ISSN : 0974 - 7427 Volume 10 Issue 2

BIOCHEMISTRY
An Indian Journal

Regular Paper

BCAIJ, 10(2), 2016 [052-056]

Irradiation of red sea shrimp increased its content of vitamins A and E

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ABSTRACT

This study was designed to investigate the effect of one and two kilo Gray (KGy) irradiation on the Indian white prawn shrimp (*Fenneropenaeus indicus*) with regard to its microbial content of *E. coli*, *Salmonella SPP*, *Staphylococcus aureus*, *Vibrio spp*, *Listeria monocytogen* and *Proteus mirabilis* and some biochemical parameters like vitamin A and E, proteins and iodine. The results showed that *Vibrio spp* was resistant to the one and two kGy doses. Surprisingly, vitamin A and vitamin E increased with the increase in the *Vibrio spp* count.

KEYWORDS

Fenneropenaeus indicus;
Vibrio spp;
Gama radiation;
Vitamin A;
Vitamin E.

INTRODUCTION

Peneaus (Fenneropenaeus) indicus is one of the shrimp types. It is named by the Food and Agriculture Organization (FAO) as Indian white prawn. It lives in the Indo- west pacific which includes east and south east Africa, south China, New Guinea and north Australia. The normal habitat of the Indian white prawn is 2 to 90 meters deep in the bottom mud or sand of marines (Adult shrimps) and estuarine (Juvenile shrimp). The maximum total length of the male shrimp is 184 mm and for females is 228 mm[1].

Indian white prawns are rich in proteins and deficient in fats and calories. Indian white prawn contains valuable amounts of minerals like sodium, potassium, magnesium, cupper, phosphorus, iron, cobalt, manganese and chromium[2]. Indian white prawns are rich in polyunsaturated fatty acids including Omega 3 fatty acids[3].

Regarding the vitamins content of the Indian white prawn, Hala Ali Abdel-Salam registered high content of vitamin B1 and B2 in the Indian white prawn mucles[4]. It is well known that the Indian white prawns are rich source of vitamin A, D, E and vitamin B1, B2 and B3[5].

One of the major risk factors of sea food including Indian white prawn is the presence of different pathogens like the *Salmonella*, *Staphylococcus*, *Escherichia coli* and *Vibrio cholera*[6].

Bacteria although most of them are pathogenic, some are very good for the health of plants, animals and humans. They accepted their importance from their production of many nutritionally valuable molecules like

proteins, water soluble vitamins (B1, B2, B3, B5, B6 and B12 and fat soluble vitamins (A, E and K). Bacteria are used in the biotechnology to produce these bio-molecules either naturally or through bio-engineering[7,8].

Gama Irradiation is one of the food preservation methods to increase the shelf life of food and to fight food contamination through killing the microorganisms with a very limited effect on the physical and chemical properties of food. Irradiation is used as one method to preserve shrimps[9].

The aim of this study is to investigate the effect of one kilo gray radiation dose on the growth of bacteria and on some nutritional parameters. Specifically the bacteria investigated were *E. coli*, *Salmonella SPP*, *Staphylococcus aureus*, *Vibrio spp*, *Listeria monocytogen* and *Proteus mirabilis*. The nutritional parameters were vitamin A, vitamin E, total protein and iodine.

MATERIAL AND METHODS

In a true quasi experimental and longitudinal research design, red sea shrimp (*Fenneropenaeus Indicus*) was used as study subject after an ethical and academic approval from health and atomic energy authorities.

9 groups of the shrimps were used. 3 groups were used as control and six were irradiated with 1kGy and 2kGy (three samples each). Samples for microbiological and chemical analysis were taken immediately after irradiation, after 21 day of irradiation and after 45 days of irradiation. However, the shrimp samples were stored at room temperature.

Methods

Irradiation of shrimps was done with cobalt 60 gamma source (Nordion gamma cell 220-Excell, Canada).

Protein percentage, vitamin A and vitamin E concentration were determined according to the Association of Official Analytical Chemists (AOAC) protocol[10]. The iodine concentration was measured following the SandellandKolthoff method for iodine measurement[11].

Regarding the microbial analysis *Salmonella spp, Staphylococcus aureus, Vibrio spp* and *Listeria monocytogen* were counted using the standard methods of Harrigan[12]. Proteus spp colonies were determined according to the standard method of Xilinas[13].

RESULTS AND DISCUSSION

Results

The results of this article reflected the resistance of *Vibrio spp* to irradiation with 1 and 2 kGy (TABLE.1). Regarding the irradiation of shrimps with 1kGy,the number of colonies of vibrio spp was affected by irradiation compared to the control, but it increased in the 21st day sample and it decreased in the 45th day. Vitamin A and E concentration decreased in the first sample after irradiation compared to the control, increased in the 21st day sample and decreased in the

TABLE 1 : Bacterial growth in the control and irradiated shrimps with one and two KGy

Sample		APC cfu/g	*E.coli* MPN/g	*Salmonella spp* cfu/g	*Listeria monocytogen* cfu/g	*Vibrio spp* cfu/g	*Proteus mirabilis* cfu/g
	S0	$8.0x10^7$	0.00	0.00	0.00	$6.0x10^3$	0.00
Control	S21	$6.0x10^7$	24.7	0.00	$4.7x10^2$	$8.4x10^3$	$4x\ 10^2$
	S45	-	-	-	-	-	-
	S0	$6.0x10^7$	0.00	0.00	0.00	$6.0x10^2$	0.00
1 KGy	S21	$7.8x10^4$	0.00	0.00	0.00	$7.9x10^2$	0.00
	S45	$6.0x10^4$	12	0.00	$4.5x\ 10^2$	$6.0x10^2$	$5.7x\ 10^2$
	S0	$4.2x10^3$	0.00	0.00	0.00	$3.3x10^2$	0.00
2 KGy	S21	$7.6x10^3$	0.00	0.00	0.00	$5.0x10^2$	0.00
	S45	$7.0x10^3$	6.3	0.00	$3.2x\ 10^2$	$8.5x10^2$	$3.7x\ 10^2$

CFU: Colony Forming Units.; MPN: Most Probable Number.; S0: Sample after irradiation (immediately).; S21: Sample on the 21st day.; S45: Sample on the 45th day.

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45th day sample (TABLE 2 and 3 and Figure 1).

The 2 kGy irradiation showed the resistance of the *Vibrio spp*, however, its growth was decreased in the after irradiation sample and increased in the 21st and 45th days samples (TABLE 1). The change in vitamin A concentration followed the same pattern of the change in *Vibrio spp* growth while vitamin E decreased in the 45th day sample (unlike the growth of the *Vibrio spp* and the concentration of vitamin A) (TABLE 2 and 3 and Figure 1).

The 45th day sample of the irradiated samples showed increased colonies of *E coli*, *Listeria monocytogen* and *Proteus mirabilis* which means that the shelf life of irrdaited shrimps with one and two kGy is less than 45 days if stored at room temperature.

The total protein and iodine were decreasing in the after irradiation, 21st day and 45th day samples compared to the control sample (TABLE 2).

The radiation doses did not affect the texture and the appearance of the samples up to the 21st day sample. At the 45th day the appearance of the samples was affected (yellow and black colors appeared in the samples).

Discussion

Our results showed that *Vibrio spp* were detected in the raw shrimps and that they were resistant to the 1 and 2 kGy radiation doses and that vitamin A and E were increasing with the growth of the *Vibrio spp* when one kGy was applied. The *Vibrio spp* may be induced to produce the vitamins by the two radiation doses. In the 2 kGy vitamin E decreased in the 45th day sample. The protein and iodine were decreasing with time. The texture of the shrimp was not affected by the two doses.

Contamination of fish and fishery products with *salmonella* and *vibrio* has been reported by many researchers[14-20]. However, some of the authors stated that the presence of the bacteria may be due to external contamination[20].

All the previous studies showed that the vibrio spp are sensitive to irradiation with low radiation doses as follows:

V K G ABREU and his research group in 2009[6] found that the 2, 4 and 6 KGy doses significantly decreased the growth of *Vibriocholera*. However, the

TABLE 2 : Biochemical analysis results of irradiated shrimp

Storage days	Control shrimp				Irradiated shrimp				Dose
	Vit A	Vit E	Total protein	Iodine	Vit A	Vit E	Total protein	Iodine	1KG
0	29.60	7.90	18.6	0.33	13.60	1.68	17.05	0.26	
21	30.00	4.20	17.40	0.29	150.00	14.00	15.45	0.21	
45					19.14	5.84	14.25	0.21	
0	29.60	7.90	17.40	0.29	14.4	1.54	16.50	0.24	2 KG
21	30.00	4.20	17.40	0.29	99.00	9.14	15.90	0.19	
45					100.00	2.98	9.95	0.14	

Vitamin A and vitamin E concentration were measures in µg/ 100g and the percentages of protein and iodine were in weight/ weight (100g)

TABLE 3 : The *Vibrio spp* growth compared to the vitamins concentration.

Storage days	Irradiated shrimp					Dose
	Vibrio cfu/g	Vit A	Vit E	Total protein	Iodine	
0 (after irradiation)	$6.0x10^2$	13.60	1.68	17.05	0.26	1KG
21	$7.9x10^2$	150.00	14.00	15.45	0.21	
45	$6.0x10^2$	19.14	5.84	14.25	0.21	
0 (after irradiation)	$3.3x10^2$	14.4	1.54	16.50	0.24	
21	$5.0x10^2$	99.00	9.14	15.90	0.19	2 KG
45	$8.5x10^2$	100.00	2.98	9.95	0.14	

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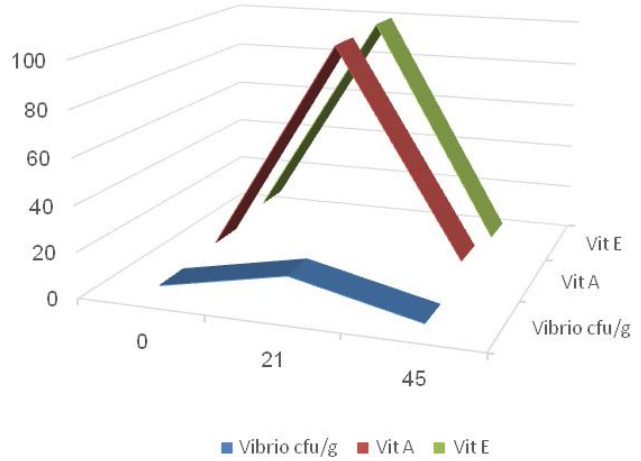

Figure 1

effective doses were the 4 and 6 KGy doses.

It is known that vibrio spp are sensitive to irradiation since their D10 value is 0.06KGy[21].

Irradiation with one KGy is enough to control the colonies of *V. parahaemolyticus* in the acceptable levels as specified by the USA Food and Drug Administration (FDA)[22].

In 2001 E CISNEROS DESPAIGNE research team contaminated oysters with different Vibrio spp and after irradiation they found that a dose of 1.2 kGy is enough to eliminate numbers of Vibrio spp up to 10^7 $CFUg^{-1}$[23].

However, we did not find any published research registering the resistance of vibrio spp to 1 and 2 kGy radiation doses i.e. this is the first time to register the resistance of Vibrio spp to low radiation doses.

Regarding the increase of vitamin A and vitamin E concentration with the increase of the Vibrio spp growth, it is registered in 1932 by C. E. Skinner and M. F. Gunderson that corynebacterium was capable of producing vitamin A[24]. However, (Jennifer K. Miller et al 2013) genetically, engineered the E coli to produce Beta carotene to help solving of vitamin A deficiency[25]. Our study accidently produced vitamin A and E through irradiation of Indian white prawn shrimps contaminated with Vibrio spp.

CONCLUSION

The *Vibrio spp* was resistant to irradiation with one and two KGy doses. Vitamin A concentration was changing with the change in the *Vibrio spp* growth.

CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest.

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