



Original Article

Proximate and mineral composition of induced mutants of eggplant (*Solanum melongena* and *Solanum aethiopicum*) resistant to *Fusarium wilt*

Momoh, E. B., Gado, A. A., Dagana M. C., Bello, I. M., Daudu, O.A.Y., Ibrahim, K.K., Adeniran, A.E

Federal University of Technology, Department of Plant Biology, Minna, Nigeria
Federal University of Education, Department of Agricultural Education, Kontagora, Nigeria

Submitted: July 2025; Accepted: September 2025; Published: December 2025

ABSTRACT

Enhancing the nutritional composition of crops while improving their resistance to diseases is a strategic priority in sustainable agriculture. This study evaluates the proximate and mineral composition of induced mutants of *Solanum melongena* and *Solanum aethiopicum* developed for resistance to *Fusarium wilt* using gamma irradiation (50–200 Gy), 1% ethyl methane sulfonate (EMS), and their combinations. The objective was to identify promising mutant lines that combine enhanced nutritional value with potential disease resistance for future breeding and biofortification efforts. In *Solanum aethiopicum*, the combination of 50Gy + 1% EMS produced the most nutritionally enriched profile, recording the highest dry matter (19.18%), crude fibre (6.39%), carbohydrate (6.19%), and energy value (70.12 kcal/100g). Protein content peaked under the 1% EMS treatment (4.90%), while ash content was highest at 100Gy (1.50%), suggesting increased mineral accumulation. Notably, potassium content rose sharply under 1% EMS (3.23%), surpassing all other treatments and the control (0.60%). This improvement in nutritional quality complements previously reported enhanced *Fusarium wilt* resistance under similar treatments. For *Solanum melongena* although variations were less pronounced, improvements were still observed. The 150Gy + 1% EMS treatment yielded the highest dry matter (9.98%) and fibre (3.33%), while energy content peaked at 47.56 kcal/100g under 200Gy + 1% EMS. Fat accumulation was greatest in 50Gy + 1% EMS (4.84%). Potassium content remained highest in the control (1.51%), though several EMS-based treatments maintained competitive values. Mineral contents such as calcium and magnesium remained relatively stable, with slight enhancement in combined treatments. These results demonstrate that mutation breeding, particularly through the integration of EMS and gamma irradiation, can significantly enhance the nutritional composition of *Solanum* species. The combined benefits of improved nutrient profiles and reported *Fusarium wilt* resistance underscore the potential of these mutants in varietal development programs aimed at improving food and nutritional security in disease-prone environments.

Keywords: Eggplant, Proximate, Mineral, Gamma irradiation, Ethyl methane sulphonate.

*Corresponding author's email: momohenyojoblessing@gmail.com 09158076551

INTRODUCTION

Eggplant (*Solanum* spp.) is a widely cultivated vegetable in tropical and subtropical regions of the world, valued for its economic significance and nutritional benefits. It belongs to the family *Solanaceae* and the genus *Solanum*, which comprises more than 90 genera and nearly 3,000 species [1]. Globally, eggplant ranks as the fifth most important solanaceous crop after potato (*Solanum tuberosum*), tomato (*Solanum lycopersicum*), pepper (*Capsicum annuum*), and tobacco (*Nicotiana tabacum*) [2]. In 2021, global eggplant production reached approximately 58.6 million metric tons, reflecting its relevance to global food systems [3]. The crop contributes substantially to food and nutrition security while offering good economic returns, especially in low- and middle-income countries [4]. In Nigeria, however, eggplant yield remains suboptimal, primarily due to restricted genetic diversity among cultivated varieties and the use of low-fertility soils [5]. *Solanum melongena* L., commonly known as eggplant or aubergine, is believed to have originated from the Indian subcontinent particularly India and Myanmar where it has been cultivated for over 4,000 years [6]. From its center of origin, the crop spread to China, Europe, Africa, and eventually the Americas via trade routes and colonial expansion [7]. While, *Solanum aethiopicum* L., known as African or scarlet eggplant, is indigenous to tropical Africa and is believed to have evolved from *Solanum anguivi* [8].

Nutritionally, eggplants are characterised by low energy density and high levels of essential minerals such as potassium, calcium, magnesium, sodium, and iron [9]. Iron from eggplant is particularly beneficial for vulnerable populations such as pregnant women

and adolescent girls, helping to combat anemia and related disorders [10]. Eggplant is also rich in vitamins C, K, B6, and folate, making it an excellent source of micronutrients [11]. In addition to its nutrient profile, eggplant contains a diverse array of bioactive compounds with therapeutic properties. These include phenolics such as chlorogenic acid, flavonoids like nasunin, and various anthocyanins that act as powerful antioxidants [12]. These compounds contribute to anti-inflammatory, anti-obesity, anti-diabetic, and cardio protective effects [13]. Anthocyanins in purple eggplant also support visual health and reduce oxidative stress by neutralizing reactive oxygen species [14]. Furthermore, studies have documented the antibacterial, cytotoxic, and anti-ulcer activities of eggplant extracts [15]. The combined nutritional and therapeutic properties make eggplant a promising crop for both conventional and functional food applications.

This study, therefore, has been carried out to evaluate the proximate composition and mineral profile of *Solanum melongena* and *Solanum aethiopicum* in order to elucidate its dietary importance and its usefulness to the daily needs of man.

MATERIALS AND METHODS

Study Area

The study was carried out at the experimental garden, Federal University of Technology, Minna, Niger State. Geographically, Minna which is the capital of Niger State in the North-Central Nigeria, is located within longitude 6° 33'E and latitude 9° 37'N [16].

Seeds Collection

Seeds of *Solanum melongena* and *Solanum aethiopicum* were collected from Kure market Minna, Niger State, and Farin-Gada market Jos, Plateau State respectively. These regions were chosen due to their significance as major cultivation areas of eggplants and their distinct agro-ecological characteristics, which contribute to a diverse genetic pool.

Seed Treatment

200g of seeds of the collected varieties were taken to Centre for Energy Research and Training (CERT), Ahmadu Bello University, Zaria for gamma irradiation at different intensity of 50Gy, 100Gy, 150Gy and 200Gy.

Both irradiated and non-irradiated seeds (100 g each) were soaked in 100 ml of distilled water for 6 hours at room temperature. Afterwards, the soaked seeds were treated with ethyl methane sulphonate (EMS) at optimum concentration of 1%. Seeds soaked according to treatment were drained, washed up under running tap for 20 minutes, sun dried and planted [17]. Untreated seeds were taken as control.

Experimental design and field layout

The experiment was laid out in a Complete Randomized Block Design (CRBD) with 3 replicates. The two different varieties were sown in planting bags containing loamy soil, five seeds were sown in each bag. After two weeks of germination, the seedlings were thinned to two plants per stand.

Proximate Composition Analysis

Fresh fruits of mutant eggplants were harvested and taken to the Laboratory at National Cereals Research Institute (NCRI) Badegii, Bida, Niger State. Moisture content, crude fat, carbohydrate, total protein, total ash and fibre were determined respectively using standard procedures of the Association of Official Analytical Chemists [18].

Determination of Crude fibre

Crude fibre of *Solanum melongena* and *Solanum aethiopicum* were determined using the method of [18]. A measure of 5g of each fruit sample was placed into separate 500ml Erlenmeyer flask and 100ml of trichloroacetic acid (TCA) digestion reagent was added. It was then brought to boiling point and refluxed for exactly 40 minutes counting from the start of boiling. The flask was removed from the heater, cooled for about 10 minutes, and then filtered with a Whatman paper. The residue was rinsed with hot water and was stirred continuously using a spatula. The sample was dried overnight at 105 °C. After drying, it was transferred to a desiccator and was allowed to cool. The sample was then weighed as W_1 . It was then burnt in a furnace at 500 °C for six (6) hours and allowed to cool, and reweighed as W_2 . The crude fibre content was calculated as:

$$\text{Percentage crude fiber} = \frac{W_1 - W_2}{W_0} \times 100$$

W_1 = Weight of crucible + fiber + ash

W_2 = Weight of crucible + ash

W_0 = Dry weight of food sample

Determination of Protein content

The protein content of *Solanum aethiopicum* and *Solanum melongena* were determined using a micro-Kjeldahl method [18] which involves wet digestion, distillation, and

titration. An aliquot 3 g of each sample was weighed into separate boiling tubes that contained one catalyst tablet (0.15 g CuSO₄, 5 g K₂SO₄, and 0.1 g TiO₂) and 25 ml of concentrated sulfuric acid. The tubes were gradually heated for digestion to occur. The digest was diluted with 10 ml of 40 % NaOH, 100 ml distilled water, and 5 ml Na₂S₂O₃ anti-bumping agent was added. Exactly 10 ml of boric acid was then added to the sample. The NH₄ content in the distillate was determined by titrating with 0.1 N standard HCl using a 25 ml burette. A blank was prepared without the sample. The protein value obtained was multiplied by a conversion factor, and the results were expressed as the amount of crude protein. The percentage crude protein was calculated as:

$$\% \text{ crude protein} = \frac{\text{actual titre value} - \text{titre value of blank} \times 0.1 \times 0.014 \times \text{conversion factor}}{\text{Weight of food sample}} \times 100$$

Determination of Fat content

Fat content *Solanum aethiopicum* and *Solanum melongena* were analyzed using the [18] method. 10 grams of each sample, wrapped in filter paper, was placed in an extraction thimble and dried. The samples were extracted using petroleum ether, and the solvent was evaporated in an oven. The residue was weighed

$$\text{Percentage of Total fat content} = \frac{\text{Weight of fat extracted}}{\text{Weight of food sample}} \times 100$$

Determination of Ash content

Ash content of *Solanum aethiopicum* and *Solanum melongena* were determined using the method of [18]. About 2 g of each sample was weighed into crucibles in duplicate, and then the sample was incinerated in a muffle furnace at 550 °C until a light grey ash is observed and a constant weight obtained. The sample cooled in the desiccators to avoid

absorption of moisture and weighed to obtain ash content.

$$\text{Percentage ash content} = \frac{\text{change in weight}}{\text{Initial weight of food before drying}} \times 100$$

Determination of Moisture content

Moisture content of *Solanum aethiopicum* and *Solanum melongena*, were determined using method of Association of Official Analytical Chemists [18] by weighing 2 g of each sample into pre-weighed petri dishes and drying in an oven at 105 ± 1 °C for 4 hours. After drying, the dishes were cooled in desiccators and weighed.

$$\text{Moisture (\%)} = \frac{W_1 - W_2}{W_1} \times 100$$

W₁ = Weight of sample before drying

W₂ = Weight of sample after drying

Determination of Total carbohydrate content

Carbohydrate content of *Solanum aethiopicum* and *Solanum melongena*, were determined using method of Association of Official Analytical Chemists [18]. By subtracting the total sum of the percentage of moisture, ash, crude fibre, and crude protein from hundred (100)

$$\text{Percentage carbohydrate (\%)} = 100 - (\text{Crude fiber} + \% \text{ Ash} + \% \text{ Fat} + \% \text{ Moisture} + \% \text{ Protein})$$

Mineral Composition

The following mineral elements: Na, K, Ca, Mg and P were detected by using the Atomic Absorption Spectrophotometer (AAS) as in [19]. The Atomic absorption (AA) spectrometer was used to analyze metals at very low concentrations, typically in the parts per million (ppm) or parts per billion (ppb) ranges. A liquid sample containing dissolved material whose concentration is to be measured was aspirated into a thin, wide AA flame, or is introduced into a small carbon furnace which is heated to a high

temperature. The principle of AAS is the measurement of absorption of radiation by free atoms. The total amount of absorption depends on the number of free atoms present and the degree to which the free atoms absorb the radiation. At the high temperature of the AA flame, the sample was broken down into atoms and it is the concentration of these atoms that is measured.

Data Analysis

Proximate and mineral composition data collected were subjected to statistical analysis. Analysis of Variance (ANOVA) was employed to evaluate differences among treatment means, and Duncan's Multiple Range Test (DMRT) was used as a post hoc test to separate significantly different means at a 5% significance level ($p < 0.05$).

RESULTS

Proximate analysis

The proximate analysis revealed significant variations ($p < 0.05$) in the nutritional content of the various treatments, as presented in Table 1. These variations suggest that mutagenic treatments induced compositional changes in both *Solanum aethiopicum* and *Solanum melongena*, which may influence their suitability for specific nutritional or functional applications. Moisture content in *S. aethiopicum* ranged from 80.82% in 50Gy+1% EMS to 92.88% in 150Gy+1% EMS. The treatment 150Gy+1% EMS exhibited the highest moisture content and correspondingly the lowest dry matter (7.12%), indicating greater water retention capacity under this treatment. Conversely, the highest dry matter (19.18%) was observed in 50Gy+1% EMS, which also recorded the lowest moisture content. These findings suggest

an inverse relationship between moisture and dry matter content and imply that gamma irradiation and EMS treatments at specific doses can modulate the water composition of *S. aethiopicum* fruits. Ash content, reflecting the total mineral content, was significantly highest in the 100Gy treatment (1.50%) and lowest in 50Gy (0.11%). This suggests that the 100Gy treatment enhanced mineral accumulation, possibly by stimulating mineral uptake or metabolism. Crude fat content varied significantly ($p < 0.05$) among treatments, with the control recording the highest value (5.49%), followed by 50Gy (4.29%). The lowest fat content (0.65%) was recorded in 100Gy, suggesting that certain mutagenic treatments may suppress lipid biosynthesis. This trend may have implications for dietary planning, particularly for consumers requiring low-fat diets. The highest crude protein content (4.90%) was observed in the 1% EMS treatment, indicating that EMS at this concentration may stimulate protein synthesis or reduce protein degradation. In contrast, the lowest protein content (0.25%) was found in 150Gy+1% EMS. The substantial variation in protein content among treatments confirms the potential of induced mutagenesis for protein enhancement or suppression depending on dosage. Crude fibre content also showed significant variation ($p < 0.05$), with the highest value recorded in 50Gy+1% EMS (6.39%) and the lowest in 200Gy+1% EMS (1.23%). These results highlight the potential of moderate mutagenic exposure to enhance dietary fibre content, which is vital for gastrointestinal health. Carbohydrate content was highest in 50Gy+1% EMS (6.19%) and lowest in 150Gy+1% EMS (0.31%). This trend was mirrored in the energy values, with 50Gy+1% EMS yielding the highest

calorific value (70.12 kcal/100g) and 150Gy+1% EMS the lowest (19.32 kcal/100g). The superior energy density of 50Gy+1% EMS may be attributed to its higher fat and carbohydrate composition, making it more suitable for high-energy dietary needs. In *S. melongena*, moisture content ranged from 90.02% in 150Gy+1% EMS to 92.65% in 50Gy, indicating less variation compared to *S. aethiopicum*. Dry matter content ranged from 7.35% in 50Gy to 9.98% in 150Gy+1% EMS, with the latter showing a potential to improve solid nutritional constituents. Crude fat was highest in 50Gy+1% EMS (4.84%), followed by 200Gy+1% EMS (4.28%), indicating the potential of mutagenesis to enhance lipid content under specific conditions. Crude protein content showed no statistically significant differences among treatments ($p>0.05$), though numerically, 100Gy recorded the

highest protein content (2.06%) while 150Gy had the lowest. Crude fibre was highest in 150Gy+1% EMS (3.33%) and lowest in 50Gy (2.45%), although these differences were not statistically significant ($p>0.05$). This suggests a moderate influence of mutagens on fibre content in *S. melongena*. Carbohydrate content was generally uniform across treatments, with the exception of the control, which recorded the highest value (2.41%), significantly different (∅) from other treatments. The lowest carbohydrate level (0.12%) was observed in 100Gy+1% EMS. Energy values were highest in 200Gy+1% EMS (47.56 kcal/100g), likely due to a balanced contribution from fat and protein. This highlights the potential of higher mutagenic doses to enhance the overall energy profile in *S. melongena*.

Table 1: Combine effect of ethyl methane sulfonate (EMS) at optimal concentration and gamma irradiation on proximate composition of eggplant species (*Solanum melongena* and *Solanum aethiopicum*)

Species	Treatments	Dry Matter (%)	Moisture (%)	Ash Content (%)	Crude fat (%)	Crude protein (%)	Crude fibre (%)	CHO (%)	Energy Value Kcal/100 g
<i>S. aethiopicum</i>	50GY	12.52±0.06 ^{ab}	87.48±0.06 ^b	0.11±0.00 ^a	4.29±0.00 ^{ab}	2.41±0.04 ^{ab}	4.17±0.02 ^{ab}	1.54±0.08 ^a	54.42±0.17 ^{ab}
	100GY	9.50±0.37 ^{ab}	90.50±0.37 ^a	1.50±0.16 ^b	0.65±0.00 ^a	2.18±0.10 ^c	3.98±0.42 ^b	1.18±0.11 ^a	19.32±0.79 ^a
	150GY	13.97±0.05 ^b	86.03±0.05 ^{ab}	0.17±0.00 ^a	4.03±1.17 ^{ab}	2.34±0.94 ^{ab}	4.66±0.02 ^{ab}	2.77±0.19 ^{ab}	56.71±5.96 ^b
	200GY	8.34±0.08 ^a	91.67±0.08 ^a	0.60±0.00 ^{7a}	2.29±0.02 ^b	2.15±0.03 ^c	1.38±0.00 ^{3a}	1.92±0.16 ^{6a}	36.88±0.36 ^c
	50GY+1%EMS	19.18±0.04 ^d	80.82±0.04 ^a	0.23±0.00 ^{0a}	3.98±0.00 ^{3ab}	2.39±0.07 ^{ab}	6.39±0.00 ^{1c}	6.19±0.00 ^{6c}	70.12±0.27 ^c
	100GY+1%EMS	14.15±0.01 ^b	85.85±0.01 ^{1ab}	0.13±0.00 ^{0a}	3.58±0.00 ^{2a}	1.29±0.07 ^{ab}	4.52±0.00 ^{0ab}	4.44±0.00 ^{4b}	55.09±0.08 ^{ab}
	150GY+1%EMS	7.12±0.22 ^a	92.88±0.22 ^{2ab}	0.64±0.00 ^{3a}	4.23±0.00 ^{9c}	0.25±0.00 ^a	1.70±0.00 ^{7a}	0.31±0.33 ^{3a}	40.29±0.95 ^d
	200GY+1%EMS	7.94±0.06 ^a	92.06±0.06 ^{6a}	0.46±0.00 ^{3a}	1.32±0.00 ^{2ab}	1.27±0.01 ^b	1.23±0.00 ^{9a}	3.66±0.17 ^{7b}	31.55±0.81 ^b
	1% EMS	13.51±0.26 ^b	86.49±0.26 ^{6a}	0.24±0.00 ^{0a}	3.69±0.10 ^{0a}	4.90±0.35 ^b	3.53±0.00 ^{6a}	1.14±0.20 ^{4a}	57.38±1.31 ^c
	CONTROL	15.63±0.00 ^{0c}	84.37±0.00 ^{0ab}	0.13±0.00 ^{0a}	5.49±0.28 ^{8b}	1.66±0.09 ^b	5.21±0.00 ^{0b}	3.13±0.19 ^{9ab}	68.60±1.41 ^c

<i>S. melongena</i>	50GY	7.35±0.06 a	92.65±0.0 6 ^b	0.10±0.0 1 ^a	2.97±0.0 0 ^a	1.60±0.02 a	2.45±0.0 2 ^a	0.22±0.0 7 ^a	34.04±0. 18 ^a
	100GY	8.07±0.10 a	91.93±0.1 0 ^b	0.19±0.0 0 ^a	2.28±0.0 1 ^a	2.06±0.22 a	2.69±0.0 3 ^a	0.85±0.2 9 ^a	32.15±0. 22 ^a
	150GY	7.93±1.61 a	92.08±1.6 1 ^b	0.14±0.0 0 ^a	2.91±0.0 0 ^a	0.96±0.09 a	2.64±0.5 4 ^a	1.27±1.1 6 ^a	35.14±4. 30 ^a
	200GY	9.54±0.06 ab	90.46±0.0 6 ^{ab}	0.13±0.0 0 ^a	3.26±0.0 0 ^a	1.75±0.09 a	3.18±0.0 2 ^a	1.22±0.1 3 ^a	41.24±0. 14 ^b
	50GY+1%EMS	8.23±0.36 a	91.78±0.3 6 ^b	0.06±0.0 0 ^a	4.84±0.0 5 ^{ab}	1.88±0.04 a	2.74±0.1 2 ^a	0.70±0.2 3 ^a	42.87±1. 22 ^b
	100GY+1%EM S	8.11±0.17 a	91.89±0.1 7 ^b	0.20±0.0 0 ^a	3.78±0.0 0 ^a	1.36±0.04 a	2.70±0.0 6 ^a	0.12±0.0 6 ^a	40.71±0. 45 ^b
	150GY+1%EM S	9.98±0.01 ab	90.02±0.0 1 ^{ab}	0.12±0.0 0 ^a	3.31±0.0 0 ^a	1.88±0.13 a	3.33±0.0 0 ^a	1.34±0.1 3 ^a	42.68±0. 02 ^b
	200GY+1%EM S	9.48±0.00 a	90.52±0.0 0 ^c	0.04±0.0 0 ^a	4.48±0.0 3 ^{ab}	0.99±0.02 a	3.16±0.0 0 ^a	0.82±0.0 5 ^a	47.56±0. 15 ^a
	1% EMS	8.06±0.47 a	91.94±0.4 7 ^b	0.07±0.0 0 ^a	2.63±0.0 0 ^a	1.53±0.04 a	2.69±0.1 6 ^a	1.15±0.3 5 ^a	34.35±1. 24 ^a
	CONTROL	9.27±0.18 a	90.73±0.1 8 ^{ab}	0.14±0.0 0 ^a	1.75±0.4 2 ^a	1.88±0.22 a	3.09±0.0 6 ^a	2.41±0.7 6 ^{ab}	32.89±1. 64 ^a

Values are Means ± Standard Error, values followed by the same superscript(s) along the column are not significantly different at $p>0.05$ as tested by DMR

Mineral analysis

In *Solanumaethiopicum* mineral analysis showed statistically significant differences ($p<0.05$) in some mineral elements. Potassium (K) was significantly highest in the 1% EMS treatment (3.23%) and lowest in 50Gy (0.46%). While sodium (Na) content did not vary significantly among treatments ($p>0.05$), the highest Na content (0.70%) was recorded in 1% EMS and the lowest (0.08%) in 50Gy. Calcium (Ca) showed significant differences, with the highest content (0.22%) observed in 100Gy and the lowest (0.05%) in 100Gy+1%EMS. Magnesium (Mg) content was highest in 150Gy (0.11%) and lowest in 50Gy and 1%EMS (0.02%), although, there were no significant differences ($p > 0.05$). Phosphorus (P) content did not show significant variation ($p > 0.05$) but was highest in 50Gy+1%EMS (0.83%) and lowest in 100Gy, reflecting differential

nutrient accumulation across treatments.

In *S. melongena*, the mineral composition showed no statistically significant differences among treatments ($p>0.05$), suggesting a more stable mineral profile across mutagenic interventions. Potassium was highest in the control (1.51%) and lowest in 200Gy+1% EMS (0.31%). Sodium and calcium peaked in 100Gy+1%EMS (0.72%) and 50Gy (0.34%) respectively, while the lowest values were recorded in 200Gy+1%EMS (Na: 0.07%, Ca: 0.09%). Magnesium showed no significant difference among treatments, with the highest value (0.28%) in 50Gy and the lowest (0.02%) in 200Gy+1%EMS. Phosphorus content ranged from 0.23% in 100Gy+1%EMS to 0.68% in 200Gy+1%EMS, with no significant variation ($p > 0.05$).

Table 2: Combine Effect of ethyl methane sulfonate (EMS) at optimal concentration and gamma irradiation on mineral composition of eggplant species (*Solanum melongena* and *Solanum aethiopicum*)

Species	Treatments	Potassium (k) (%)	Sodium (Na) (%)	Calcium (Ca) (%)	Magnesium (Mg) (%)	Phosphorus (P) (%)
<i>S. aethiopicum</i>	50GY	0.46±0.01 ^a	0.08±0.00 ^a	0.13±0.00 ^a	0.02±0.00 ^a	0.77±0.00 ^a
	100GY	0.83±0.03 ^a	0.17±0.01 ^a	0.22±0.00 ^{ab}	0.10±0.00 ^a	0.21±0.00 ^a
	150GY	0.74±0.01 ^a	0.10±0.00 ^a	0.09±0.00 ^a	0.11±0.01 ^a	0.76±0.00 ^a
	200GY	1.99±0.01 ^b	0.60±0.00 ^a	0.14±0.00 ^a	0.07±0.00 ^a	0.31±0.04 ^a
	50GY+1%EMS	0.76±0.01 ^a	0.12±0.00 ^a	0.07±0.00 ^a	0.08±0.00 ^a	0.82±0.00 ^a
	100GY+1%EMS	0.73±0.01 ^a	0.10±0.00 ^a	0.05±0.00 ^a	0.04±0.00 ^a	0.56±0.00 ^a
	150GY+1%EMS	1.16±0.01 ^{ab}	0.31±0.01 ^a	0.15±0.00 ^a	0.03±0.00 ^a	0.38±0.02 ^a
	200GY+1%EMS	1.21±0.01 ^{ab}	0.29±0.00 ^a	0.11±0.00 ^a	0.04±0.00 ^a	0.25±0.02 ^a
	1% EMS	3.23±0.03 ^b	0.70±0.01 ^a	0.17±0.00 ^a	0.02±0.00 ^a	0.39±0.00 ^a
	CONTROL	0.60±0.00 ^a	0.35±0.00 ^a	0.07±0.00 ^a	0.08±0.00 ^a	0.73±0.00 ^a
<i>S. melongena</i>	50GY	0.98±0.03 ^a	0.49±0.01 ^a	0.34±0.00 ^a	0.28±0.00 ^a	0.24±0.00 ^a
	100GY	1.16±0.01 ^a	0.34±0.01 ^a	0.20±0.00 ^a	0.12±0.00 ^a	0.31±0.00 ^a
	150GY	1.34±0.01 ^a	0.29±0.01 ^a	0.26±0.00 ^a	0.19±0.00 ^a	0.31±0.00 ^a
	200GY	1.20±0.00 ^a	0.25±0.01 ^a	0.18±0.00 ^a	0.09±0.00 ^a	0.27±0.00 ^a
	50GY+1%EMS	0.89±0.01 ^a	0.33±0.02 ^a	0.18±0.00 ^a	0.11±0.00 ^a	0.27±0.00 ^a
	100GY+1%EMS	1.31±0.01 ^a	0.72±0.02 ^a	0.30±0.00 ^a	0.23±0.00 ^a	0.23±0.00 ^a
	150GY+1%EMS	1.25±0.00 ^a	0.50±0.01 ^a	0.23±0.00 ^a	0.15±0.00 ^a	0.29±0.00 ^a
	200GY+1%EMS	0.31±0.00 ^a	0.07±0.00 ^a	0.09±0.00 ^a	0.02±0.00 ^a	0.68±0.00 ^a
	1% EMS	1.26±0.01 ^a	0.39±0.02 ^a	0.15±0.00 ^a	0.08±0.00 ^a	0.26±0.00 ^a
	CONTROL	1.51±0.01 ^a	0.34±0.01 ^a	0.25±0.00 ^a	0.20±0.00 ^a	0.29±0.01 ^a

Values are Means ± Standard Error, values followed by the same superscript(s) along the column are not significantly different at $p>0.05$ as tested by DMRT

DISCUSSION

The results from this study reveal that both *Solanum melongena* and *Solanum aethiopicum* exhibited high moisture content across all treatments, indicating their inherently high-water composition. These findings are consistent with those of [20], who reported a moisture content of 90.89% in *S. aethiopicum*, and [21], who documented moisture contents of

92.70%, 92.10%, and 93.00% in brinjal genotypes Shamli, Pearl Long, and Black Beauty, respectively. Similarly, [22] recorded a moisture content of $92.50 \pm 0.14\%$ in *S. melongena*. The enhanced water retention capacity observed under these treatments could be attributed to physiological or biochemical modifications induced by mutagenic agents such as gamma irradiation and

EMS. These modifications could affect the structure of the cell wall, the composition of water-binding components, or the osmotic balance within fruit tissues. While high moisture content enhances fruit palatability and freshness, it may also increase susceptibility to microbial spoilage; however, the fibrous skin of eggplant could offer some resistance to microbial penetration [23]. Dry matter content, which is inversely related to moisture content, exhibited varying trends across treatments. This study, however, contrasts with the 9.07% dry matter content reported by [20], suggesting a possible enhancement of solid constituents as a result of mutagenic influence. In *S. melongena*, dry matter ranged from 7.35% to 9.98%, indicating that mutagenic treatments could be due to the fruit's high water content and limited accumulation of structural carbohydrates and fibers, which are major contributors to dry biomass. Nevertheless, the dry matter values in this study fall within the range of 6.03%–9.14% reported by [24], reflecting general consistency with earlier findings. Ash content is the mineral residue that remains after a food sample is incinerated to burn off its water and organic matter. It serves as an important measure of the food's overall mineral composition [25]. In *S. aethiopicum*, the ash content ranged 0.11% to 1.50% contradicts the 0.51% to 0.84% reported by [26]. Meanwhile, *S. melongena* exhibited a range of 0.04% to 0.20% ash content values which were lower than those reported by [27], who documented a range of 1.96% to 3.15%. These differences may be attributed to varietal characteristics, environmental conditions, and possible mutagenic suppression of mineral accumulation in *S. melongena*. Protein content showed promising trends in both species,

suggesting that EMS at optimal concentrations could stimulate protein synthesis pathways. The protein content 0.25% to 4.90% in *S. aethiopicum* was observed to align with the findings of [28], who reported 4.20% protein content in *S. aethiopicum*. Likewise, in *S. melongena* the protein content ranged from 0.96% to 2.06%, indicating that lower doses of gamma irradiation has the potential to enhance protein accumulation. This aligns with the report of [29], who documented a protein content of 2.38% in *S. melongena*. Crude fat content ranged from 0.65% to 5.49%, the result of this study was within the range noted by [29], who reported a fat content of 8.05%. The lower fat levels observed in the treated samples may be attributed to the suppressive effects of mutagenic agents on lipid biosynthesis pathways. Despite this, the low-fat nature of these eggplant genotypes enhances their suitability for dietary management of metabolic conditions such as diabetes and cardiovascular diseases, as emphasized by [30]. Crude fibre content was notably higher in *S. aethiopicum*, this suggests that induced mutagenesis can influence fibre development. The observed values 1.23% to 6.39% were higher than the 2.92% reported by [31]. In *S. melongena*, crude fibre content ranged from 2.45% to 3.33%, which aligns with the findings of [32], who reported values ranging from 2.48% to 3.61%, and [22], who documented a value of 3.11%. Mutagenic treatments led to an increase in carbohydrate content in *S. aethiopicum* indicating that gamma irradiation and EMS could increase the activity of the biological processes (pathways) that produce or store carbohydrates in the plant. The value of carbohydrate content in this study ranged 0.31% to 6.19%, this contradicts the value ($4.14 \pm 0.11\%$) reported by [22] and (4.26%) [33],

pointing to favourable mutagenic effect. Meanwhile, *S. melongena* the findings in this study, suggests a potential adverse effect of mutagens on carbohydrate accumulation. Nevertheless, the observed value 0.12% to 2.41% was within the 2.80%–6.82% range reported by [34]. Mutagenic agents can cause changes in the plant's genes, which could affect how certain enzymes work in producing energy. These changes can lead to an increase in carbohydrates and fats nutrients that provide a lot of energy resulting in higher energy content in the treated plants of *S. aethiopicum* and *S. melongena*. The result of this study for *S. aethiopicum* and *S. melongena* ranged from 31.55% to 70.12% and 32.15% to 47.56% were higher than those reported by [35], who recorded values of 33.03 ± 0.74 for *S. macrocarpon* (round), 34.02 ± 0.95 for *S. aethiopicum*, 22.90 ± 0.46 for *S. macrocarpon* (oval), and 30.11 ± 0.87 for *S. gilo*. In contrast, *S. melongena* exhibited higher carbohydrate content in the control than in the treated samples, suggesting a potential adverse effect of mutagens on carbohydrate accumulation. This variation emphasizes the potential of targeted mutagenic interventions to improve the calorific and overall nutritional quality of eggplant varieties.

The mineral analysis of *Solanum aethiopicum* and *Solanum melongena*, The findings of this study for potassium (K) and calcium (Ca) levels suggest that chemical mutagenesis using EMS (ethyl methane sulphonate) could enhance potassium uptake or retention in eggplant tissues. However, the potassium concentrations (0.46% to 3.23% and 0.31% to 1.51%) observed for *Solanum aethiopicum* and *Solanum melongena* respectively in this study were notably lower than the range of 238.10–245.37 mg/100 g reported by [27]. Similarly, calcium content (0.05%

to 0.22% and 0.09% to 0.34%) observed in this study for *Solanum aethiopicum* and *Solanum melongena*. [36] reported higher calcium contents of 20.83% and 14.40% in *Amaranthus cruentus* and *Ocimum gratissimum*, respectively which contradict the findings of this study. Calcium is a vital mineral that supports the development and maintenance of bones, teeth, and muscle function [37]. The relatively low calcium concentration observed in the treated eggplant samples could indicate a species-specific limitation in calcium accumulation or possibly a suppressive effect of mutagenic treatments on calcium uptake and translocation pathways. Sodium (Na) content for *Solanum aethiopicum* and *Solanum melongena* in this study ranged from 0.08% to 0.70% and 0.07% to 0.72% respectively, suggesting a strong homeostatic regulation of sodium uptake despite the mutagenic stress. Compared to those obtained in this study, [38], reported higher sodium values 43.948 mg/kg, 59.248 mg/kg, and 46.030 mg/kg for the Green, White, and Agric eggplant varieties, compared to those obtained in this study. Sodium and potassium are essential electrolytes, functioning as key intracellular and extracellular cations, respectively. Sodium plays a critical role in the regulation of plasma volume, acid-base balance, nerve impulse transmission, and muscle contraction [39]. Magnesium (Mg) contents 0.02% to 0.28% and phosphorus (P) contents 0.21% to 0.82% in *Solanum aethiopicum* and *Solanum melongena* were found to be very low compared to the values reported by [40]. These discrepancies may be attributed to genetic differences, environmental factors, or the effects of mutagenic treatments on mineral assimilation pathways.

CONCLUSION

This study confirms that mutation breeding using gamma irradiation and EMS can significantly enhance the nutritional and mineral qualities of *Solanum aethiopicum* and *Solanum melongena*. The combined treatments, especially at moderate levels, were most effective in improving vital traits such as dry matter, fibre, and energy content—particularly in *S. aethiopicum*. These results establish the potential of induced mutagenesis in developing improved, nutrient-dense eggplant varieties.

Declarations Section

Authors Contribution

MEB: conceptualized the study, conducted field and laboratory work, analysed and interpreted data, drafted manuscript. GAA: conceptualized the study, supervised, reviewed, DMC: supervised and reviewed DOAY: conceptualized the study and interpreted data BIM and IKK reviewed the manuscript, AAE: participated in the laboratory work All authors contributed to the development of final manuscript approval and submission

Disclosure of Conflict of Interest

None

Ethics Approval and Informed Consent.

This study did not use human or animal subjects. Therefore, ethical consideration was not applicable.

Disclosure of Funding

This study did not receive any external funding

REFERENCES

1. Melissa, P. (2017). List of plants in the family Solanaceae

- (Encyclopedia Britannica). Retrieved from <https://en.m.wikipedia.org/wiki/Eggplant>
2. FAO. (2014). FAOSTAT: Production database. <http://www.faostat.fao.org>
3. FAOSTAT. (2023). *Food and Agriculture Organization of the United Nations (FAO)*. <https://www.fao.org/faostat/en/#data/QC>
4. FAOSTAT. (2012). *Eggplant statistics, 2010*. Statistical Division, Food and Agriculture Organization of the United Nations. <https://www.fao.org/faostat/en/#data/QCL>
5. Dauda, N., Aliyu, L., & Chiezey, U. F. (2003). Effect of variety, seedling age and poultry manure on growth and yield of garden egg (*Solanum gilo* L.). In *Proceedings of the 32nd Conference of the Horticultural Society of Nigeria*, School of Agriculture, Lagos State Polytechnic (pp. 66–71).
6. Daunay, M. C., Laterrot, H., & Janick, J. (2001). Iconography and history of Solanaceae: Antiquity to the 17th century. In A. C. Leslie (Ed.), *Solanaceae IV: Advances in Biology and Utilization*. Royal Botanic Gardens, Kew. (pp. 1-40).
7. Prohens, J., Whitaker, B. D., & Plazas, M. (2005). Wild relatives of eggplant: African species of the genus *Solanum* subgenus *Leptostemonum*. *Genetic Resources and Crop Evolution*, 52(4), 399-418.
8. Sseremba, G., Tongoona, P., Savior, J., Eleblu, Y., Danquah, E. Y., Kabod, N. P., & Kizito, E. B. (2017). Morphological distinctiveness between *Solanum aethiopicum* Shum group and its progenitor.

- Journal of Plant Breeding and Crop Science*, 9(8), 118–129. <https://doi.org/10.5897/JPBCS2017.0673>
9. Raigón, M. D., Prohens, J., Muñoz-Falcón, J. E., & Nuez, F. (2008). Comparison of eggplant landraces and commercial varieties for fruit content of phenolics, minerals, dry matter and protein. *Journal of Food Composition and Analysis*, 21(5), 370–376.
 10. Cassidy, A., Mukamal, K. J., Liu, L., Franz, M., Eliassen, A. H., & Rimm, E. B. (2013). High anthocyanin intake is associated with a reduced risk of myocardial infarction in young and middle-aged women. *Circulation*, 127(2), 188–196.
 11. Dias, J.S., (2011). World Importance, Marketing and Trading of Vegetables, *ActaHorticulturae*, 921: 153-169.
 12. Plazas, M., Lopez-Gresa, M. P., Vilanova, S., Torres, C., Hurtado, M., Gramazio, P., Andújar, I., Herraiz, F. J., Bellés, J. M., & Prohens, J. (2013). Diversity and relationships in key traits for functional and apparent quality in a collection of eggplant: Fruit phenolics content, antioxidant activity, polyphenol oxidase activity, and browning. *Journal of Agricultural and Food Chemistry*, 61(38), 8871–8879. <https://doi.org/10.1021/jf402491h>
 13. Tajik, N., Tajik, M., Mack, I., & Enock, P. (2017). The potential effects of chlorogenic acid, the main phenolic component in coffee, on health: A comprehensive review of the literature. *European Journal of Nutrition*, 56, 2215–2244
 14. Casati, L., Pagani, F., Braga, P. C., Scalzo, R. L., & Sibilia, V. (2016). Nasunin, a new player in the field of osteoblast protection against oxidative stress. *Journal of Functional Foods*, 23, 474–484.
 15. Afshari, F., Serah, H., Hashemi, Z. S., Timajchi, M., Olamafar, E., Ghotbi, L., Asadi, M., Elyasi, Z., & Ganjibakhsh, M. (2016). The cytotoxic effects of eggplant peel extract on human gastric adenocarcinoma cells and normal cells. *Modern Medical Laboratory Journal*, 1 (1), 42–48.
 16. Jonah, S. A., James, G. O., Adeku, D. E., Ahmed, F., Alhassan, A., Hamza, S., Igbideba, O. I., Kwaghua, F. I., Kyari, M., Macaulay, V. F., Olarewaju, S. I., Onyeodili, G., Popoola, G. B., Sofeso, O. A., Switzer, F. K., & Umoh, U. E. (2014). Pre-drilling geoelectrical survey at a built-up compound at Barkin-Sale Ward, Minna, Niger State, Nigeria. *Journal of Information, Education, Science, and Technology*, 1(2), 86–97.
 17. Jankowicz-Cieslak, J., & Till, B. J. (2016). Chemical mutagenesis of seed and vegetatively propagated plants using EMS. *Current Protocols in Plant Biology*, 1, 617–635
 18. AOAC. (2019). *Official methods of analysis of AOAC International* (21st ed.). AOAC International. <http://www.aoac.org/resources/official-methods-of-analysis-revision>
 19. Karpiuk, N. N., Azzam, A. L., Abudayeh, K. M., Kislichenko, Z. M., Naddaf, V., Cholak, A., & Yemelianova, O. I. (2016). Qualitative and quantitative content determination of macrominor elements in *Bryoniaalba* L. roots using flame

- atomic absorption spectroscopy technique. *Advanced Pharmaceutical Bulletin*, 69 (2), 285–291.
20. Adeyeye, A., Salami, A. I., Sulaiman, W. K., & Akinyode, O. A. (2020). Proximate composition and fatty acid profile of garden egg (*Solanum aethiopicum* L.) fruits. *International Journal of Food Science and Nutrition*, 5(2), 9–13.
21. Khan, I. A., Habib, K., Akbar, R., Khan, A., Saeed, M., Farid, A., Ali, I., & Alam, M. (2015). Proximate chemical composition of brinjal, *Solanum melongena* L. (Solanales: Solanaceae), genotypes and its correlation with the insect pests in Peshawar. *Journal of Entomology and Zoology Studies*, 3(4), 303–306.
22. Edeke, A., Uchendu, N., Omeje, K., & Odiba, A. S. (2021). Nutritional and pharmacological potentials of *Solanum melongena* and *Solanum aethiopicum* fruits. *Journal of Phytopharmacology*, 10(1), 61–67.
23. Ma, M., Sun, Q. J., Li, M., & Zhu, K. X. (2020). Deterioration mechanisms of high-moisture wheat-based food: A review from physicochemical, structural, and molecular perspectives. *Food Chemistry*, 318, 126495. <https://doi.org/10.1016/j.foodchem.2020.126495>
24. Arivalagan, M., Gangopadhyay, K. K., Kumar, G., Bhardwaj, R., Prasad, T. V., Sarkar, S. K., & Roy, A. (2012). Variability in mineral composition of Indian eggplant (*Solanum melongena* L.) genotypes. *Journal of Food Composition and Analysis*, 26(1–2), 173–176.
25. Zubair, M., Wang, S., Zhang, P., Ye, J., Liang, J., Nabi, M., & Cai, Y. (2020). Biological nutrient removal and recovery from solid and liquid livestock manure: Recent advance and perspective. *Bioresource Technology*, 301, 122–823
26. Haruna, S.S., Ahmed, O. & Abdullahi, S.K. (2016) Phytochemical, Proximate and Mineral Analysis of *Solanum aethiopicum* L. Fruit. *International Journal of Chemistry, Materials and Environment Research*, 3, 8-13.
27. Agoreyo, B. O., Obansa, E. S., & Obanor, E. O. (2012). Comparative nutritional and phytochemical analyses of two varieties of *Solanum melongena*. *Science World Journal*, 7 (1), 1–4.
28. Eze, S. O., & Kanu, C. Q. (2014). Phytochemical and nutritive composition analysis of *Solanum aethiopicum* L. *Journal of Pharmaceutical and Scientific Innovation*, 3(4), 358–362.
29. Henry, M. U., Dogun, D., Ozeanyi, K. A., Ibidota, S. M., & Henry, U. I. (2022). Phytochemical, nutritional and trace element composition of some *Solanum* (garden egg). *Nigerian Journal of Biotechnology*, 39(2), 44–52.
30. Showemimo, F. A., & Olarewaju, J. D. (2004). Agro-nutritional determinants of some garden egg varieties (*Solanum gilo* L.). *Journal of Food Technology*, 2(3), 172–175. <https://medwelljournals.com/abstract/?doi=jftech.2004.172.175>
31. Chinedu, S. N., Olasumbo, A. C., Eboji, O. K., Emiloju, O. C., Arinola, O. K., & Dania, D. I. (2011). Proximate and phytochemical analyses of *Solanum aethiopicum*

- L. and *Solanum macrocarpon* L. fruits. *Research Journal of Chemical Sciences*, 1(3), 63–71.
32. Tsafack, H. D., Tchinda, M. M., Kemtsop, M. P., Tueguem, G. J. T., Nouemsi, A. P. K., & Womeni, H. M. (2024). Effect of nutrients and phytochemical compounds of *Solanum melongena* (eggplants) on cognitive protection in rats. *Journal of Diseases and Medicinal Plants*, 10(2), 17–28.
33. Ikpeazu, V. O., Okezie, E., Ekweogu, C. N., Akara, E. U., & Ugbogu, E. A. (2019). A comparative nutritional assessment of leaf extracts of *Ocimum gratissimum* and *Solanum aethiopicum*. *American Journal of Biomedical Research*, 7(2), 27–31. <https://doi.org/10.12691/ajbr-7-2->
34. Bidaramali, V., Akhtar, S., & Das, A. (2020). Proximate composition and bioactive compounds in diverse eggplant genotypes. *Current Journal of Applied Science and Technology*, 39(4), S113-121.
35. Ossamulu, I. F., Akanya, H. O., Jigam, A. A., & Egwim, E. C. (2014). Evaluation of nutrient and phytochemical constituents of four eggplant cultivars. *Elixir Food Science*, 73, 26424–26428.
36. Oluwole, S. O., Fajana, O. O., Ogun, M. L., Ogbe, A. A., & Ademola, O. A. (2019). Proximate and mineral composition analysis of the leaves of *Amaranthus cruentus* and *Ocimum gratissimum* in some selected areas of Lagos State, Nigeria. *International Journal of Ecosystem*, 9(1), 6–11. <https://doi.org/10.5923/j.ije.20190901.02>
37. Okaka, J. C., Enoch, N. T. A., & Okaka, N. C. A. (2006). *Food and human nutrition* (pp. 135–153). O.J.C. Academic Publishers.
38. Adu, A. A., Aderinola, O. J., Avoseh, O., & Omolounnu, S. O. (2021). Comparative analysis of the proximate evaluation and heavy metal contents of the three varieties of *Solanum melongena* L. (eggplant) collected from Iyanalba market of Ojo Local Government Area in Lagos, Nigeria. *Journal of Humanities and Social Science*, 26(7), Ser. 4), 38–46. <https://doi.org/10.9790/0837-2607043846>
39. Akpanyung, E. O. (2005). Proximate and mineral element composition of bouillon cubes produced in Nigeria. *Pakistan journal of nutrition*, 4(5), 327–329.
40. Otitoju, G. T. O., & Ene-Obong, H. N., & Otitoju, O. (2014). Macro and micronutrient composition of some indigenous green leafy vegetables in South-East zone Nigeria. *Food Process Technology*, 5(11). <https://doi.org/10.4172/2157-7110.1000389>