

Effects of gamma irradiation on salted and frozen mullet fish during storage period

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Abstract

The objective of the present study was to investigate the influence of gamma irradiation on decontamination of microbial loud of salted and frozen mullet fish. Mullet fish samples were divided into two groups: The first group was frozen at – 20C° and the second group was dry salted with ordinary commercial refined salt at ratio 1 kg fish / 0.8 kg. Each group was subjected to 0, 2.5 and 5 kGy of gamma irradiation doses before storage period. The results showed that, gamma irradiation hadn't any significant ($P \leq 0.05$) effects on the chemical composition and minerals content of mullet fish samples under investigation. Gamma irradiation doses (2.5 and 5.0 kGy) had not significant remarkable effect at $P \leq 0.05$ on sensory properties (appearance, odor, texture and color) of dry and frozen mullet fish samples neither at zero time nor during storage periods. Microbial aspects (total bacterial counts, coliform bacteria, salmonella, sporeforming bacteria and total molds and yeasts) were detected. Also it could be concluded that, gamma irradiation had a significant ($P \leq 0.05$) decrease effects on microbial loud and improve the microbiological safety of salted and frozen mullet fishes without any adverse effects on their chemical contents and quality.

Keywords: key words, Gamma irradiation, Salting, freezing, Mullet fish, Minerals, Microbial loud.

1. Introduction

The salting is as important as the preservative effect of fish product's potential shelf life. Recent studies showed that the level and preservative effect of salt has direct proportion (Espe et al., 2001; Goulas and Kontaminas, 2005; Yanar and Acamca 2006). However, other studies report that high salt level trigger some health problems such as chronic heart disease, hypertension and nasopharingeal carcinoma (Yu et al., 1986; Shewmake and Huntington, 2009; Turk et al., 2009). There are different salting methods: dry salting, brine salting and injection salting or their combinations which are used in the smoking industry for years. Several studies report on the effect of different salting techniques on shelf life of seafood reveal that brine salting is more effective compare to dry salting in relation to brining time and temperature (Cardinal et al., 2001; Bugueno et al., 2003; Goulas and Kontaminas, 2005 and Zayde and Hasan 2010).

Picart et al., (2004) reported that a reduction of 1.7 log cycle was observed for L. innocua and M. luteus (4.6 log cycle for P. fluorescens) when salmon mince was subjected to pressure-shift freezing (PSF) (i.e. PSN from 207 MPa and −21°C as above followed by further freezing to −25°C at 0.1 MPa). PSF with pressure release in 18 min enhanced reduction to 2 and 2.5 log cycles for L. innocua and M. luteus, respectively. Bahmani et al., (2011) determined quality changes of whole ungutted golden gray mullet (Liza aurata) while stored in ice or in a refrigerator and changes in microbiological quality (total viable and psychrophilic counts, lactic acid bacteria and Enterobacteriaceae), raw fish sensory attributes were evaluated during 16 days of storage. They found that the sensory attributes of golden gray mullet correlated well with the microbiological analyses ($r = 0.92$) and the shelf life of the raw golden gray mullet was 10 days in ice and about 14 days in a refrigerator.

Food irradiation is the process of exposing food to ionizing radiation at different doses in order to disinfest, sterilize, or preserve food. Administered hygienically at low doses, it extends shelf life and delays the ripening or sprouting of fruits and vegetables. At higher doses, it eliminates insects, moulds, bacteria and other potentially harmful micro-organisms that cause spoilage in foods. Today's increasingly densely populated world, where half of the global population lives in near starvation conditions, the provision of sufficient and safe food is a high priority concern. Irradiation is a safe and effective method of food preservation used in many countries around the world. Irradiated Mackerel at 1 – 45 kGy and kept in plastic bags at -22 °C, these fish do not display any changes in amino acids, digestibility, biological values and protein use. While irradiated shrimps at 2-45 and stored in different temperature and level of humidity, shrimps have been shown to lose a small amount of tryptophan (Asli, 2007).

Badr, (2012) studied the potential health hazards of smoked fish by gamma irradiation and reported that irradiation at doses of 1 and 3 kGy inactivated 6.59 and 6.05 log cfu/g of Listeria monocytogenes and Vibrio parahaemolyticus in the inoculated samples, respectively. Therefore, gamma irradiation dose of 3 kGy could be successfully applied to provide significant improvement in the safety of cold smoked salmon with respect to L. monocytogenes, V. parahaemolyticus, without adverse effects on chemical or sensory quality attributes of the product.

Moreover, Arvanitoyannis and Stratakos, (2010) reported that gamma irradiation has been considered as an interesting method of preservation to extend the shelf life of fish and also to reduce qualitatively and quantitatively the microbial population in fish and fish products. Irradiation doses of 2–7 kGy can reduce important food pathogens such as Salmonella, Listeria, and Vibrio spp., as well as many fish specific spoilers such as Pseudomonaceae and Enterobacteriaceae that can be significantly decreased in number. Food irradiation can be used to improve the microbiological safety and to extend the shelf life of foods. Fish products (cephalopods, mussels and crustacean) spices and supplements, especially at import stage from countries where non approved irradiation facilities are operating (e.g. Vietnam and China) (Michele et al., 2013).Therefore, this study was undertaken to assess the effect of gamma irradiation on the microbiological safety of salted and frozen mullet fish. Also the changes of chemical composition and sensory evaluation were determined during frozen storage. In addition, the study aimed to finding out the optimum dose of gamma irradiation that does not adversely affect on the quality of salted and frozen fish.

2. Experimental

2.1. Materials

Mullet fish samples were purchased from local market in Domiata, Dakahlia governorate, Egypt. All samples transported to our laboratory of food irradiation unit, Nuclear Research Center in ice-box and microbiological surveyed for counts of total bacterial count, psyhcrophilic bacteria, sporeforming bacteria, total molds and yeasts. Then, Mullet fish samples divided into two groups: The first group was packed in tightly sealed polyethylene pouches and stored in freezing (-20°C) till irradiation treatments and the second group of mullet fish was dry salted with ordinary commercial refined salt at a ratio 1 kg fish / 0.8 kg salt in plastic containers without drainage (Ozlem, 2011). The first layers of salt were put into plastic containers and then layers of fish were added followed layer of salt and stored at room temperature (20-25°C) till irradiation treatments. Three replicates were conducted and at regular time intervals (1-3 months) during storage salting periods. Fish samples from each group were analyzed (chemical, microbiological and sensory evaluation).

2.2. Gamma irradiation treatments

Three bags from each group of mullet fishes (salted and frozen) were exposed to gamma irradiation doses at 0, 2.5, and 5 kGy using cobalt-60 gamma chamber. The dose rate was 1.366 kGy/h in Cyclotron Project, Nuclear Research Center, Atomic Energy Authority, Inshas, Cairo, Egypt. After irradiation salted fish samples stored at room temperature (20-25), while frozen fish samples stored at -20ºC.

2.3. Proximate composition

Proximate chemical composition: Homogeneous mixtures of minced fillets weighed 5g were dried at 105ºC to constant weight for moisture determination, Total protein was determined by kjeldahl's method using a conversion factor (6.25 × N), fat was determined using Soxhlet system, ash content was determined by ignition at 550 ºC in an electric furnace according to the methods described in AOAC, (2002). The total carbohydrate was calculated by using difference of the value of each nutrient. Total carbohydrates % = 100 - (moisture% + total protein %+ fat % + ash %) according to Egan et al., (1981).

2.4. Minerals determinations

Samples were placed in an oven to dry at 105 °C for 6 – 8 h. About 0.2 gram of each sample transfer into digestion flasks and 10 ml of H2SO4 and 2 ml of H2O2 was added then the digestion flask was placed on a hot plate at 120 °C (gradually increased). The digestion flasks were kept on the hot plate till the sample was digested. The digest diluted with distilled water to 100 ml and the blank sample digest was carried out in the same way without sample. The residual analysis of Sodium (Na), Potassium(K), Palladium (Pb), Mercury (Hg), Manganese(Mn), Cadmium (Cd), Copper (Cu) and Zinc (Zn) were determined in all treatments using an Atomic Absorption Spectrophotometery (Perkin-Elmer) according to the procedures recommended by AOAC (2002)

2.5. Microbial determination:

Colony forming units for total bacterial count were counted by plating on plate count agar medium and incubated at 30°C for 3-5 days(APHA, 1992).Total molds and yeasts were counted according to Mossel et al., (1970). Detection and enumeration of coliform, Salmonella spp, Psyhcrophilic and sporeforming bacteria count according to FDA, (2002).

2.6. Sensory evaluation

Sensory evaluation including appearance, odor, texture and color and taste of salted and frozen mullet fishes with different doses of gamma irradiation were examined every month during storage at room temperature (20-25°C) and frizzing (-20°C), respectively. The panel consisted of ten members from our laboratory and scores were obtained as described by Wierbicki, (1985)

2.7. Statistical analysis

The statistical analysis of the mean data was compared using one-way analysis of variance (ANOVA) according to Zar, (1984). The chosen level of significance was $P \leq 0.05$.

3. Results and Discussion

3.1. Chemical composition of dry salted and frozen mullet fish

Table (1) shows the chemical composition of salted and frozen mullet fish as affected by gamma irradiation doses during storage periods. It can be noticed that, in the first month the moisture total protein, fat, carbohydrates and ash contents were 65.52 %, 76.33 %, 13.37 %, 2.93 and 7.37 % for non-irradiated (0 kGy) salted mullet fishes, while these values were 80.68 %, 76.47 %, 13.19 %, 5.14 and 5.20 % for non-irradiated (0 kGy) frozen mullet fishes, respectively. The effect of various gamma irradiation doses on the chemical composition of salted and frozen mullet fish was studied and the analysis of variance illustrated in table (2). It could be noticed that no significant differences at ($P \leq 0.05$) of chemical analysis of salted and frozen irradiated mullet fish with gamma doses (2.5, and 5.0 kGy) as compared with non irradiated sample(0 kGy), moreover the moisture content of dry salted samples were lower than frozen samples. This reduction may be due to effect of sodium chloride. Such results are in agreement with those obtained by Badr, (2012), who found that irradiation treatments for smoked fish had not any significant differences at levels $P \leq 0.05$.

Table 1

Effect of gamma irradiation on chemical composition of salted and frozen mullet fish during storage

Chemical composition (%)	Storage period (Months)	Treatments					
		Dry salted fish			Frozen fish		
		0.0 KGy	2.5 kGy	5.0 kGy	0.0 KGy	2.5 kGy	5.0 kGy
Moisture	1	65.52	65.32	65.44	80.68	80.65	80.65
	2	59.21	59.24	59.22	80.69	80.63	80.66
	3	50.53	50.5	50.54	80.66	80.67	80.64
Total protein*	1	76.33	76.31	76.29	76.47	76.47	76.53
	2	76.31	76.3	76.3	76.43	76.51	76.45
	3	76.35	76.32	76.29	76.49	76.49	76.59
Fat*	1	13.37	13.37	13.35	13.19	13.19	13.18
	2	13.43	13.23	13.5	13.23	13.2	13.33
	3	13.32	13.39	13.4	13.18	13.18	13.21
Carbohydrates*	1	2.93	3.02	3.06	5.14	5.06	5.08
	2	2.94	3.16	2.88	5.23	5.08	5.02
	3	2.95	2.99	3.00	5.12	5.13	4.98
Ash*	1	7.37	7.30	7.30	5.20	5.28	5.21
	2	7.32	7.31	7.32	5.11	5.21	5.20
	3	7.38	7.30	7.31	5.21	5.20	5.22

*: On dry weight basis.

Table 2
Analysis of variance for effect of gamma irradiation on chemical composition of salted and frozen mullet fish during storage

Chemical composition (%)	Source of Variation	df	F crit	Dry salted fish			Frozen fish		
				MS	*F*	*P-value*	*MS*	*F*	*P-value*
Moisture	Storage period	2	6.94	168.1*	46136.07	1.88	1.11 [NS]	0.03	0.97
	Treatments	2	6.94	0.00 [NS]	0.96	0.46	0.00 [NS]	1.97	0.25
Total protein	Storage period	2	6.94	0.00 [NS]	1.31	0.37	0.00 [NS]	1.53	0.32
	Treatments	2	6.94	0.00 [NS]	6.28	0.06	0.00 [NS]	1.53	0.32
Fat	Storage period	2	6.94	0.00 [NS]	0.05	0.95	0.00 [NS]	2.95	0.16
	Treatments	2	6.94	0.01 [NS]	0.70	0.55	0.00 [NS]	1.47	0.33
Carbohydrates	Storage period	2	6.94	0.00 [NS]	0.05	0.95	0.00 [NS]	0.26	0.78
	Treatments	2	6.94	0.01 [NS]	1.29	0.37	0.01 [NS]	4.36	0.10
Ash	Storage period	2	6.94	0.00 [NS]	0.26	0.78	0.00 [NS]	1.94	0.26
	Treatments	2	6.94	0.00 [NS]	4.90	0.08	0.00 [NS]	1.94	0.26

*: Significant [NS]: Non significant Data were analyzed by ANOVA, F test means ($P \leq 0.05$).

3.2. Minerals content of dry salted and frozen mullet fish

Table (3) revels the concentrations of minerals (Sodium, Potassium, Palladium, Mercury, Manganese, Cadmium, Copper and Zinc) expressed in (ppm) on dry weight in dry salted and frizzed mullet fish. Sodium (187.35±0.15; 60.51±0.42) was the major mineral followed by Potassium (10.65±0.18; 10.47±0.15), Mercury (8.42±0.28; 8.69±0.60), Manganese (7.59±0.56; 7.55±0.26), and Palladium (5.27±0.42; 5.63±0.24) in dry salted and frozen mullet fish, respectively. It is worthy to mention that both dry salted and frozen mullet fish showed no detected in Cadmium, Copper and Zinc. Moreover, the highest concentrations of sodium were found in dry salted fish samples and the differences in sodium levels between dry salted and frozen mullet fish this may be due to crossing sodium inside dry salted fish and release water outside it by osmosis reverse. Also from data in tables 3 and 4, it could be noticed that, gamma irradiation hadn't any significant effects on minerals content of mullet fish samples under investigation. Data in table (4) showed that there are no any significant differences at $P \leq 0.05$ among all treatments of mullet fish samples under investigation.

Table 3

Effect of gamma irradiation on minerals content of salted and frozen mullet fish

Minerals (ppm)	Treatments					
	Dry salted fish			Frozen fish		
	0.0 kGy	2.5 kGy	5.0 KGy	0.0 kGy	2.5 kGy	5.0 KGy
Sodium (Na)	187.35±0.15	187.64±0.30	187.33±0.10	60.56±0.16	60.51±0.42	60.39±0.05
Potassium(K)	10.65±0.18	10.48±0.47	10.67±0.19	10.47±0.15	10.56±0.29	10.45±0.11
Palladium (Pb)	5.27±0.42	5.32±0.30	5.45±0.31	5.63±0.24	5.41±0.34	5.35±0.23
Mercury (Hg)	8.42±0.28	8.41±0.04	8.87±0.10	8.69±0.60	8.27±0.11	8.7±0.05
Manganese(Mn)	7.59±0.56	7.27±0.23	7.21±0.38	7.55±0.26	7.65±0.20	7.56±0.10
Cadmium (Cd)	ND	ND	ND	ND	ND	ND
Copper (Cu)	ND	ND	ND	ND	ND	ND
Zinc (Zn)	ND	ND	ND	ND	ND	ND

Values are means of three replicates ± standard deviation.
[ND]: Not detected

Table 4
Analysis of variance between treatments for salted and frozen mullet fish as affected by gamma irradiation

Source of variation between treatments		Total square values	Degree of freedom	Main square values	F values	P-value	F crit.
Dry salted fish	**Sodium (Na)**	0.183	2	0.091 NS	2.193	0.192	5.143
	Potassium(K)	0.069	2	0.034 NS	0.351	0.718	5.143
	Palladium Lead (Pb)	0.051	2	0.025 NS	0.214	0.814	5.143
	Mercury (Hg)	0.421	2	0.210 NS	0.835	0.028	5.143
	Manganese(Mn)	0.253	2	0.127 NS	0.745	0.514	5.143
Frozen fish	**Sodium (Na)**	0.044	2	0.022 NS	0.320	0.738	5.143
	Potassium(K)	0.022	2	0.011 NS	0.273	0.770	5.143
	Palladium Lead (Pb)	0.130	2	0.065 NS	0.878	0.462	5.143
	Mercury (Hg)	0.405	2	0.203 NS	1.649	0.269	5.143
	Manganese(Mn)	0.017	2	0.009 NS	0.222	0.807	5.143

NS**:** Non significant**.**
Data were analyzed by ANOVA (Single factor); F test means ($P \leq 0.05$).

3.3. Microbial evaluation of dry salted and frozen mullet fish

Microbial aspects (total bacterial counts, total coliform bacteria, total salmonella, spore forming bacteria and total molds and yeasts) of dry salted and frozen mullet fish as affected by gamma irradiation doses (2.5 and 5.0 kGy) were enumerated and recorded in table (5). The initial total bacterial counts of different treatments were 4.839, 4.681 and 4.041 log cfu/g for non-irradiated and irradiated dry salted mullet fish samples with 0.0, 2.5 and 5.0 kGy gamma rays, respectively. While non-irradiated and irradiated frozen mullet fish samples with 0.0, 2.5 and 5.0 kGy gamma rays were 4.991, 4.826 and 4.322 log cfu/g, respectively. Total coliform and spore forming bacteria had not detected in samples under investigation. Total salmonella were detected and recorded only in non-irradiated and irradiated frozen mullet fish samples with 2.5 kGy gamma rays while, it had not detected in another samples under investigation. Also, spore forming bacteria in salted mullet fish samples reached in zero time to 3.949, 3.903 and 3.812 log cfu/g, respectively. However frozen mullet fish samples which treated with gamma irradiation at the same doses were 3.973, 3.756 and 3.591 log cfu/g, respectively, while total molds and yeasts in the same samples were 4.996, 3.924 and 3.740 log cfu/g (for dry salted mullet fish samples) and 5.84, 4.612 and 4.342 log cfu/g (for frozen mullet fish samples), respectively. Data in table 5 and 6 showed that gamma irradiation had a significant ($P \leq 0.05$) decrease effects on microbial loud of salted and frozen mullet fishes at zero time and during storage period. The same trend of results was confirmed by Arvanitoyannis and Stratakos (2010) and Michele et al., (2013).Irradiation treatments induced ionization for the cell of bacteria and directly effects on DNA of nucleus cells (Shea et al., 2000 and Temur and Tiryaki 2013)

Table 5

Logarithmic number of microbial aspects for non-irradiated and irradiation of salted and frozen mullet fish during storage period

Microbial determination Log CFU/g	Storage period (Months)	Treatments					
		Dry salted fish			Frizzed fish		
		0.0 KGy	2.5 kGy	5.0 kGy	0.0 KGy	2.5 kGy	5.0 kGy
Total bacterial count	Zero time	4.839	4.681	4.041	4.991	4.826	4.322
	1	5.944	5.756	5.519	5.740	5.505	5.080
	2	6.792	6.732	6.623	6.950	6.778	6.176
	3	7.279	7.079	7.000	7.886	7.633	7.000
Total molds and yeasts	Zero time	4.996	3.924	3.740	5.845	4.612	4.342
	1	5.991	4.833	4.114	6.991	5.833	4.954
	2	6.255	5.301	5.176	7.114	6.041	6.041
	3	6.991	5.763	5.255	7.279	6.146	6.000
Total coliform bacteria	Zero time	ND	ND	ND	ND	ND	ND
	1	ND	ND	ND	ND	ND	ND
	2	ND	ND	ND	ND	ND	ND
	3	ND	ND	ND	ND	ND	ND
Salmonella	Zero time	ND	ND	ND	3.991	3.785	ND
	1	ND	ND	ND	4.079	3.954	ND
	2	ND	ND	ND	5.114	4.301	ND
	3	ND	ND	ND	5.079	4.602	ND
Sporoforming bacteria	Zero time	ND	ND	ND	ND	ND	ND
	1	ND	ND	ND	ND	ND	ND
	2	ND	ND	ND	ND	ND	ND
	3	ND	ND	ND	ND	ND	ND
Psychrophilic bacteria	Zero time	3.832	3.556	ND	3.897	3.544	ND
	1	4.778	4.079	ND	4.770	4.591	ND
	2	4.991	4.812	ND	5.982	5.000	ND
	3	5.301	5.176	ND	5.763	5.505	ND

ND: Not detected

Table 6

Analysis variance of logarithmic number of microbial aspects for non-irradiated and irradiation of salted and frozen mullet fish during storage period

Microbial determination Log CFU/g	Source of variance	Total square values	Degree of freedom	Main square values	F values	P-value	F crit.
Total bacterial count	Storage period (Months)	25.507	3	8.502*	221.07	1.240	3.287
	Treatments	1.565	5	0.313*	8.141	0.001	2.901
	Error	0.577	15	0.038			
Total molds and yeasts	Storage period (Months)	9.737	3	3.246*	65.290	7.710	3.287
	Treatments	12.829	5	2.566*	51.617	6.380	2.901
	Error	0.746	15	0.050			
Total coliform bacteria	Storage period (Months)	2.301	3	0.767*	32.269	0.009	9.277
	Treatments	0.126	1	0.126 NS	5.316	0.104	10.128
	Error	0.071	3	0.023			
Salmonella	Storage period (Months)	1.384	3	0.461*	9.557	0.048	9.277
	Treatments	0.328	1	0.328 NS	6.802	0.080	10.128
	Error	0.145	3	0.048			
Psychrophilic bacteria	Storage period (Months)	7.170	3	2.390*	45.596	9.100	3.863
	Treatments	0.997	3	0.332*	6.339	0.013	3.863
	Error	0.472	9	0.052			

*Significant
NS: Non significant
Data were analyzed by ANOVA: (Two-Factor without Replication), F test means (P<0.05).

3.4. Sensory evaluation of dry salted and frozen mullet fish

Table (7 and 8) showed the changes in sensory evaluation of dry salted and frozen mullet fish as affected by gamma irradiation during storage period. It is noticed that gamma irradiation doses (2.5 and 5.0 kGy) had not significant remarkable effect ($P \leq 0.05$) on sensory properties (appearance, odor, texture and color) of mullet fish samples under investigation at zero time of storage period and during storage periods.

Table 7

Sensory attributes of dry salted and frozen mullet fish as affected by gamma irradiation during storage

Sensory attributes	Storage period (Months)	Treatments					
		Dry salted fishes			Frozen fish		
		0.0 KGy	2.5 kGy	5.0 kGy	0.0 KGy	2.5 kGy	5.0 kGy
Appearance	Zero time	9.25	9.45	9.14	9.14	9.45	9.48
	1	9.32	9.42	9.14	9.12	9.01	9.24
	2	9.24	9.34	9.45	9.10	8.79	8.95
	3	9.63	9.12	9.14	8.92	8.96	8.87
Odor	Zero time	8.65	8.29	8.18	8.08	8.71	8.08
	1	8.85	8.28	8.45	8.75	8.70	8.42
	2	8.65	8.15	8.51	8.52	8.10	8.35
	3	8.52	8.40	8.21	8.12	8.00	8.14
Texture	Zero time	9.52	9.51	9.42	9.45	9.15	9.42
	1	9.40	9.58	9.72	9.61	9.42	9.28
	2	9.43	9.21	9.52	9.45	9.41	9.12
	3	9.41	9.13	9.13	9.46	9.41	9.45
Color	Zero time	8.98	8.85	8.45	8.92	8.77	8.74
	1	8.55	8.75	8.45	8.12	8.41	8.89
	2	8.45	8.24	8.38	8.51	8.79	8.75
	3	8.49	8.31	8.45	8.67	8.76	8.67

Table 8

Analysis of variance of sensory attributes for salted and frozen mullet fish as affected by gamma irradiation

Sensory attributes	Source of variance	Total square values	Degree of freedom	Main square values	F	P-value	F crit.
Appearance	Storage period (Months)	0.154	3	0.051 NS	1.310	0.307	3.287
	Treatments	0.345	5	0.069 NS	1.758	0.182	2.901
	Error	0.588	15	0.039			
Odor	Storage period (Months)	0.374	3	0.125 NS	2.999	0.063	3.287
	Treatments	0.449	5	0.090 NS	2.158	0.114	2.901
	Error	0.624	15	0.042			
Texture	Storage period (Months)	0.102	3	0.034 NS	1.368	0.290	3.288
	Treatments	0.095	5	0.019 NS	0.765	0.589	2.901
	Error	0.373	15	0.025			
Color	Storage period (Months)	0.285	3	0.095 NS	2.209	0.129	3.287
	Treatments	0.269	5	0.054 NS	1.256	0.333	2.901
	Error	0.644	15	0.043			

NS: Non significant
Data were analyzed by ANOVA: (Two-Factor without Replication), F test means ($P \leq 0.05$).

4. Conclusion

Gamma irradiation has been considered as an interesting method of preservation to extend the shelf life of fish and also to reduce qualitatively and quantitatively the microbial population in fish and fish products. Irradiation doses of 2.5 and 5.0 kGy can reduce important food pathogens such as Salmonella, and total bacteria counts, Coliform bacteria, Spore forming bacteria, Psychrophilic bacteria and total molds and yeasts. And 5 kGy was the optimum dose of gamma irradiation that had a significant ($P \leq 0.05$) decrease effects on microbial loud without any adversely affect the quality of salted and frozen mullet fish.

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