IOSR Journal of Biotechnology and Biochemistry (IOSR-JBB)
ISSN: 2455-264X, Volume 8, Issue 2 (Mar. – Apr. 2022), PP 21-28
www.iosrjournals.org

Consequences of X-Ray Irradiation on the Proximate Levels of Fluted PUMPKIN (*Telfairia occidentalis* Hook.F) LEAF.

Ibeabuchi, ThankGod. C., Osuagwu, Gabriel. G. E., and Adie, Emmanuel .B
Department of Plant Science and Biotechnology, Michael Okpara Univerity of Agriculture Umudike, Abia state, Nigeria.
Department of Crop Science, University of Calabar, Cross River State, Nigeria.
Corresponding author: thankgodibeabuchi@yahoo.com

Abstract-
A research was conducted at the National Soil Science Laboratory Research Farm of Federal Ministry of Agriculture and Rural Development Umuahia, Abia State, to probe the consequences of x-ray irradiation on the proximate levels of fluted pumpkin (Telfairia occidentalis Hook. F) leaf in M_1 and M_2 generations. The fluted pumpkin seed treatments include 0.00 mGy, 6.75 mGy, 10.08 mGy, 14.08 mGy and 18.75mGy. Treated seeds were planted in a randomized complete block design (RCBD) with five replications to raise the M_1 and M_2 generations. Fresh leaves were harvested six (6) weeks after planting and analyzed for proximate levels in both generations. There was a significant (P<0.05) decrease in the level of crude protein, moisture content and carbohydrate contents as the treatment concentration increased in both generations. At 10.08mGy treatment dose, a significant (P<0.05) increase in fat level was recorded as crude fiber and ash levels also increased at 14.08mGy and 6.75mGy respectively. Though not significant (P>0.05).This is a clear cut that increased dose of x-ray irradiation reduces the level of crude protein, moisture and carbohydrate in fluted pumpkin whereas crude fiber, fat and ash levels can be enhanced with 14.08mGy, 10.08mGy and 6.75mGy x-ray treatment respectively.

***Key Words**: Analysis, concentration, consequences, Telfairia occidentalis, x-ray, proximate, mutation.*

Date of Submission: 02-04-2022 Date of Acceptance: 15-04-2022

I. Introduction:

Induced mutations which are alterations in the genetic makeup of an organism due to interaction with mutagens have been found to successfully create variability and produce new desirable mutants which are multiplied and put to use after vigorous selection and breeding to homozygosity. The frequency of induced mutation is 10-3 gametes against 10-6 gametes in the case of spontaneous mutation and this has made the induced mutation preferable to spontaneous mutation (Muller, 1927).

This research was stemmed by the need to increase variability and availability of fluted pumpkin leaves for human nutritional and medicinal uses as to close the gap created by increase in demand due by increasing population.

Physical mutagens like x-rays and gamma rays have been used to induce plant traits such as nutritional attributes, disease resistance, yields, and height (Iwo *et al.*, 2013). It allows for the induction of the desired characteristics that are either not exhibited naturally or lost during the evolutionary passage. Previous studies (Akpaniwo *et al.*, 2015) revealed that the seed of fluted pumpkin when exposed to high doses of X-rays reduced germination and survival rates of pumpkin. Also, (Al-Enezi *et al.* 2012) revealed significant retardation in seed germination and survival rate in date palm. Hameed *et al.* (2008) and Al-Salhi *et al.* (2004) has found that high exposure to gamma rays disrupt protein synthesis, leaf gas exchange, hormonal balance, and activities of enzymes in seeds.

Fluted pumpkin (*T. occidentalis*) is a perennial plant with coiled tendrils and bifids that enables it in climbing. They belong to the family Cucurbitaceae. The fruits are noted by 10 observable longitudinal ridges and are known to be the largest known (16-50 cm length, 9 cm diameter). The seeds are big, non-endospermic, and normally dark crimson in color, and according to Akoroda, (1990), are lodged within a bright-yellow fibrous endocarp. In different countries and languages, *T. occidentalis* is known as follow s: Telfairia nut, fluted gourd, fluted pumpkin, oil nut, and oyster nut, (English); Oroko, pondokoko and Gonugbe (Sierra Leone); Krobonko (Ghana); Costillada (Spanish); Ugwu (Igbo-Nigeria), Ikong (Efik/Ibibio-Nigeria) and Aworoko, Eweroko (Yoruba-Nigeria) (Gbile, 1984).

Fluted pumpkin (*Telfairia occidentalis*) is a vegetable crop consumed for its high nutritional and medicinal value namely: High oil content (30%) (Akoroda, 1990). The Shoots of *T. occidentalis* contain a high amount of iron and potassium, while the seeds are composed of 27% and 53% crude proteins and fats respectively (Aiyelaagbe *et al*., 2002). High concentration of antioxidants on the leaves (Nwanna *et al.*, 2008). High level of fat and protein in seed. The leaves possess high level of carbohydrates, iron, copper, potassium, and manganese (Idris, 2012). Its medicinal benefits include: anti-microbial functions (Oyewole *et al*., 2012), anti-diabetic functions (Stanaway *et al.*, 2000), treatment of infertility (Akang *et al.*, 2010), hematological and anti-malaria functions (Okokon *et al.*, 2009).

Following the huge economic, medicinal and nutritional weight of fluted pumpkin, it's of no doubt that its demand has outweighed its variability, availability and supply. To close the demand space, mutation breading which is a source of increasing variability and improvement without significantly altering acceptable phenotype is needed to supplement conventional breeding (Ojomo *et.al.*, 1979).

In this research, five different x-ray doses (0.00 mGy, 6.75 mGy, 10.08 mGy, 14.08 mGy and 18.75mGy) were used to treat five different sets of fluted pumpkin by exposure to x-ray irradiation.

The objectives of this research were to establish the consequences of x-ray irradiation on the proximate level in fluted pumpkin leaves and also to determine the x-ray treatment dose which increases a particular nutrient in fluted pumpkin leaves.

II. Materials And Method

The research was carried out at the National Soil Science Laboratory Research Farm of Federal Ministry of Agriculture and Rural Development Umuahia, Abia State Nigeria. The site is located within longitude 07°33E and latitude 05°29N with altitude of 122m above sea level. Umuahia is a humid tropic with total average rainfall of about 286mm/annum and classified as sandy loam ultisol (Agboola, 1979).

The fluted pumpkin pods were obtained from the National Agricultural Seed Council of National Root Crop Research Institute Umudike. The pods were cut open and the fluted pumpkin seeds extracted.

Treatment of the fluted pumpkin seeds with different doses of X-ray irradiation were carried out at Mecure Diagnostic Center of Abia State Specialist Hospital, Umuahia.

Five samples of twenty seeds each were treated with different doses of X-ray irradiation (0.0 mGy, 6.75 mGy, 10.8 mGy, 14.8 mGy and 18.75 mGy) respectively using a therapeutic medical X-rays device (Clinac 23EX Linear Accelerator, Varian Medical Systems, USA).

The field for planting was properly cleared, ploughed and harrowed to fine tilt, beds were made and planting was done on March 20th 2018 to raise the M_1 generation and March 1st 2019 to raise the M_2 generation.

The experiment was designed in randomized complete block with five replications. The plot size was 2m x 2 m with 0.5 m apart. The planting distance was 120 cm x 60 cm with 2 seeds sown per hole and later thinned to one. All cultural practices such as staking/weeding and fertilizer application were carried out two weeks and four weeks after planting respectively. Six (6) weeks after planting, some portion of the fresh leaves were harvested from all treatment and analyzed for proximate levels while some were left to grow to full maturity and seeds were harvested and used to raise the M_2 generation whose fresh leaves were also harvested after six (6) weeks of planting and analyzed.

Proximate analysis was carried out at O-J Laboratories, Umudike, Abia State.

Data were generated for proximate analysis on the different treatments, based on the following:

- ***Crude protein percentage***

The protein was determined using a micro-kjeldahl method as described by (AOAC, 2005). The protein value was obtained by a conversion factor, and the result expressed as the amount of crude protein.

$$\% \text{ CP}=\%N_2 \left[\frac{(100 \times N\ 14 \times V_f\ T)\}}{W \times 1000 \times V_a} \right. \times 6.25$$

Where:

W=weight of sample analyzed

N =concentration of H_2SO_4 titrant

V_f=Total volume of digest

V_a=Volume of digest distilled

T=titre value- blank.

CP= Crude protein

- ***Crude fibre percentage***

Fibre content was determined using the method of (AOAC, 2005). The crude fibre content of each sample was calculated gravimetrically as;

$$\% CF = \frac{W2 - W_3 \times 100}{\text{Weight of sample}}$$

Where:
W_2= weight of crucible + sample after washing and drying in oven
W_3= weight of crucible + sample ash.
CF=Crude fibre

- ***Fat percentage***

Fat content was determined using the method of (AOAC, 2005).
The percentage fat content was calculated as follows:
% Fat = Weight of the extracted × 100
Weight of the sample

- ***Ash content***

Ash content was determined using the method of (AOAC, 2005).
Percentage ash was calculated using the formula: $\frac{W_2 - W_1 \text{ x } 100}{W1}$

Where;
W= Dry weight of food sample,
W_1= weight of crucible,
W_2 = weight of crucible and ash

- ***Moisture content percentage***

Moisture content was determined using the method described by Association of Official Analytical Chemist (AOAC, 2005).
The moisture content was calculated as follows:
% MC= Change in weight X100
Initial weight of sample before drying

- **Carbohydrate percentage**

The carbohydrate content was calculated by difference as the nitrogen free extractive (NFE), a method separately described by James (2005).
The nitrogen free extractive will be calculated as
% NFE = 100 - % (a+b+c+d+e)

Where; a = protein
b = fat
c = fiber
d = ash
e = moisture.

III. Result

Figure 1 below shows a bar chart representation of the effects of different doses of x-ray treatment on crude protein, crude fiber, fat, ash, moisture content and carbohydrate levels in fluted pumpkin leaves during M_1 and M_2 generation.

Crude Protein:

The bar chat shows a gradual reduction in the level of crude protein as the treatment concentration was increasing. This trend was observed in both M_1 and M_2 generations.
From the result obtained, it was observed that the mutagenic effect on the crude protein was significant ($P<0.05$) during the M_1 generation. Treatment 0.00mGy recorded the highest percentage of crude protein, followed by 6.75mGy treatment and downwards where treatment 18.75mGy gave the lowest percentage.
Similarly, in M_2 generation, the result of the analysis of variance indicated that the effect of the x-ray doses on the crude protein was highly significant ($P<0.05$) when compared to the control. From the result, it was also observed that increase in the x-ray doses resulted to a gradual decrease in the protein content of fluted pumpkin. The lowest dose (6.75mGy) recorded the protein content (18.60%) amongst the treatment levels followed by 10.08 mGy (18.12%) and 14.08 mGy (17.95%) whereas 18.75 mGy recorded 17.10% protein content. The controlled plant however gave the highest protein content level (18.85%).

Crude Fiber:

Highest percentage of crude fiber (5.17%) was recorded on 14.08mGy x-ray dose treatment, followed by10.08mGy dose treatment which gave 5.15%. the untreated (0.00mGy) gave 5.10% which was higher than treatment 18.75mGy dose (5.00%).

However, analysis of variance shows that there was no significant difference ($P>0.05$) based on the different treatment doses.

In M_2 generation, there was a gradual continuous decrease in crude fiber percentage as the treatment concentration increased. Analysis of variance also showed that there was no significant difference ($P>0.05$) on the effects of the treatment.

Fat:

In the M_1 generation, treatment dose of 10.08mGy gave the highest fat percentage of 1.88%. This was followed by 6.75mGy treatment dose which gave 1.82%. Next was the untreated sample which gave 1.77% followed by dose 14.08mGy (1.73%) and 18.75mGy (1.63%).

Analysis of variance shows a significant difference ($P<0.05$) on the effects of the different treatment doses.

In M_2 generation, there was a reduction in the fat percentage as treatment concentration was increasing. The highest among the treated samples was at 10.08mGy (1.82%) which was still lower than the percentage of the control sample (1.89%).

Analysis of variance shows a significant difference ($P<0.05$) on the effects of the mutagen at different doses.

Ash:

Treatment dose 6.75mGy gave the highest percentage of ash (8.22%), this was followed by treatment dose 10.08mGy (8.02%).

However, the control (0.00mGy) gave 7.96% which was higher than doses 14.08mGy (7.45%) and 18.75mGy (7.21%).

Analysis of variance showed that there was no significant difference ($P>0.05$) on the effects of the different treatment doses in M_1 generation.

In M_2 generation, there was a highly significant difference ($P<0.05$) on the effect of the different treatment doses. As the treatment concentration increased, the ash percentage decreased.

Moisture content:

Analysis of variance in both generations showed that there was a highly significant difference ($P<0.05$) on the effects of the different treatment doses.

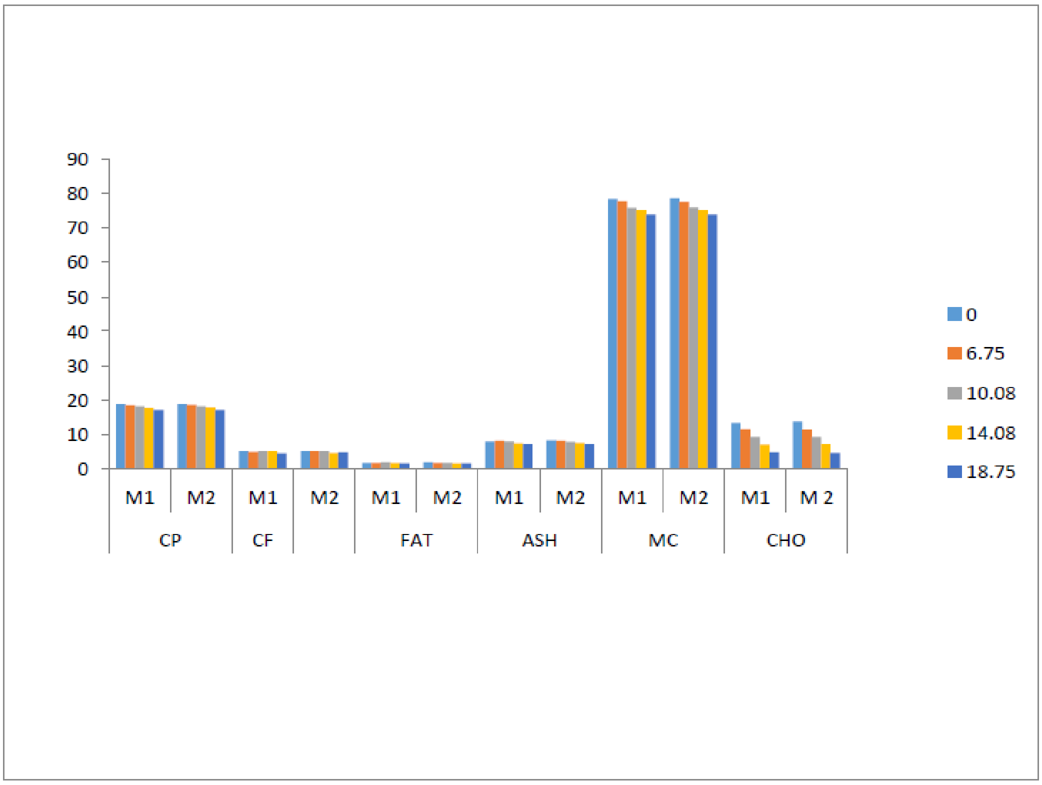
As the treatment concentrations were increasing, the moisture content reduced. This was recorded during M_1 and M_2 generations.

Carbohydrate percentage:

In both generations M_1 and M_2, there was a trendy decrease of carbohydrate percentage as the treatment doses increased.

This result shows a highly significant difference ($P<0.05$) on the effects of the different treatment doses as revealed by analysis of variance.13.39% (0.00mGy) was the highest carbohydrate percentage that was recorded while 4.80% (18.75mGy) was the lowest recorded percentage during the M_1 generations.13.76% (0.00mGy) was the highest carbohydrate percentage that was recorded while 4.66% (18.75mGy) was the lowest recorded percentage during the M_2 generation.

Fig 1. Consequences of x-ray irradiation on the proximate level of fluted pumpkin leaf.



CP= Crude protein, CF= Crude Fiber, MC= Moisture content, CHO= Carbohydrate

IV. Discussion

This research which aimed at investigating the consequences of x-ray radiation on the proximate level in fluted pumpkin leaves has revealed that crude protein, moisture content and carbohydrate level of the fluted pumpkin leaf were reduced by increase in the x-ray doses. The highest percentage of proximate levels were obtained at treatment 0.00mGy. This shows the destructive (alteration) potentials of x-ray irradiation on the nutrient metabolic oxidation pathway and biochemical processes (Younis *et al.* 1962). However, at 10.08mGy treatment dose, a very significant increase ($P<0.05$) in fat level was observed (1.88). At 14.08mGy and 6.75mGy treatment doses, there were increase in crude fiber and ash levels respectively above other treatments though not significant ($P>0.05$).

V. Conclusion

The present investigation was conducted to investigate the mutagenic effects of x-ray doses on proximate compositions of fluted pumpkin. Findings from this study showed that increased dose of x-ray irradiation reduces the level of crude protein, moisture and carbohydrate in fluted pumpkin whereas crude fiber, fat and ash levels can be enhanced with 14.08mGy, 10.08mGy and 6.75mGy x-ray treatment respectively.

VI. Recommendations

The overall results suggest that x-ray doses 6.75mGy, 10.08mGy and 14.08mGy can be used to increase ash, fat and crude fiber levels in fluted pumpkin respectively. Furthermore, mutant generation lines should be advanced to M_3 and above if effective and more reliable selection is desired. The chlorophyll content of the leaves of the fluted pumpkin should be studied as this contributes to the yield and nutrient level of the plant. The effect of consuming this genetically modified plant material by man should also be studied, though it is a research material and not meant for consumption at this stage. Plant breeders can utilized the information generated from this study as a guide in mutation breeding of fluted pumpkin.

Acknowledgement

I thank almighty God for the grace to carry out this research work and to Prof. G.G.E Osuagwu who painstakingly supervised this work from beginning to end, I feel indebted to you. Having considered the great supervisory role you played in the success of this research work, I pray for more wisdom on you.

References

[1]. A.O.A.C. (2005). Methods of analysis of the association of official analytical chemist, 18th ed. Washington, D.C. USA**.**

[2]. Ahloowalia, B. S. and Maluzynski, M. (2001). Induced mutation: A new paradigm in plant breeding. *Euphytica*, 188 (2): 167-173.

[3]. Ahloowalia, B. S., maluszynski, M. and Nichterlein, M. (2004). Global impact mutation-derived varieties. *Euphytica,* 135(2): 187-204.

[4]. Aiyelaagbe, I. O. O. and Kintomo, A. A. (2002)."Nitrogen response of fluted pumpkin (*Telfairia occidentalis* Hook. F) grown sole or intercropped with banana." *Nutrient Cycling in Agroecosystems,* 64: 231-35.

[5]. Akang**,** E.N., Oreemosu, A.A., Dosumu, O.O., Noronha, C.C. and Okanlawon, A.O. (2010).The effects of fluted pumpkin (*Telfairia occidentalis*) seed oil (FPSO) on testis and semen parameters, *Agriculture and Biology Journal of North America*, 1(4): 697-700.

[6]. Akoroda, M. (1990). Ethnobotany of *Telfairia occidentalis* (Cucurbitaceae) among Igbos of Nigeria. *Economic Botany*, 44(1): 29-39.

[7]. Akpaniwo, E. G., Ittah, M. A. and Iwo, G. A. (2015). Field performance and morphological variations of X-ray induced M_2 mutant lines of fluted pumpkin (*Telfairia occidentalis* Hook. F.). *International Journal of Research in Agriculture and Forestry* 2(I0): 12-16.

[8]. Akpaniwo, E. G., Ittah, M. A. and Iwo, G. A. (2015).Field performance and morphological variations of x-ray induced m2 mutant lines of fluted pumpkin (*Telfairia occidentalis,* Hook. F.) *International Journal of Research in Agriculture and Forestry*, 2: I10-134.

[9]. Al-Enezi, N. A. and Al-Khayri, J.M. (2012). Alterations of DNA, ions and photosynthetic pigments content in date palm seedlings induced by X-irradiation. *International Journal of Agricultural Biology*, 14: 329–336.

[10]. Al-Nimer, S. M. and A. Z. Abdul-lateef. 2009. X-rays radiation directly produced favorable and harmful effects on the constituents of different medicinal plants. *Pharmaceutical Research*, 1: 333-335.

[11]. Al-Salhi, M., Ghannam, M. M., Al-Ayed, M.S., El-Kameesy, S. U. and Roshdy, S. (2004). Effect of gamma-irradiation on the biophysical and morphological properties of corn. *Nahrung*., 48: 95-98.

[12]. Ambli, K. and Mullainathan, L. (2016). Mutagenic effectiveness and efficiency of Gamma rays and Ethyl Methane Sulphonate in Pearl Millet (*Pennisetum typhoides* (Burn.F.) Stapf .and C.E.Hubb.) Var.CO (cu)-9.*Academia Journal of Agricultural Research,* 4(2), 041-044.

[13]. Auti, S. A. (2012). Lhb mutant-A Novel mutant of mungbean (Vigna radiate (L.)Wilezek) Induced by Gamma. *Radiation Biodiversity and Bioavailability*, 6 (1), 87-93.

[14]. Berrington, G. A. and Darby, S. (2004). "Risk of cancer from diagnostic X-rays: estimates for the UK and 14 other countries". *Lancet,* 3(63): 345–351.

[15]. Borzouei, A., M. Kafi, H. Khazaei, Naseriyan, B. and Majdabadi, A. (2010). Effects of gamma radiation on germination and physiological aspects of wheat (*Triticum aestivum* L.) seedlings. *Pakistan Journal of Botany*, 42: 2281-2290.

[16]. Brenner, D. J. and Hall, E. J (2007). "Computed tomography—an increasing source of radiation exposure". N. Engl. *Journal of Medicine*, **357** (22): 2277–2284.

[17]. Chopra, V. (2005). Mutagenesis: Investigating the process and processing the outcome for crop improvement. *Current Science* 89; 353-359.

[18]. De Santis, M., Cesari, E., Nobili, E., Straface, G., Cavaliere, A. F. and Caruso, A. (2007). "Radiation effects on development". Birth Defects Res. C Embryo Today.**81** (3): 177–82. Ce4Rt (Mar 2014).Understanding Ionizing Radiation and Protection.p. 174.

[19]. Dellaporta., J. W., James, B. and Hicks. K. (1983). A plant DNA mini preparation: version II. *Plant Molecular Biology Reporter,* 1(4):19-21.

[20]. Dhakshanamoorthy, D., R. Selvaraj and Chidambaram, A. (2010).Physical and chemical mutagenesis in *Jatrophacurcas* L. to induce variability in seed germination, growth and yield traits. *Roman Journal of Biology and Plant Biology*, 55: 113-125.

[21]. Dhanavel, D. and Girija, M. (2009).Mutagenic Effectiveness and Efficiency of gamma rays. Ethyl Methane sulphonate and their combined treatments in cowpea (*Vignaunguiculata* (L.) Walp).*Global Journal of Molecular Sciences* 4 (2): 68-75.

[22]. Emebiri, L. and Nwufo, M. (1990). "Pod rots of fluted pumpkin (*Telfairia occidentalis* Hook. F.) in Imo State, Nigeria. "*International Biodeterioration*, 26: 63-68.

[23]. Esnault, M. A., Legue, F. and Chenal, C. (2010). Ionizing radiation: Advances in plant response. *Environmental and Experimental Botany*, 68: 231-237.

[24]. Eze, C. (2016). Effects of x-irradiation on the growth rate and DNA of three varieties of egg. Plant, Ngwa large (*Solanum gilo* L.), Ngwa 2 (*Solanum gilo* L.) and Gawuta (*Solanum melongena* L.).M.Sc Thesis, Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria.

[25]. Fayeum, L. S. and Odiyi, A. C. (2012). Cluster Analysis of Genetics Diversity in Thirty-five Genotypes of the Fluted Pumpkin (*Telfairia occidentalis. Hook. F*) Collected from Southern Nigerian. In. Proc. 36thAnnual Conference of the Genetic Society of Nigeria, held in the University of Calabar 15th–18th October 2012 p 197 –206.

[26]. Floris, C. P. and Anguillesi, M. C.(2003). Response to X-rays of dormant and non-dormant seeds of *Triticum durum* Desf. *Mutation Research- Fundamental and Molecular Mechanisms of Mutagenesis*, 28:63-67.

[27]. Forster, B. P. and Shu, Q, Y, (2012). Plant mutagenesis in crop improvement: basic terms and applications. In: Shu, Q.Y., Forster, B. P. and Nakagawa, H, editors. Plant mutation breeding and biotechnology. Walling ford: CAB1.pp 9-20.

[28]. Gbile, Z. O. (1984). Vernacular names of Nigerian plants (Yoruba). Ibadan: Forestry Research Institute of Nigeria.-. En Geog, 1984; p 101.

[29]. Genter, C. F. and Brown, H. M. (1941). X-ray studies on the field bean. *Journal of Hereditary*, 32:39-44.

[30]. Giami, G. (2003). Plant foods for human nutrition. 58(3):1-8. DOI: 10.1023/B:QUAL.0000041167.61992.4d.

[31]. Gomez-Pando, L., Eguiluz, A., Jimenez, J., Falconi, J. and Aguilar, E. H., (2009).Barley (*Hordeun vulgare*) and Kiwi cha (*Amaranthus caudatus*) improvement by mutation induction in Peru. Induced plant mutations in the Genomics Era, Food and Agriculture Organization of the United Nations, Rome.371-374.

[32]. Gustafsson, A. (1947). Mutations in agricultural plants. *Hereditas* 33 (1-2) 1-100.

[33]. Hall, E. J. and Brenner, D. J (2008). "Cancer risks from diagnostic radiology". *British Journal of Radiology*.,**81** (965): 362–78. doi:10.1259/bjr/01948454. PMID 18440940

[34]. Hameed, A., Mahmud, T. S., Atta, B. M., Haq, M. A., Sayed, H. (2008). Gamma irradiation effects on seed germination and growth, protein content, peroxidase and protease activity, lipid peroxidation in desi and kabuli chickpea. *Pakistan Journal Botany*. 40, 1033–1041 (2008).

[35]. Hammed, A., Shah, T.M., Atta, B. M., Ahsanul, H. M. and Sayed, H. (2008). Gamma irradiation effects on seed germination and growth, protein content, peroxidase and protease activity, lipid peroxidation in desi and kabuli chickpea. *Pakistan Journal of Botany*, 40:1033-1041

[36]. Hoballah, A. A. (1999). Selection and Agronomic evaluation of Induced Mutant lines of Sesame. In. Induced mutations for sesame improvement IAEA-TECDOC, IAEA, Vienna. Pp. 71-84

[37]. Idris, S. (2012). Compositional Studies of *Telfairia occidentalis* Leaves. *American Journal of Chemistry*, 1(2): 56-59

[38]. Iwo, G. A., Amadi, C. O., Eleazu, C. O. and Ukpabi, J. U. (2013). Induced mutagenesis on ginger for improved yield components and oleoresin content. *Canadian Journal of Plant Breeding*, 1(3): 90 -96.

[39]. Jade, B. A., Carter, E. A., Eastgate, H., Hackett, M. J., Harris, H. H., Levina, A., Lee, Y. C., Chen, C., Lai, B., Vogt, S. and Lay, P. A. (2010). Biomedical applications of X-ray absorption and vibration spectroscopic microscopes in obtaining structural information from complex systems. *Radiation and Physical Chemistry*., 79: 176-184.

[40]. Javed, M. A., Khatri, A., Khan, I. A., Ahmad, M., Siddiqui, M. A. and Arain, A. G. (2000).Utilization of Gamma irradiation for the Genetic improvement of oriental mustard (*Brassica guncea* L.).*Pakistan Journal of Botany*, 32:77-83.

[41]. Johnson, E. L. (1936). Susceptibility of seventy species of flowering plants to x-irradiation. *Plant Physiology*, 11:319.

[42]. Khan, S. and Goyal, S. (2009). Improvement of mungbean varieties through induced mutations. *Africa Journal of Plant Science* 3:164-180.

[43]. Khan, S. and Siddiqui, B. A. (1996).Mutation genetic studies in mingbean II. Frequency and spectrum of morphological mutants. *Thai Journal of Agricultural Science, 71):212-143*.

[44]. Kharakwal, M .C, Nagar, J. P. and Kala, Y. K. (2005). BGM 547-A high yielding chicken pea (*Cicer arietinum* L.) mutant variety for late sown condition in North Western plain zone of India. *The Indian Journal of Genetics and Plant Breeding*, 65 (3):229-30.

[45]. Kharkwal, M. C. and Shu, Q. Y. (2009). The role of induce mutations in world food security. In: Shu, Q. Y. (Edition). Induced Plant mutations in the genomics era. Rome: *Food and Agriculture Organization of the United Nations*, Pp 149-189.

[46]. Kon, E., Ahmad, O. H., Saamin, S. and Majid, M. A. (2007). Gamma radio sensitivity study on Long Bean (*Vigna sesquipedalis*).*American Journal of Applied Sciences*, 4 (12): 1090-1093.

[47]. Kotwaliwale, N., Singh, K. and Kalne. (2014). *Journal of Food Science Technology*, 51: 1-10.

[48]. Kozgar, M. I. and Khan, S. (2009). Genetic improvement of chicken pea through induced mutation. *Journal of Phytology,* 1(6) 65-70.

[49]. Ladeji, O., Okoye, Z. S. C. and Ojobi, T. (1995).Chemical evaluation of the nutritive value of leaf of fluted pumpkin (*Telfairia occidentalis). Food Chemistry*, (53) pp. 353-354.

[50]. Legue, B. and Chanal, A. (2010).Mitochondrial free radical generation, oxidative stress, and aging. *Emirates Journal of Food and Agriculture*., 24(5):415-424.

[51]. Luo, X. M., Tinker, N. A., Jiang, Y., Xuan, P., Zhang, H. Q. and Zhou, Y. P. (2013). "Suitable dose of ^{60}Co γ-ray for mutation in Roegneria seeds," *Journal of Radioanalytical and Nuclear Chemistry*, 295(2): 1129–1134, 2013.

[52]. Marcu, D., Damian, G., Cosma, C. and Cristea V. (2013). Gamma radiation effects on seed germination, growth and pigment content and ESR study of induced free radicals in maize (*Zea mays*). *Journal* of *Biology and Physics*., 39 (4): 625-634.

[53]. Markeen, K. G., Suresh, B. and Lavanya G. R. (2007); Effect of mutagenesis on M_1 population in urd bean. *Journal of Food Legum*es, 20(1): 109-110.

[54]. Mba, C. (2013). Induced mutations unleash the potentials of plant genetic resources for food and agriculture. *Agronomy*, 3(1): 200-231.

[55]. Mejri, S., Mabrouk, Y., Voisin, M., Delavault, P., Simier, P., Saidi, M. and Belhadj, O. (2012). Variation in quantitative characters of faba bean after seed irradiation and associated molecular changes. *African Journal of Biotechnology,* 11:8383–8390.

[56]. Monica, S. and Seetharaman, N. (2016).Mutagenic effectiveness and efficiency of Gamma rays and EMS *in Lablab purpureus* (L.)Sweet var. typicus. *International Journal of Advanced Multidisciplinary Research,* 3(11): 76-81.

[57]. Muller, H. J. (1927). "Artificial Transmutation of the Gene" *Science* New Series, 66(1699): 84-87

[58]. Novak, F. J. and Brunner, H. (1992). Plant breeding: Induced mutation technology for crop improvement. *IAEA Bulletin*, 4:25-33.

[59]. Nwanna, E. E. and Oboh, G. (2008). Antioxidant and hepatoprotective properties of polyphenol extracts from *Telfairia occidentalis* (fluted pumpkin) leaves on acetaminophen induced liver damage. *Pakistan Journal of Biological Sciences*, 10: 2682-2687.

[60]. Odeigah, P. G. C., Osanyinpeju, A. O. and Myers, G. O. (1998).Induced mutation in cowpea, *Vigna unguiculata* (Leguminosae).*Rev. Biol*. *Trop*., 46 (3): 579-586.

[61]. Ogidi, E. G. O., Omosun, G., Markson, A. A. and Kalu, M. (2010). Effects of gamma ray irradiation on the metric traits of vegetable cowpea (*Vigna unguiculata* (L.) Walp) in Umudike Southern Nigeria. *Asian Journal of Science and Technology*, 5: 086-090.

[62]. Okokon, J. E., Ekpo, A. J., Eseyin, O. A. (2009). Evaluation of in vivo antimalarial activities of ethanolic leaf and seed extracts of *Telfairia occidentalis, Journal of Med Food*, 12:1-9.

[63]. Okoli, B. E. and Mgbeogu, C. M. (1983). Fluted pumpkin, *Telfairia occidentalis*: West African vegetable crop. *Economic Botany,* 37: 145-149.

[64]. Okwu, D. E and Ndu, C. E. (2006). Evaluation of phytonutrients, minerals and vitamin content of some varieties of yam. *International Journal of Molecular and Advanced Sciences,* 2(2):199-203.

[65]. Oyewole, O. and Abalaka, M. (2012). Antimicrobial Activities of *Telfairia occidentalis* (fluted pumpkins) Leaf extract against selected intestinal pathogens. *Journal of Health Science,* 2(2): 1-2.

[66]. Roobottom, C. A., Mitchell. G. and Morgan-Hughes, G. (2010). "Radiation-reduction strategies in cardiac computed tomographic angiography". *Clinical Radiology*, **65** (11): 859–67

[67]. Roychowdhury, R. and Tah, J. (2013).Mutagenesis-a potential approach for crop improvement. In: Hakeem, K. R., Ahmad P. and Oztur, K editor. Crop Improvement: new approaches and modern techniques. New York (NY): Springer. Pp. 149-187.

[68]. Rudolph, T. D. (2003). Effects of X-irradiation of seed on X_1 and X_2 generations in *Pinusbanksiana* Lambert. *Radiation Botany*., 7:303-312.

[69]. Rustikawati, Rustikawati.,Eko, Suprijono., Atra, Romeida., Catur, Herison., Surjono, H. and Sutjahjo. (2012*)*. Identification of M_4 gamma irradiated maize mutant based on RAPD markers. *Journal of Agricultural Science,* 34(2): 161-165.

[70]. Sansare, K., Khanna. V. and Karjodkar, F. (2011). "Early victims of X-rays: A tribute and current perception". *Dentomaxillofacial Radiology*. **40** (2): 123–125.

[71]. Schum, A. (2003). Mutation breeding in ornamentals: An efficient breeding method in XXI international Eucarpia symposium on classical verse molecular breeding of ornamentals:-Part 1612: 47-60.

[72]. Simmond, N. W. (1979). Principles of Crop Improvement. Longman Ltd, London

[73]. Singh, S. P. M., Singh, R. P., Prasad, J. P., Agrawal, R. K. and Shahi, J. P. (2006). Induced genetic variability for protein content, yield and yield components in microsperma Lentil (*Lens culinaris* Medik). *Madras Agriculture Journal*, 93:155-159.

[74]. Stanaway, S. and Gill, G. (2000). Protein glycosylation in diabetes mellitus: biochemical and clinical considerations. *Pract Diabetes Int,* 17(1): 21-23.

[75]. Taheri, S., Abdullah, T. L., Ahmad, Z. and Abdullah, N. A. P. (2014). "Effect of acute gamma irradiation on *Curcuma alismatifolia* varieties and detection of DNA polymorphism through SSR marker," *BioMed Research International*, pp. 245–256
[76]. Wani, A. A. and Anis, M. (2001). Gamma rays and EMS induced bold seeded high yielding mutants in chicken pea (*Cicer arietinum* L.). *Turkish Journal of Biology*, 32:161-166.
[77]. Wani, M. R., Khan, S. and Kozgar, M. I. (2011). Induced chlorophyll mutations. Mutagenic effectiveness and efficiency of EMS, HZ and SA in mungbean. *Frontiers of Agriculture in China* 5 (4):514-518.
[78]. Yakoob, M. and Rshid, A. (2001). Induced mutation studies in some mungbeans (*Vigna radiata* L.) Wilezex cultivars. Online *Journal of Biological Sciences*, 1: 805-808.
[79]. Zelles, L. (2003). Effect of X-ray and UV-light on the levels of NAD(P), NAD(P)H and hydroxyl proline in *Pinus silvestris* pollen. *Environment and Experimental Botany.,* 18:39-45

Ibeabuchi, ThankGod. C, et. al. "Consequences of X-Ray Irradiation on the Proximate Levels of Fluted PUMPKIN (Telfairia occidentalis Hook.F) LEAF." *IOSR Journal of Biotechnology and Biochemistry (IOSR-JBB), 8*(2), (2022): pp. 21-28.