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Effect of Gamma Irradiation on Nutritional Quality and shelf life of Groundnut Species Produced in Benue State Nigeria

[1]Akaagerger, N. B. and *[2]Ochokwunu, P. E.

Centre for Food Technology and Research Benue State University Makurdi Benue State, Nigeria.

*Corresponding author's email: ochokwunup@gmail.com

ABSTRACT

Groundnut is a perishable crop and is subject to quality losses during storage through insect pests, rodent infestation and fungal development. Gamma (γ) irradiation has emerged as a promising technique which could effectively be used for disinfestations of stored food products therefore presenting alternative to chemical preservatives. This research investigated the effect of gamma irradiation on nutritional quality and shelf life of groundnut species produced in Benue State Nigeria. The seeds of Bernarda 1 groundnut (BE1G), Local groundnut (LOG) species were irradiated at varying doses (0, 200, 300, 400 and 500 Gy) using Cobalt-60 Gamma Irradiator. The irradiated and non-irradiated samples were each divided into two portions. The first portion was used for proximate analysis while the second was stored for a period of four months under the same ambient temperature and conditions in a polythene bags and its percentage weight loss were determined. Proximate analysis revealed no significance difference at ($p \geq 0.01$) in moisture, protein, crude fibre and fats composition of BE1G species between non irradiated and irradiated samples, however a significant variation ($p \leq 0.01$) was observed in its ash and carbohydrate across 200 Gy, 300 Gy and 400 Gy. The result also revealed no significant difference in the proximate composition of LOG species for 400 Gy and 500 Gy doses. After four months storage, percentage weight loss analysis indicated a significant difference between irradiated and control seeds of samples. The 500 Gy dose exhibited the least weight loss in the samples. These findings suggest 500 Gy as gamma irradiation dose for BE1G and LOG, highlighting the optimal effective doses for their preservation.

Keywords:
Dose,
Groundnut,
Irradiation,
Proximate,
Shelf life.

INTRODUCTION

Food losses refer to the decrease in edible food mass (dry matter) or nutritional value of food that was originally intended for human consumption (FAO, 2013). As the human population grows, food demand increases, and there is need for adequate, substantial and sustainable sources of food and practicable methods for food preservation (Adejumo, 2012). Adejumo and Raji (2007) reported that these losses are experienced during postharvest activities mainly in crops such as maize, rice, sorghum, millet, cowpea, groundnut, soyabeans, yam, cassava, plantain and fruits in many developing countries particularly in Africa. Farmers and food sellers have been concerned about losses since agriculture began. Yet the problem of how much food is lost after harvest to processing, spoilage, insects and rodents, or to other factors takes on greater importance as world food demand grows. Cutting postharvest losses could, presumably, add a sizable quantity to the global food supply, thus reducing the need to intensify production in the future. Proper postharvest handling operations have important roles to play in ensuring availability of grains and other crops since agricultural production is seasonal while the demand for agricultural commodities is daily (Manandhar*et al.,* 2018). A number of new preservation techniques are being developed to satisfy the current demands for more efficient preservation and higher consumer satisfaction with regard to nutritional and sensory aspects, safety, low price, environmental safety and convenience. These methods include thermal processing, drying, freezing, chemical treatment, high pressure processing and so on. However, all these preservation methods have both beneficial and adverse effects on food quality (Manzo or *et al.*,2014). Chemicals applications is the most common method used to control pests of stored produce. The use of toxic chemicals such as ethylene oxide or propylene oxide to control insects has been questioned due to its toxic residues. Since there is an increasing demand for fresh and nutritious food products with high organoleptic attributes, improved safety and prolonged shelf life, various non-thermal processes like high hydrostatic pressure, pulsed electrical field, and irradiation technologies have been investigated (Junqueira *et al.*, 2011). Among them food irradiation has been found to be the most promising techniques which could effectively be used for disinfestations of stored food products. The principal objective of food preservation is to increase its shelf life, retain original nutritional values, colour, texture, and flavour.

MATERIALS AND METHODS

The materials used for this research include the following: Cobalt - 60 gamma Irradiator, Desiccators, Crucibles, Oven, Muffle furnace, Sample holder, Weighing balance, Soxhlet, Round bottom flask, Thimbles, Methanol, Ethanol, Sulphuric acid, Petroleum ether, Potassium Sulphate, Mercury oxide and Hydrochloric acid.

A Brief Description of Study Area

Aliade is located in Gwer East local government of Benue State Nigeria, with Latitude of 7^o 17'46" N and a Longitude of 8^o 28' 58" E. It is a tropical wet savanna region suitable for agricultural practices. Inadequate infrastructure such as storage facilities, roads and markets are major challenges faced by the farmers in the region.

Methods

Sample Collection

Three different varieties of groundnut were collected from farms in Aliade Benue State and were taken to Department of Biological Sciences Benue State University Makurdi, for identification with Herbarium index number (HBI-OPE-001-BSU24). The samples were carefully shelled manually and transported in polythene bags to the Ahmadu Bello University Center for Energy Research and Training (CERT) Zaria for irradiation.

Sample Preparation and Irradiation

Groundnut samples were divided into two portions. The first portion of each sample were sealed in polythene bags and kept as control samples. The second portion of samples were exposed to irradiation at different doses of 200 Gy, 300 Gy, 400 Gy and 500 Gy of gamma irradiation using cobalt 60 source at the dose rate of 1.5 Gy/hr. After irradiation, each irradiated sample were divided into two portions. First portion were kept for determination of Shelf life and the second portion were used for proximate analysis.

Determination of Proximate Composition of Samples: Methods as outlined by AOAC (2000) were used to determine the Moisture, crude protein, crude fat, ash, crude fibre, and carbohydrates contents of irradiated (200 Gy, 300 Gy, 400 Gy, and 500 Gy) and non-irradiated seeds of the different species of groundnut

Determination of Shelf life: The irradiated and non-irradiated samples (control) of groundnut were stored in a laboratory under the same conditions for four months. The shelf life of both the control and the irradiated samples were determined by physical examination and by weighing the samples after some period to determine the loss in their weights.

$$\%\,weight\ loss = \frac{initial\ weight - final\ weight}{intial\ weight} \times 100$$

Statistical analysis

The proximate compositions of groundnut samples were determined in triplicates and the mean value was calculated. Data obtained from the Proximate and weight analysis was analysed using the analysis of variance (ANOVA) using SPSS 20.0. The significance level was set at 0.01.

RESULTS AND DISCUSSION

Proximate composition

The tables 1 and 2 showed the results of the mean proximate composition of BE1 and LO respectively. The effects of gamma irradiation on the proximate compositions are discussed below.

Table 1: Proximate Composition of BE1G

Dose (Gy)	%Moisture	%Protein	%Crude fibre	%Fats	%Ash	%Carbohydrate
0	6.20±0.01	24.27±0.06	16.22±0.08	40.09±0.07	2.15±0.01	11.05±0.04
200	5.91±0.61	24.40±0.10	16.14±0.05	39.98±0.01	2.00±0.02	11.24±0.10
300	6.19±0.01	24.13±0.06	16.15±0.06	40.17±0.15	2.19±0.36	10.18±0.02
400	6.25±0.05	24.01±0.08	16.44±0.06	39.97±0.01	2.30±0.63	11.59±0.01
500 G	6.23±0.07	24.02±0.07	16.14±0.14	40.02±0.02	2.34±0.83	10.68±1.31

Table 2: Proximate Composition in percentage of LOG

Dose (Gy)	Moisture	Protein	Crude fibre	Fats	Ash	Carbo
0	6.50±0.01	22.71±0.06	26.20±0.01	40.44±0.02	1.89±0.02	2.28±0.01
200	6.59±0.04	22.78±0.02	24.97±0.01	40.46±0.15	1.90±0.02	2.21±0.02
300	6.54±0.01	22.81±0.08	23.78±0.01	40.60±0.17	2.10±0.03	2.84±0.01
400	6.37±0.04	22.25±0.39	26.19±0.01	40.54±0.16	1.93±0.03	2.70±0.17
500	6.49±0.05	22.54±0.11	26.26±0.51	39.96±0.83	1.93±0.01	2.73±0.23

Effects of Gamma irradiation on BE1G Proximate Composition

To access the homogeneity of variance in the mean proximate composition of BE1, Levene's test was conducted on it. The results indicated non-homogenous variation for the following proximate compositions ($P_{moisture} < 0.001$, $P_{lipids} = 0.019$, $P_{ash} = 0.003$, Pcarb < 0.001). Afterward, Welch's Robust test was employed to determine the significance of this mean variations. Significant variations was observed in the Ash (P = 0.001), Carbohydrate (p < 0.001). However, there were no significant differences in the mean moisture content (p = 0.382), lipids (p = 0.082). To identify which groups presented statistical significant difference in comparison to the control, the Games-Howell post hoc test was used. Specifically, ash content exhibited non-significance difference for 300 Gy (p = 1.000), 400 Gy (p = 0.989) and 500 Gy (p = 0.992) exposure but exhibited significant variation for 200 Gy (p = 0.002) from the control. In a similar manner, Carbohydrate exhibited statistical variation for 300 Gy (p = 0.001). However, exposure for 200 Gy (p = 0.229) and 500 Gy (p = 0.981) showed no significance variations from the control content of Carbohydrate. Table 3 showed the summary of the significance of the mean proximate composition of BE1G.

Table 3: Significance in mean Proximate Composition of BE1 in relation to control

Dose (Gy)	Moisture	Protein	Crude fibre	Fats	Ash	Carbohydrate
200	NS	NS	NS	NS	Sig	NS
300	NS	NS	NS	NS	NS	Sig
400	NS	NS	NS	NS	NS	Sig
500	NS	NS	NS	NS	NS	NS

Key: NS = Not Significant
Sig = Significant

Effect of Gamma irradiation on LOG proximate composition

To access the homogeneity of variance in the mean proximate composition of LOG, Levene's test was conducted on it. It was observed that the variation in ash (p = 0.078) was homogenous whereas variations in moisture (p = 0.046), protein (p = 0.002), fibre (p = 0.005), lipids (p = 0.002) and carbohydrate (p = 0.002) contents were non-homogenous.

Consequently, an ANOVA test was employed to evaluate the significance of variations in ash content. Meanwhile, the Welch Robust test was used to determine the significance of variations in moisture, protein, fibre, lipids and carbohydrate contents. The ANOVA test for LOG's ash (p < 0.001) showed a significant difference in the components. To identify specific groups difference, the Tukey Honest Significance Difference (HSD) post hoc test was used. The mean ash content in the control group, 200 Gy, 500 Gy irradiation did not significantly differ from each other. But the mean ash contents in 300Gy exposure showed significant variation from the control. The results of the Welch Robust test for equality of mean for moisture, protein, fibre, lipids and carbohydrate of LOG showed non- significance in variation for protein (p = 0.108) lipids (p = 0.617). However, the significant variation was observed for moisture (p = 0.007), fibre (p < 0.001) and carbohydrate content (p < 0.001). To identify groups with significant difference, the Games-Howell post hoc test was used. Specifically, moisture content exhibited no significance variations from the control. Similarly only the carbohydrate content in 300 Gy exposure (p = 0.000) had significant difference from the control carbohydrate content. The 400 Gy (p = 0.743), and 500 Gy (p = 1.000) of group fibre contents did not show statistical significance difference from the control.

A summary of the results for the significance in mean proximate composition of LOG was presented in Table 4.

Table 4: Significance of variation in Proximate Composition of LOG in relation to control

Dose (Gy)	Moisture	Protein	Crude fibre	Fats	Ash	Carbohydrate
200	NS	NS	Sig	NS	NS	NS
300	NS	NS	Sig	Sig	NS	Sig
400	NS	NS	NS	NS	NS	NS
500	NS	NS	NS	NS	NS	NS

Key: NS = Not Significant
Sig = Significant

Effect of Gamma irradiation on the Shelf life of the BE1G

The data present in Table 5 shows the effects of gamma irradiation on the shelf life of BE1G by considering its weight as a factor. It was observed that the percentage weight loss shows a significant difference between non-irradiated and irradiated samples. The samples irradiated at higher dose had less weight loss compared to those irradiated at lower doses. The total weight loss of 200Gy (1.20±0.79) show a decrease as compared to total weight loss of the control (2.57±2.01). Among the various irradiation doses investigated, 500 Gy was the most favourable in terms of shelf life extension and also it exhibited no statistically significant impact on the proximate composition of BE1G.

Table 5: Percentage Weight loss of BE1G Samples

% weight loss	0 Gy	200 Gy	300 Gy	400 Gy	500 Gy
1st month	0.20±0.29	0.19±0.27	0.05±0.10	0.04±0.08	0.00±0.00
2nd month	1.46±0.60	0.94±0.15	0.50±0.23	0.42±0.23	0.34±0.19
3rd month	3.45±0.56	1.46±0.18	1.15±0.19	0.88±0.16	0.88±0.11
4th month	5.14±0.58	2.20±0.32	1.90±0.26	1.42±0.22	1.47±0.25
Total % weight loss	2.57±2.01	1.20±0.79	0.90±0.74	0.69±0.56	0.67±0.60

Effect of Gamma irradiation on the Shelf life of the LOG

The data present in Table 6 shows the effects of gamma irradiation on the shelf life of LOG taking its weight as a factor. It was observed that the percentage weight loss shows a significant difference between non-irradiated and irradiated samples. The samples irradiated at higher dose had less weight loss compared to those irradiated at lower doses. The dose of 500 Gy had less weight loss compared to 400 Gy dose. Therefore, 500 Gy was the most favourable in terms of shelf life extension and also exhibited no statistically significant impact on the proximate composition of LOG.

Table 6. Percentage Weight loss of LOG Samples

% weight loss	0 Gy	200 Gy	300 Gy	400 Gy	500 Gy
1st month	0.22±0.21	0.09±0.12	0.03±0.06	0.03±0.06	0.00±0.00
2nd month	1.15±0.28	0.46±0.12	0.34±0.12	0.25±0.10	0.18±0.17
3rd month	1.46±0.48	1.02±0.21	0.68±0.16	0.53±0.12	0.47±0.06
4th month	2.86±.23	1.46±0.12	1.18±0.16	0.93±0.16	0.72±0.12
Total % weight loss	1.42±1.02	0.76±0.55	0.56±0.45	0.43±0.36	0.34±0.29

CONCLUSION

Gamma irradiation has shown potential as a method to enhance the shelf life of groundnut seeds without affecting its proximate composition. In this study, it is shown that irradiation cannot cause any significant loss of nutrition in groundnut samples locally produced in Benue State Nigeria. These findings suggest 500 Gy as the optimal gamma irradiation dose for BE1G and LOG preservation.

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