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STUDIES ON THE EFFECT OF GAMMA IRRADIATION ON THE CHEMICAL AND MICROBIAL PARAMETERS OF CHILLED MINCED BEEF MEAT

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SUMMARY

Changes in quality parameters of minced beef meat samples treated with different doses of gamma irradiation (0,3,5,7 and 9 KiloGray "KGy") were followed to assess acceptability during refrigeration storage at 4°C. The obtained results indicated that irradiation improved the organoleptic quality and delayed deterioration of chilled minced meat. Application of irradiation resulted in development of off flavour which was more pronounced at high doses specially at 7 and 9 kGy but slightly dissipated after exposure to air . Application of gamma irradiation reduced the rate of development of all deteriorative changes. Irradiation with different doses had a slight significant changes in chemical analysis. Moisture content was decreased. Protein content slightly increased by increasing the irradiation doses and decreased with the progress of storage , while fat % and ash% increased with storage and irradiation doses. pH values of irradiated samples were lower than those of unirradiated samples. Application of ionizing radiation resulted in a remarkable increase in thiobarbituric acid "T.B.A."content in chilled minced meat samples followed by a proportional increase during refrigeration storage . Total volatile basic nitrogen was decreased specially at doses of 7 and 9 KGy. The microbial load of chilled minced meat was affected by the exposure to different doses of irradiation as well as the reduction of bacterial counts were observed by increasing the irradiation doses . In conclusion , irradiation of minced meat can be effectively used as a supplement to refrigeration process and for increasing the acceptability, safety of the products and shelf life of chilled minced meat .

INTRODUCTION

Minced meat is constituent of a large proportion in all the comminuted meat products. It contains various microbial flora during preparation specially if meat used is of low quality which frequently carry large numbers of pathogenic organisms (Foster et al. 1977).

In Egypt, large quantities of minced meat are commercially packed either chilled or frozen by many meat factories. Application of gamma irradiation techniques approved to be satisfactory method for shelf life extension by reduction of the microbial load of foods and ensuring the keeping quality of food without changing in their nutritive and sensory characters. Since 1976 and under specific restrictions, the preservation of meat and meat products by ionizing irradiation became an acceptable method in nearly 40 countries (WHO,1988 and Pszezola,1993). In 1983,the FDA approved irradiation as a means of controlling microorganisms on spices. Moreover,in1985 the FDA increased the allowed uses of irradiation to additional foods such as strawberries, poultry, ground beef and pork. Over 30 years of toxicologic, carcinogenic and teratogenic studies covering different food revealed that no evidence of any significant toxicolgical compounds with up to 10 KGy dose which make such foods safe (WHO,1981and Elias,1983). Moreover, WHO (1988) recommended the acceptability of such foods. The high dose may result in development of undesirable flavours, odours and colours as well as losses of nutrients (Hedin et al.,1960 and Banwart, 1981).

Therefore, the purpose of the current study was to follow up the sensory, chemical and microbial changes of chilled minced beef irradiated at different doses of gamma irradiation and to ensure the extension of shelf-life of this product.

MATERIALS AND METHODS

Experimental design:

1-Collection of samples:

A total of 35 kilograms of beef meat were immediately obtained after slaughtering from El-Hawamdia slaughter house at Cairo,Egypt. The collected samples were immediately minced and kept in polyethylene bags at 4C°. Chilled minced beef samples were divided into five groups, the first group was used as a control (18 samples, each sample was weighed 250 g); the other four groups; each contained 30 samples, each sample was weighed 250 g.

2-Irradiation process:

Four groups were separately irradiated by limited doses of 3,5,7 and 9 KGy, respectively using the cobalt 60 self- contained gamma irradiation source (Model : Indian Gamma Cell) at National Center for Radiation Research and Technology (NCRRT), Nasr City , Cairo . The dose rate was one Mega /6 hours and the activity was about 2000 Curie at the time of the experiment , the cobalt half life time is 5.2 years .

3- Experimental techniques:

Control and irradiated samples were immediately examined after the end of irradiation process (Zero time), at appropriate intervals 0, 1, 3, 5, 7, 10, 14, 21, 28 and 35 days during refrigeration storage at 4°C till the signs of spoilage became evident. Three trials for each examination were done and the average was calculated and recorded.

3.1: Sensory examinations:

The samples were examined for the colour , odour and texture by single number of panel judgers using 9- points hedonic scale as the method described by FAO/IAEA (1970).

3.2: Chemical examinations:

3.2.1:Proximate analysis:

Minced tissues were analyzed for moisture , protein , fat and ash according to the method recommended by A.O.A.C.(1990).

3.2.2: Deterioration criteria :

3.2.2.1: Determination of pH value :

Hydrogen ion concentration was measured by using digital pH meter (cuntexts-1) with a probe type combined electrode (Ingold) according to the technique recommended by A.O.A.C.(1990) .

3.2.2.2: Determination of Total Volatile Basic Nitrogen "TVBN" :

TVBN was determined by using the Conway's method as described by FAO(1980) . It was determined by heating a known volume of distilled water with minced meat samples and few drops of 2 MHCl for 10 minutes; followed by cooling and filtration . TVBN was estimated by using the Conway's dish. HCl in the inner compartment was titrated with 0.01 N NaOH using 2-3 drops methyl red as indicator. T.V.B.N was calculated as mg/100g minced meat.

3.2.2.3: Determination of Thiobarbituric Acid "TBA" :

The method recommended by Vyncke (1970) was applied as follows :

Minced sample was homogenized with butylated hydroxyanisol and trichloroacetic acid and then filtered . Equal volumes of "TBA" reagent were mixed with filterate and kept in boiling water bath for 40 minutes. After cooling, the developed colour was measured at 538 nm against a blank. TBA was determined as mg malonaldehyde /100g minced meat .

3.3. Bacteriological examinations :

3.3.1 : Preparation of samples :

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

3.3.2: Bacteriological techniques:

Aerobic plate counts (APC) at either 35°C and 25°C, *Enterobacteriaceae* count, *Proteolytic, Lipolytic* and *Staphylococcus aureus* counts were enumerated as described by AOAC (1990).

4- Statistical analysis:

The obtained data were statistically analysed according to the method recommended by Petrie and Watson (1999).

RESULTS AND DISCUSSION

The data in table (1) showed that, the irradiated minced meat samples developed a disagreeable flavour which was more obvious in samples treated with high doses (7 and 9kGy) but slightly dissipated after exposure to air . Similar odours were developed in irradiated beef and ground beef which observed by Hassan (1980); Dempster et al. (1985) and Aziz et al. (1994) .

In this respect , Hedin et al.(1960) reported that hydrogen sulphide was probably one of the most important components of the undesirable odours developed in meat during irradiation .On the other hand , Champagne and Nawar (1969) stated that sensory changes may be attributed to the formation of volatile compounds from lipid and protein precursors . In the present study, the irradiated samples at zero day were judged bright red colour in surface , the intensity is related to the levels of myoglobin in meat which is alterd by high irradiation doses . This substitutes the findings reported by Taub et al. (1979) . Aziz et al. (1994) and Monk et al. (1995). During storage, the raw (unirradiated) and irradiated samples became more progressively discoloured. The raw samples (control) showed the signs of spoilage after 10 days from storage at 4°C . This deterioration was accompanied with increasing in bacterial counts, each constituting 10^9, 6 x 10^8, 2x 10^7, 2 x 10^8 , 2 x 10^7 and 10^6 organisms / g for APC at 35°C, 25°C, *Enterobacteriaceae* count, *proteolytic, lipolytic* bacteria and *staphylococcus aureus* count respectively (Table 4). This agrees with that reported by Dempster et al. (1985) and Aziz et al. (1994).

The results in table (1) indicated that gamma irradiation increased the shelf life of irradiated samples for up to 21 and 28 days for samples treated with 3 & 5 and 7& 9 KGy, respectively . However, Aziz et al. (1994) found that application of gamma irradiation on chilled ground beef with 8 and 10 KGy leads to increase the shelf life of samples up to 10 and 12 weeks.

The data in table (2) revealed that irradiation with up to 9 KGy had slightly significant changes in protein and ash content of chilled minced meat. Nearly similar results were reported by Hassan

(1976). El-Bedewy et al. (1978) and Aziz et al. (1994). In this respet , Mohamed (1999) reported that only small change in protein content of irradiated meat samples had been detected . No significant impairment in the nutritional quality of proteins had been in properly processed irradiated foods. From the obtained data in table (2) it was detected that the most significant effects were in moisture and fat contents . Moisture content was significantly decreased at the first 7 days of storage , then slightly decreased in both irradiated and unirradiated samples with more pronounced effect in case of 7 and 9 KGy treatments. Irradiation as well as refrigeration storage were significantly increased fat content . The decrease in moisture content during refrigeration storage may be attributed to the fall of pH, decrease in water holding capacity and increase in drip loss and evaporation. The high fat content of irradiated samples may be explained on the basis of its inverse relation with moisture content. Nearly in accordance with those reported by Khan and Vanderberg (1965) ; Gelfand et al. (1972) ; Daoud and Emara (1999) and Mohamed (1999).

The obtained results in table (3) showed that the pH values of irradiated samples were significantly lower than those of unirradiated ones . The rate of increase in pH values were inversely related to the applied dose.

The changes in pH values may be due to breakdown of glycogen and the formation of lactic acid; also explained on the basis of bacterial and / or enzymatic degradation of protein with the formation of ammonia .This held the view reported by Hasegawa et al. (1970) , Unin et al. (1971) , El- Bedewy et al. (1978) and Daoud and Emara (1999). From table (3), data revealed that irradiated samples showed high loss in total nitrogen as compared with unirradiated ones during subsequent chilled storage ; the total volatile basic nitrogen of all samples were progressively increased with different rates as the storage period was prolonged . The changes during refrigeration storage was inversely proportional to the used dose. The loss in TVBN in irradiated samples may be due to weepage and fluid losses that contain nitrogen compounds as well as volatilization of small amounts of amonia through produced deamination by high doses of irradiation. This held the view reported by Desrosier (1970), El-Bedewy et al. (1978) , Emam (1987) and Aziz et al. (1994).

However , the growth of *proteolytic* bacteria may cause breakdown to protein as well as volatile compounds. *The proteolytic* bacteria was increased with the time reaching 8 x 10^6 , $2x10^7$, 10^7 and 10^5 microorganisms per g after 14 , 21, 28 , 35 days in samples exposed to 3,5,7 and 9 KGy , respectively (Table 4).

Table (1): Sensory evaluation of control and irradiated minced meat samples during chilled storage at 4°C.

Parameters	Appearance					Texture					Odour					Mean				
Storage Period (days) \ Dose (KGy)	0	3	5	7	9	0	3	5	7	9	0	3	5	7	9	0	3	5	7	9
0 (Zero day)	* 1.0	* 1.0	* 1.0	* 1.4	* 1.5	* 1.0	* 1.0	* 1.0	* 1.1	* 1.2	* 1.0	* 1.2	* 1.3	* 1.4	* 1.5	1.00	1.06	1.10	1.30	1.40
1	1.3	1.2	1.4	1.7	1.8	1.3	1.1	1.1	1.3	1.4	1.1	1.3	1.4	1.5	1.8	1.23	1.20	1.30	1.50	1.66
3	2.0	1.5	1.6	1.9	2.3	2.8	1.5	1.4	1.3	1.3	2.3	1.8	1.7	1.6	1.3	2.36	1.60	1.56	1.60	1.63
5	3.6	3.0	2.8	2.6	2.5	4.3	1.9	1.7	1.6	1.5	3.0	2.3	2.1	2.0	1.5	3.63	2.40	2.20	2.06	1.83
7	5.0	3.8	3.2	2.7	2.6	5.0	2.0	1.8	1.7	1.6	4.9	2.8	2.6	2.3	1.6	4.96	2.86	2.35	2.23	1.93
10	6.8	4.2	3.7	3.5	3.4	6.8	2.7	2.0	1.9	1.6	6.9	3.4	3.0	2.6	2.3	• 6.83	3.43	2.90	2.66	2.43
14	-	4.8	4.6	4.4	4.0	--	3.8	3.5	3.4	3.2	--	4.4	3.9	3.3	3.0	--	4.33	3.80	3.76	3.63
21	--	5.0	4.8	4.6	4.3	-	4.9	4.6	4.4	3.8	--	5.0	4.8	4.0	3.7	--	4.96	4.56	4.40	4.03
28	--	6.5	5.9	5.0	4.9	--	6.8	6.0	4.9	4.8	--	6.4	5.8	4.9	4.6	--	• 6.56	• 5.90	4.93	4.76
35	--	--	--	6.8	6.4	--	--	--	6.4	6.1	--	--	--	6.2	6.0	--	--	--	• 6.46	• 6.16

0 : Control sample
* Mean values of three samples
KGy : KiloGray
-- : No samples examined
• : Rejected samples

Score system:

1: Extremely liked
9 : Extremely disliked
> 5: Rejected

Table (2): Effect of gamma irradiation on chemical composition of chilled minced meat

Radiation Dose (KGy)	Chemical Examinations	Storage period (days)									
		0	1	3	5	7	10	14	21	28	35
0 KGy Control		*	*	*	*	*	*	*	*	*	*
	Moisture %	66.75 ± 6.01	66.84 ±7.98	64.66 ± 5.95	63.50 ± 6.15	62.33 ± 5.85	62.10 ± 5.92	--	--	--	--
	Protein %	18.69 ± 2.06	18.54 ± 1.65	18.42 ± 1.63	18.29 ± 1.73	18.15 ± 1.61	18.10 ± 1.65	--	--	--	--
	Fat %	14.33 ± 1.72	14.73 ± 1.25	14.78 ± 1.16	14.82 ± 1.35	14.87 ± 1.25	15.73 ± 1.19	--	--	--	--
	Ash %	1.60 ±0.16	1.62 ± 0.12	1.70 ± 0.15	1.75 ± 0.16	1.76 ± 0.15	1.77 ± 0.14	--	--	--	--
3 KGy	Moisture %	65.49 ± 6.43	65.33 ± 7.15	64.42 ± 5.97	63.00 ± 5.23	62.28 ± 4.52	62.08 ± 3.99	61.80 ± 4.02	61.60 ± 3.85	61.33 ± 4.52	--
	Protein %	18.88 ± 2.15	18.82 ± 2.03	18.80 ± 1.93	18.55 ± 1.72	18.41 ± 1.13	18.35 ± 1.25	18.30 ± 0.95	18.24 ±1.37	18.19 ± 1.56	--
	Fat %	14.71 ± 1.63	14.74 ± 1.55	14.79 ± 1.62	15.07 ± 1.32	15.22 ± 1.03	15.56 ± 1.01	15.72 ± 1.05	16.00 ± 1.32	16.02 ± 1.41	--
	Ash %	1.65 ± 0.15	1.71 ± 0.14	1.75 ±0.16	1.78 ± 0.15	1.79 ± 0.10	1.85 ± 0.09	1.88 ± 0.08	1.90 ± 1.11	1.95 ± 0.12	--
5 KGy	Moisture %	65.30 ±4.95	65.00 ± 5.32	64.31 ± 7.07	62.97 ± 6.23	62.20 ± 5.59	62.00 ± 5.58	61.56 ± 4.82	60.98 ± 5.21	60.32 ± 3.97	--
	Protein %	18.90 ± 1.32	18.88 ± 2.07	18.85 ± 1.58	18.87 ± 1.69	18.72 ± 1.72	18.70 ± 0.97	18.56 ± 1.32	18.50 ± 1.02	18.42 ± 0.95	--
	Fat %	14.85 ± 1.23	15.04 ± 1.65	15.06 ± 1.33	15.08 ± 1.20	15.27 ± 1.22	15.64 ± 1.00	15.82 ± 1.11	16.00 ± 1.05	16.09 ± 1.32	--
	Ash %	1.75 ± 0.25	1.80 ± 0.16	1.82 ± 0.20	1.85 ± 0.16	1.89 ±0.17	1.90 ±0.87	1.92 ±0.82	1.94 ±0.82	1.95 ±0.75	--
7 KGy	Moisture %	64.98 ± 4.33	64.66 ± 4.54	64.00 ± 3.59	62.21 ± 5.02	61.99 ± 4.03	61.33 ± 3.36	61.00 ±3.21	60.60 ±5.72	60.30 ±3.87	60.00 ±5.42
	Protein %	18.95 ± 0.723	18.91 ± 0.87	18.98 ± 0.97	18.85 ± 1.23	18.80 ± 1.12	18.72 ± 1.52	18.70 ± 1.12	18.65 ± 1.41	18.62 ± 1.32	18.59 ± 1.32
	Fat %	14.88 ± 0.882	15.12 ± 0.97	15.23 ± 0.32	15.28 ± 0.98	15.64 ± 1.08	15.82 ± 0.82	16.00 ± 0.95	16.20 ± 1.12	16.32 ± 1.11	16.17 ± 1.10
	Ash %	1.85 ± 0.255	1.86 ± 0.32	1.88 ±0.12	1.90 ± 0.67	1.92 ± 0.72	1.95 ± 0.09	1.96 ± 0.55	1.98 ± 0.72	2.00 ± 0.85	2.05 ± 0.93
9 KGy	Moisture %	64.82 ±5.28	64.09 ± 5.13	63.66 ± 5.50	62.03 ± 4.93	61.58 ± 4.82	60.88 ± 3.56	60.32 ± 4.67	59.89 ± 3.75	59.72 ± 4.32	59.20 ± 4.21
	Protein %	18.97 ± 1.31	18.93 ± 1.11	18.90 ± 0.95	18.86 ± 1.09	18.82 ± 1.08	18.75 ± 0.87	18.71 ± 0.88	18.68 ± 1.12	18.95 ± 1.00	18.62 ± 1.02
	Fat %	15.11 ± 0.97	15.23 ± 0.85	15.29 ± 0.87	15.37 ± 0.92	15.72 ± 0.98	16.05 ± 1.21	16.21 ± 1.31	16.72 ± 1.40	16.91 ± 1.33	17.10 ± 1.09
	Ash %	1.90 ± 0.06	1.92 ± 0.07	1.94 ± 0.07	1.94 ± 0.06	1.96 ± 0.07	1.98 ± 0.07	2.00 ± 0.09	2.04 ± 0.09	2.07 ± 0.09	2.90 ± 0.09

0 KGy: Zero KGy (control samples)　KGy : KiloGray

-- : No samples examined　* Mean values of three samples

Table (3): Effect of gamma irradiation on deterioration criteria of chilled minced meat

Radiation Dose (KGy)	Chemical Examinations	Storage period (days)									
		0	1	3	5	7	10	14	21	28	35
0 KGy Control		*	*	*	*	*	*	*	*	*	*
	pH	5.80 ±0.001	6.10 ±0.001	6.21 ±0.002	6.40 ±0.001	6.98 ±0.003	7.25• ±0.002	--	--	--	--
	T. V. B. N.	12.36 ±1.121	12.63 ±1.090	13.62 ±1.008	17.49 ±1.232	19.48 ±1.450	22.28• ±1.757	--	--	--	--
	T. B. A.	0.137 ±0.080	0.143 ±0.072	0.159 ±0.061	0.210 ±0.051	0.248 ±0.071	0.321• ±0.063	--	--	--	--
3 KGy	pH	5.76 ±0.002	6.08 ±0.001	6.12 ±0.001	6.17 ±0.002	6.19 ±0.001	6.21 ±0.002	6.23 ±0.003	6.30 ±0.001	6.55• ±0.001	--
	T. V. B. N.	11.98 ±1.231	12.17 ±1.412	12.88 ±1.123	13.09 ±1.090	13.14 ±1.087	14.89 ±0.975	14.94 ±1.310	16.26 ±1.008	19.94• ±1.750	--
	T. B. A.	0.140 ±0.013	0.151 ±0.027	0.167 ±0.030	0.172 ±0.035	0.178 ±0.065	0.191 ±0.035	0.199 ±0.015	0.225 ±0.023	0.375• ±0.076	--
5 KGy	pH	5.74 ±0.001	6.04 ±0.002	6.10 ±0.001	6.11 ±0.001	6.13 ±0.002	6.14 ±0.001	6.16 ±0.001	6.25 ±0.002	6.42• ±0.001	--
	T. V. B. N.	11.66 ±0.950	11.69 ±0.833	12.63 ±0.931	12.74 ±1.009	12.79 ±0.875	13.97 ±1.012	14.11 ±0.913	16.07 ±1.720	19.07• ±1.755	--
	T. B. A.	0.146 ±0.023	0.156 ±0.031	0.173 ±0.042	0.180 ±0.033	0.185 ±0.041	0.206 ±0.025	0.210 ±0.037	0.232 ±0.042	0.381• ±0.050	--
7 KGy	pH	5.70 ±0.001	6.00 ±0.001	6.08 ±0.002	6.10 ±0.001	6.11 ±0.002	6.12 ±0.001	6.14 ±0.002	6.22 ±0.001	6.35 ±0.001	6.85• ±0.002
	T. V. B. N.	11.50 ±0.835	11.58 ±0.721	11.88 ±0.701	12.09 ±0.832	12.17 ±0.772	13.78 ±0.835	13.97 ±0.725	15.18 ±0.825	17.20 ±0.720	19.65• ±0.932
	T. B. A.	0.158 ±0.027	0.162 ±0.031	0.178 ±0.044	0.184 ±0.051	0.190 ±0.055	0.210 ±0.071	0.218 ±0.063	0.236 ±0.055	0.392 ±0.072	0.398• ±0.077
9 KGy	pH	5.65 ±0.002	5.88 ±0.001	6.00 ±0.001	6.05 ±0.002	6.10 ±0.001	6.11 ±0.001	6.15 ±0.002	6.20 ±0.001	6.32 ±0.001	6.80• ±0.002
	T. V. B. N.	11.39 ±0.632	11.42 ±0.663	11.66 ±0.555	11.85 ±0.501	11.98 ±0.433	13.54 ±0.353	13.84 ±0.254	14.99 ±0.375	16.98 ±0.623	19.40• ±0.675
	T. B. A.	0.161 ±0.028	0.168 ±0.015	0.181 ±0.031	0.190 ±0.026	0.196 ±0.035	0.215 ±0.040	0.220 ±0.012	0.241 ±0.022	0.398 ±0.019	0.441• ±0.035

0 KGy: Zero KiloGray (control)
T.V.B.N.: Total Volatile Basic Nitrogen (mg/100g meat)
T.B.A.: Thiobarbituric Acid (mg malonaldehyde/100g)
* Mean values of three samples
• : Rejected samples
- : No samples examined

Table (4): Effect of irradiation and chilled storage on bacterial quality of minced meat

Bacterial Counts	Storage period (days)	Irradiation dose (KGy) 0	3	5	7	9
Aerobic plate count at 35°C	0	* $8x10^4$	* $2x10^3$	* $8x10^2$	* $4x10^2$	* 10^2
	1	$4x10^5$	10^4	10^3	10^3	$2x10^2$
	3	$6x10^6$	$2x10^5$	$8x10^3$	$2x10^3$	$2x10^3$
	5	$2x10^8$	10^6	$4x10^4$	$2x10^4$	10^4
	7	10^9	$8x10^6$	10^5	$8x10^4$	$4x10^4$
	10	spoil	$2x10^7$	$4x10^6$	$2x10^5$	10^5
	14	-	10^8	$2x10^7$	10^6	$8x10^5$
	21	-	spoil	$2x10^8$	$2x10^7$	$4x10^6$
	28	-	-	spoil	10^8	10^7
	35	-	-	-	spoil	spoil
Aerobic plate count at 25°C	0	$2x10^3$	$8x10^2$	10^2	$<10^2$	$<10^2$
	1	$4x10^4$	10^3	$4x10^2$	10^2	$<10^2$
	3	$4x10^5$	$4x10^4$	$8x10^2$	$2x10^2$	10^2
	5	10^6	10^5	$4x10^3$	$4x10^2$	$4x10^2$
	7	$6x10^8$	$6x10^5$	$2x10^4$	10^3	$8x10^2$
	10	spoil	$2x10^6$	10^5	$8x10^3$	$2x10^3$
	14	-	10^7	$2x10^6$	$2x10^4$	10^4
	21	-	spoil	$4x10^7$	10^5	$2x10^4$
	28	-	-	spoil	$2x10^6$	10^5
	35	-	-	-	spoil	spoil
Enterobacteriaceae count	0	$4x10^2$	$2x10^2$	$<10^2$	$<10^2$	$<10^2$
	1	$4x10^3$	$2x10^3$	10^2	$<10^2$	$<10^2$
	3	$8x10^4$	10^4	$2x10^2$	10^2	10^2
	5	10^6	$6x10^4$	10^3	$2x10^2$	10^2
	7	$2x10^7$	10^5	$4x10^3$	$6x10^2$	$4x10^2$
	10	spoil	$8x10^5$	$2x10^4$	10^3	$6x10^3$
	14	-	$2x10^6$	10^5	$8x10^3$	10^4
	21	-	spoil	$4x10^6$	$4x10^4$	$4x10^4$
	28	-	-	spoil	10^5	$8x10^4$
	35	-	-	-	spoil	spoil
Proteolytic Bacteria	0	$<10^2$	$4x10^2$	$2x10^2$	$<10^2$	$<10^2$
	1	$2x10^2$	10^3	$4x10^2$	$<10^2$	$<10^2$
	3	10^4	$2x10^3$	$8x10^2$	$2x10^2$	$<10^2$
	5	$4x10^7$	10^4	$2x10^3$	$8x10^2$	10^2
	7	$2x10^8$	$8x10^4$	$6x10^3$	$4x10^3$	$8x10^2$
	10	spoil	$2x10^5$	10^5	10^4	10^3
	14	-	$8x10^6$	$6x10^6$	10^5	$6x10^3$
	21	-	spoil	$2x10^7$	$2x10^6$	10^4
	28	-	-	spoil	10^7	$6x10^4$
	35	-	-	-	spoil	10^5 spoil
Lipolytic Bacteria	0	$<10^2$	$2x10^2$	10^2	$<10^2$	<10
	1	$8x10^3$	$6x10^2$	10^2	$<10^2$	$<10^2$
	3	10^4	10^3	$2x10^2$	10^2	$<10^2$
	5	$4x10^5$	$4x10^3$	$8x10^2$	$6x10^2$	$2x10^2$
	7	$2x10^7$	$8x10^3$	10^3	10^3	$8x10^2$
	10	spoil	$4x10^4$	$2x10^3$	$2x10^3$	10^3
	14	-	10^5	$6x10^3$	$4x10^3$	$2x10^3$
	21	-	spoil	$8x10^4$	$6x10^4$	10^4
	28	-	-	spoil	$8x10^5$	$6x10^4$
	35	-	-	-	spoil	spoil
Staphylococcus aureus count	0	$4x10^2$	10^2	$<10^2$	$<10^2$	$<10^2$
	1	$8x10^4$	$6x10^2$	10^2	$<10^2$	$<10^2$
	3	$6x10^5$	10^3	10^2	$<10^2$	$<10^2$
	5	$8x10^5$	$2x10^3$	$4x10^2$	10^2	$<10^2$
	7	10^6	$2x10^4$	$8x10^2$	$4x10^2$	$2x10^2$
	10	spoil	$4x10^4$	$2x10^3$	$8x10^2$	$8x10^2$
	14	-	$8x10^6$	$6x10^3$	$4x10^4$	10^3
	21	-	spoil	10^4	$8x10^3$	$4x10^3$
	28	-	-	spoil	$2x10^4$	10^4
	35	-	-	-	spoil	spoil

* Mean values of three samples   - : No samples examined

During chilled storage , the rate of increase in solubility of untreated samples was higher than the irradiated ones (Paul et al.,1990). Table (3) showed that, the increase in thiobarbituric acid content (TBA) being linear with both irradiation dose and storage period . The changes in TBA probably occurred due to the effect of free radicals formed upon irradiation and this might cause an acceleration of hydroperoxide and peroxide formations and subsequently the formation of aldehydes (Hassan, 1976) and also due to the auto-oxidation of lipids , microbial degradation of malonaldehyde and or formation of TBA- reacting substances.

Nearly similar results were reported by El-Bedewy et al. (1978), Daoud and Emara (1999) and Mohamed (1999) . Bacterial counts were decreased with increasing the irradiation dose. However, the signs of spoilage were appeared after 21 days for 3 KGy dose exposure in which APC at 35°C and 25°C, *Enterobacteriaceae* count, *Proteolytic, Lipolytic* and *Staphylococcus aureus* were 10^8, 10^7 , 2 x 10^6, 8 x 10^6, 10^5 and 8 x 10^6, organisms/ g after 14 days storage, respectively, while in 5 KGy exposure , such counts were $2x10^8$, $4x10^7$, $4x10^6$, 2x 10^7 , 8 x 10^4 and 10^4, organisms/g after 21 days chilled storage. The signs of spoilage were appeared in samples exposed to irradiation dose 7 KGy after 28 days during chilled storage; each constituting10^8, $2x10^6$, 10^5, 10^7, $8x10^5$ and $2x10^4$ organism/g respectively, while such counts were reached to 10^7,10^5,$8x10^4$,$6x10^4$, $6x10^4$ and 10^4 organisms /g in samples exposed to irradiation dose 9 KGy (Table 4) .

In conclusion , irradiation of minced meat can be effectively used as a supplement to refrigeration process. The most advantage feature of the application of ionizing radiation in preservation of chilled minced meat is the possibility of increasing safety and acceptability of the products.

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