



**การใช้รังสีภาชนะบรรจุและก๊าซไนโตรเจน
เพื่อรักษาคุณภาพผลิตภัณฑ์กุ้ง
Combination Effects of Radiation
Packaging and N₂ - Gas on
Shelf - Life Extension of Shrimp**

โดย

พองเพ็ญ รัตตกุล
Pongpen Rattagool
ฮิโตะชิ ฮิโตะ
Hitoshi Ito

เอกสารวิชาการ ฉบับที่ 3/2534
กองพัฒนาอุตสาหกรรมสัตว์น้ำ
กรมประมง

Technical Paper No. 3/1991
Fish. Tech. Devel. Div.
Department of Fisheries

การใช้รังสีภาชนะบรรจุและก๊าซไนโตรเจน
เพื่อรักษาคุณภาพผลิตภัณฑ์กุ้ง

COMBINATION EFFECTS OF RADIATION,
PACKAGING AND N₂-GAS OF
SHELF-LIFE EXTENSION OF SHRIMP

โดย

พงษ์เพ็ญ รัตตกุล
ฮิโตะชิ อิโต*

กองพัฒนาอุตสาหกรรมสัตว์น้ำ
กรมประมง กระทรวงเกษตรและสหกรณ์

Pongpen Rattagool
Hitoshi Ito*

Fishery Technological Development Division
64 New Road, Yannawa BKK, Thailand

*Radiation Chemistry Research, Establishment,
Takasaki, JAERI, Japan

CONTENT

	Page
Abstract	1
Introduction	2
Objectives	2
MATERIALS AND METHODS	
Chemical Analysis	2
Microbiological Analysis	3
Sample Preparations	3
I. frozen shrimp	3
II. frozen cooked (shell-on) shrimp (FC)	3
III. cooked and peeled srhimp	4
RESULTS AND DISCUSSIONS	
TREATMENT I. (irradiated frozen shrimp)	4
TREATMENT II. (irradiated cooked shell-on shrimp).	5
Acknowledgement	6
References.....	6
Figuer 1,2	7
Figuer 3,4	8
Table 1	9
Table 2	10
Table 3	10

COMBINATION EFFECTS OF RADIATION, PACKAGING AND N₂-GAS
FOR SHELF - LIFE EXTENSION OF SHRIMP

PONGPEN RATTAGOOL
HITOSHI ITO

ABSTRACT

To evaluate the influence of different parameters on the shelf-life of cooked shrimp experiments were made, introducing radiation in the shrimp (peeled and unpeeled) at different temperature (deep frozen at -35°C and chilled at 5°C and using different packing materials ethylene vinylalcohol copolymer polypropylene & polyethylene (EG-Q) and cellophane (CP). To reduce the oxidation effects, the experiments were performed under the addition of the Nitrogen gas.

The irradiation was done with gamma rays emitted by a Cobalt-60 source of 5.55×10^{15} Bq (150 KCi) at a dose rate of 6 kGy. per hour. The usual irradiation doses of 1.5 and 3 kGy. were applied as well as a range of 0.5, 1, 2, 3, 4, 5, 6 and 8 kGy.

The experiments confirmed that the radiation sensitivity of microorganism like coliforms and aerobic microorganisms and enterobacteriaceae is temperature dependent.

The peroxide value showed also to be temperature depending and in addition of the packaging material.

The TMA-N value was not significantly influenced by the applied radiation doses, irradiated shrimp at chilled conditions showed off-flavours at 1.5 kGy. Off-flavours could be detected at a dose of 3 kGy when the shrimp was irradiated in deep frozen condition. No differences was observed on the radiation effects of peeled and unpeeled shrimp.

INTRODUCTION

Since 1985 farmed shrimp especially tiger (*P. monodon*) was introduced for frozen shrimp export. Unfortunately, shrimp was rejected because of high bacterial count and also *Salmonella* contamination especially by the FDA, USA. (FDA annual report 1985). *Salmonella* contamination on farmed shrimp was detected even when good manufacturing practice had been applied, as previous reported (Ref. 6). One disadvantage was the formation of off-odours which developed on shrimp, especially those irradiated at higher dose, off-odours were detected at 3 kGy in cooked shrimp when irradiated under chilled condition. Higher dose can be applied if shrimp are irradiated under frozen condition.

OBJECTIVES

1. To extend the shelf-life of frozen shrimp and cooked shrimp.
2. To study the chemical and microorganism change during storage.
3. To find radiation dose to eliminate the pathogenic microorganisms.
4. To investigate the radiation dose, the cause of flavour, the cooked or uncooked under frozen or chilled condition.

MATERIALS AND METHODS

CHEMICAL ANALYSIS

Trimethylamine nitrogen (TMA-N) has been following A.O.A.C. method (Horwitz, 1980)^(1, 3, 5)

Lipid will be extracted by Folch's method then the peroxide value (3) which is measured for the state of oil deterioration which will be expressed as a number of milliequivalents of peroxide per kilogram of the sample.

MICROBIOLOGICAL ANALYSIS

Total bacterial count (TVC/gm) was carried out by following Bacteriological Analytical Manual (BAM) for food, FDA (1976). (2) Nutrient agar is used for standard plate count but .2% glucose, 5% yeast extract and .2% K_2HPO_4 were added (Ito, HI modification) and Coliform was enumerated by MacConkey agar, and incubated at 30°C over night and 2 days.

SAMPLE PREPARATIONS

Headless and shell on frozen shrimp (size 26-30 per pound) from South East Asia was used for 3 treatments;

I. FROZEN SHRIMP

5 gm of frozen shrimp in ethylene vinylalcohol copolymer poly propylene & polyethylene (EG-Q) and N_2 gas in addition. The shrimp was irradiated at 1, 2, 3, 4, 5, 6 and 8 kGy under frozen and chilled condition.

Peroxide value (POV) and microorganisms (Total Viable count = TVC, and coliforms) were analysed after 2 days. The frozen shrimp in EG-Q bags with N_2 -gas irradiated at 1, 2, 3, 4, 5, 6 and 8 kGy under chilled on first treatment and frozen condition on the second treatment. Off adour was investigated soon after radiation had been applied.

II. FORZEN COOKED (SHELL-ON) SHRIMP (FC)

Shrimp was cooked at 100°C for 3 minutes in 1% brine solution 5 gm of each sample was packed into EG-Q and cellophane (CP) bags and (N_2 -gas) was an addition. The sample in EG-Q and CP were irradiated at 0.5, 1, 2, 3, 4, 5, 6 and 8 kGy under frozen condition.

The treated samples were analysed for POV, trimethylamine (TMA) and total viable aerobic count right after irradiated process. Also another set of treated samples were irradiated at 0, 1.5 and 3.0 kGy under frozen

condition, then stored at 5°C (refrigerator) for 12 days. The samples were periodical drawn for POV, and TVC determined for every 3 days (0, 3, 6, 9 and 12 days) during storage.

III. COOKED AND PEELED SHRIMP

5 gm of cooked and peeled shrimp in EG-Q and CP bags with N₂-gas. Then the first treatment was irradiated at 0, 1.5 and 3.0 kGy, while the second treatment was irradiated at 0, 3, 5, and 8 kGy., under frozen condition on both treatments. The POV, was determined on the first treatment but POV, TMA and TVC were analysed on the second treatment.

RESULTS AND DISCUSSIONS

TREATMENT I. (irradiated frozen shrimp)

It was found the POV on the treated shrimp in EG-Q bag with N₂-gas and irradiated (at 0, 1, 2, 3, 4, 5, 6 and 8 kGy) under chilled condition increased rapidly with at higher radiation doses. It also slightly increased on shrimp using the same treatment, but irradiated under frozen condition. (Fig. I)

For TVC and coliforms determination (Fig.II) it was found that TVC on the shrimp which was irradiated under frozen condition, showed more resistance microorganisms on the higher radiation dose (8 kGy) compared to the irradiated shrimp under chilled condition.

The same reaction was observed on coliforms but this microorganisms seem to be very sensitive microorganisms even lower radiation dose (1 kGy) was used.

Off odour also was investigated by sensory evaluation, it was first detected at a radiation dose of 1 kGy and would be rejected at 3 kGy and irradiated shrimp under frozen condition, rejected at 5 kGy.

TREATMENT II (irradiated cooked shell-on shrimp)

POV was investigated between EG-Q and CP packing on the irradiated shrimp (at 0, 1.5 and 3 kGy) under frozen condition. It was found that POV was higher at 3 kGy sample than 1.5 kGy and also higher than 0 kGy (Fig. III).

On irradiated shrimp (CP) packaging gave a higher POV at the higher radiation doses (3 kGy). which was similar to shrimp in EG-Q bags.

The POV increases as the radiation dose increase in both (EG-Q) and (CP). However, samples in EG-Q packing gave, a lower POV. than samples in CP packing. Microorganisms did decrease while the radiation doses were increased the determination of D_{10} value is 2.79 kGy.

Red colony was identify to *Deinococcus spp.* (Ito, H. et. al., 1986)⁽⁴⁾ and it was found at higher doses.

For storage studied of irradiated cooked and peeled shrimp at 0, 1.5 and 3.0 kGy. for 0, 3, 6, 9 and 12 days under 5°C storage.

Cooked peeled shrimp in both packaging and irradiated 1.5 and 3 kGy under frozen, gave low count (10^2 cfu) even in 0 kGy. However, the bacterial number will slightly decreased of the cellophane packing especially at higher radiation dose.

Table 2 The development of POV is influenced by a combination of factors, oxygen permeability of the packaging material, radiation doses and storage times. In the shrimp packed in N_2 under frozen condition. The POV develops faster using cellophane POV also increases with the higher radiation doses under both packaging materials.

Table 3 POV developed more slightly at the higher radiation dose after 5 days storage. TVC on cooked and peeled

shrimp is easy to eliminate at 3 kGy because it was low at day 0. TMA also changed very little with the radiation doses.

ACKNOWLEDGEMENTS :

I would like to express my thank for IAEA that supported my research contract No.6377/DP under RPFI phase III and also give me the opportunity for my presentation at FAO/IAEA Asian Co-ordination Meeting under RPFI (III) Jakarta, Indonesia, 15-19 July 1991. I also would like to express my thank to JAERI, Takasaki, Radiation Chemistry Research, Establishment to provide me the gamma sources. I will never be forgot all the Japanese Scientist that gave a great cooperation until my work can go through Dr. Machi Director, and Dr. Ishikaki, Dr. H. Ito. also provided all facilities.

REFERENCES

1. A.O.A.C. 1980. Official Methods of Analysis 13thed. Assoc. Off. Anal. Chem Wash., D.C.
2. FDA. 1976. Bacteriological Analytical Manual for Foods. American Public Health Association. Wash. D.C.
3. Horwitz W. 1980. Official Methods of Analysis Association of Official Chemists. 13th Ed. A.O.A.C.
4. Ito, H., Adulyatham, P., Sangthong N. and Ishikaki, I. 1989. Effects of Gamma Radiation on Frozen shrimp to reduce Microbial contamination. Radiation physics, chemist. 18thed. 34 (6) : 1009-1010.
5. Pearson, D. 1976. The chemical Analysis of Foods (7thed) : 494-495.
6. Rattagool, P. 1986. Using radiation to eliminate Salmonella & Shigella in frozen shrimp. FAO/IAEA, RCFI meeting. Dubrovnik, Yugoslavia.

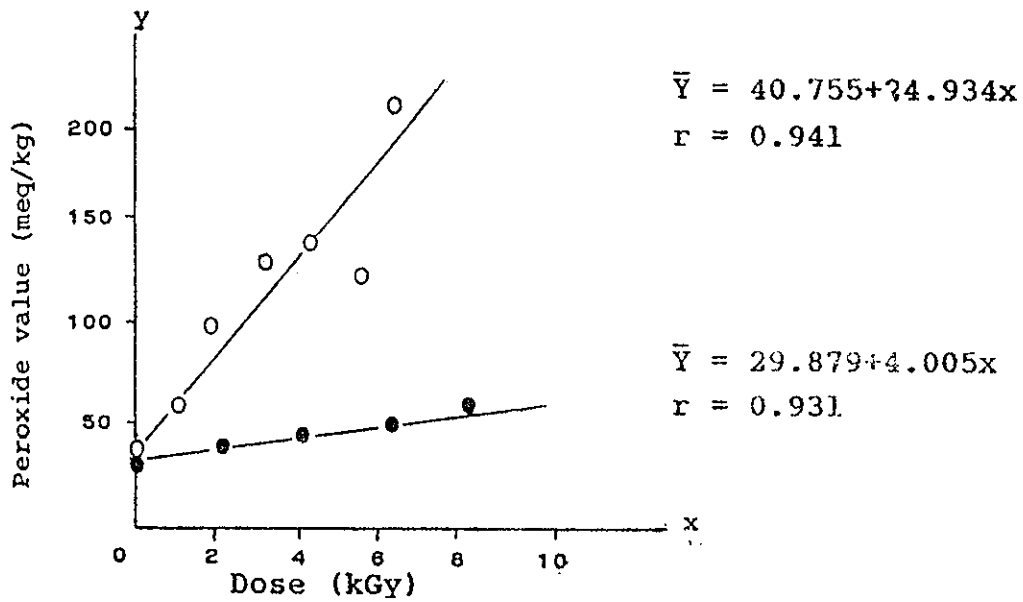


Fig. I Frozen headless shell-on shrimp, was packed into EG-Q with N₂-gas then irradiated at 0, 1, 2, 3, 4, 5, 6 and 8 kGy with a radiation rate at 6 kGy per hour.

● = irradiated at frozen stage.
 ○ = irradiated at unfrozen stage.

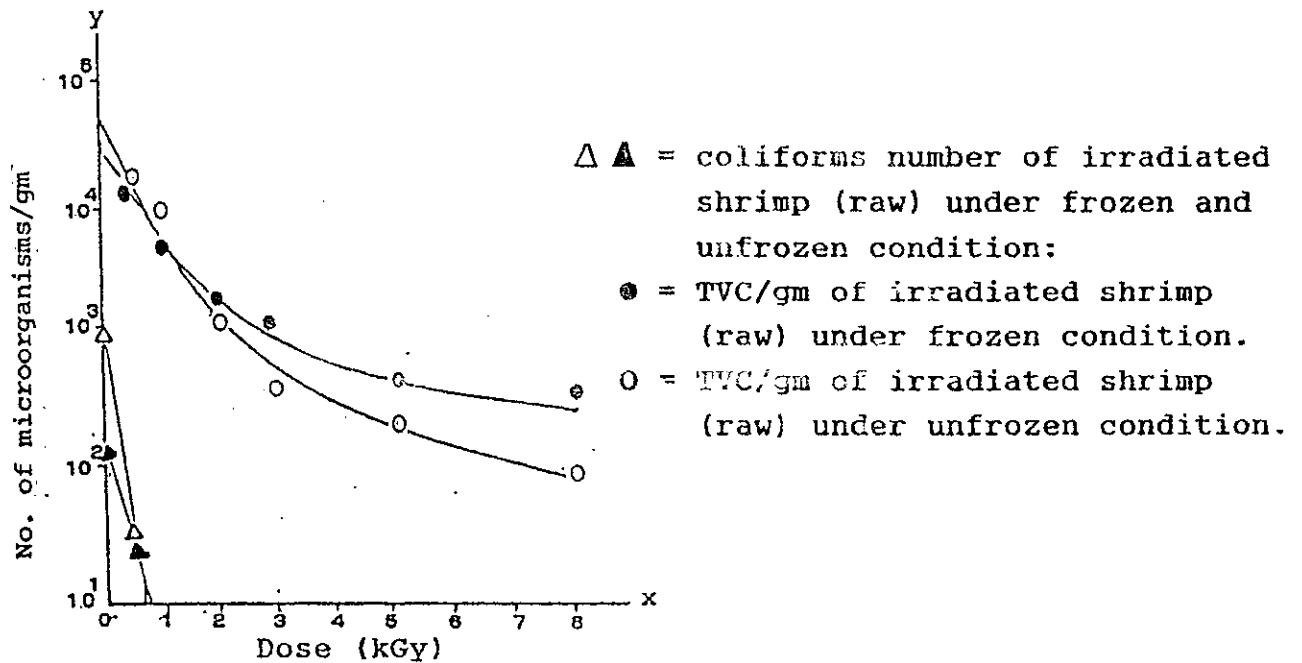


Fig. II Total viable aerobic count (TVC/gm) and Coliforms number changed when the radiation dose increased.

●▲ = irradiated at frozen stage.
 ○△ = irradiated at unfrozen stage.

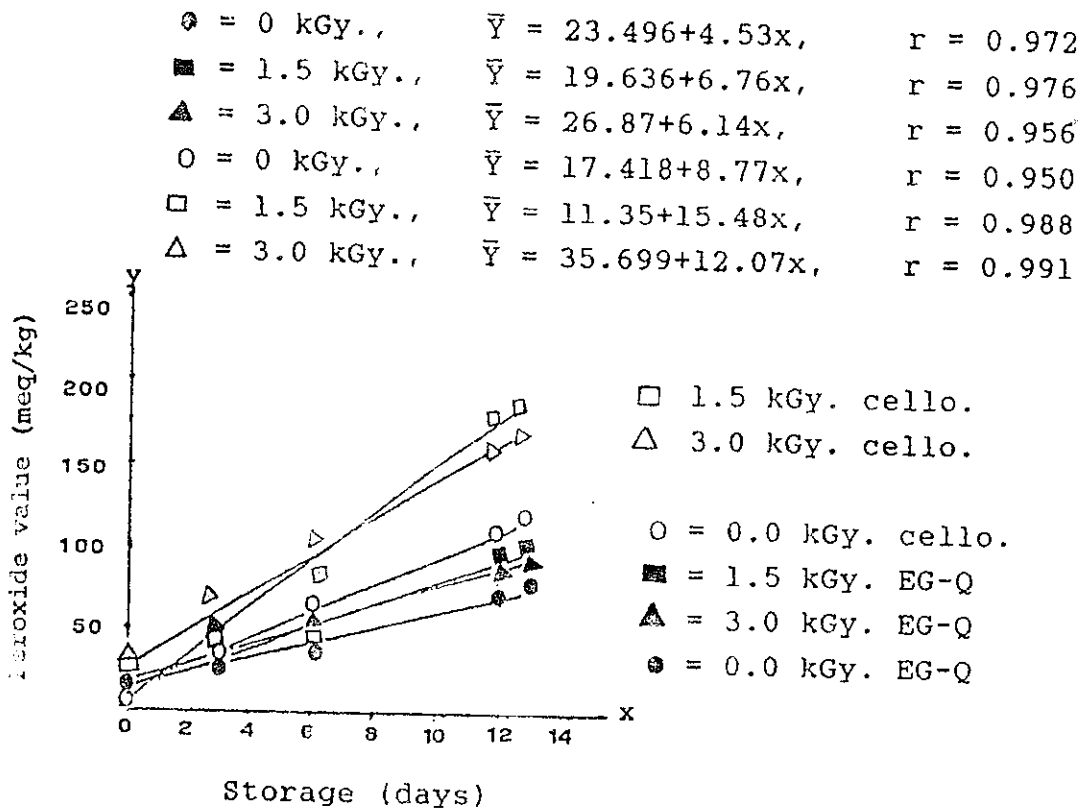


Fig. III Frozen cooked shrimp packed in EG-Q and cellophane bags with N₂-gas then irradiated at 1.5, 3.0 kGy, under frozen condition, stored at 5°C for 12 days.

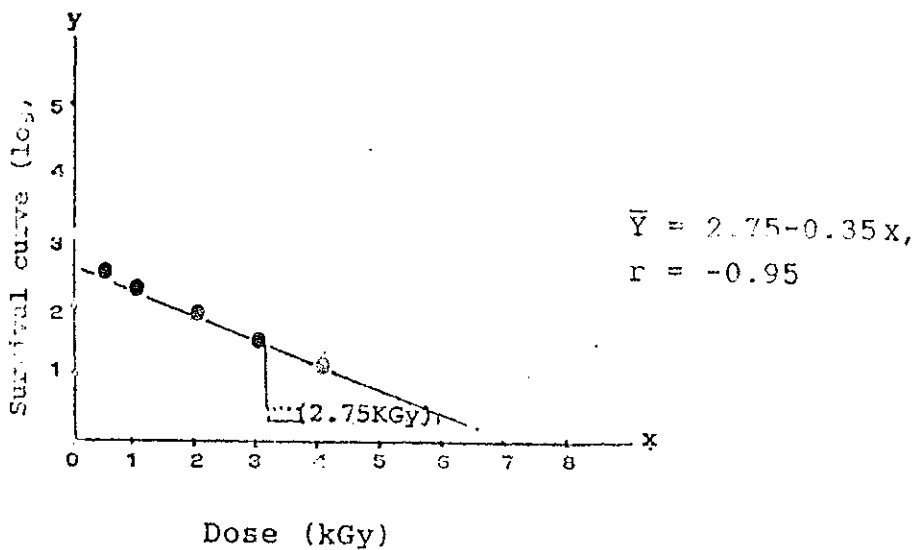


Fig. IV Microorganisms changed after frozen cooked shrimps (shell-on), were packed in EG-Q bags with N₂-gas then irradiated under frozen condition at 0, 0.5, 1, 2, 3, 4, 5, 6 and 8 kGy.

Table 1 Microorganisms changed on cocked (shell-on) frozen shrimp was packed in EG-Q and cellophane with N₂-gas then irradiated under frozen condition (dry-ice) at 0, 1.5 and 3.0 kGy, stored at 5°C for 12 Days.

TVC (cell/gm)						
Storage (days)	EG-Q film			Cellophane		
	0 kGy	1.5 kGy	3.0 kGy	0 kGy	1.5 kGy	3.0 kGy
0	2.25x10 ²	2.5x10 ²	N.D.	2.25x10 ²	3.75x10 ²	N.D.
3	1.4x10 ²	7.5x10 ²	1.5x10 ²	4.25x10 ²	1.0x10 ²	5.0x10 ¹
6	2.5x10 ²	3.3x10 ¹	3.3x10 ¹	6.2x10 ²	6.7x10 ¹	3.3x10 ¹
9	2.5x10 ²	2.6x10 ¹	2.5x10 ¹	3.25x10 ²	N.D.	N.D.
12	1.75x10 ²	1.5x10 ¹	5.1x10 ¹	1.5x10 ²	1.5x10 ¹	5.0x10 ¹

N.D. = not determined

Table 2 Peroxide value changed on the frozen cooked (peeled) shrimp which was packed into EG-Q film with N₂-gas then irradiated at 0, 1.5 and 3.0 kGy, under frozen condition, and stored at 5°C for 12 days.

Packaging materials	Storage (days)	POV (meq/kg)		
		0 kGy	1.5 kGy	3.0 kGy
EG-Q	0	17.640	13.259	17.443
	3	44.370	50.939	58.799
	6	61.462	56.876	62.329
	9	N.A.	N.A.	N.A.
	12	75.641	99.851	97.902
Cellophane	0	15.910	20.999	26.540
	3	46.752	56.023	81.302
	6	68.545	87.545	112.332
	9	N.A.	N.A.	N.A.
	12	N.A.	102.461	176.053

N.A. = not available sample

Table 3 Cooked & frozen shrimp were packed in EG-Q bags then irradiated at 1, 3, 5 and 8 kGy under frozen condition. TMA-N, Peroxide value and Total viable aerobic microorganisms were determined at 0 and 5 days after 5°C storage.

Doses (kGy)	POV. (meq/kg)		TVC/gm		TMA-N (mgN%)	
	0 day	5 days	0 day	5 days	0 day	5 days
0	29.059	31.625	3.0x10 ²	6.25x10 ²	3.050	1.742
1	30.996	31.360	2.0x10 ²	3.0x10 ²	2.915	1.921
3	40.464	38.596	1.25x10 ²	0	2.875	1.805
5	42.702	45.614	0	0	2.464	1.160
8	41.467	65.674	0	0	2.690	0.962

