Asian Journal of Chemical Sciences

2(2): 1-6, 2017; Article no.AJOCS.32299

Effect of Irradiation on Rotting and Mass of Mango Fruits with Gamma Ray from Cobalt-60 Source

Idodo Maxwell[1*], Ali Haruna[1] and Baba Kutigi[2]

[1]Department of Physics, Nigerian Defence Academy, Kaduna, Nigeria.
[2]Department of Physics, Federal University, Dutsin-Ma, Katsina, Nigeria.

Authors' contributions

This work was carried out in collaboration between all authors. Author IM designed the study, performed the statistical analysis wrote the protocol and the first draft of the manuscript. Authors AH and BK managed the analyses of the study. Author AH managed the literature searches. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/AJOCS/2017/32299
Editor(s):
(1) Dimitrios P. Nikolelis, Chemistry Department, Athens University, Panepistimiopolis-Kouponia, Athens, Greece.
Reviewers:
(1) R. D. Mavunda, South African Nuclear Energy Corporation (NECSA), South Africa.
(2) Kamol Dey, University of Chittagong, Bangladesh.
Complete Peer review History: http://prh.sdiarticle3.com/review-history/18864

Original Research Article

Received 19th February 2017
Accepted 10th April 2017
Published 1st May 2017

ABSTRACT

In this study four varieties of mango fruits were irradiated with Gamma ray from Cobalt-60 source at different dose points of 50 Gy, 100 Gy, 300 Gy and 800 Gy to investigate effect of irradiation on rotting and masses. The observations were made at two different days, namely day 21 and day 14. We noticed that sample A of mango fruits irradiated with 50 Gy had 50% spoilage. sample B irradiated with 100 Gy showed only 30% of spoilage, sample C irradiated with 300 Gy showed only 20% of spoilage, sample D irradiated with 800 Gy showed 10% of spoilage. After 14 days the samples A-D show 20%, 18%, 15% and 10% loss of their mean mass and the control has lost 35% of its mass.

Keywords: Shelf life; gamma source; radiation dose; irradiation; mango fruit.

**Corresponding author: E-mail: blesoekm.mbi@gmail.com;*

1. INTRODUCTION

Mango fruit is one of the most popular, nutritionally rich fruit with unique flavor, fragrance, taste and health promoting qualities making it often called super fruit [1]. Mango fruit is one delicious seasonal fruits grown in the tropics. The tree is believed to be originating in the sub-Himalayan plain of Indian subcontinent. Mango (*Mangifera indica)*, family *Anacardiaceae*, is a large, branched perennial erect tree with wide evergreen crown which attains a great height [2]. Approximately 50% of all tropical fruits produced worldwide are mangoes. There are eight varieties in Nigeria characterized as green, orange and red-blushed almost tan fruit from Cotonou to Ogbomosho [3] (Kitchen, 2015). This fruits is only available from December to April in a year.

Mango fruit contain antioxidant compound namely quercetin**,** isoquercitrin, astragalin, fisetin, gallicacid and methylgallat, which help to protect against colon, bosom, leukemia and prostate cancer. It also contain low cholesterol with high level of fiber, pectin and vitamin C, iron which promotes good eyesight and prevents night blindness and aid digestion. Resource poor people especially women, derived a good income from its production, and marketing [4]. According to natural health school.com, mango fruit is rich in tartaric acid, malic acid and traces of citric acid that primarily help in maintaining the alkali reserve of the body. Mango has aphrodisiac qualities and is also called the 'love fruit'. It increases the virility in men. Vitamin E, which is abundantly present in mangoes, helps to regulate sex hormones and boosts sex drive. A mashed mango paste mixed with honey is used as body scrub, to keep the skin smooth and tender. Mango fruits are used in Chinese medicine because its capacities to reducing the risk of kidney stone, for pregnant and menopausal women it increases their iron and calcium level and at the same time help those suffering from anemia [5].

Among internationally traded tropical fruits, mango ranks only second to pineapple in quantity and value major markets for fresh and dried mangoes in 1998 were Malaysia, Japan, Singapore, Hong Kong, and the Netherlands, while for canned mango were Netherlands, Australian and united kingdom, Germany, France and USA. India's mango exports were the highest in the globe (50% of world's mango production) which occurs mainly on the month of May and the Middle East is the major buyer. In country like Nigerian mango trees is cultivated through-out the state of the federation but more in the middle belt because of rain fall and the loamy alluvial, well drained aerated deep soils rich in organic matter with PH range of 5.5 to 7.5 [6]. Currently Nigeria has no history of export but there is large commercial market between urban-rural and the price is determined by the supplies.

Mango fruit suffers considerable post-harvest losses which can be high to 55% [7] and the losses we are to account for is dropping and damage in ripening due heavy rains, strong winds and cyclones during fruiting season. Others losses could be caused by external agents, such as insects, birds, fungi and bacteria as well as transportation waste to exposure to sun and heat. Harvested Mango fruit is better stored precooled at 10 –15°C for 4-7 days depending on the varieties [8].

Among the various physiological factors which affect storage of harvested mango fruits, early ripening is the most obvious manifestation which leads to attack by fungi and bacteria. The stored fruit at high humid environment at 10 – 13°C cannot last for more than 5- 7 days [9].

In order to prevent this early ripening and spoilage, farmers sell their produce cheaply during harvest time, this lead to early shortage and high price on the available one as well as shortage on the export markets. There is also significant loss in quality through rotting and softening of the stored produce [10]. There is need to extend shelf life and improve the quality of stored mango fruits for long period of time, although this depend on the variety, climate condition, harvest maturity, mechanical damage, microbial infections and the storage environment particularly the temperature.

This research work intends to employ different doses of gamma radiation to delay ripening of fruit so as to increase longevity of mango fruit at due season

2. MATERIALS AND METHODS

Mango fruits were harvested at matured green stage from GIF orchard locate at SHEDA and were immediately and carefully transported to the laboratory. They were selected and washed with distill water to remove stain and to help in the detection of wounds. The samples were dried at average temperature of 28.2°C and relative humidity (RH) of 50 $\pm$5%. The mango fruits were packed in four pairs per group, containing 20 fruits at which 10 were used for both sensory and physiochemical analysis.

The groupings was done carefully by picking ten fruits from each variety and without mix–up, pack them in an air conditional room where they are labeled as follows A, B, C, D and E (Fig. 1).

The sample A, B, C and D, were irradiated with 0.05, 0.10, 0.30 and 0.8 KGy respectively while the sample E which contained no irradiation served as the bench mark for comparism.

(Sample –A)

(Sample –B)

(Sample –C)

(Sample –D)

(Sample –E (control))

Fig. 1. Showing grouping of different variety of mango fruits. (a). Flat mangoes, (b). Binta sugar mangoes, (c). Barki Akus mangoes and (d). The camerom mangoes

The mango fruits were then put into a container covered with carton ready and transported to irradiation room containing C0-60 source of current activity of about 5.5 x 10^{15} Bq (=170KCi) as shown in Fig. 2 below:

Fig. 2. Showing mango fruits ready for irradiation

2.1 Sample Irradiation

Irradiation was carried out in the stationary mode of operation with the dose rate 2 Gy/min. The four different dose points used were 50Gy, 100Gy, 300Gy and 800Gy under a reliable uniform irradiation with Gamma ray from Cobalt-60 source to investigate effect of irradiation on rotting and mass loss and accurate computer controlled irradiation dosage monitoring.

2.2 Characterization and Measurement

The absorbed dose was measured using Brukere-scan alanine dosimetry reader system, model SCO205, manufactured by Bruker Biospin Corporation, USA. The weight/ masses of all the mango fruits were measured and recorded before, immediately after irradiation and on daily bases for period of 21 days (3 weeks) until a certain stage of rotting (spoilage) using analytical chemical balance. The appearance of soft spot and wet surface on the mango fruits were carefully examined and recorded every day for period of three weeks to determine the point of rotting with a conventional method, that is near eye check.

3. RESULTS AND DISCUSION

The result of effects of gamma irradiation on rotting, masses, vitamin C, Titreable acidity, moisture contents and taste of mango fruits are discussed as follows;

3.1 Absorbed Dose

The dose points for required dose and actual dose detected are shown as presented in Table 1.

3.2 Weight / Weight Loss

Table 2 shows the mass loss in % per evaluation day.

The initial mean mass (Kg), final mean mass (Kg), mass loss (Kg) and percentage of mass loss of mango fruits for period of three weeks were presented in Table 2. It was observed that after a period of two weeks (14days), the control (sample E) has loss mass significantly by 35% and later start to increase after 21 days due to rot thereby absorbing water from the atmosphere. The other samples A-D show 20%, 18%, 15% and 10% loss of their mean masses. At this time the pulp is still strong in-spite complete ripening.

It can however be drawn that, there is no significant loss of mass of mango fruits due to irradiation and also, the irradiation preserved the mass of the mango fruits at large extent even when there are significant loss of mass due storage before rot. The high dose points prevent mass loss while low dose point such as 0.05KGy and 0.10KGy has no effect on mass preservation. The result is in agreement with similar studies carried out by Youssef et al. [11] which describes moisture loss decrease as dose increases. The moisture loss and decrease in acidity at storage is attributed to the activities such as respiration, transpiration and other metabolic changes such as conversion of starch to sugar by enzyme.

3.3 Observation of Rotting/ Spoilage

The appearance of soft spot and wet surface on the mango fruits are characterized as rotting or spoilage. These were carefully examined every day for period of three weeks to determine the point of rotting /spoilage and records were made as presented in Table 3.

As shown in Table 3, at the end of 21days the sample A irradiated with 0.05 KGy had only 50% of spoilage, the sample B irradiated with 0.1 KGy showed only 30% of spoilage, sample C irradiated with 0.3 kGy showed only 20% of spoilage, sample D irradiated with 0.8 KGy showed 10% of spoilage.

Table 1. Showing dose points result for required dose and actual dose detected

Sample	Required dose (Gy)	Actual dose		
		Minimum	Maximum	Average
Batch A	50	47	62	54.50
Batch B	100	100	106	103.00
Batch C	300	286	305	295.50
Batch D	800	792	810	801.00

Table 2. Weight / mass loss of irradiated and control mango fruits

Sample	Initial mass	Final mass	Mass loss	% mass loss
A	1.00	0.75	0.25	25%
B	1.00	0.77	0.23	23%
C	1.20	1.05	0.15	12.5%
D	1.10	0.99	0.11	10%
E	1.00	0.65	0.35	35%

Table 3. Observance of spoilage of the mango fruits

Sample				1st wk							2nd wk							3rd wk			
A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	1	1	-	1
B	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	1
C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1
D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
E	-	-	-	2	2	3	1	2		-	-		-	-	-	-	-	-	-	-	-

The (control) sample E un-irradiated mango fruits showed 100% of spoilage before the end of 8days. This is in agreement with Medwell that irradiation increase the shelf life of mango fruits from 7-10 day beyond the un-irradiated mango fruits [12] (Medwell, 2007). This finding is similar to that reported by Calore and Vieites [13] (2003), who studied the effect of gamma radiation on the preservation of peaches and found that a dose of 0.05 kGy did not really slow the ripening process with regard to acidity. The results of the present study demonstrate that higher doses (0.30 and 0.8 kGy) were effective in delaying the ripening as well preserving the firmness of the mango fruits.

The subsequent delayed ripening brings about slower changes in the rate of tissue softening which make them more resistant to normal stresses involved during transportation and handling.

4. CONCLUSION

The research finding demonstrated that, as irradiation dose increases, rotting and mass loss of the mango fruits decreases. The study further showed that high dose points prevent rotting and mass loss while low dose point such as 0.05 KGy and 0.10 KGy has no effect on rotting preservation of mass loss.

Fig. 3. Mango sample at the end of 21 days

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
http://prh.sdiarticle3.com/review-history/18864