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THE ABDUS SALAM INTERNATIONAL CENTRE FOR THEORETICAL PHYSICS

THE FIRST STEP IN STUDYING THE ABILITY OF DESTROYING THE ANTIBIOTICS BY GAMMA RADIATION

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Abstract

This paper presents the research results of the possibility to destroy the antibiotics in the form of liquid by gamma radiation to break the molecular bond of antibiotics. The ^{60}Co gamma radiation with the doses of 4.7 kGy to 29.3 kGy was irradiated on chloramphehicol and flumequine solution to define the content of antibiotics by the high performance liquid chromotography method. After irradiating, concentration of antibiotics is reduced from 30.26% to 98.89%. Based on the results, we can draw the conclusion that, with appropriate doses, the gamma radiation can destroy antibiotics. This result can be used to destroy after-content of antibiotics in seafood products.

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Introduction

Commercial food irradiation technology has now resulted worldwide [1,2]. However, the use of irradiation technology to destroy residual antibiotics in seafood hasn't been of concern as yet. In this work, we study to eliminate the antibiotics in the form of a liquid by gamma radiation with sterilization doses and we hope sterilization associated with elimination after-content of antibiotics will optimize the food handling process by radiation technology.

Experimental

Firstly, chloramphenicol and flumequine were mixed onto solution with concentration as shown in the Table 1. Next, a concentration of antibiotics was determined by the high performance liquid chromotography (HPLC) method.

Table 1 : Dosage and concentration of antibiotics before and after irradiating

Name	Dosage	Concentration of mixture	Solvent		Concentration of HPLC
			Water	*Ethanol*	
Chloramphenicol	1/20 (kg/ton)	0.05/200 (g/ml)	100 ml	100 ml	250.01 ppm
Flumequine	100/100 (g/kg)	0.2/200 (g/ml)	200 ml	0.00	104.17 ppm

After that, the samples were irradiated by the ^{60}Co gamma radiation source. We investigated energy values of antibiotics by Chem & Bio 3D 11.0 computer programs and we examined the attenuation of gamma rays when they pass through matter. Then, we claimed that a dose of 1 kilogray (1 kGy = 1 kJ/kg) can break the bonds and destroy molecules. Thus, studying the influence of gamma radiation on antibiotics, we required irradiating doses of about 4, 8, 12, 20, 24 kGy.

Results and discussion

After irradiating, the samples changed color. A change in the color intensity depends on exposure doses as follows 4.7, 9.2, 13.1, 24.4 and 29.3 kGy.

From measuring concentration of irradiated antibiotics, we realized that various doses reduced concentration of chloramphenicol and flumequine in solution. Table 2 lists various doses, concentration of antibiotics in solution after irradiating and a percentage of degraded antibiotics concentration.

Table 2: Concentration and percentage of disintegration of antibiotics with exposure doses

Requested doses (kGy)	Exposure doses (kGy)	Concentration of chloramphenicol		Concentration of flumequine	
		Unit (ppm)	*Degradation*	*Unit (ppm)*	*Degradation*
Before irradiating		250.01	0.00	104.17	0.00
4	4.7	123.47	50.61	43.63	58.12
8	9.2	132.13	47.15	22.54	78.36
12	13.1	174.36	30.26	10.25	90.16
20	24.4	135.96	45.62	1.86	98.21
14	29.3	158.43	36.63	1.16	98.89

Figures 1, 2, 3, 4 show the relations between antibiotic concentration after irradiating with the percentage of degraded antibiotics concentration with different exposure doses.

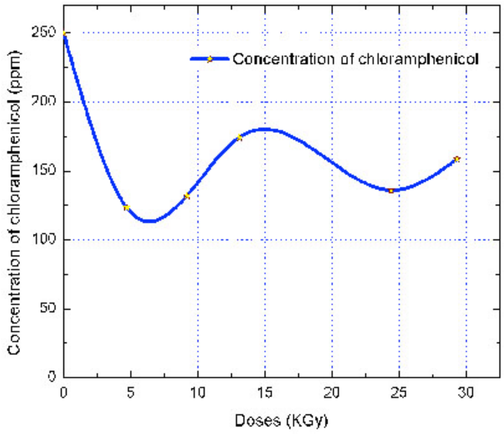

Figure 1: Relation between chloramphenicol concentration with exposure doses after irradiating

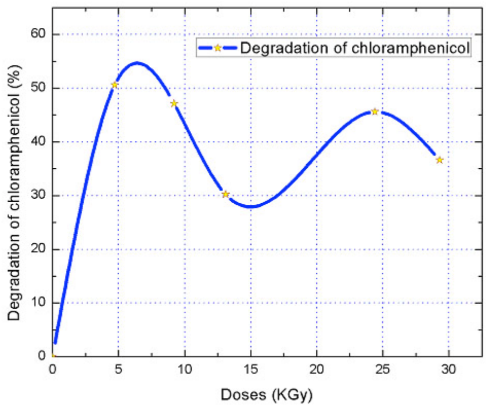

Figure 2: Relation between chloramphenicol degradation with exposure doses

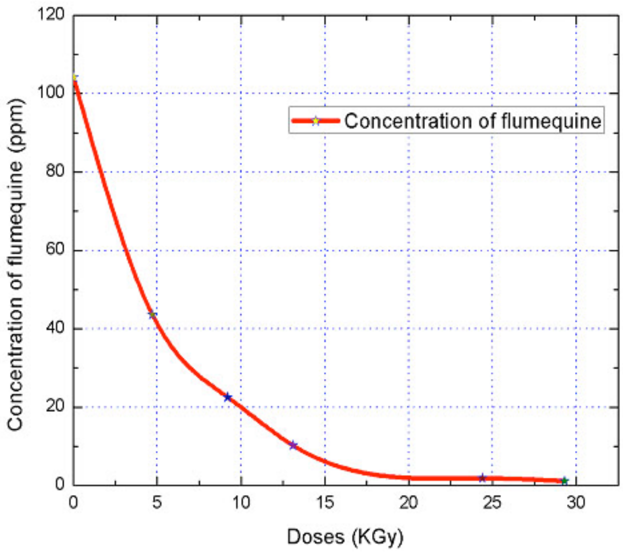

Figure 3: Relation between flumequine concentration with exposure doses after irradiating

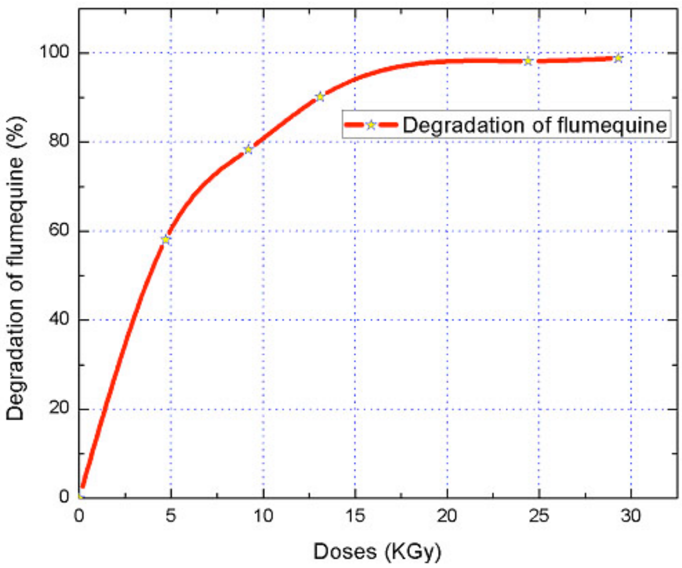

Figure 4: Relation between flumequine degradation with exposure doses

Degradation of chloramphenicol and flumequine in solution after irradiating showed the change is significant. For example, degradation of chloramphenicol is about 30.26% but degradation of flumequine is up to 90.16% while the change of color is the same.

We consider that maybe the change in color is because of the effects of gamma radiation on the solvent – this is the only substance that absorbs radiation energy.

The molecular structure of chloramphenicol and flumequine is different, thus the effect of interaction between the gamma radiation with molecules is also different. This is why degradation of chloramphenicol and flumequine in solution is different [3,4].

In our research, the possibility to eliminate flumequine in solution by gamma radiation is by 58.12% to 98.89%. The possibility will increase with exposure doses. Maybe the possibility to eliminate flumequine in solution by gamma radiation depends on exposure doses, irradiation time and initial contents of antibiotics remaining in the solution.

Table 3: Shows the ability to eliminate the residual antibiotics after handling corresponding to doses in 4.7, 9.2, 13.1 kGy.

Exposure doses	**4.7 kGy**		**9.2 kGy**		**13.1 kGy**	
Residual antibiotic (ppm)	Degradation 58.12% (ppm)	Residual antibiotic after irradiating (ppm)	Degradation 78.36% (ppm)	Residual antibiotic after irradiating (ppm)	Degradation 90.16% (ppm)	Residual antibiotic after irradiating (ppm)
1	0.58	***0.42***	0.78	***216.40***	0.90	***98.40***
2	1.16	0.84	1.57	***432.80***	1.80	***196.80***
3	1.74	1.26	2.35	649.20	2.70	***295.20***
4	2.32	1.68	3.13	865.60	3.61	***393.60***
5	2.91	2.09	3.92	1082.0	4.51	***492.00***
6	3.49	2.51	4.70	1298.4	5.41	***590.40***

Table 4: Shows the ability to eliminate the residual antibiotics after handling corresponding to doses in 24.4, 29.3 kGy.

Exposure doses	**24.4 kGy**		**29.3 kGy**	
Residual antibiotic (ppm)	Degradation 98.21% (ppm)	Residual antibiotic after irradiating (ppb)	Degradation 98.89% (ppm)	Residual antibiotic after irradiating (ppb)
1	0.98	***17.90***	0.99	***11.10***
2	1.96	***35.80***	1.98	***22.20***
3	2.95	***53.70***	2.97	***33.30***
4	3.93	***71.60***	3.96	***44.40***
5	4.91	***89.50***	4.94	***55.50***
6	5.89	***107.40***	5.93	***66.60***
7	6.87	***125.30***	6.92	***77.70***
8	7.86	***143.20***	7.91	***88.80***
9	8.84	***161.10***	8.90	***99.90***
10	9.82	***179.00***	9.89	***111.00***
11	10.8	***196.90***	10.88	***122.10***
12	11.79	***214.80***	11.87	***133.20***
13	12.77	***232.70***	12.86	***144.30***
14	13.75	***250.60***	13.84	***155.40***
15	14.73	***268.50***	14.83	***166.50***
16	15.71	***286.40***	15.82	***177.60***
17	16.70	***304.30***	16.81	***188.70***
18	17.68	***322.20***	17.80	***199.80***
19	18.66	***340.10***	18.79	***210.90***
20	19.64	***358.00***	19.78	***222.00***
21	20.62	***375.90***	20.77	***233.10***
22	21.61	***393.80***	21.76	***244.20***
23	22.59	***411.70***	22.74	***255.30***

24	23.57	***429.60***	23.73	***266.40***
25	24.55	***447.50***	24.72	***277.50***
26	25.53	***465.40***	25.71	***288.60***
27	26.52	***483.30***	26.70	***299.70***
28	27.50	***501.20***	27.69	***310.80***
29	28.48	***519.10***	28.68	***321.90***
30	29.46	***537.00***	29.67	***333.00***
31	30.45	***554.90***	30.66	***344.10***
32	31.43	***572.80***	31.64	***355.20***
33	32.41	***590.70***	32.63	***366.30***
34	33.39	608.60	33.62	***377.40***
35	34.37	626.50	34.61	***388.50***
36	35.36	644.40	35.60	***399.60***
37	36.34	662.30	36.59	***410.70***
38	37.32	680.20	37.58	***421.80***
39	38.30	698.10	38.57	***432.90***
40	39.28	716.00	39.56	***444.00***
41	40.27	733.90	40.54	***455.10***
42	41.25	751.80	41.53	***466.20***
43	42.23	769.70	42.52	***477.30***
44	43.21	787.60	43.51	***488.40***
45	44.19	805.50	44.50	***499.50***
46	45.18	823.40	45.49	***510.60***
47	46.16	841.30	46.48	***521.70***
48	47.14	859.20	47.47	***532.80***
49	48.12	877.10	48.46	***543.90***
50	49.11	895.00	49.45	***555.00***
51	50.09	912.90	50.43	***566.10***
52	51.07	930.80	51.42	***577.20***
53	52.05	948.70	52.41	***588.30***
54	53.03	966.60	53.40	***599.40***

In tables 3 and 4, the underlined figures show the remaining concentration of antibiotics after radiation treatment is lower than the permissible limit of concentration in seafood .

The results show that the higher the exposure doses are, the more residual antibiotics are eliminated. Thus, gamma radiation is very efficient for destroying the residual flumequine in seafood or food in general.

Chloramphenicol is degraded by 50.61%, however, if irradiation time and exposure doses are increased, chloramphenicol will be eliminated more and more. Additionally, while gamma radiation is being emitted on seafood, the residual antibiotics will degrade and will be affected by both gamma radiation and the enzyme of living creatures. Thus, it is necessary to study more about antibiotics remaining in seafood to determine for the possibility to eliminate chloramphenicol.

Conclusion

- The gamma radiation can destroy antibiotics in the form of liquid.
- Destruction of antibiotics by gamma radiation depends on the exposure dose.

- Destruction of antibiotics by gamma radiation depends on the chemical component of solution.
- With appropriate doses, the gamma radiation can destroy flumequine.
- This result is the first base for studying and developing a radiation technique for destroying antibiotics.

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