO.	%
0	*B.cereus*	3	15	2	10	4	20
	Salmonella	1	5	1	5	1	5
	Staph.aureus	4	20	2	10	4	20
2	*B.cereus*	2	10	1	5	3	15
	Salmonella	1	5	0	0	1	5
	Staph.aureus	2	10	1	5	3	15
3	*B.cereus*	1	5	0	0	2	10
	Salmonella	0	0	0	0	0	0
	Staph.aureus	1	5	0	0	1	5
3.5	*B.cereus*	0	0	0	0	0	0
	Salmonella	0	0	0	0	0	0
	Staph.aureus	0	0	0	0	0	0
4	*B.cereus*	0	0	0	0	0	0
	Salmonella	0	0	0	0	0	0
	Staph. aureus	0	0	0	0	0	0

Table 3: Sensory evaluation of control and irradiated camel's meat products

Dose/Kgy	Appearance					Texture					Odor				
	0	2	3	3.5	4	0	2	3.5	3.5	4	0	2	3	3.5	4
Hawawshi	1.3	1.5	1.7	1.9	2.8	1	1.8	1.3	1.4	1.6	1.3	2.3	2.1	2	**1.5**
Minced meat	1.1	1.3	1.2	1.5	1.7	1	1.8	1.3	1.2	1.5	1.2	1.4	1.5	1.06	**1.3**
Rice kofta	**1.3**	**1.2**	**1.4**	**1.8**	**1.2**	**1**	**1.4**	**1.8**	**1.23**	**1.3**	**1.1**	**1.5**	**2**	**1.4**	**1.8**

Table 4: Effect of gamma irradiation on the chemical composition of camel's meat products.

Type of product	Chemical examination	Doses of irradiation / KGy				
		0	2	3	3.5	4
Hawawshi	PH	5.82	5.83	5.81	5.80	5.80
	Moisture	67.9	67.8	67.7	67.5	67.4
	TVB-N	10.51	10.53	10.54	10.55	10.57
	TBA	0.76	0.78	0.79	0.82	0.83
Minced Meat	PH	5.93	5.90	5.89	5.91	5.88
	Moisture	67.32	67.30	67.25	67.21	67.10
	TVB-N	11.32	11.33	11.34	11.36	11.38
	TBA	0.65	0.66	0.68	0.69	0.69
Rice Kofta	PH	6	5.98	5.96	5.83	5.91
	Moisture	78.4	78.3	78.1	77.9	77.8
	TVB-N	10.3	10.4	10.6	10.7	10.8
	TBA	0.75	0.76	0.77	0.79	0.79

DISCUSSION

Microbial changes:

The bacteriological examinations of retail packages of camel's meat products, i.e. refrigerated hawwshi, minced meat and rice kofta samples were carried out and their bacteriological aspects were evaluated. The data obtained (Table 1) indicated a wide variation in total bacterial populations in the different products and within samples of the same product, this variation may be attributed to the general conditions in handling of the product at manufacturing level and/or post manufacture storage conditions. The effect of different doses of gamma irradiation on the microbial content of hawwshi, minced meat and rice kofta were determined. Samples of each product were exposed to gamma radiation at dose levels of 2, 3, 3.5 and 4 KGy. Total counts were estimated before and after treatment. The results recorded in Table (1) showed that the mean values of total aerobic plate counts in unirradiated hawwshi, minced meat and rice kofta samples were $8.6x10^6$, $4.3x10^6$ and $5.1x10^6$; *B.cereus* mean counts were $1x10^3$, $1.1x10^3$ and $1.8x10^5$, and *Staph. aureus* counts were $1.1x10^3$, $1x10^3$ and $7.2x10^3$ respectively. Gamma irradiation reduced the initial total

bacterial counts; the microbial reduction increased as the irradiation dose level increased. Whereas, irradiation at 2kGy dose reduced the numbers of aerobic plate count by only one log cycle reduction, about three, four and more than four log cycles reduction occured at 3, 3.5, and 4 KGy respectively. Lefebvre *et al.* (1992) reported a three log reduction in aerobic bacteria in ground beef irradiated at 2.5 KGy, while El-Mongy *et al.* (2001) reported 3.6 log cycle reduction in total bacterial count in minced meat irradiated at 8 KGy. Monk *et al.* (1994) reported that application of dose 2.5 KGy was sufficient to kill 5.1 log cycles of *Staph. aureus* in ground beef.

The obtained results in Table (2) revealed that 15, 10 and 20% of hawawshi, minced meat and rice kofta samples, respectively, were positive for *B.cereus*. Similar results were recorded by Ouf (2004). On the other hand, 5% of all the examined samples were positive for *Salmonella*, nearly similar results were recorded by Ouf (2004) and Hassan and Antown (2005), while higher results recorded by El-Magoli *et al.* (2001). Also *Staph. aureus* was isolated from 20, 10 and 20% of the examined hawawshi, minced meat and rice kofta samples respectively, higher results were recorded by El-Magoli *et al.* (2001), Ouf (2004) and Hassan and Antown (2005). From these results, it could be concluded that hawawshi and rice kofta were highly contaminated with *B.cereus*, *Salmonella* and *Staph.aureus*. This indicates very bad and very low hygienic condition throughout the whole processing, handling, packaging and storage. Such contaminations may lead to reduction of shelf life and/or spoilage of the products.

Gamma irradiation reduced the microbial density. Results in Tables 1 and 2 revealed that irradiation at 3.5 KGy almost eliminated the pathogenic and indicator bacteria that contaminated the camel's meat products; Similar results were also reported for different meat products by Farkas and Andrassy (1993); Thayer (1993); Thayer and Boyd (1993); and Lee *et al.* (1995).

It can be concluded that, from the public health point of view, irradiation of camel's meat products can be effectively used as a supplement to refrigeration process. The most advantage feature of the application of ionizing radiation in preservation of the camel's meat products is the possibility of increasing safety and acceptability of the products.

Chemical changes:

Table (3) indicated that no obvious differences in appearance, texture and odor scores were observed between the unirradiated and

irradiated hawwshi, minced meat and rice kofta samples exposed to 2, 3, 3.5and 4 KGy. These findings agree with Thayer (1993) and Lagunas-Solar (1995).

Table (4) reveled that no significant changes could be detected in the pH values due to irradiation, it was also found that radiation has no effect on the major constituents as moisture of camel's meat products. These findings agreed with Josephson (1983) and Thayer (1990). Total volatile base nitrogen (TVB-N) tended to increase with the increase of radiation dose which agreed with Paul *et al.* (1990). Also TBA tended to increase with the increase in the radiation dose, this could be attributed to the formation of TBA reacting substances and/or the possibility that irradiation could activate the auto oxidation chain reaction as reported by Chipault and Mizuno (1966) and Savagoan (1972).

REFERENCES

A.O.A.C. (1990): Association of Official Analytical Chemists. Official Methods of Analysis.15th ed., Washington, D.C., U.S.A.

Banwart, G.J. (1981): "Basic Food Microbiology" Chapter 12, p.441. AVI Publishing Company, Inc. West port, Connecticut.

Chipault, J.R. and Mizuno, G.R. (1966): Effect of ionized radiation on stability of fats. J. Agr.Food Chem., 14, 225.

El-Amin, F.M. (1979): The Dromedary camel of the Sudan. In: Camel's. IFS Symposium, Sudan .35-45.

Elias, P.S. (1983): Toxicological Aspects of Food Irradiation. In Food Irradiation p.235 El-Sevier Biomedical Press. Amsterdam.

El-Magoli, Salwa B.M.; El-Mongy, T.M.; Salaam, Y.I. and Hana. (2001): Effect of gamma irradiation on the microbiological quality of some Egyptian meat products. Egypt. J. Rad. Sci. Applic. Vol.14 No.1, pp.95-109.

El-Mongy, T.M.; El-Magoli, B.M. Salwa and Mohamed, H. Hanan (2001): Irradiation of frozen mince meat for public health protection.Egypt. J. Rad. Sci. Applic. Vol.14 No.1, pp.95-109.

FAO (1980): Manual of Food Quality Control. Food and Agriculture Organization of United Nation, Rome.

FAO (1992): Food and Agriculture Organization of United Nation "Manual of Food Quality Control .1.Microbiological Analysis. United Nation, Rome.

FAO/IAEA (1970): Training Manual on Irradiation Technology and Techniques. Technical Report Series. No.114, Vienna.

Farkas, J. and Andrassy, E. (1993) Interaction of ionizing radiation and acidulants on the growth of the microflora of a vacuum packaged chilled meat product. Int. J. Food Microbiol. 19.145.

Hassan, Hala F. and Antown, Isis G. (2005): Microbiological comparison between some camel's and beef products. Egypt. J. of Appl. Sci., 20 (12b) 602.

ICMSF (1978): Microorganisms in Food Vol. 1. 2nd Ed. University of Toronto, Toronto, Canada.

ICMSF (1980): (Factors affecting life and death of microorganisms) Microbial Ecology of Foods.Vol.1, New York, Academic Press.

ISO (1987): International Organization for Standardization. Microbiology-general guidance for enumeration of microorganisms. ISO-4833.

Josephson, E.S. (1983): Radappertization of meat, poultry, fin fish, shellfish and special diets. In "Preservation of Food by Ionizing Radiation".Vol.III. Josephson, E.S. and Paterson, M.S.eds., p.231. Boca Raton, Florida: CRC Press.

Kaferstein, F.K. (1992): Food irradiation. The position of the World Health Organization. In XXXVI General Conference of the IAEA Scientific Session, Food Irradiation Newslet.17(2), 16-19, International Atomic Energy Agency, Vienna.

Kalalou (2004): Extending shelf life of fresh minced camel meat at ambient temperature by *Lactobacillus dlbrueckii* subsp. *delbrueckii* Electronic j. of Biotechnology ISSN: 0717- 3458. Vol.7, No.3, Issue of December 15, 2004.

Lagunas-Solar, M.C. (1995): Radiation processing of foods: an overview of scientific principles and current status.J.Food Prot., 58,168.

Lee, M.S.; Sebranek, J.G.; Olson, D.G. and Dickson, J.S. (1995): Irradiation and packaging of fresh meat and poultry.J.Food Prot., 59, 62.

Lefebvre, N.; Thibault, C. and Charbonneau, R. (1992): Improvement of shelf life and wholesomeness of ground beef by irradiation. Microbial Aspects. Meat Sci., 32, 203.

Monk, J.D.; Rocelles, M.A.; Calvero, R.S.; Beuchat, L.R.; Doyle, M.P. and Brackett, R.E. (1994): Irradiation inactivation of *Listeria monocytogenes* and *Staphylococcus aureus* in low and high fat, frozen and refrigerated ground beef. J.Food Prot., 57,969.

Ouf, Jehan M. (2004): Microbiological evaluation and mycotoxin residues in some frozen camel's meat products. Vet .Med. J.,Giza. 52 (2) 213.

Patterson, M.F.; Stevenson, M.H; Grant, I.R; McAteer, N.J. and Stewart, E.M (1998): Effect of gamma irradiation on the microbiological and organoleptic quality of ready prepared chilled meals. IAEA 54:159-179.

Paul, P.; Venugopal, V. and Nair, P.M. (1990): Shelf life enhancement of lamb meat under refrigeration by gamma irradiation.J.Food Sci., 55,865.

Savagoan, K.A.; Venugopol, V.; Kumta, U.S. and Sreenivasan, A. (1972): Radiation preservation of tropical shrimp for ambient temperature storage.2-storage studies. J. Food Sci., 37, 151.

Shalash, M.R. (1979): Utilization of camel meat and milk in human nourishment. In: Camel's. IFS Symposium, Sudan .285-306.

Thayer, D.W. (1990): Food irradiation: Benefits and concerns. J. Food Qual.13, 147.

Thayer, D.W. (1993): Extending shelf life of poultry and red meat by irradiation processing. J.Food Prot., 56,831.

Thayer, D.W. and Boyd, G. (1993): Elimination of *Echerechia coli* 0157:H7 in meats by gamma irradiation. Food SafetyRes. Unit, E.Reg. Res. Cent., ARS, USDA, 600 Eust Mermaid Lane, Philadelphia, PA 19118,U.S.A.

Vassiliadis, P.; Trichopoulos, D. and Papaiconomou, N. (1978): Isolation of *Salmonella* from minced meat by the use of a new procedure of enrichment. Zentrablatt Fur Bacteriologie, Parasiten Und Infections Krankheiten Und Hygiene, B.166:81.

Vyncke, W. (1970): Direct determination of the thiobarbituric acid value in trichloroacetic acid extracts of fish as means of oxidative rancidity. Fette Seifen Anstrichmitte., 72:1084-1087.

WHO (1981): Wholesomeness of Irradiated Food. Report Series.No.659. World Health Organization. Geneva.

WHO (1988): Food Irradiation. A Switzerland Technology for Preservation and improving the safety of Food. World Health Organization. Geneva.