A STUDY ON EFFECTS OF GAMMA IRRADIATION ON FRESH CUCUMBER FRUIT (*Cucumis sativus* L.)

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Abstract

Cucumber is a versatile food and features in a number of beauty products. This research deals with the study on the effects of gamma irradiation on some physicochemical properties (shelf life, weight loss, pH, moisture, vitamin C) of fresh cucumber fruit due to the highest content of water and light sensitive of vitamin C in it. The sample was collected from Mhawbi market, Yangon Region. This sample was gamma irradiated with 0.5 kGy and 0.7 kGy doses from Co-60 source. The non-irradiated sample was used as comparative study. The shelf life of non-irradiated and two doses of gamma irradiated samples were assessed by changing cucumber skin colour and weight loss at room temperature (29 °C and humidity 74 %). The experimental results revealed that, the shelf life of 0.5 kGy and 0.7 kGy doses of γ irradiated cucumber sample (7 days) was prolonged two times than that of non-irradiated sample (3 days) at room temperature under same condition. At day-2, there were no weight loss of all γ-irradiated samples whereas non-irradiated sample lose 4.5 % of original weight. The moisture contents and pH values of non-irradiated and γ irradiated samples of 0.5 kGy , and 0.7 kGy doses were found to be (97.90 % , 88.89 % , 82.56 %) and (5.67, 5.93, 5.51) by using moisture balance and pH meter. Vitamin C contents of all these samples were found to be 6.34 mg/100g on a fresh weight basis by using iodmetoric titration at day-2. During the storage time, Vitamin C contents of γ irradiated samples of 0.5 kGy, and 0.7 kGy doses were found to be slightly reduced from 6.34 mg/ 100g to 5.37 mg/100g from day-2 to day-5 and from 5.37 mg/100g to 4.29 mg/100g from day-5 to day-7. The pH values of γ irradiated samples of 0.5 kGy , and 0.7 kGy doses were found to be slightly reduced from 5.93 to 4.62 and 5.51 to 4.91 from day-2 to day-7, receptively. From these results, the shelf life of γ irradiated cucumber fruit extended two times than that of control to distribute as fresh product. The vitamin C contents and pH values of irradiated samples are slightly reduced during the storage time.

Keywords: cucumber, Co-60, shelf-life, vitamin C

Introduction

The cucumber (*Cucumis sativus* L.) is a member of the Cucurbitaceae family, along with squash and different kinds of melon (Tatioglu, 1993). Cucumbers are a refreshing, nutritious and incredibly versatile addition to any diet. They are low in calories, fat, cholesterol and sodium but high in water and several important vitamins and minerals (Naganatha and Hartline, 2015). Eating cucumbers may lead to many potential health benefits, including weight loss, balanced hydration, digestive regularity and lower blood sugar levels. They can help prevent dehydration due to consist mostly of water. Dehydration is important for many things including maintaining a healthy intestine, preventing constipation, and avoiding kidney stones. They aid in weight loss due to low in calories, high in water. They help reduce dry skin and blackheads. Therefore, cucumber also features in a number of beauty products (Raaz Maheshwari *et al*., 2014). The food is exposed to doses of ionizing energy, or radiation. At low doses, irradiation is one of the most popular preservation technique used world-wide. On the other hand called "cold pasteurization" because irradiation relies on the energy of ionizing radiation extends a product's shelf life. At higher doses, this process kills insects, moulds, bacteria and other potentially harmful micro-

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organisms. Irradiated food has been exposed to radiation but does not become radioactive itself. The gamma radiation used by Co-60 source is not strong enough to decay the nucleus of even one atom of a food molecule (IAEA, 2003). Finding ways to prevent the deterioration of food and control infection by microorganisms has been a major preoccupation of man over the centuries. Controls such as refrigeration or pasteurization are now common place, and it is expected that one day the technique of food irradiation will also be widely used. Food irradiation can offer a wide range of benefits to food industry and the consumer (ICGFI, 1999).

Materials and Methods

Firstly, the fresh cucumber fruits were collected from Mhawbi Market, Yangon Region. And then, this sample was immediately transported to the Department of Atomic Energy, Ministry of Education, for irradiation. The sample was divided into three groups. Each group contains twenty fresh cucumber fruits. First and second groups were placed in polyethylene bag and treated with two different doses of gamma radiation (0.5 and 0.7 kGy) from Co-60 source which has dose rate of 0.965 kGy/h. Third group involved non-irradiated cucumber (0 kGy) was used as comparative study.

For study on postharvest storage time, the shelf life of two types of γ-irradiated (FCG 0.5, FCG 0.7) and non-irradiated (FCG 0)samples was studied by assessing postharvest changes (colour and weight loss) at room temperature(29 °C and humidity 74 %).

For study on weight loss of each sample during postharvest storage period, periodical weighing was made by using Spring Dial Scale, TL-103.The percentage of weight loss of each sample was calculated by dividing the weight change during storage by the original weight as shown in following.

$$\text{Weight loss (\%)} = [(Wi - Ws)/ Wi] \times 100$$

Where, Wi = initial weight , Ws =weight at sampling period

For study on moisture content of the each sample due to the highest content of water in it, at day-2, about (1) g of each sample was put into a SHIMADZU moisture balance (MOC 63u) and moisture content was obtained automatically.

For study on vary in Vitamin C content in each sample during storage time, a redox titration using iodine solution (or) iodometric titration method (AOAC, 2000) was used. Each fresh juice sample (10 mL) was placed in a conical flask. The solution was titrated with 0.001 M iodine solution. The first appearance of a permanent blue-black coloured due to the starch-iodine complex was taken as the end point. The titration was triplicates and from these results, the ascorbic acid (vitamin C) in the samples was calculated at day-2, day-5 and day-7.

For study on vary in pH values in each sample during storage time, pH value of the each sample was determined by using pH meter at day-2, day-5 and day-7. The electrode was placed in the beaker containing the sample juice of (10 mL) and checked for the reading in the pH meter and waited until to get a stable reading and recorded the pH value.

Results and Discussion

Study on the Effect of γ-Irradiation on Weight Loss of Fresh Cucumber Fruit

Weight loss is one of the physiological parameters used as quality indicator in fruits. The weight loss is because of evaporation of water from the fruit surface as a result of respiration and transpiration. It affects the mainly quality characteristics of fresh, appearance and texture, and these processes are dependent on surrounding temperature and relative humidity (Khattak *et al.*, 2005). Weight losses of non-irradiated and γ-irradiated samples were studied by weighing until deteriorated. According to the results in Table 1, it was found that there were no weight loss of all γ-irradiated samples (FCG 0.5, FCG 0.7) at day-2. They retain their original weight, whereas non-irradiated sample (FCG 0) did not retain its original weight. The percentage of weight loss of all γ-irradiated samples slightly increased in parallel during storage period (7 days). Thus, 0.5 and 0.7 kGy doses of γ-irradiation affect on weight loss of fresh cucumber fruit. It can extend the shelf life of cucumber fruit.

Table 1 Weight Loss of Non-Irradiated and γ-Irradiated Fresh Cucumber Fruit Samples during Different Storage Periods

Storage period (day)	Weight loss (%)		
	FCG 0	FCG 0.5	FCG 0.7
1	0	0	0
2	4.5	0	0
3	4.5	4.5	4.5
4	ND	4.5	4.5
5	ND	4.5	4.5
6	ND	4.5	4.5
7	ND	9.1	9.1

ND = not detected due to deterioration
FCG 0 = Gamma dose of 0 kGy of fresh cucumber fruit (control)
FCG 0.5 = Gamma dose of 0.5 kGy of fresh cucumber fruit
FCG 0.7 = Gamma dose of 0.7 kGy of fresh cucumber fruit

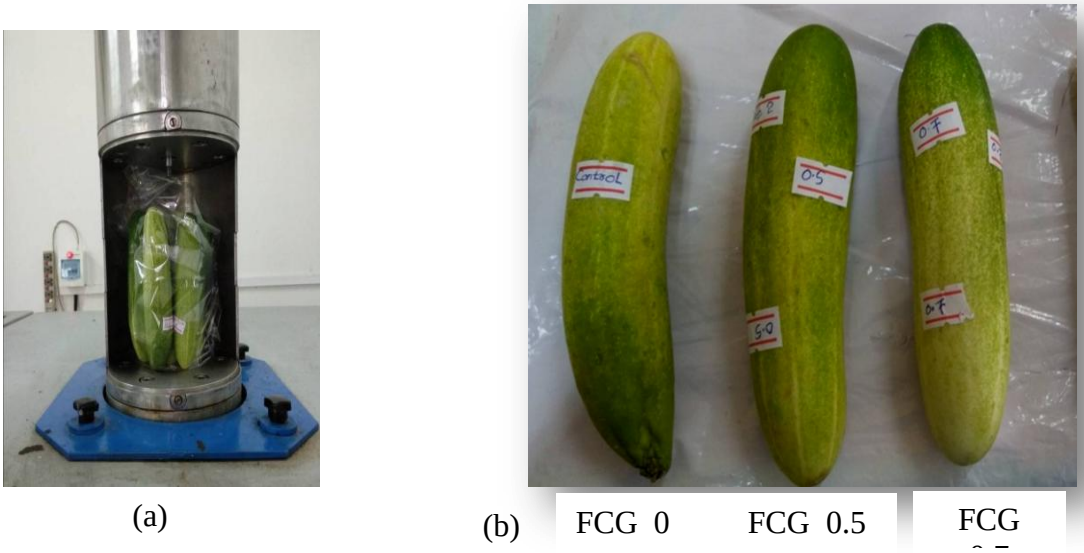
Study on the Effect of γ-Irradiation on Shelf Life of Fresh Cucumber Fruit at Room Temperature

The shelf lives of non-irradiated and γ-irradiated samples were assessed by seeking postharvest deterioration such as (change in colour and weight loss) at room temperature (29 °C and humidity 74 %). The experimental results revealed that the colour of γ-irradiated samples did not significantly change to yellow and retains the freshness during storage period (Table 2, Figure 1). There were no weight loss of all γ-irradiated samples (FCG 0.5, FCG 0.7) at day- 2. Therefore, the shelf life of γ-irradiated (FCG 0.5, FCG 0.7) and non- irradiated (FCG 0) samples were prolonged 7 days and 3 days at room temperature. Hence, the shelf life of γ-irradiated samples were extended two times than that of non-irradiated sample as fresh product.

Table 2 Shelf Life of the Non-Irradiated and γ-Irradiated Fresh Cucumber Fruit Samples at Room Temperature (29 °C and humidity 74%)

No.	Sample	Shelf life at RT (day)
1	FCG 0	3
2	FCG 0.5	7
3	FCG 0.7	7

FCG 0 = Gamma dose of 0 kGy of fresh cucumber fruit (control)
FCG 0.5 = Gamma dose of 0.5 kGy of fresh cucumber fruit
FCG 0.7 = Gamma dose of 0.7 kGy of fresh cucumber fruit



(a) (b)

Figure 1 (a) Gamma irradiation on fresh cucumber fruits at day-1
(b) Observation of the change of the non-irradiated and γ-irradiated fresh cucumber fruits samples during storage at day- 5

Study on the Effect of γ-Irradiation on Moisture Content of Fresh Cucumber Fruit

Water content is a quality factor of food products and is inversely related to its dry matter (total solids). Because food is composed dry matter and moisture. Moisture determination is important in food preservation from microbial growth, sprouting and browning**.** Moisture content recorded depends greatly on the freshness of fruit. Because moisture content is related to the alterations taking place during storage and processing and affects the final quality, it is of direct economic importance to food manufactures and consumers (Pomeranz and Meloan,1978). Therefore, the effect of gamma irradiation on moisture contents of cucumber samples were studied at day- 2. According to the experimental results reported in Table 3, it was found that γ-irradiated samples (FCG 0.5, FCG 0.7) were slightly affected on moisture content of fresh cucumber fruit and the increasing the dose of gamma irradiation, the reducing the moisture content occur. Nevertheless, moisture content of cucumber fruit does not significantly reduce due to the gamma irradiation.

Table 3 Moisture Content of the Non-Irradiated and γ-Irradiated Fresh Cucumber Fruit Samples at Day-2

No.	Samples	Moisture Content (%)
1	FCG 0	97.90
2	FCG 0.5	88.89
3	FCG 0.7	82.56

FCG 0 = Gamma dose of 0 kGy of fresh cucumber fruit (control)
FCG 0.5 = Gamma dose of 0.5 kGy of fresh cucumber fruit
FCG 0.7 = Gamma dose of 0.7 kGy of fresh cucumber fruit

Study on the Effect of γ-Irradiation on pH value of Fresh Cucumber Fruit

Acidity is a major determinant of the taste and quality of most fruits, in combination with sugars and flavor volatiles (Sweeney *et al*., 1970). The pH value of the each sample was determined by using pH meter during storage. From this study (Table 4), it was found that pH values of γ-irradiated samples of different doses did not significantly differ from their control at day-2 and pH values of these samples decreased in parallel during storage period (7 days). This happens whenever food are preserved or stored long-term. Thus, there is no effect of 0.5 and 0.7 kGy doses of γ-irradiation on pH value of fresh cucumber fruit.

Table 4 pH values of the Non-Irradiated and γ-Irradiated Fresh Cucumber Fruit Samples during Different Storage Periods

No.	Samples	pH value		
		Day-2	Day-5	Day-7
1	FCG 0	5.67	ND	ND
2	FCG 0.5	5.93	5.15	4.62
3	FCG 0.7	5.51	4.72	4.91

ND = not detected due to deterioration
FCG 0 = Gamma dose of 0 kGy of fresh cucumber fruit (control)
FCG 0.5 = Gamma dose of 0.5 kGy of fresh cucumber fruit
FCG 0.7 = Gamma dose of 0.7 kGy of fresh cucumber fruit

Study on the Effect of γ-Irradiation on Vitamin C Content of Fresh Cucumber Fruit

Vitamin C (or) ascorbic acid ($C_6H_8O_6$) is a six carbon compound related to glucose. It is a natural water- soluble vitamin. It is found naturally in citrus fruits and many vegetables, cannot be produced or stored by humans and must be obtained in the diet. Ascorbic acid is an essential nutrient in human diets, and necessary to maintain connective tissue and bone. Its biologically active form, vitamin C, functions as a reducing agent and coenzyme in several metabolic pathways. Vitamin C is considered an antioxidant (Mayne, 1994). It is sensitive and can be destroy by heat, light, alkaline pH, cooking, refrigeration and frozen and food preparation (Pauling, 1973). Therefore, vitamin C contents of non-irradiated and γ-irradiated samples of different doses were studied during storage period. From the Table 5, it was found that irradiation with 0.5 and 0.7 kGy doses had no significant effect on vitamin C levels in cucumber fruits at day-2. From the literature survey, this result agree with the irradiation on Melon with 0.5 and 1.0 kGy had no significant effect in vitamin C levels in fruits studied from four harvests

over two consecutive years (Lalaguna, 1998). During the storage time, the vitamin C contents of irradiated samples are slightly reduced. This also happens whenever foods are preserved or stored long-term. Therefore, there is no cause a risk to the health of consumers by using food irradiation.

Table 5 Vitamin C Contents in the Non-Irradiated and γ-Irradiated Fresh Cucumber Fruit Samples during Different Storage Periods

No.	Samples	Vitamin C content (mg/100g)		
		Day-2	Day-5	Day-7
1	FCG 0	6.34	ND	ND
2	FCG 0.5	6.34	5.37	4.29
3	FCG 0.7	6.34	5.37	4.29

ND = not detected due to deterioration
FCG 0 = Gamma dose of 0 kGy of fresh cucumber fruit (control)
FCG 0.5 = Gamma dose of 0.5 kGy of fresh cucumber fruit
FCG 0.7 = Gamma dose of 0.7 kGy of fresh cucumber fruit

Conclusion

In this work, effects of gamma irradiation on the fresh cucumber fruit samples were studied by treatment with 0.5 and 0.7 kGy doses of Co-60 gamma source. From overall results, weight loss, freshness and shelf life of the γ-irradiated fresh cucumber samples are found to be more retained than that of control except slightly reduce moisture contents in them. Moreover, vitamin C content and pH value of gamma irradiated cucumber fruits do not change than that of control at day 2. During the storage time, vitamin C contents and pH value are reduced in these samples as usual. This benefit can be achieved to distribute as fresh product without harmful effect on consumption.

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