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Quality Characteristics of Pre-treated Yam Chips Produced from Irradiated Yams

Joyce Agyei-Amponsah[1*], Mavis Owureku-Asare[1], Wisdom Selorm K. Agbemavor[1], Jonathan Armah[1], Abena Okyere[1], Elvis Baidoo[2], Solomon Dowuona[2] and Charles Tortoe[2]

[1]Biotechnology and Nuclear Agriculture Research Institute, Radiation Technology Centre, Accra, Ghana.
[2]Council for Scientific and Industrial Research, Food Research Institute, Accra, Ghana.

Authors' contributions

This work was carried out in collaboration between all authors. Author JAA designed the Study and wrote the first draft of the manuscript. Authors JAA and CT managed the literature searches. Authors JAA, WSKA, MOA, AO, EB, JA, SD and CT performed the statistical analysis, wrote the protocol, conducted the irradiation and managed the analyses of the study. All authors read and approved the final manuscript.

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Original Research Article

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ABSTRACT

Aims: The objective of this research was to study the effect of irradiation on some quality characteristics of yam chips produced from irradiated yam tubers.
Study Design: In this study, irradiated yam (*Lariboko*) was processed into yam chips and quality characteristics (moisture, texture and colour) of the frozen yam chips evaluated

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

over 4 weeks storage period.
Place and Duration of Study: This study was carried out at the Radiation Technology Centre of BNARI and Food Research Institute of CSIR, between November 2011 to September 2013.
Methodology: Yam samples were irradiated at 0Gy (control), 120Gy and 200Gy at the Gamma Irradiation Facility (GIF) of the Biotechnology and Nuclear Agriculture Research Institute (BNARI), Accra at the rate of 0.3927kGy/hr. Irradiated yam samples were washed and peeled. The mid sections of the tubers were diced into chips (1 x 1 x 7cm) and divided into 3 groups. Each group was dipped into 0.1% Citric Acid (CA), 0.1% Sodium Metabisulphite (SMBS) and Blanched (BLA) in boiling water for 1min. The treated samples were vacuum packed and blast frozen to Maxi chill (-26℃) for 1½ hours and then stored in a freezer at - 20℃. Moisture was determine by air-oven method (AOAC), tristimulus colour L*a*b* was measured, and TX plus Texture Analyzer (Gallenkamp hotbox oven, UK) used to determine the texture characteristics.
Results: Gamma irradiation doses significantly affected (*P=.000)* the hardness of the yam chips and only affected the surface elasticity in the 2^{nd} and 3^{rd} weeks of storage. There was a low negative correlation (*R = -.095*) between hardness and surface elasticity of the treated samples at the various doses. Irradiation did not have a significant effect on the Lightness, L*colour index of the yam chips produced, however L* for the irradiated samples was relatively higher compared to the un-irradiated samples. Irradiation also affected the moisture contents of chips treated with both CA and SMBS significantly (*P<.05).*
Conclusion: Combination treatment of gamma irradiation at an optimum dose of 120Gy with chemical treatments with SMBS or CA is recommended for the processing of yams into chips all year round.

Keywords: Postharvest management; irradiation; yam; quality characteristics.

1. INTRODUCTION

Yam (*Dioscorea* spp.) is an important crop in Ghana and is produced in most parts of the country particularly in the northern parts of the country. Yams belong to the *Dioscorea* genus and are staple foods of cultural, economic and nutritional importance in the tropics. Ghana is the second largest producer of yams in the world, second to Nigeria, producing approximately 7 million metric tons of yams in 2012 [1]. In terms of the export market, Ghana yam export accounts for over 94% of total yam exports in West Africa [2]. Ghana yam is enjoyed all over the world due to its quality and taste. In 2007, yam consumption in Ghana accounted for 11% of the total consumption pattern [2]. Some popular varieties of yams grown in Ghana included local varieties such as *Pona, Dente, Lariboko, Asana* and *Serwah*.

According to Kleih et al. [3] popularly consumed white yams stores for a maximum period of 3 months and this situation threatens the year-round availability of the crop. Farmers annually bemoan the losses of yam as a result of poor storage mechanisms together with sprouting after harvest. There has been the call for increased production of yam to offset the losses but this has not brought about the needed relief for yam farmers who still lose a large part of their harvest. Also, to escape the losses associated with storage of yams, farmers are forced to sell their produce cheaply to middle men and therefore lose a large amount of revenue.

There is a need to manage the tubers to prevent postharvest losses and extend their shelf-life to make fresh tubers available all year round; for yam export and domestic consumption. There is also the secondary need to diversify some of these produce into higher value-added products such as yam chips processing to reduce wastage and make yam more convenient for the urban consumer.

However, during the processing of tubers into value-added products, a lot of chemical and biological changes occur affecting some of the quality attributes of the final product, hence pre-treatments are employed in food processing to minimize some of these undesirable changes. Pre-treatments include, dipping the processed yams into food grade preservatives such as sulphites and its derivatives, citric acid and sodium chloride. Some foods are also blanched either by hot water or steam.

Problems associated with yam storage are essentially of three kinds: direct damage by diseases, pest and nematodes; sprouting losses; and respiratory / evaporation losses. These reduce the quantity and overall quality of tubers depleting food reserves. [4] reported storage losses of yam in the range of 10 – 15% after the first three months and approaching 50% after six months of storage. Okigbo [5] also estimated up to 56% of loss due to rot alone. A Lot of studies have been conducted on treatments and techniques to reduce these physiological activities and protect the yam tubers from postharvest diseases. These include treatment with chemicals, plant extracts such as palm wine and gamma irradiation. Storage techniques used for postharvest storage of the tubers included cold storage, underground storage and improved yam barns. In West Africa, yams are traditionally stored in yam barns for proper aeration and also reduction of temperature to reduce further metabolic activities. A study conducted by Bansa and Appiah [6] and another by Apea – Bah et al. (Unpublished results) at the Biotechnology and Nuclear Agriculture Research Institute revealed that irradiation at 120Gy was effective in sprout inhibition and disinfesting white yams of the coffee bean weevil (*Araecerus fasciculatus*), a pest on stored white yams. Also developmental studies conducted in many countries recommended doses between 50 and 150Gy for sprout control of tubers during their dormant state and shortly after harvest [7,8,9].

It is nonetheless important that further studies be conducted to ascertain possible changes that might arise, during storage, after irradiation, and processing. Research conducted by [10] to determine the effect of irradiation on some pre-treated potato, revealed that exposure to irradiation pre-treatment (3.0 - 12.0 kGy) resulted in an increase in cell wall permeabilization, leading to softening of tissue, thereby affecting textural and histological properties. Also in a study by Afoakwa and Sefa-Dedah [11], on the chemical and physical changes associated with raw and cooked yam *Dioscorea dumetorum* tubers in relation to the hardening phenomenon of the tubers after harvest, found that, the moisture and starch contents of the tubers decreased during storage. This study assessed the use of gamma irradiation as a pre-storage treatment on the quality characteristics of frozen yam chips.

2. MATERIALS AND METHODS

2.1 Gamma Irradiation Treatment of Samples

Yam (*Lariboko*) samples were purchased from the Northern region of Ghana and irradiated at 0Gy (control), 120Gy and 200Gy at the Gamma Irradiation Facility (GIF) of the Biotechnology and Nuclear Agriculture Research Institute (BNARI) at the rate of 0.3927kGy/hr.

2.2 Yam Chips Production

Irradiated yam samples were washed and sanitized with 1% sodium metabisulphite before peeling. Only the mid sections of the tubers were used for the study (5cm from the heads and ends were cut off). The mid sections of the yam samples were diced into chips (1cm x 1cm x 7cm) and given different treatments; dipped into 0.1% citric acid, blanched in boiling water for 1min and in 0.1% sodium metabisulphite solution. Immediately after the various treatments, samples were vacuum packaged (Vacuum Sealer, Audion-Vac VM 150H (A1 Packaging Ltd. London, England) and blast frozen to Maxi chill (-26℃) in a blast freezer (Foster BCF21, Foster Refrigerator, Norfolk, U.K) for 1hour 30mins and thereafter stored in a freezer (Ocean NJ40TLL, Ocean Br. Overseas S. R.L, Italy) at - 20℃ and weekly analyses conducted for 4 weeks.

2.3 Moisture Content Determination

Yam chips (5g) were weighed into a previously washed and dried dish of a known weight. This was then dried at 105℃ to a constant weight in an air oven (Gallenkamp hotbox oven, UK). The experiment was run for each treatment in triplicates for all samples. The dishes with the dried samples were collected and placed into desiccators and allowed to cool for about 30 minutes and then weighed. The weight of each dried sample was expressed as a percentage of the fresh weight as shown in the following relation.

$$\% \mathbf{Moisture} = \left(\frac{\mathbf{Weight\ of\ Moisture\ Loss\ \ (g)}}{\mathbf{Weight\ of\ Fresh\ Sample\ (g)}}\right) \times \mathbf{100}$$

2.4 Texture Analysis

Instrumental Texture Profile Analysis (TPA) was conducted on the yam chips weekly using a TX Texture analyser TA-XT2i (Stable Micro Systems, U.K.). The texture analyser was calibrated daily for force and height prior to all the analysis. Force calibration was done by using a 5kg weight provided by the manufacturer and height was calibrated to 14 mm. A load cell of 30 kg capacity was used. The distance the probe moved after touching the sample was 30% strain (compression). The cross head speed was 1.0 mm/s with time of 5s between the first and the second compressions. Force was measured as compression with a trigger force of 0.05N. The textural parameters on yam chips measured were maximum shearing force, shear energy and surface elasticity.

2.5 Colour Determination

The measurement of the colour indices of the samples was The L*a*b*, or CIELab, colour space is an international standard for colour measurements, adopted by the Commission Internationaled' Eclairage (CIE, 1976). Where, L* is the degree of lightness of the colour. This refers to the relation between reflected and absorbed light. L* values equals to zero for black and 100 for white, a* (red-green) is the degree of redness (0 to 60) or greenness (0 to -60) and b * (yellow blue) is the degree of yellowness (0 to 60) or blueness (0 to -60). This was carried out using the Hunters Lab equipment for L*a*b* parameters.

2.6 Statistical Analysis

Data obtained was analysed using STATGRAPHICS Plus, version 3.0 (Statistical Graphics Corporation, STSC Inc, U.S.A). One-way analysis of variance (ANOVA) procedures was used to determine differences in absorbed doses, treatments and storage means. Fisher's least significant difference (LSD at p<.05) was used for mean separation.

3. RESULTS AND DISCUSSION

3.1 Moisture Content of Yam Chips Produced from Irradiated Yams

From the statistical analysis, irradiation significantly affected *(P<.05)* the moisture contents of the chemically treated yam chips but did not affect *(P>.05)* the moisture contents of the BLA samples significantly. Moisture content of the un-irradiated samples ranged between 55.75 to 61.88%, while the moisture content of the irradiated ranged from 53.28 to 63.53% (Table 1). These values were rather low compared to values reported by [12] (65 -81%) and [13] (60- 80%) for yam tubers in general. Although the moisture content of the blanched samples generally were higher for both the irradiated and un-irradiated compared to the SMBS and CA treated samples, that of the irradiated samples gradually increased up to the 4th weeks of storage for both the SMBS and CA treated samples.

In the case of the two chemical treatments, samples treated with SMBS had relatively lower moisture contents compared to the CA treated samples. The high moisture content of the blanched samples could probably be due to the fact that, during the blanching process the chips most likely imbibe some water increasing their moisture content. Moreira et al. [14] suggested that blanching could cause gelatinization of the starches on the surface of potatoes. This phenomenon probably happened in the BLA yam chips causing a decrease in the rate of moisture loss hence retaining the intrinsic moisture content. Also according to [15], blanching can lead to structural softening and hence facilitates moisture removal during moisture content determination. However low moisture contents were recommended for the production of good quality French fries as high moisture contents produce soggy French fries [16]. At the end of the 4th week of storage, there was no significant effect of the various treatments on the moisture content of the yam chips for the un-irradiated samples. Also both physical and chemical treatments significantly affected *(P<.05)* the moisture contents of irradiated samples.

3.2 Lightness L* Colour of Yam Chips Produced from Irradiated Yams

Colour is an important attributes used by consumers to evaluate food quality. It is important for products such as yam to maintain its fresh appearance and appeal as an indicator of good quality. Consistency in colour must be maintained throughout storage. Although irradiation generally did not have a significant effect on the lightness of the yam chips at the end of the storage period (4 weeks), lightness of only the CA treated samples were significantly affected *(P=.01)* by irradiation dose at (200Gy). Lightness (L*) indices for the irradiated samples were relatively higher (75.65 to 80.33) compared to the un-irradiated samples (74.43 to 80.25), with samples irradiated at 120Gy having comparatively higher L*values for all the various treatments throughout the storage period (Figs. 1, 2, 3).

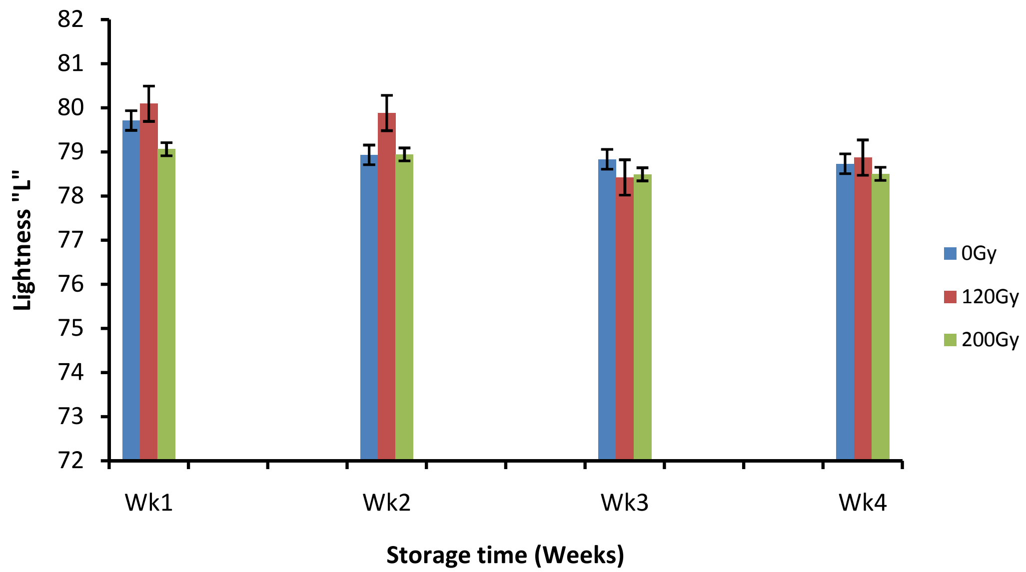

Fig. 1. Effect of irradiation and storage time on the lightness (L*) values of yam chips when treated with sodium metabisulphite

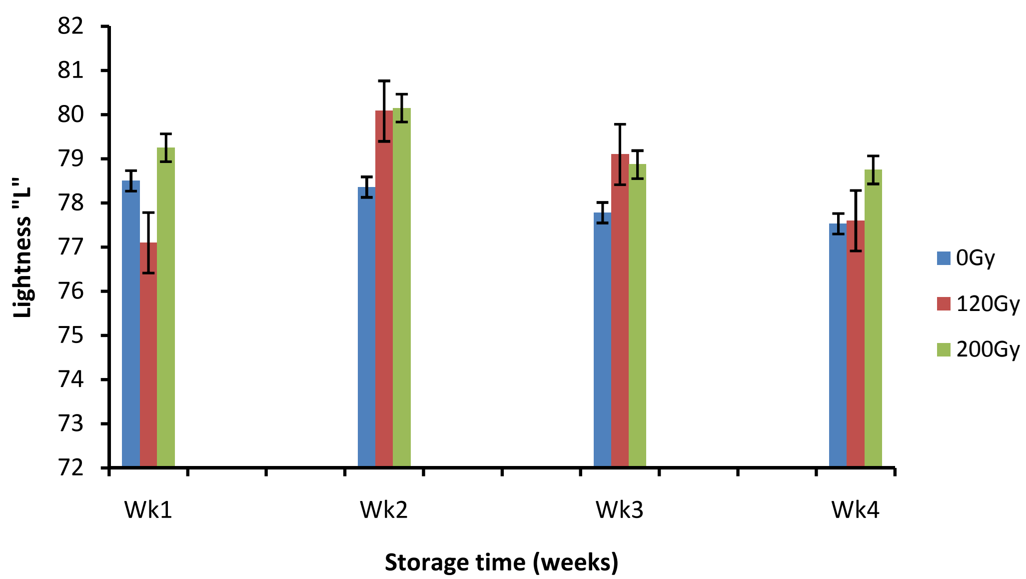

Fig. 2. Effect of irradiation and storage time on the lightness L* of yam chips when treated with citric acid

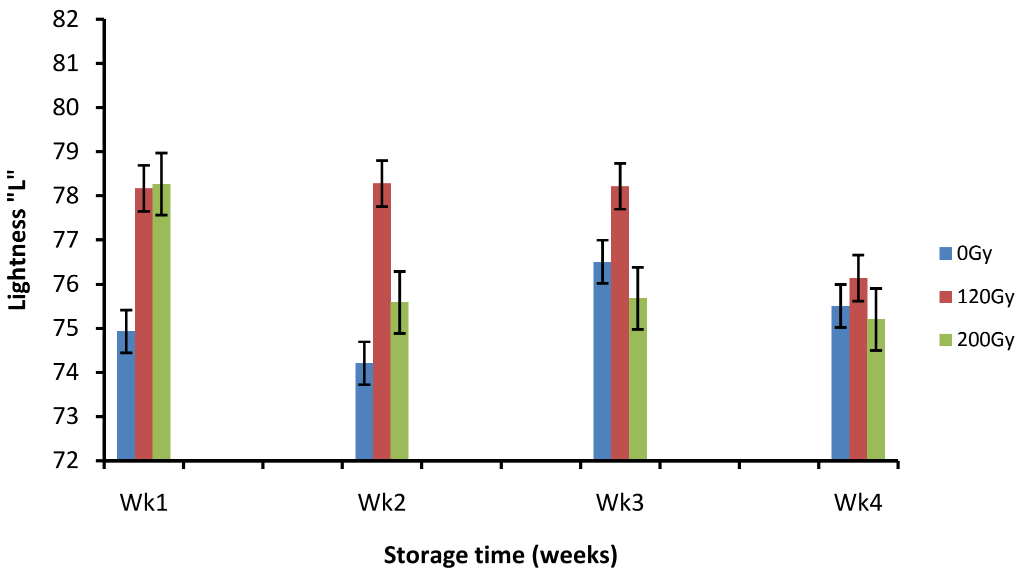

Fig. 3. Effect of irradiation and storage time on the lightness L* of Blanched yam chips

These values are however lower compared to the value of 85.7 lightness as reported by [17], when fresh cut sweet potato was stored at 5ºC for 14 days after pre-treating with SMBS and CA. In this study, the results obtained were contrary to suggestions made by [18-25] that gamma irradiation for sprout inhibiting may induce or enhance darkening in whole tubers after cooking. A general trend of lower lightness, L* values (an indicator of browning) was observed for the blanched samples in comparison to the chemically treated samples; as lower values of L* indicate greater degree of browning. This difference was found to be significant *(P<.05)* for both the irradiated and un-irradiated samples. However, the lightness of the chemically treated samples decreased gradually by the 4^{th} week of storage for both irradiated and un-irradiated samples. On the other hand, higher L* values (78.73 to 79.71) were recorded for SMBS treated samples for control (unirradiated) samples throughout the storage period. These values were significantly different from that recorded for the BLA and CA treated samples. Nonetheless, L* values obtained for both SMBS and CA were somewhat comparable for the irradiated samples (120 and 200Gy). This could possibly be due to the combined effect of the low irradiation doses and the chemical treatments given to the yam tubers prior to storage. It was reported by [26] that the importance of pre-treatments to overcome problems of browning to improve quality and shelf-life of chips produced from sprouted potato tubers. It is assumed that sulphites inhibit enzymatic browning by reducing o-quinones to colourless diphenols [27] or by reacting irreversibly with o-quiniones to form stable colourless products [28]. No colour change was reported for sliced sweet potatoes upon treatment with 4 various additives (citric acid, ascorbic acid, chlorine and sulphite) [29]. Also [22,23,30] proposed the use of some pre-treatments such as soaking and cooking of tubers in solutions of diaminoethane-tetra acetic acid sodium salt (EOTA) or citric acid, sodium acid pyrophosphate prior to cooking can reduce the after-cooking darkening.

3.3 Textural Characteristics of Yam Chips Produced from Irradiated Yams

3.3.1 Hardness

The attribute, maximum shearing force (N) can be defined as the force needed to cut through the samples completely and this peak force required to shear the sample is referred to as the measure of hardness of the samples. Absorbed irradiation doses given to the yam tubers for purpose of postharvest management significantly affected *(P<.05)* the hardness of the yam chips. Although no particular trend was observed in terms of the effect of irradiation on the hardness, samples irradiated to 200Gy had the highest maximum force (17.81N) by the 4th week. This was contrary to findings by [10] where irradiation pre-treatment led to softening of tissues of potato. BLA samples generally had lower hardness values compared to the chemically treated samples. However, within the BLA samples, the irradiated samples had higher maximum shearing force comparable to the un-irradiated samples (Table 2). The moisture levels present in a food substance can influence the textural properties of the food therefore the higher moisture contents of the BLA samples could have contributed to the lower shearing forces recorded for the BLA samples. Nonetheless it was reported that, blanching apart from inactivating enzymes also forms a layer of gelatinized starch that improves the final texture of the product [14]. However, hardness of the chips in the case of samples treated with either SMB or CA were similar for both the irradiated and unirradited samples with hardness ranging from 13.39 to 23.01N for SMB and 13.52 to 22.33N for CA treated samples (Table 2). Improved firmness or hardness in sliced apples was reported when combined treatments of sulphites and calcium ions were given them [31]. In considering the interactions between the various factors, it was observed (Table 2) that, there was no significant effect *(P>.05)* between the storage weeks and the absorbed dose on the hardness of the yam chips. On the other hand, the treatment given and the absorbed dose had a significant effect *(P<.05*) on the hardness of the yam chips. Knowledge of the textural characteristics of food is very important to a food processor as this forms a major contribution to the overall acceptability of the product.

3.3.2 Surface elasticity

From the statistical analysis, the effect of the absorbed dose was significant *(P<.05)* in the samples treated with SMBS and CA in the 2nd and 3rd week of storage where lower surface elasticity values were also recorded. These values ranged between 1.87 to 3.02mm and 2.24 to 4.54mm for SMBS and CA treated samples respectively. Surface elasticity defined as the distance the probe travels just before the sample is cut through was found to be significantly affected*(P<.05)* by the various treatments by the end of the storage period (4 weeks) but this effect was not significant in the first 3weeks of storage for the un-irradiated samples. Unlike in the un-irradiated samples, the treatment significantly affected the surface elasticity throughout the storage period for the irradiated samples. This is in agreement with the findings of [32] who reported that, during minimal processing of sweet potatoes, there was some form of dehydration of the surface tissues. However, storage weeks had a significant effect *(P=.000)* on surface elasticity of the irradiated samples. By the end of the 4th week the SMBS treated samples had the highest surface elasticity with CA having the least (Table 3). Storage weeks sparingly affected the surface elasticity of the controlled samples at the various treatments.

Table 1. Effect of irradiation on moisture content of yam before and after treatments over 4 weeks storage

Dose /kGy	Initial % moisture content	Treatment	% Moisture content			
			Wk1	Wk2	Wk3	Wk4
0	59.33±0.29	SMBS	$_{x}58.9^{Apq}\pm0.76$	$_{x}55.75^{Ap}\pm0.53$	$_{x}57.95^{Ap}\pm0.40$	$_{x}61.46^{Aq}\pm3.55$
		CA	$_{y}60.22^{Apq}\pm0.67$	$_{y}59.15^{Apq}\pm0.51$	$_{x}58.47^{Ap}\pm0.46$	$_{x}58.61^{Ap}\pm0.68$
		BLA	$_{z}61.88^{Bp}\pm0.48$	$_{z}61.39^{Bp}\pm0.48$	$_{y}61.18^{Ap}\pm0.86$	$_{x}61.48^{Ap}\pm0.36$
120	52.00±0.77	SMBS	$_{x}59.09^{Aq}\pm0.53$	$_{x}59.20^{Bq}\pm0.79$	$_{x}57.49^{Ap}\pm0.16$	$_{y}59.29^{Aq}\pm0.21$
		CA	$_{y}60.58^{Aq}\pm0.44$	$_{x}58.64^{Ap}\pm0.15$	$_{y}60.53^{Bq}\pm0.25$	$_{z}62.60^{Cr}\pm0.19$
		BLA	$_{x}58.57^{Ap}\pm0.85$	$_{x}58.53^{Ap}\pm0.15$	$_{y}59.77^{Aq}\pm0.87$	$_{x}58.21^{Ap}\pm0.17$
200	57.08±0.75	SMBS	$_{x}59.98^{Aq}\pm0.30$	$_{x}58.95^{Bp}\pm0.29$	$_{y}63.53^{Bs}\pm0.23$	$_{y}60.67^{Ar}\pm0.35$
		CA	$_{x}60.44^{Aq}\pm0.36$	$_{x}58.75^{Ap}\pm0.56$	$_{x}61.90^{Br}\pm1.25$	$_{xy}59.97^{Bpq}\pm0.58$
		BLA	$_{x}61.12^{Bq}\pm0.91$	$_{y}61.33^{Bq}\pm0.29$	$_{xy}62.81^{Br}\pm0.32$	$_{x}59.73^{Bp}\pm0.30$

- *Values are means of triplicate readings with a standard deviation.*
- *Mean values in a column across various doses for each treatment per week, with the same superscript (ABC) are not significantly different (P<.05) from each other*
- *Mean values in a row along the various weeks for each treatment per dose, with the same superscript (pqrs) are not significantly different (P<.05) from each other*
- *Mean values within a column for the various treatments for each dose per week, with the same subscript (XYZ) are not significantly different (P<.05) from each other; SMBS-Sodium Metabisulphite, CA-Citric Acid, BLA-Blanch*

Table 2. Effect of irradiation on maximum shearing force (hardness) of yam chips at different treatments over 4 weeks of storage

Dose (Gy)	Treatments	Maximum shearing force (N)			
		Week 1	Week 2	Week 3	Week 4
0 (Control)	SMBS	$_{Y}17.98^{Ap}\pm0.89$	$_{Y}18.42^{ABp}\pm2.25$	$_{Y}22.68^{Aq}\pm3.33$	$_{Z}17.36^{Bp}\pm1.09$
	CA	$_{Z}22.33^{Bq}\pm2.87$	$_{Y}17.69^{Ap}\pm0.73$	$_{Y}21.70^{Aq}\pm4.19$	$_{Y}15.41^{Bp}\pm0.91$
	BLA	$_{X}3.22^{Ap}\pm0.31$	$_{X}3.44^{Ap}\pm1.36$	$_{X}3.86^{Ap}\pm0.66$	$_{X}3.28^{Ap}\pm0.38$
120	SMBS	$_{X}18.20^{Aq}\pm0.59$	$_{Y}17.56^{Aq}\pm1.60$	$_{Z}18.78^{Ar}\pm0.96$	$_{Y}13.39^{Ap}\pm1.56$
	CA	$_{X}17.82^{Aq}\pm1.33$	$_{Y}17.07^{Aq}\pm0.80$	$_{Y}17.60^{Ar}\pm0.88$	$_{Y}13.52^{Ap}\pm1.26$
	BLA	$_{X}4.21^{Bp}\pm0.68$	$_{X}3.75^{Ap}\pm0.66$	$_{X}5.65^{Bq}\pm2.98$	$_{X}8.99^{Br}\pm2.62$
200	SMBS	$_{Y}20.69^{Br}\pm2.15$	$_{Y}19.48^{Bpq}\pm1.66$	$_{Z}23.01^{As}\pm2.84$	$_{Y}17.81^{Bp}\pm1.65$
	CA	$_{Z}17.55^{Apq}\pm1.54$	$_{Y}18.50^{Bq}\pm0.94$	$_{Y}21.30^{Ar}\pm1.05$	$_{Y}16.74^{Cp}\pm1.65$
	BLA	$_{X}4.78^{Cp}\pm0.65$	$_{X}6.85^{Bq}\pm1.08$	$_{X}6.42^{Bq}\pm1.94$	$_{X}3.77^{Ap}\pm1.08$

- *Values are means of triplicate readings with a standard deviation.*
- *Mean values in a column across the various doses for each treatment per week, with the same superscript (ABC) are not significantly different (P<.05) from each other*
- *Mean values in a row along the various weeks for each treatment per dose, with the same superscript (pqrs) are not significantly different (P<.05) from each other*
- *Mean values within a column for the various treatments for each dose per week, with the same subscript (XYZ) are not significantly different (P<.05) from each other; SMBS-Sodium Metabisulphite, CA-Citric Acid, BLA-Blanch*

Table 3. Effect of irradiation on surface elasticity of yam chips at different treatments over 4 weeks of storage

Dose (Gy)	Treatments	Surface elasticity (mm)			
		Week 1	**Week 2**	**Week 3**	**Week 4**
0 (control)	SMBS	$_{X}3.13^{Ap}\pm1.44$	$_{X}2.41^{Ap}\pm1.44$	$_{X}3.13^{Bpq}\pm1.28$	$_{Y}4.17^{Aq}\pm0.10$
	CA	$_{X}2.62^{Ap}\pm1.69$	$_{X}2.74^{Bp}\pm0.58$	$_{X}2.97^{Ap}\pm0.91$	$_{Z}4.34^{Aq}\pm1.02$
	BLA	$_{X}3.70^{Ap}\pm1.23$	$_{X}2.90^{Bp}\pm1.82$	$_{X}3.30^{Cp}\pm1.46$	$_{X}3.63^{Ap}\pm1.12$
120	SMBS	$_{X}3.21^{Ap}\pm1.66$	$_{Y}2.29^{Ap}\pm0.56$	$_{X}3.02^{ABp}\pm0.71$	$_{Y}4.20^{Aq}\pm0.98$
	CA	$_{Y}4.18^{Aqr}\pm1.09$	$_{XY}2.24^{Ap}\pm0.83$	$_{X}3.00^{Aq}\pm1.30$	$_{Y}4.34^{Ar}\pm0.96$
	BLA	$_{Y}3.90^{Aq}\pm1.04$	$_{X}1.83^{Bp}\pm1.37$	$_{X}3.43^{ABq}\pm1.30$	$_{X}3.80^{Aq}\pm1.12$
200	SMBS	$_{X}2.98^{Aq}\pm1.26$	$_{X}2.46^{Aq}\pm0.722$	$_{X}1.87^{Ap}\pm0.91$	$_{Y}4.13^{Ar}\pm1.06$
	CA	$_{X}3.41^{ABpq}\pm1.63$	$_{X}3.25^{Bp}\pm0.85$	$_{Z}4.54^{Bqr}\pm0.60$	$_{Y}4.19^{Ar}\pm1.03$
	BLA	$_{X}4.12^{Ap}\pm1.08$	$_{X}3.82^{Bp}\pm1.20$	$_{Y}3.61^{Ap}\pm1.31$	$_{X}3.75^{Ap}\pm1.28$

- *Values are means of triplicate readings with a standard deviation.*
- *Mean values a column across the various doses for each treatment per week, with the same superscript (ABC) are not significantly different (P<.05) from each other*
- *Mean values a row along the various weeks for each treatment per dose, with the same superscript (pqrs) are not significantly different (P<.05) from each other*
- *Mean values within a column for the various treatments for each dose per week, with the same subscript (XYZ) are not significantly different (P<.05) from each other*; *SMBS-Sodium Metabisulphite, CA-Citric Acid, BLA-Blanch*

4. CONCLUSION

Absorbed irradiation doses given to the yam tubers for the purpose of postharvest management significantly affected the hardness of the yam chips and only affected the surface elasticity in the 2nd and 3rd weeks of storage. There was a low negative correlation (R = -0.0951) between hardness and surface elasticity of the treated samples at the various doses. Irradiation generally did not have a significant effect on the lightness (L*) colour index of the yam chips produced but significantly (p<.05) affected the moisture contents of the chemically treated yam chips. Irradiating yams to an optimum dose of 120Gy can ensure adequate inhibition of sprouting to prevent postharvest losses and make the yams available all year round for yam chips processing. However a combination of gamma irradiation and chemical treatments is recommended for processing yams into chips.

COMPETING INTERESTS

Authors declare that there are no competing interests.

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