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ABSTRACT

SOME PHYSICO-BIOCHEMICAL CHARACTERISTICS OF IRRADIATED PAPAYA (Carica papaya Linn.). An experimental work was done to determine the effect of gamma irradiation on some biochemical characteristics of irradiated papaya before and after storage.Matura green papayas of "semangka paris" variety were treated under 3 different conditions, i.e. dipped in hot water at 50°C for 10 minutes; irradiated in air with the dose of 0.5 kGy;treated with combination of hot water dipping at 50°C for 10 minutes and irradiation with the dose of o.5 kGy. Quality evaluation was done subjectively during storage on the colour, texture, and taste as well as on weight loss. Biochemical characteristics such as vitamin C content, ß- carotene, total soluble pectin, and reducing sugar were also determened. The results revealed that ripening of mature green papaya could be delayed by irradiation with the dose of 0.5 kGy. Best result was obtained from the combination treatment. The treated papayas were still acceptableafter 8 days of storage, whereas the untreated ones were acceptable only up to 5 days of storage. There was no significant loss of the nutritive constituents in treated papayas.

ABSTRAK

BEBERAPA KARAKTERISTIKA FISIKO-BIOKIMIA PAPAYA IRADIASI (Carica papaya Linn.) Suatu penelitian telah dilakukan untuk menentukan pengaruh iradiasi gamma pada beberapa karakteristika biokimia pepaya baik sebelum maupun sesudah penyimpanan. Pepaya varietas semangka paris pada kondisi matang pohon diberi 3 jenis perlakuan yang berbeda, yaitu pencelupan ke dalam air hangat dengan suhu 50°C selama 10 menit; diiradiasi dengan dosis 0,5 kGy; dan perlakuan kombinasi antara pencelupan dan iradiasi. Penilaian mutu secara subjektif selama penyimpanan dilakukan terhadap warna, tekstur dan rasa dan juga terhadap susut bobot. Karakteristika biokimia seperti kandungan vitamin C, ß-karoten, pektin yang terlarut, dan gula preduksi juga diteliti. Hasil yang diperoleh menunjukan bahwa iradiasi dengan dosis 0,5 kGy dapat menunda proses pematangan pepaya. Hasil terbaik diperoleh pada perlakuan kombinasi. Pepaya yang telah diberi perlakuan kombinasi tersebut masih dapat diterima sampai penyimpanan 8 hari, sedangkan kontrol hanya tahan disimpan sampai 5 hari. Kandungan nutrisi pepaya yang telah diberi perlakuan tersebut tidak mengalami penurunan yang berarti.

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*) Centre for the Application of Isotopes and Radiation, National Atomic Energy Agency, Jakarta

INTRODUCTION

Irradiation of fresh fruits and vegetables has been developed as a means for prolonging the shelf-life by preventing decay and delaying the senescence (1). Results of studies conducted on more than 20 species of fresh fruits and vegetables revealed that irradiation offered promising result only for strawberries (2). However, other studies indicated that irradiation in combination with heat, or chemical treatments could extend the shelf-life of certain fruits without giving serious damage to the fruits (3-6). Combination treatments such as heating and irradiation may give synergistic effect. By using the combined treatment, irradiation dose can be reduced for giving less detrimental effect to quality attributes of the fruits. Such a combination treatment has been shown to be effective for controlling brown rot in stone fruits and anthracnose in papayas (7).

Several factors related to characteristics of each commodity or to irradiation procedures influence the response of fresh fruits and vegetables to irradiation. Preharvest factors such as climatic conditions and cultural practices also affect composition and quality of these commodities which may influence their response to irradiation.

During ionization resulting from treating foods with ionizing radiation, free radicals are produced. These free radicals react with various food constituents and may cause injury to the cells. Since fruits and vegetables contain 80-95%

water, and their intercellular space contain oxygen, the most free radicals produced in irradiated fresh produce are those from water and oxygen. Consequently, treating fresh fruits and vegetables with ionizing radiation in nitrogen atmosphere can reduce the amount of free radicals and possible injuries in the plant tissues. However, this will also reduce the treatment effectiveness in killing insect and in inhibiting growth of fungi which may be present (8).

The main purpose of irradiation on papaya is to delay ripening and senescence as well as spoilage without affecting the nutritive value. Previous investigators reported that papaya has a high tolerance to ionizing radiation stress at doses less than 1 kGy, while irradiation at doses above 1 kGy can induce various types of physical disorders in the fruit (9).

The objective of this study was to find out the possibility of using gamma irradiation to prolong the shelf-life of papaya of "semangka paris" variety without affecting some physico-biochemical characteristics.

MATERIALS AND METHOD

Materials and Apparatus. Mature green papayas of "semangka paris" variety were obtained from a farmer at Pasar Minggu, South Jakarta.

The fruits were selected based upon uniformity in shape, size and weight. The sizes were 30-40 cm in length , and 875-1200 g in weight. Moisture content of the fruits was approximately

80-90%. After grading, the fruits were kept overnight at room temperature prior to further treatments.

The packaging material used for irradiation was commercial carton box of 39 x 39 x 19 cm size.

Irradiation was conducted in a pilot scale latex irradiator using Cobalt-60 gamma source with activity of 171.218 kCi during the experiment. Cobalt-glass was used as dosemeter during the process. Optical density of the dosemeter was measured using a Beckman 26 Spectrophotometer.

A high pressure liquid chromatography (HPLC) apparatus made by WATERS was used to characterize β-carotene.The mobile phase used was a mixture of tetra-hydro-furane (THF) with the ratio of THF/Me-OH/H2O = 126/150/30, column - μ Bondapak C-18, detection at 436 nm using a UV detector, sensitivity 0.02, flow rate 2 ml/min, and chart speed 0.25 cm/min. Prior to sample analysis, β-carotene standard (0.05 ppm) was first injected into the column as much as 0.5μl; 1μl; 2μl; 5μl; 8μl and 11μl to find better resolution.

Determination of Dose Uniformity in Irradiated Samples. Carton box containing ± 5kg of fresh papaya was irradiated in stationary condition from 2 alternating sides. Dosemeters were placed at 18 spots in the package as illustrated in Figure 1. The dosemeters were measured spectroscopically after irradiation by measuring the optical density at 305 nm to determine the absorbed dose at each spot.

Treatments and Quality Evaluation of Papayas. The papaya samples were divided into 4 groups, each group consisted of 18-20 fruits. Group A was untreated sample, Group B was treated by hot water dipping at 50° C for 10 minutes. Group C was irradiated with the dose of 0.5 kGy, and group D was treated by hot water dipping (50°C,10 min) followed by irradiation (0.5 kGy). The samples were then stored at 23-25° C and 60-70% RH for 5 days, then removed to 28-29°C and 80-90% RH to accelerate normal ripening for another 3 days. All changes during storage were noted.

The quality of the samples during storage was evaluated using organoleptic attributes (colour, texture and taste), weight loss, and biochemical indices (vitamin C, β- carotene, total soluble pectin and reducing sugar contents) as parameters. Organoleptic attributes were evaluated subjectively, and weight loss was measured using a Berkel balance.

Methods of Chemical Analyses. Vitamin C content of the samples was measured as total ascorbic acid using 2,4 - dinitrophenyl hydrazine method (10). The principle of this method is based upon the oxidation of ascorbic acid into dehydroascorbic acid, subsequent conversion of dehydroascorbic acid into diketogluconic acid, followed by coupling with 2,4-dinitrophenyl hydrazine under carefully controlled conditions to give red colour of d-osazones.

β-carotene in the samples was measured using a chromatographic method (10).The method is based upon the separation of biologically active carotenoid pigment from a total carotenoid pigments in an extract using an adsorbent with varying affinities.

Total soluble pectin in the samples was determined using a gravimetry method, meanwhile reducing sugar was analyzed according to Luff-Schroll titration method (10).

Experimental Design. This experiment was carried out as a factorial experiment using a complete randomized design with three replicates.

RESULTS AND DISCUSSION

Dose Distribution. Dose distribution within carton box containing papayas is presented in Table 1. It shows that maximum absorbed dose in carton box with the dimension of 39 x 39 x 19 cm was obtained at point 5 and minimum absorbed dose was at points 10 and 16. Dose uniformity ratio in the package was 1.32.

Organoleptic Attributes. Visual examination revealed that there were some changes in the colour of the fruits skin after storage. The colour has changed from green to yellow after 5 days of storage at 23-25°C and 60-70% RH. The ripening of the treated samples were slower than the control.In the control, protoplast will change into chromoplast normally, while in treated samples this process will be suppressed. The changes of these components will affect the fruit colour from green into various colours such as yellow and red colour in the skin.

After removing the samples into 28-29°C and 80-90% RH, the results showed that group C had better appearence than the others. After 8 days of storage, all control became shriveled, and some severe damages occurred in the flesh. It is well known that the main physical change in fruits and vegetables after harvest is loss of moisture due to transpiration and respiration resulting in loss of turgor. Removing the samples from lower temperature with lower relative humidity to higher temperature and relative humidity can probably minimize turgor loss during storage. Lower temperature frequently render the commodity more firm and crisp and this effect is reversible.Furthermore, heat treatment can also give an effect on the tissue such as expansion of intercellular air and then most of the air escape through the surfaces.In addition, heat treatment can inhibit the activity of some enzymes, such as pectolytic enzymes which are usually active during ripening process. Those structural changes which occur in fruit tissues will have strong relation to degree of maturity and colour changes.

Weight Loss. There was no significant difference between weight loss in treated samples and control (Table 2). However, storage time gave significant value in increasing weight loss in all samples.

Biochemical Parameters. Vitamin C content showed a non significant decrease after irradiation and the combined treatments (Table 3), meanwhile vitamin C content in hot water dipped samples was significantly lower than the others. This is probably due to variability of the samples. Previous investigators reported that ascorbic acid (vit. C) is radio-sensitive and its losses range from 0 to 95 % depending on the commodity, cultivar, irradiation dose, duration, and storage condition (12). It was also reported that irradiation of commercially mature papaya var. solo with the dose of 1-1.5 kGy could effectively suppress the synthesis of vitamin C although no effect on the existing ascorbic acid was detected (9).

-carotene content in all treated fruits did not change, but it increased significantly after ripening (Table 3). Ionizing energy at doses which fresh fruits and vegetables can tolerate does not reduce the caloric value or nutritional quality of the produces significantly; only negligible losses in niacin, riboflavin and carotene (pro-vit.A) have been detected due to irradiation (13,14).

Data presented in Table 4 indicate that the decrease of total soluble pectin in the treated samples which could be due to breakdown of soluble pectin after heating and irradiation is not significant ($p > 0.05$). Generally, the solubilization of pectin, cellulose, hemicellulose and starch in response to irradiation dose less than 0.6 kGy is important because it may cause softening of fresh fruits such as mangoes which is undesirable for postharvest handling. The undesirable effects of ionizing radiation on firmness can be reduced by irradiating at low temperature and/or under nitrogen atmosphere (15).

Table 4 also shows that reducing sugar contents in all treated samples are not different with the control either before or after ripening.

It seems that the combined treatment between hot water dipping and irradiation in this experiment give a synergistic effect and more effective in controlling disease in the fruits. MAXIE and KADER (12) reported that the changes of pigment, sugars, fats, protein, and enzymes in fresh fruits and vegetables subjected to irradiation with doses below 3 kGy were slight in most cases.

Irradiation dose of 0.5 kGy seemed to be a tolerance dose for papaya var. "semangka paris". Based on this result, irradiation dose below 1 kGy could be a recoverable region which suggests that even if there are some damages, the fruit is still capable to repair itself and able to recover.Other investigator reported that papaya juice is an efficient radical scavenger for highly reactive hydroxyl radicals (OH) formed from water radiolysis (11).

CONCLUSION

Based on this investigation, it can be concluded that hot water dipping at 50°C for 10 minutes, irradiation with the dose of 0.5 kGy and combination of these two treatments do not affect significantly the physico-biochemical characteristics of papaya var. "semangka paris". Ripening of mature green papaya can be delayed by irradiation at 0.5 kGy. From organoleptic point of view, combination of hot water dipping and irradiation gave the best result. The combined treatment could extend the storage life of papayas up to 8 days, while the control could only be stored for 5 days.

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Table 1. Dose distribution in carton box of 39 x 39 x 19 cm size containing 5 kg of fresh papaya, measured by Cobalt-glass dosemeter.

Spot measured	Irradiation dose (kGy)
1	0.759
2	0.775
3	0.762
4	0.771
5	0.790 *)
6	0.785
7	0.763
8	0.781
9	0.774
10	0.599 **)
11	0.615
12	0.602
13	0.609
14	0.619
15	0.611
16	0.599 **)
17	0.605
18	0.601

$$\text{Uniformity} = \frac{D_{max}}{D_{min}} = 1.32$$

Table 2. Effects of hot water dipping at 50°C for 10 min.; gamma irradiation at 0.05 kGy and combination of both treatments on the percentage of weight loss of papaya during storage.

Treatment	Weight loss (%)			
	2 days	4 days	6 days	8 days
Control	0	1.42	2.54	5.92
Hot water dipping at 50°C for 10 min.	0	1.59	3.23	7.74
Irradiation at 0.5 kGy	0	1.34	2.99	7.59
Combination of both treatments	0	1.62	3.35	6. 48

Table 3. Effect of gamma irradiation on vitamin C and β-carotene contents of papaya.

Treatment	Mature green stage		Edible ripe stage	
	Vit. C (mg/100 g sample)	β-carotene (ppm)	Vit. C (mg/100 g sample)	β-carotene (ppm)
Control	18.37^{d}	0.049^{bc}	30.41^{c}	0.067^{b}
Hot water dipping at $50^{o}C$ for 10 min.	14.87^{e}	0.008^{c}	38.65^{a}	0.155^{a}
Irradiation at 0.5 kGy	17.57^{d}	0.001^{c}	35.18^{b}	0.157^{a}
Combination of both treatments	18.02^{d}	0.003^{c}	35.24^{b}	0.113^{a}

a,b,c,... Mean values in the same column not followed by the same letter are significantly different ($P < 0.05$).

Table 4. Effect of gamma irradiation on total soluble pectin and reducing sugar of papaya.

Treatment	Mature green stage		Edible ripe stage	
	Total soluble pectin (%)	Reducing sugar (%)	Total soluble pectin (%)	Reducing sugar (%)
Control	0.46 [ab]	0.74 [c]	0.77 [a]	2.19 [ab]
Hot water dipping at $50^{\circ}C$ for 10 min.	0.27 [b]	1.05 [bc]	0.62 [a]	2.42 [a]
Irradiation at 0.5 kGy	0.22 [b]	0.75 [c]	0.71 [a]	2.27 [ab]
Combination of both treatments	0.30 [b]	1.25 [bc]	0.72 [a]	2.41 [a]

a,b,c,... Mean values in the same column not followed by the same letter are significantly different ($P < 0.05$).

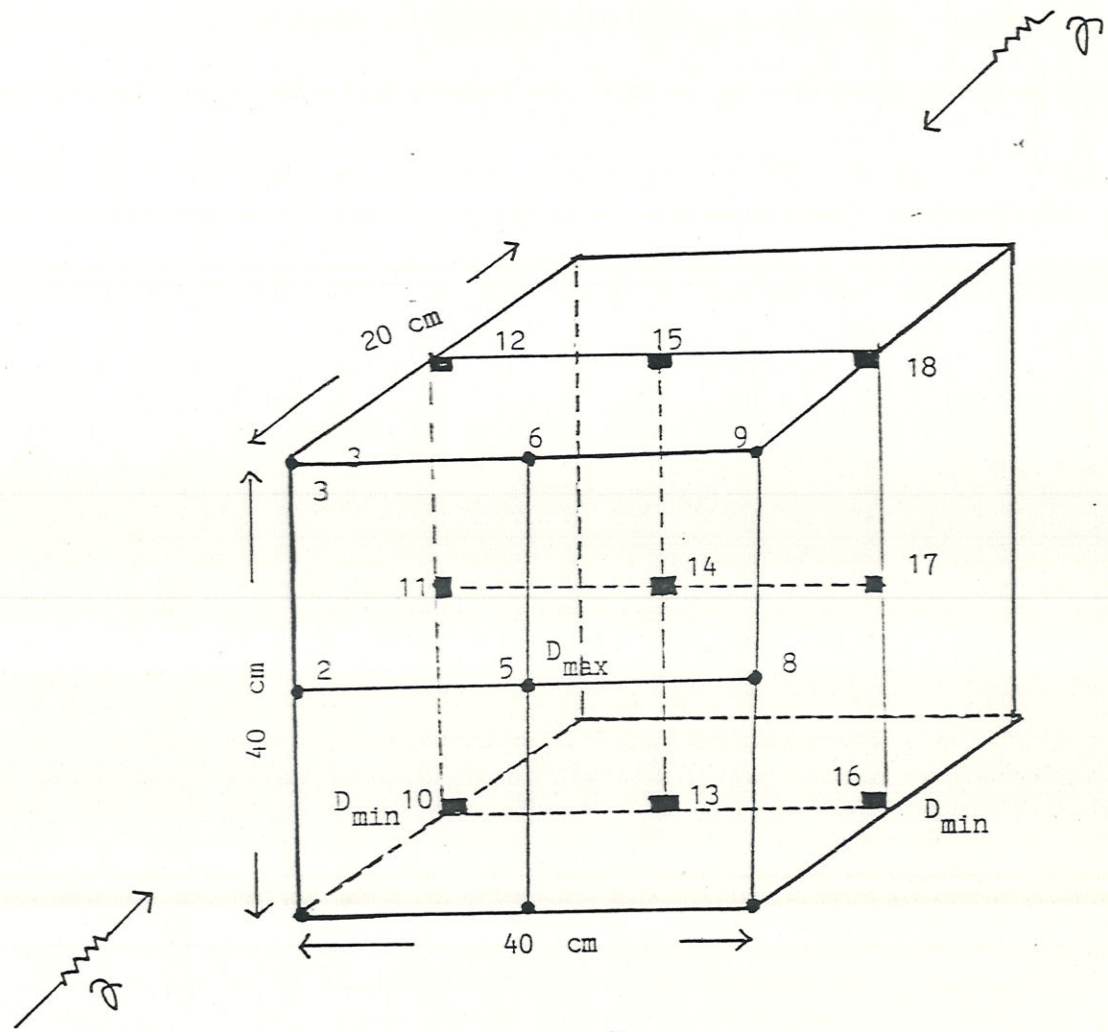

Figure 1. Dose distribution measurement in carton box loaded with papaya.