EVALUATION OF GAMMA-RAY INDUCED MUTANT LINES OF SESAME (*Sesamum indicum* L.) FOR PHYSICOCHEMICAL PARAMETERS OF THE SEED-OIL

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ABSTRACT

The physicochemical properties of sesame oil determine its application and also form the criteria for genetic improvement of the crop. Most of the released sesame varieties in Nigeria do not consider oil properties of the seed and where it is only oil quantity is used. This study was conducted to evaluate the physicochemical parameters of gamma-ray induced mutant M_5 lines of sesame seed oil. The physicochemical parameters determined include the refractive index, free fatty acid, ester, glycerine, viscosity, iodine, peroxide, saponification, unsaponification and acid values. The results revealed M_5 mutant lines displayed significant disparity in some of the parameters measured. The highest values in viscosity (10.00, 10.00), Saponification (219.49), Acid (3.14), ester (217.55) were from NCRIBEN-03L, 03L-250-G_{1-1}; 01M-350-G_{1-2}, 01M-350-G_{2-2-2} and 01M-350-G_{1-2} (217.55) respectively, while the least values for the respective parameters were from 03L-450-G_{2-2} (4.00); 04E-550-G_{1-3} (172.43); 04E-550-G_{2-3} (0.4) and 04E-550-G_{1-3} (171.92). The study deduced that gamma-ray irradiation could be used as a tool for the improvement of seed oils. Oils from mutants (NCRIBEN-03L, 03L-250-G_{1-1}; 01M-350-G_{1-2}, 01M-350-G_{2-2-2} and 01M-350-G_{1-2}) have the potential to be used for cosmetic industry and Mutants (03L-450-G_{2-2}; 04E-550-G_{2-3}) for domestic and confectionery applications.

Keywords: cold-press, extraction, hexane solvent, oil seed

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INTRODUCTION

Sesame (*Sesamum indicum* L.) belongs to the family Pedaliaceae and is widespread in tropical and subtropical regions of Asia, Africa and South America. In Nigeria, sesame is locally called by different names; 'Ridi' in Hausa, 'Esso' in Nupe, 'Eeku' in Yoruba and 'Ekuku' in Igbo (Muhammad, 2018). Sesame seeds contain nearly 44% – 57% oil, 18% – 25% protein and 13% - 14% carbohydrates (Borchani *et al.,* 2010). According to Hegde (2012), sesame seed contains 37%–63% oil depending on the variety, growing season and cultivar. The most prominent feature of Sesame oil is its resistance towards oxidation rancidity during long exposure to air (Islam *et al.,* 2016). Islam *et al.* (2016); Mujtaba *et al.* (2020), reported that Sesame is the most valued and oldest oilseed crop due to its high-quality seed oil. Sesame is utilized for the treatment of anaemia, amenorrhea, respiratory infections, cholera, scorpion bites, dysmenorrhea, tinnitus, diarrhoea, dizziness, memory enhancement and bleeding piles (Khan *et al.,* 2014; Kapoor, 2017). Hegde (2012), opined sesame oil is used to treat coughs, burns, migraines, snake bites, tuberculosis, hair loss, eye diseases and demulcent in addition to being used as an antitussive. Low quality sesame oil is also used to produce soap, paints and lubricants (Anilakumar *et al.,* 2010).

Sesame is considered as a major source for solving the problem of deficiency of micronutrients deficiencies in modern day nutrition (Aglave, 2018). Most of the released sesame varieties in Nigeria do not consider oil properties of the seed and where it is only oil quantity is used. The aim of this study is to evaluate the physicochemical parameter of gamma induced mutant M_5 lines of sesame.

MATERIALS AND METHODS

The Gamma-irradiated mutant genotypes of Sesame used for the experiment were obtained from the stored gamma-irradiated mutant lines of M_5 generation in the department of Plant Biology Federal University of Technology Minna Niger state, Nigeria. A total of 14 entries (11 mutants and 3 checks) were raised in a Randomized complete block design (RCBD) with three replicates. Each plot size of 3x3M^2 was used, with planting space of 20 x 20 cm. After the harvest, the sesame oil was extracted using cold-press and hexane solvent as described by Kate *et al.* (2014) with little modifications. The physicochemical properties as the refractive index, Acid value, Free fatty acid, Iodine value, Peroxide value, Saponification value, Unsaponification value, Ester, Glycerine, Viscosity was determined by reported methods described by Olaleye *et al.* (2018) and (United State pharmacopeial convention, 2015).

Statistical analyses

The data was subjected to Randomized Complete Block Design analysis of variance (ANOVA) at P=0.05 using Statistical Tool for Agricultural Research (STAR) by International Rice Research Institute (IRRI) 2013 - 2020.

RESULTS AND DISCUSSION

The results from this study revealed significant changes ($p < 0.05$) in the physicochemical parameters of the oil. However, there was no significant difference in the refractive index and unsaponification value (Table 1). Similarly, no significant change was recorded in the iodine value except in check-3 NCRIBEN-03L (15.62) had the highest value. The highest acid value (3.14), free fatty acid (1.57) (Table 2).

The refractive index obtained (1.46-1.49) could be corroborated with Olaleye *et al.* (2018), who reported (1.47) in sesame samples. Aniołowska *et al.* (2016), opined that the high refractive index of oil is due to the presence of long-chain fatty acids. The refractive index is in agreement with the acceptable range (1.465-1.469) International Codex standard (2005). The acid value (0.40-3.14) recorded is slightly higher than the findings of Zahran *et al.* (2020), who obtained ranged (0.28 - 0.37) in sesame. Ogbonna and Ukaan, (2013) recorded the range of iodine value of (76.14-130.07). The acid value for 04E-550-G_{1-3} (0.51) 04E-550-G_{2-3} (0.40) is within the permissible level (0.6 mgKOH/g) for all edible oils recommended by FAO/WHO. However, other mutants were above the recommended value. The saponification values (172.43-219.49) recorded is similar to findings of Olaleye *et al.* (2018), who reported (212.45-214.53) in sesame. Warra, (2011) reported 189 saponification value for sesame seed oil. Saeed and Shola (2015), obtained slightly higher saponification (229.545 mgKOH/g) for sesame oil. The current findings are slightly above the range (186-195 mg KOH/g) of the Codex Standard (2005). According to Tunde-Akintunde *et al.* (2012), the high saponification value suggests the use of the oil in production of liquid soap, shampoos and lather shaving creams. The peroxide value range (0.55 – 3.10) observed in this study is consistent with Zahran *et al.* (2020) who reported (1.01- 2.87 meg/kg) in sesame. The peroxide value in the different treatments was less than the acceptable level (5 meq/kg) for oils according to the FAO/WHO (2009). The iodine value (11.48-15.62) is lower than the values (100-103 g) reported by Warra, (2011), Olaleye *et al.* (2018) (83.73- 92.38 g) in sesame. The iodine value is within FAO/WHO recommended iodine value (50–55/gram). The free fatty acid observed in this study (0.20- 1.57) lower than that previously reported in M_4 lines of these mutants but falls within the acceptable limits (Codex, 2001). Free fatty acid is a vital parameter that confirms the stability of oil. High level of free fatty acid indicates poor quality of oil as it gives a bad taste (Dayrit *et al.*, 2007). The presence of unsaponifiable matter directly affected the oxidative stability of vegetable oils (Abou-Gharbia et al., 2000). The observed unsaponification value (1.31 -1.67) is in line with the findings of Zahran *et al.* (2020) reported 0.92- 1.65 for five sesame genotypes. The Viscosity value recorded (4-10) was higher than the report of Mazaheri *et al.* (2019) who obtained (5.50–7.95) for black seed oil.

Conclusion

The variations in some physicochemical parameter of sesame oil of the mutants, implied gamma ray is capable of inducing changes in the physicochemical properties of sesame oil. The variations have also placed oils from some mutants to more suitable in sector than the other.

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Table 1. Physicochemical parameters of the seed-oil

Mutants	SV	USV	Ester	Glycerin
04E-550-G1-3	172.43 ± 0.21a	1.31 ± 0.00a	171.92 ± 0.21a	9.39 ± 0.01a
04E-550-G2-3	183.72 ± 0.28b	1.39 ± 0.00b	183.32 ± 0.29d	9.69 ± 0.31ab
04E-550-G3-3	188.63 ± 0.70c	1.43 ± 0.00c	187.84 ± 0.68e	10.13 ± 0.09abcd
NCRIBEN-04E	183.58 ± 0.14b	1.39 ± 0.00b	182.13 ± 0.13cd	9.88 ± 0.08abc
01M-350-G1-2	219.49 ± 0.70g	1.67 ± 0.01g	217.55 ± 0.70i	11.58 ± 0.34e
01M-350-G1-2-1	188.77 ± 0.56c	1.43 ± 0.00c	187.95 ± 0.56e	10.47 ± 0.23abcd
01M-350-G2-2	208.97 ± 1.40f	1.58 ± 0.01f	207.10 ± 1.41h	10.85 ± 0.55cde
01M-350-G2-2-2	199.01 ± 0.14e	1.51 ± 0.00e	195.87 ± 0.14g	10.51 ± 0.21bcd
NCRIBEN-01M	180.43 ± 0.21b	1.37 ± 0.00b	179.05 ± 0.20bc	10.12 ± 0.35abcd
03L-250-G1-1	176.01 ± 3.50a	1.33 ± 0.02a	175.15 ± 3.50ab	10.20 ± 0.44abcd
03L-250-G1-1-1	196.56 ± 0.21de	1.49 ±0.00de	194.78 ± 0.20fg	10.30 ± 0.35abcd
03L-450-G1-2	212.47 ± 2.10f	1.62 ± 0.02f	209.69 ± 2.09h	11.60 ± 0.25e
03L-450-G2-2	194.24 ± 2.10d	1.47 ± 0.02d	191.11 ± 2.10ef	11.06 ± 0.51de
NCRIBEN-03L	193.26 ± 0.28d	1.46 ± 0.00d	191.94 ± 0.28efg	10.50 ± 0.00bcd

Values are mean ± standard error of the mean. Values along the same column with different superscripts are significantly different at $p < 0.05$. SV: Saponification value, USV: Unsaponification value

Table 2: physicochemical parameters of the seed-oil

Mutants	RI	AV	FFA	IV
04E-550-G_{1-3}	1.46 ± 0.01^{a}	0.51 ± 0.01^{b}	0.26 ± 0.00^{b}	12.54 ± 0.69^{a}
04E-550-G_{2-3}	1.47 ± 0.01^{a}	0.40 ± 0.02^{a}	0.20 ± 0.03^{a}	12.65 ± 0.58^{a}
04E-550-G_{3-3}	1.47 ± 0.02^{a}	0.79 ± 0.00^{c}	0.40 ± 0.03^{c}	12.72 ± 0.50^{a}
NCRIBEN-04E	1.46 ± 0.01^{a}	1.45 ± 0.00^{h}	0.73 ± 0.01^{h}	12.50 ± 0.73^{a}
01M-350-G_{1-2}	1.46 ± 0.01^{a}	1.94 ± 0.00^{k}	0.97 ± 0.02^{k}	12.46 ± 0.77^{a}
01M-350-$G_{1-2}{}^{1}$	1.46 ± 0.00^{a}	0.82 ± 0.00^{d}	0.41 ± 0.00^{d}	12.54 ± 0.68^{a}
01M-350-G_{2-2}	1.46 ± 0.01^{a}	1.87 ± 0.01^{j}	0.94 ± 0.02^{j}	12.52 ± 0.71^{a}
01M-350-$G_{2-2}{}^{2}$	1.49 ± 0.00^{a}	3.14 ± 0.00^{m}	1.57 ± 0.01^{m}	12.47 ± 0.76^{a}
NCRIBEN-01M	1.46 ± 0.00^{a}	1.38 ± 0.01^{g}	0.69 ± 0.00^{g}	13.22 ± 1.27^{ab}
03L-250-G_{1-1}	1.46 ± 0.00^{a}	0.86 ± 0.02^{e}	0.43 ± 0.00^{e}	12.15 ± 1.08^{a}
03L-250-$G_{1-1}{}^{1}$	1.46 ± 0.01^{a}	1.78 ± 0.02^{i}	0.89 ± 0.02^{i}	12.55 ± 0.68^{a}
03L-450-G_{1-2}	1.47 ± 0.00^{a}	2.79 ± 0.01^{l}	1.39 ± 0.00^{l}	12.46 ± 0.77^{a}
03L-450-G_{2-2}	1.47 ± 0.02^{a}	3.13 ± 0.01^{m}	1.57 ± 0.10^{m}	11.48 ± 0.01^{a}
NCRIBEN-03L	1.46 ± 0.00^{a}	1.32 ± 0.00^{f}	0.66 ± 0.02^{f}	15.62 ± 1.38^{b}

Values are mean ± standard error of the mean. Values along the same column with different superscripts are significantly different at $p < 0.05$. RI: refractive index, AV: Acid value, FFA: Free fatty acid, IV: Iodine value, PV: Peroxide value.

Table 3: physicochemical parameters of the seed-oil

Mutants	PV	Viscosity
04E-550-G_{1-3}	1.60 ± 0.10^{c}	9.00 ± 0.00^{d}
04E-550-G_{2-3}	3.10 ± 0.10^{f}	6.00 ± 0.00^{b}
04E-550-G_{3-3}	1.95 ± 0.05^{d}	5.00 ± 0.00^{a}
NCRIBEN-04E	1.35 ± 0.05^{b}	9.00 ± 0.01^{d}
01M-350-G_{1-2}	0.75 ± 0.15^{a}	9.00 ± 0.00^{d}
01M-350-$G_{1-2}{}^{1}$	1.45 ± 0.05^{bce}	5.00 ± 0.00^{a}
01M-350-G_{2-2}	2.25 ± 0.05^{e}	5.00 ± 0.00^{a}
01M-350-$G_{2-2}{}^{2}$	0.68 ± 0.08^{a}	6.00 ± 0.03^{b}
NCRIBEN-01M	1.45 ± 0.05^{bc}	8.00 ± 0.00^{c}
03L-250-G_{1-1}	1.65 ± 0.05^{c}	10.00 ± 0.00^{d}
03L-250-$G_{1-1}{}^{1}$	1.95 ± 0.05^{d}	9.00 ± 0.00^{d}
03L-450-G_{1-2}	2.36 ± 0.03^{e}	8.00 ± 0.00^{c}
03L-450-G_{2-2}	1.50 ± 0.10^{bc}	4.00 ± 0.01^{a}
NCRIBEN-03L	0.55 ± 0.05^{a}	10.00 ± 0.00^{d}

Values are mean ± standard error of the mean. Values along the same column with different superscripts are significantly different at $P < 0.05$ PV: Peroxide value