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SHELF LIFE EXTENSION OF BANANA (*MUSA SAPIENTUM*) BY GAMMA RADIATION

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Abstract

The effect of gamma radiation on the shelf life extension of Bananas was studied. Bananas were treated with three gamma radiation doses of 0.30k Gy; 0.40k Gy and 0.50k Gy for 5 mins respectively and stored in a dry place under room conditions (25±2°C/ 80± 5% RH). The physical conditions of the radiation treated and control bananas were observed at every 2 days interval for their organoleptic properties till spoilage. The control bananas ripened within 6 days while the gamma irradiated bananas ripened within 26 days, indicating that the shelf life of banana was extended by 20 days thereby delaying banana ripening. The nutrient contents as well as some important physico-chemical parameters of the irradiated Bananas and the control Bananas were analyzed quantitatively at an interval of 24 days throughout the experimental period. A minor decrease in the ascorbic acid content was the only adverse effects observed in irradiated bananas and no other major changes occured in nutritional and organoleptic qualities and the chemical constituents of banana is maintained. A taste-testing panel of 16 panelists determined the acceptability of the fruit. The scores given by the panelists were statistically analyzed and the treated bananas were found to be acceptable up to 26 days at room temperature whereas in the case of control the fruits were spoiled within 6 days. Thus, radiation can be used for the shelf life extension of Bananas and is not harmful to health.

Key words: Banana, gamma-irradiation, shelf life extension.

Introduction

Banana is a tropical fruit of great acceptance and an economically important fruit available throughout the year. It constitutes 42% of the total production of fruits in Bangladesh. Banana is unique due to its high calories and nutritive values. As compared to apple, it contains five times more vitamin A and iron, four times protein, three times phosphorus, twice the carbohydrate and the other vitamins and minerals (Gasster 1963). Various products like banana chips, banana figs, flour, powder, jam confectionery, dehydrated slice etc. can also be prepared from banana.

But banana being a fragile, perishable fruit and cannot be preserved for longer time after harvesting. Bangladesh, therefore, annually losses a huge amount money every year due to shorter post harvest life of bananas. Post harvest fruits losses due to insect infection are a serious worldwide problem. Worldwide post harvest losses of fruit and vegetables losses are as high as 30 to 40% and even much higher in some

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developing countries. Reducing post harvest losses is very important; ensuring that sufficient food, both in quantity and in quality is available to every inhabitant in our planet. Reduction of post-harvest losses reduces cost of production, trade and distribution, lowers the price for the consumer and increases the farmer's income.

According to the International Conference on Nutrition (ICN) about 50% perishable fruits, vegetable and roots are lost due to lack of post harvest techniques, which translate into billions of dollars (IAEA report 1982). From the prevailing condition it seems that the lack of suitable preservation methods is a major factor contributing to the primary limitation to production and consumption of increased amount of the fruit (Forsyth 1980).

The Food and Drug Administration (FDA) has announced the approval in principle of irradiated fruits up to 1.0 kGy for delaying ripening (FDA 1986 and IAEA 1982). Irradiation can delay ripening of some tropical fruits, resulting in an extended shelf life. In turn, longer shelf lives will enhance trade opportunities between nations by extending time constraints under which fresh produce must be delivered to more distant geographic markets or by allowing the use of slower and less expensive modes of transportation (Kader 1986).

The safety and benefits of food processing by ionizing radiation has been studied extensively world-over, including neighboring India for decades. The Joint Expert Committee of Food Irradiation (JFCFR) convened by the Food and Agriculture Organization (FAO), the World Health Organization (WHO) and the International Atomic Energy Agency (IAEA) concluded in 1980 that the irradiation of any food commodity up to an overall average dose of 10 kGy presents no toxicological hazards and requires no further testing. JECFR further stated in the case of micro nutrients such as vitamins, losses due to irradiation treatment are comparable or lower to the conventional treatment such as heating or freezing (Bhattacharjee 2002).

Morris (1987) reported that radiation doses of 0.2-0.35 kGy delayed ripening in Bananas for up to almost 3 weeks, while in papayas, a dose of 0.75 kGy can delay ripening and extend shelf life by up to 5 days. Radiation treatment can significantly extend the shelf life of strawberries by inhibiting the growth of spoilage fungi. Doses of 2 kGy, combined with low temperature storage (1-5°C), have been reported to delay mold growth for as much as 2 to 5 weeks (IAEA 1994).

For Bangladesh, therefore, radiation processing technology holds tremendous promise for both domestic food securities as well as for higher exports earning. The farmers could be encouraged for more production of perishable fruits like banana, pine apples, mangoes, papayas etc if spoilage could be prevented by proper preservation techniques which could result in increased and balanced consumption. Moreover, a substantial amount of foreign exchange could be earned by exporting the fresh fruits like banana and processed products.

However, lack of communication and awareness leading to misconception / Ignorance about the safety of the irradiated food and inbuilt fear in accepting new technologies are the main barriers against possible the use of radiation processing technology in developing countries including Bangladesh. It is, therefore, necessary for the scientific community to bring awareness by practical demonstration of advantages of food irradiation processes to farmers, traders, entrepreneurs, marketing personnel and the public at large through series of dedicated projects / programmes.

Keeping above points in mind, the present investigation was undertaken to evaluate the effectiveness of Gamma radiation on extending the shelf life of bananas under the agro-climatic conditions of Bangladesh.

Materials and Methods

Materials: Mature green Bananas (*Musa sapientum*) were collected from the local market of Gonok Bari, Savar, Dhaka, Bangladesh.

Radiation treatment: Mature green Bananas collected from the local market were cleaned by tap water, transferred in to cellophane bags, sealed tightly and were labeled indicating the name of the product and the doses of radiation to be applied. After 10 h at 25°C, the fruits were taken to the radiation unit of the Institute of Food and Radiation Biology (IFRB), Savar, Dhaka, Bangladesh, the experimental group of bananas were submitted to gamma irradiation (0, 0.3kGy, 0.4kGy and 0.5kGy) for 5 minutes using Co-60 as source while the control group of fruits received no radiation. During the irradiation process, the fruits were turned to ensure dose uniformity. The experimental design was completely randomized with three replications and four fruit per set.

Methods: After radiation treatments, the fruits were stored in a dry place under room conditions (25±2°C/ 80± 5% RH). Evaluations were carried out on the physical conditions like ripening, shelf lives, sensory evaluation for color, flavor and overall acceptability of the treated and control bananas. Bananas were also observed at every 2 days interval for their organoleptic properties till spoilage. Taste-testing panel consisting of 16 panelists did sensory evaluations of experimental Bananas. They were asked to evaluate color, flavor and overall acceptability a scoring rate on a 9-point hedonic scale. Where, 9 = Excellent, 8 = very good, 6 = acceptable and 4 = poor. The preference differences were evaluated by statistical analysis of the data for variance.

The nutrient contents as well as some important physico-chemical parameters of the radiation treated and control Bananas were analyzed quantitatively at an interval of 2-4 days throughout the experimental period. Moisture content was determined by the conventional procedure. Vitamin C was estimated by the visual titration method using 2, 6, di-chlorophenol indophenol dye (Gyorgy and Pearson 1967). Total sugars and reducing sugars were determined from the detailed procedures as described in Lane- Eynon method (Ranganna 1986). Fat content also was estimated by Soxhlet's Fat Extractor Apparatus. pH was measured using a digital pH meter. Acidity was determined by titration method (AOAC 1975) and the results expressed as percentage of citric acid. Protein content was estimated by Micro-Kjeldahl method (AOAC 1975).

Results and Discussion

Shelf life (storage period) of the irradiated Banana

Fruits and vegetables are irradiated at low levels, usually less than 1.5 kGy which can reduce the risk of harmful insect pests and microorganisms, is inexpensive, more environmentally sound than using chemical fumigants, and can greatly reduce the waste of fruits and vegetables that can result form spoilage or sprouting. At this level and depending on a number of factors including type of product, only minimal changes occur in nutritional and organoleptic qualities.

Low-dose Irradiation can effectively extend the shelf life of some fruits including mangoes, papayas, guavas and tomatoes and vegetable products by delaying ripening and/or sprouting and by controlling microorganisms and insects that can cause spoilage or damage. The top-quality shelf life of many fruits and vegetables is lengthened when irradiation eliminates sprouting, and slows the molds that commonly cause loss.

To study the effect of gamma radiation on the shelf life extension of Bananas, in the present study, bananas were treated with three radiation doses of 0.30k Gy; 0.40k Gy and 0.50k Gy respectively and were stored in a dry place under room conditions (25±2°C/ 80± 5% RH). The physical conditions of the radiation treated and control bananas were observed at every 2 days interval for their organoleptic properties till spoilage and the results have been given in Table 1 and shown graphically in Fig.1.

Data presented in Table 1 shows the effect of Gamma radiation on the shelf life extension of the Banana stored at room temperature. It is quite evident that in all treatments, shelf life increased and storage period was extended remarkably. The control bananas ripened within 6 days while the gamma irradiated bananas ripened within 26 days. The shelf life of banana was therefore, extended by 20 days by gamma irradiation.

Also no large differences between different treatments in shelf life were noticed and all the radiation treatments were effective for increasing shelf life as compared with untreated (control) samples (Fig.1.). Therefore, irradiations of banana at doses of even 0.3 kGy was quite appropriate for extending the shelf life of bananas under the agro-climatic conditions of Bangladesh and also fall within the approved limits up to 1.0 kGy set up by the FDA and IAEA for delaying fruit ripening (FDA 1986 and IAEA 1982).

The result also agrees very well with the findings of Vendrell and McGlasson (1971) who also worked on Banana. The results were also in accordance with the findings of Updhagay *et al.* (1994) who found that, irradiation at 0.3 kGy significantly reduced rotting, delayed color development, preserved quality and extended shelf life in red mango.

Table 1. Effect of Gamma radiation on the shelf life extension of the Banana stored at room temperature

	Banana ripening (%)			
Storage period (days)	Control (Cn) 0.0kGy	Irradiation doses 0.3kGy	Irradiation doses 0.4kGy	Irradiation doses 0.5kGy
0	0	0	0	0
2	24	0	0	0
4	87	5	0	0
6	100	8	3	1
8	Nd	10	7	4
10	Nd	12	8	5
12	Nd	16	11	8
14	Nd	20	14	12
16	Nd	25	18	15
18	Nd	32	24	21
20	Nd	40	30	27
22	Nd	65	54	39
24	Nd	85	76	69
26	Nd	100	92	85
27	Nd	100	100	95
28	Nd	100	100	100

* Nd = not done as samples were spoiled.

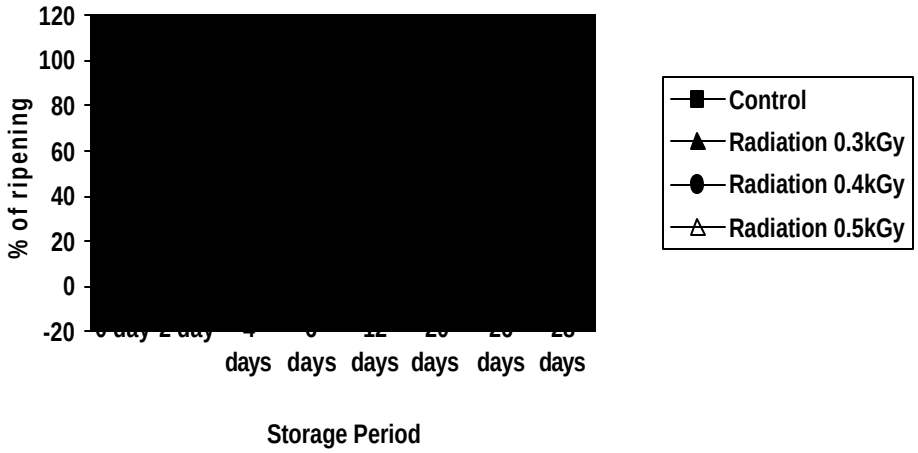

Fig. 1. Effect of Gamma radiation on the shelf life extension of the Banana stored at room temperature.

Sensory evaluation of irradiated Banana

The experimental Bananas samples were subjected to tasting by a taste panel through out the consisting of sixteen (16) members of the scientific staff of the Institute of Food and Radiation Biology (IFRB), Savar, Dhaka, Bangladesh (Initially selected for their ability to make informed judgments and their familiarity with irradiated foods). The panel judges evaluated the flavor, color and overall acceptability of the stored experimental Banana. The mean scores for color, flavor and overall acceptability of the Banana have been presented in Table 2.

Table. 2. Rating scores for overall acceptability of the Banana during storage**.**

No of taster	Banana Samples			
	Control (Cn)	Irradiation doses 0.3k Gy	Irradiation doses 0.4k Gy	Irradiation doses 0.5k Gy
1	7	6	7	7
2	6	7	8	7
3	8	6	7	8
4	9	6	6	7
5	8	7	7	6
6	9	6	6	8
7	6	8	7	6
8	7	7	8	7
9	8	6	8	8
10	8	8	7	7
11	6	7	7	6
12	8	6	8	8
13	9	8	8	6
14	7	6	7	7
15	9	7	9	6
16	7	8	8	7
Total	122	109	118	111
Mean	7.625	6.812	7.375	6.937

Hedonic scale: Excellent=9; Very good=8; Good=7; Acceptable=6; Poor=5.

A two-way analysis of variance indicated that all the sensory attributes of the experimental gamma irradiated bananas were not significantly ($P<0.05$) different and thus the sensory attributes of the banana showed equally acceptable on the hedonic scale.

Determination of physico-chemical parameters of control and gamma irradiated Banana

The nutrient contents as well as some important physico-chemical parameters of the Bananas irradiated at 0.3kGy, 0.4kGy and 0.5kGy doses and the control Bananas were analyzed quantitatively at an interval of 2-4 days throughout the experimental period and the results have been presented in Table 2.

As shown in Table 3 It is obvious that there were no remarkable changes in the moisture contents of gamma irradiated bananas during the storage period and it ranged within 72.7-75.75%, which is very close to that of the control bananas (72.8%).

The ascorbic acid (Vitamin C) content of irradiated Banana was determined at every 2-4 days interval. The results indicated that there was only a minor loss of vitamin C activity and the loss is dependent on temperature and storage time. The results are in good agreement with the results of Gyorgy and Pearson

(1967) who reported that irradiation of Bananas at doses below 1 kGy may cause only minor and insignificant chemical changes and very little loss of vitamin C content occurs and it is not nutritionally significant.

Table 3. Physico-chemical parameters of Banana just after harvesting and gamma irradiation treatment during experimental storage period.

Parameters	After harvesting * (Control)	Treatment * (After gamma-irradiation)
Moisture content	72.8%	72.5-72.75%
Vitamin C	24 mg %	18-24 mg %
Reducing sugar	2.6 %	2.6-18.0%
Total Sugar	18.0%	2.1-18%
Fat	0.25%	0.1-0.25%
Acidity	0.15%	0.14-0.20%
pH	4.2 %	4.2-5.2
Protein	1.3 %	1.1-1.3%

* Three samples per treatment

During the storage period total sugar content of the control was abruptly decreased (data, not shown). On the other hand the radiated samples showed slowly decrease with increasing storage period because of radiation. Total Sugar content of gamma-irradiated banana was found to be decreased abruptly due to inversion of sugar in presence of acid during storage. The reducing sugar contents of the control were abruptly increased due to inversion of sugar during storage period. On the other hand the radiated samples were showed slowly increase of reducing sugar because of radiation (Southgate 1969). The fat content of gamma irradiated banana remained almost unaltered as compared to the control banana and ranged from 0.1-0.25% during the storage period.

Data for pH presented in Table 2, indicated that there was a slight variation of pH throughout storage period in the gamma irradiated experimental banana and it varies from 4.2 to 5.2. The variation of pH could be due to variation of acidity occurring during the storage period at room temperature as observed by Ronald (1984).

The acidity of banana remained almost unchanged and varied from 0.14-0.20%.

In the present study, it was observed that there were no remarkable changes in protein content throughout the storage period and slight variation of protein content was observed at room temperature and protein content varied from 1.1-1.3 %. Almost similar results were obtained by Marriott (1980) who also worked on Banana.

In conclusion, Bananas irradiated at 0.3kGy, 0.4kGy and 0.5kGy doses extended the shelf life of banana by 20 days thereby delaying banana ripening. A minor decrease in the ascorbic acid content was the only adverse effects observed in irradiated bananas and no major changes occur in nutritional and organoleptic qualities and the chemical constituents of banana is maintained. Radiation does not produce any detectable change in aroma, taste of flavour and is safe for human consumption. Thus, Gamma radiation can be used to extend the shelf life of bananas under the agro-climatic conditions of Bangladesh and is not harmful for human health.

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