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Effect of 300Gy Gamma (ɣ) radiation dose on Nigerian onion: A proximate composition

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Onion (*Allium cepa*) samples purchased from one of the most populous markets (Bodija market) in the south-western part of Nigeria were irradiated with a 300Gy dose of ɣphotons using ɣBEAMX200, while some of these onions were also kept as control (non-irradiated). Proximate analyses were carried out on both irradiated and non-irradiated onion. The proximate composition revealed 0.16, 11.63 and 7.90% reduction in moisture, crude protein and ash, respectively in the irradiated sample. Additionally, the irradiation led to the increase of crude fiber, carbohydrates and crude fat contents by 3.36, 11.51 and 57.14%, respectively in the irradiated sample over the non-irradiated. Conclusively, the irradiation of onion with 300Gy does not significantly change the moisture content, but positively changed the fiber content and carbohydrate contents of the irradiated onions.

Key words: Onion (*Allium cepa*), carbohydrate, Gamma photons, proximate composition, irradiation.

INTRODUCTION

Food irradiation is a process of exposing food to a controlled amount of ionizing radiation such as ɣ rays to destroy harmful organisms and increase their shelf-life (Farkas, 2006). The use of ionizing radiation to destroy harmful biological organisms in farm produce is considered safe with well- proven process that is widely accepted (Sharma et al., 2020).

Depending on the absorbed dose of radiation, various effects could be observed resulting in reducing storage losses, extended shelf life and/or improved microbiological and parasitological safety of foods (Farkas and Mohácsi, 2011; Yuan, 2018).

Post-harvest food losses pose serious problems in most countries in Africa especially sub-Saharan Africa because of low level of development in food preservation (Gathambiri, 2021). In some cases, as much as 3% of cereal and 20.60% of tubers, root crops and bulbs are lost (Kaminski and Christiaensen, 2014; Sheahan and Barrett, 2017).

Onion in Nigeria are predominantly grown in the northern part of Nigeria and are consumed almost daily in all households in the country because of their importance in adding flavor to food and have many health benefits as well (Blamadottir, 2019).

Onion provided flavor, colour and texture to a wide variety of dishes. But much more than the flavor, the health benefits of onion make it highly significant in human health (Blamadottir, 2019). While onions are not

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particularly high in most nutrients, they contained anti-inflammatory, anti-cholesterol, anti-cancer and antioxidant components such as quercetin (Sheneni et al., 2018). Quercetin is known for its antibacterial and antioxidant activities (Ramos et al., 2006).

Fisetin, a flavonoid found in onion has a great role in treating chronic diseases (Pearlman et al., 2016). Onions are rich in vitamin C and chromiun, a trace mineral tied to insulin response (Sheneni et al., 2018).

Fat-soluble vitamins are particularly destroyed by irradiation and tocopherol is more sensitive to pasteurization doses, 0.2-0.25 kGy (Diehl, 1992). Regarding vitamin C, no alterations were registered in onions receiving irradiation doses enough for sprouting inhibition (Kilcast, 1994). Elevated irradiation dosages (0.03-0.15kGy) led to complete inhibition of sprouting and mitosis of onion, independent of application moment while low doses (0.002-0.01kGy) did not give in any desirable effects on food (Pellegrini et al., 2000).

Due to the significant loss recorded in the storage of onion in Nigeria, irradiation of onion can be used to increase their shelf-life for a longer period (Sharma et al., 2020) and according to Agbaji et al. (1981), ɣ irradiation was proven to increase the shell-life of Nigerian onion. After a thorough study of the literature, no study has reported the proximate composition of Nigerian onion irradiated up to 300 Gy; thus, the focus of this study was to know the effect of irradiation on the proximate composition of the available Nigerian onion in the market which are being consumed by the public, especially in south-western Nigeria

This study was carried out to investigate the effect of 300Gy ɣ irradiation on the proximate composition of Nigerian onion.

MATERIALS AND METHODS

Raw onion (*Allium cepa*) was collected at Bodija market (the main market in south-western Nigeria) for the experimental study. Some were irradiated to 300Gy of ɣ photons with ɣ BEAMX200 which is available at the National Institute of Radiation Protection and Research, while some were set aside (non-irradiated) as control.

For the irradiation, the air kerma dose rate of ɣBEAMX200 Co-60 ɣ photons irradiator at source-to-sample distance of 80cm for a radiation field size of 10 x 10cm^2 was determined with an IBA ion chamber connected to IBA electrometer (IAEA TRS 398). The time to irradiate the onion with 300Gy of ɣ photons was determined using the concept of dose equal product of dose rate and irradiation time. Each sample was hung on a retort stand at 80cm of 10 x 10 cm^2 field size along the central axis of the radiation beam, and irradiated with 300Gy of ɣ radiation.

Proximate analysis

Both the irradiated and non-irradiated were then analyzed for their proximate values at the Department of Human Nutrition of the University of Ibadan, Ibadan, Oyo State Nigeria.

Proximate composition was determined on the two sets of onions (irradiated and non-irradiated) which included: moisture content, crude protein, crude fat, crude fiber, ash content, and total carbohydrate. The procedure followed was in line with the official method of analysis stated in AOAC (1990).

Moisture content

The dried clean porcelain dish was weighed empty. Five grams of *Allium cepa* (irradiated and non-irradiated) was put in the dish separately and weighed. It was oven-dried at 70-80^{o}C for 20 h until weight is constant. The sample was cooled in a desiccators, dry weight of the sample and dish were taken. The moisture content of the sample was calculated as indicated in equation 1.

$$\%\ \text{Moisture} = \frac{\text{Wet weight} - \text{dry weight}}{\text{wet weight}} \text{x } 100 \quad (1)$$

Crude protein

Into a 1000 ml standard flask containing about 600 ml of distilled water, 8.9 ml of 35% hydrochloric acid was put and made up to the mark. This gave approximately 0.1N HCl standardized by titration and then diluted 10 times. % crude protein was determined from equations 2, 3 and 4. The percentage protein (wet or dry basis) is as follows:

$$\%\ \text{Protein} = \%\ \text{nitrogen x } 6.25 \quad (2)$$

Where 6.25 is the protein-nitrogen conversion factor for all protein by-products.

The percentage nitrogen (wet weight basis) as follows:

$$\%\ \text{Nitrogen (wet)} = \frac{(\text{A}-\text{B}) \text{ X } 1.4007}{\text{Weight of sample}} \text{ x } 100 \quad (3)$$

Where: A = vol. (mL) std. HCl x normality of std. HCl, B = vol. (mL) std. NaOH x normality of std. NaOH
The nitrogen content on dry basis (when moisture content is known) as follows:

$$\%\ Nitrogen\ (dry) = \frac{\%\ Nitrogen\ (wet)}{(100 - \%\ moisture)} \text{x } 100 \quad (4)$$

General factor = 6.25
Allium cepa = N_{acid} x 5. 55
Where N_{acid} = normality of acid =0.01N

Crude fat

A clean boiling flask (250cm^3) was dried in oven at 105-110^{0}C for 30 min, transferred into a desiccator and allowed to cool. The cooled boiling flask was filled with 200cm^3 petroleum ether. Two grams of the sample was accurately weighed into labeled thimbles. The extraction thimble was lightly plugged with cotton wool and the thimble was removed with care. Petroleum ether was collected at 105^{0}C for 1 h. It was then transferred from the oven into desiccators, allowed to cool and weighed. The % crude fat was calculated using equation 5.

$$\%\ Fat = \frac{Weight\ of\ fat}{Weight\ of\ sample} \text{x } 100 \quad (5)$$

Crude fiber

One gram of *Allium cepa* (irradiated and non-irradiated) was

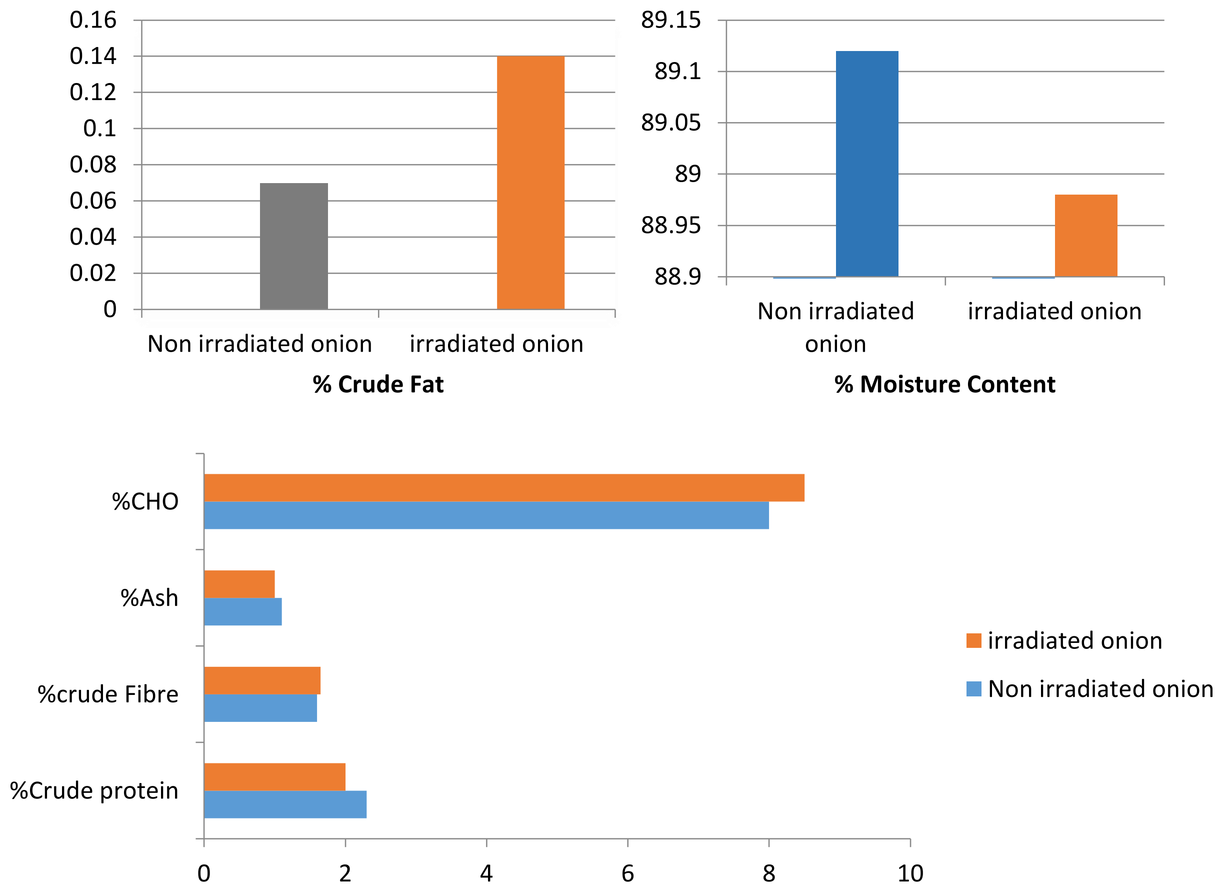

Figure 1. Proximate composition of Nigerian onion irradiated with 300Gy Ɣ radiation and the non-irradiated.
Source: Authors

weighed into 500ml conical flask. Hundred ml of trichloroacetic acid digestion reagent which is a mixture of 500ml glacial acetic acid, 450 ml water and 50 ml conc. nitric acid was added.

The mixture was boiled and refluxed for 40 min. Liquid loss was prevented with a water jacketed condenser. The flask was removed from the heater, cooled under cold tap and filtered. The residue was dried at 600°C overnight in muffle furnace, cooled in a desiccator and weighed. The % crude fiber was determined by using equation 6.

$$\% \text{ Fiber} = \frac{\text{Difference in weight}}{\text{Weight of sample}} \text{ x } 100 \qquad (6)$$

Ash

Two-5g finely ground, dry sample (irradiated and non-irradiated) was separately weighted into a silica/porcelain crucible (avoid dust contamination after weighing). The sample was charred on an electric heater to drive off most of the smoke. Then the sample was transferred into a preheated muffle furnace at 600^0C and heated at this temperature for 2 h.

Crucible was cooled in a desiccator and grey ash obtained was weighed. Its % was determined using equation 7.

$$\% \text{ Ash} = \frac{\text{Ash weight (g)}}{\text{Sample weight (g)}} \text{ x } 100 \qquad (7)$$

Carbohydrate

Carbohydrate content was determined using equation 8, by subtracting the % of moisture, ash, proteins, fiber and fats from 100.

$$\%\text{Carbohydrate} = 100 - (\%\text{moisture} + \%\text{crude protein} + \%\text{crude fat} + \%\text{crude fiber} + \%\text{Ash}) \qquad (8)$$

Statistical analysis

Independent sample T-test was carried out on the proximate composition of the two sets of onions (irradiated and non-irradiated) to show if the nutritional content of irradiated onions is significantly different from the control (non-irradiated) ones.

RESULTS AND DISCUSSION

Figure 1 showed that the proximate composition of Nigerian onion irradiated with 300Gy Ɣ radiation and the non-irradiated. From Figure 1 and Table 1, it could be observed that the moisture, ash and crude protein contents of the irradiated sample became lower by 0.16,

Table 1. Proximate composition of Nigerian onion irradiated with 300Gy ɣ radiation and non-irradiated onion with their % differences.

Treatment	% Moisture content	% Crude protein	% Crude fat	% Crude fiber	% Ash	% CHO
Control (non- irradiated						
1st	89.13	2.14	0.07	1.19	0.76	7.47
2nd	89.08	2.17	0.07	1.20	0.75	7.45
3rd	89.15	2.14	0.06	1.19	0.76	7.49
Mean*	89.12±0.04	2.15±0.02	0.07±0.01	1.19±0.01	0.76±0.01	7.47±0.02
Irradiated						
1st	89.08	1.90	0.11	1.22	0.69	8.26
2nd	88.93	1.91	0.11	1.23	0.70	8.35
3rd	88.92	1.90	0.11	1.24	0.70	8.37
Mean	88.96±0.07	1.90±0.01	0.11±0.00	1.23±0.01	0.70±0.01	8.33±0.06
%Difference	0.16	11.63	57.14	3.36	7.90	11.51

No of replicates= 3.
Source: Authors

Table 2. Statistical analysis of the proximate composition of irradiated and non-irradiated onions.

Proximate composition	*P-value
Moisture content	0.0620
Crude protein	0.0000
Crude fat	0.0002
Crude fiber	0.0053
Ash content	0.0002
CHO	0.0000

*P value > 0.05 means no significant difference and P value < 0.05 means there is significant difference.
Source: Authors

7.9 and 11.63%, respectively than the non-irradiated sample. The reduction in the moisture content could have been caused by a possible raise in the temperature of the irradiated sample (Bliznyuk et al., 2022). The reduction in the protein content of the irradiated onion is also in agreement with the Agbaji et al. (1981) and this could be due to the deamination of polypeptides and protein in the irradiated onion by the ɣ radiation.

Furthermore, the crude fiber, carbohydrate and crude fat contents of the irradiated sample were increased by 3.36, 11.51 and 57.14% over the control. It is interesting to observe that the crude fat that increased after irradiation is also in agreement with Agbaji (1988), who investigated that the lipid content of Nigerian onion after irradiation although the radiation doses are different.

The statistical analysis in Table 2 showed that, there is no significant difference between the moisture content of irradiated onions and the non-irradiated ones ($p>0.05$), but there is significant difference ($p< 0.05$) between the crude protein, crude fat, crude fiber, ash and CHO contents of irradiated and non-irradiated onions. This implied that the crude protein, crude fat, crude fiber, ash and CHO contents of the irradiated onions are significantly different from the non-irradiated onions. Comparing Tables 1 and 2, the proximate composition showed that positive significance in crude fiber and carbohydrate contents while negative significance in crude protein, crude fat and ash content. This is in agreement with the Munir et al. (2017) who investigated the effect of gamma radiation on the shelf life, physiological and nutritive value of onion. The positive significance is as a result of % increase in crude fiber and CHO contents. The presence of crude fiber in diet aids digestion and improves the elimination of waste from human systems, while CHO will be a good source of glucose (Khan et al., 2013; Munir et al., 2017).

Conclusion

It could be observed that exposure of onion to ɣ ray up to 300Gy do not significantly change the moisture content. The protein, fat, Ash, fiber and CHO contents of the irradiated onions is significantly different from the control (non-irradiated) onions. Both the fiber and the CHO content were positive significant because of their relevance in human diet.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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