Journal of Sohag Agriscience (JSAS) 2024, 9(1): 204-213

ISSN 2357-0725
https://jsasj.journals.ekb.eg
JSAS 2024; 9(1): 204-213

Received: 14-03-2024
Accepted: 09-06-2024

Ismail M. A. Bedawy
Agronomy Department
Faculty of Agriculture
Sohag University
Sohag
Egypt

Mohamed A. H. Toweir
Food Science and Technology Department
Faculty of Agriculture
Omar Al-Mokhtar University
Libya

Mohamed A. Kelany
Food Science and Nutrition Department
Faculty of Agriculture
Sohag University
Sohag
Egypt

Corresponding author:
Mohamed A. Kelany
Mohamed.kelany@agr.sohag.edu.eg

Evaluation of Physio-chemical Characteristics of Sesame Oil from Promising Sesame (*Sesamum indicum L.*) Lines and Varieties

Ismail M. A. Bedawy, Mohamed A. H. Toweir and Mohamed A. Kelany

Abstract

The present study was conducted for assessment of the oil quality traits of 22 sesame genotypes including 16 promising sesame lines, 4 local varieties, and 2 introduced lines. Highly significant variances found between studied genotypes for all studied traits. Results revealed notable physical, chemical, and phytochemical characteristics. Variations in oil content, ranging from 46.7% to 61.85%, were attributed to genetic diversity. Physical properties such as refractive index, viscosity, and pH values varied among varieties, consistent with previous research on deferent sesame cultivars. Iodine numbers aligned with FAO recommendations and showed slight variations based on cultivars. Peroxide and acid values displayed significant differences across cultivars, potentially influenced by genetic and environmental factors. DPPH scavenging activity varied, with tocopherol content ranging from 287.39 mg/kg to 630.95 mg/kg, supported by previous studies. Total phenol content (TPC) ranged from 10.69 to 27.54 mg GAE/kg, sufficient for preserving the oxidative stability of fatty foods based on previous findings. These comprehensive characterizations significantly contribute to the understanding of sesame seed varieties and their potential applications.

Keywords; Sesame, Phytochemical, Oil, Quality, genotype

INTRODUCTION

Sesame (*Sesamum indicum* L.) is one of the most important and oldest oil crops grown in the world (Bedigian 2004). Sesame seeds are characterized by their high oil content, which reaches 60% and 30 % protein (Ashri 1998; and Arslan *et al.* 2007). Sesame oil is characterized by its high content of antioxidants such as sesamin and sesamol and highly stable (Davidson 1999), as well as its high content of important nutrients such as calcium and Phosphorous and Vitamin E (Weiss 2000, Hamza and Abd El-Salam 2015). Sesame is reported it could be grown in the new reclaimed soils (Boureima *et al*., 2016). The production of new varieties of sesame crops through breeding programs is considered a major challenge at the present time. Due to the fluctuating climatic conditions and the high sensitivity of sesame to diseases infection especially wilt disease. The assessment of sesame varieties based on their physical, chemical, and phytochemical properties is vital for determining their agricultural potential, oil quality, and nutritional benefits. Sesame is recognized for its diverse genetic traits, which significantly influence the quality of the oil produced, making it a crop of considerable economic and nutritional importance worldwide (Anilakumar *et al.,* 2010). Physically, sesame seeds vary widely in weight, size, and density, factors that collectively impact the overall oil yield. Recent studies have reported that the 1000-seed weight of different sesame varieties falls between 2.74 and 3.16 grams, while true density measurements range from 1190.66 to 1215.58 kg/m³ (Zebib *et al.,* 2015; Oboulbiga *et al.,* 2023). These physical characteristics are crucial as they affect both the efficiency of oil extraction, and the quality of the oil extracted. Chemically, oil content and fatty acid composition are critical for assessing oil quality. (Olasunkanmi *et al.,* 2017). Chemical analyses typically evaluate parameters such as saponification value, free fatty acids (FFA), and oxidative stability, all of which are essential for determining the oil's edibility and shelf life (Olaleye *et al.,* 2018). As an illustration, the Abasena variety is classified as producing non-edible oil due to its low saponification value and high FFA content, indicating substandard oil quality (Mbaebie *et al.,* 2010; Olaleye *et al.,* 2019). From a phytochemical perspective, sesame oil is rich in bioactive compounds, including lignans (such as sesamin and sesamolin), tocopherols, and phytosterols, which contribute to its antioxidant properties (Zebib *et al.,* 2015; Oboulbiga *et al.,* 2023). The presence of these beneficial compounds is associated with various health advantages, such as reducing oxidative stress and lowering cholesterol levels, thus highlighting sesame oil as an essential nutritional resource (Idowu *et al.,* 2021). Furthermore, comparative evaluations of different sesame cultivars reveal significant biochemical diversity, emphasizing the need to select appropriate varieties for specific health and nutritional benefits (Anilakumar *et al.,* 2010). In this study, we sought to evaluate 22 sesame varieties based on various physical, chemical, and phytochemical properties to identify the most suitable varieties for widespread cultivation. Specifically, the objective was to assess yield and oil quality traits associated with distinct sesame lines previously selected for their resistance to wilt disease and high yield (Bedawy and Mohamed, 2018; Bedawy and Moharam, 2018). Additionally, we aimed to examine the chemical and physical characteristics of the oil extracted from these seeds, as these properties are crucial for determining oil quality. By investigating the relationship between crop characteristics and oil quality, this study contributes to the selection of exceptional varieties that can be adopted and promoted among farmers.

MATERIALS AND METHODS

1. Materials

Sesame Seed Cultivars: The present plant material consisted of 22 sesame genotypes (16 promising lines, 2 introduced lines and 4 local cultivars). The promising lines used in this work were previously selected against wilt disease and it has a high yield (Mahdy *et al*., 2005 and b, Bedawy and Moharam 2018 and Bedawy and Moharm 2019). The twenty-two sesame genotypes were shown in field experiment in summer season of 2023 and

arranged in RCBD with three replicates each genotype was represented in one row in the replication, the row was 3 meter long, 20 cm between halls, 60 cm apart. Four yield traits were studied; seed yield per plant, capsule number, capsule length and thousand seed weight all these traits are considered as yield related traits.

2. Methods

2.1. Preparation of Sesame Seed for Analysis:

The seeds were cleaned, sorted out and crushed into smaller particles. Part of the seed was kept at 4°C for further analysis. The other part was used for oil extraction.

2.2. Oil Extraction:

The oil from crushed seeds was extracted by Soxhlet device using petroleum ether for 72 hours at room temperature. The extracted oil was filtered and then evaporated under vacuum at 50°C. The oil obtained was dried on anhydrous sodium sulphate and kept for further analysis.

2.3. Physicochemical Analysis of Seed Oil:

The pH value, refractive index, viscosity, iodine value, value, acid value and peroxide value of oil samples were determined by AOAC (2000) methods.

2.4. The Total Phenolic Content determination:

The total phenolic content (TPC) of sesame seed oils was determined using the Folin-Ciocalteu colorimetric method, with some modifications. Phenols were extracted by adding 3 ml of a 80:20 methanol:water solution to 1 g of oil, followed by vortexing and centrifugation. This extraction was repeated three times, and the methanolic extracts were combined and concentrated. For quantification, 0.2 ml of the phenolic extract was mixed with Folin–Ciocalteu reagent and sodium carbonate, then diluted to 10 ml with distilled water and left for 30 minutes in the dark. The absorbance was measured at 765 nm using a UV–Vis spectrophotometer. Results were expressed in milligrams of gallic acid equivalents per kilogram of oil (mg GAE/kg), based on a standard curve prepared with concentrations ranging from 25 to 200 mg/l in a 70% methanol solution according to Kelany *et al.* (2024).

2.5. Tocopherol content determination:

To determine tocopherol levels according to Matthäus & Özcan (2018), a solution of 250 mg of oil was dissolved in 25 mL of n-heptane for HPLC analysis. The analysis was performed on a Merck-Hitachi low-pressure gradient system using a L-6000 pump and a F-1000 fluorescence spectrophotometer, with excitation at 295 nm and emission at 330 nm. A 20 µL sample was injected using a Merck 655-A40 autosampler onto a Diol phase HPLC column (25 cm x 4.6 mm ID) with a flow rate of 1.3 mL/min. The mobile phase consisted of n-heptane and tert-butyl methyl ether in a 99:1 ratio (v/v).

2.6. Antioxidant Activity:

The free radical scavenging activity of studied oil samples was determined using the diphenyl picrylhydrazyl (DPPH) assay according to Ramadan *et al.* (2012). The evaluation method is based on monitoring the decrease in absorbance of the DPPH radical (2,2-diphenyl-1-picrylhydrazyl) in the presence of antioxidants. The reaction mixture contained 150 µL DSPC-HPH and 2850 µL methanolic DPPH (0.24 mM). The mixture was incubated at room temperature for 30 min and the absorbance at 515 nm was determined. The percentage of DPPH scavenged was calculated from the following equation.

DPPH scavenging *% = (A0 – As/A0) X 100*
Where A0 is the absorbance of the blank, and AS is the absorbance of sample at 515 nm.

3. Statistical analysis

The data were statistically analyzed in SAS statistical software (SAS 9.2, SAS Institute 2008). The LSD at 5% and 1% significant levels were calculated according to Petersen (1985), for comparing the genotypes mean values of the studied traits.

RESULT AND DISCUSSION

Highly significant differences were found for all the studied traits of 22 studied genotypes (Table 1). Heretabilty in broad sense values were higher than 90% for nine traits; oil percentage, capsule length, capsule number, thousand seed weight, Viscosit, Iodine V, PV, acid V and T Tocophe. Also, heritability values have values higher than 80% for four traits: seed yield/ plant, RF index, pH and Total Phe. The lowest heritability value was recorded for %DPPH trait (Table 1).

Table 1 Analysis of variance of studied genotypes for the seed yield and quality traits

S.O.V	DF	Oil%	Seed yield	Capsule length	Capsule number	1000 seed weight	RF index	Viscosity	pH	Iodine V	PV	Acid V	Total Phe	T Tocophe	%DPPH
		MS													
Rep.	2	0.02	0.17	0.0003	13.23	0.003	0.0000001	0.57	0.005	0.49*	0.003	0.11	3.09	214.37	10.99
Genotypes	21	56.27**	9.00**	0.11**	515.13**	0.38**	0.000026**	7.55**	0.47**	23.67**	11.01**	4.33**	52.36**	35262.79**	76.77**
Error	42	0.40	0.37	0.001	13.99	0.005	0.0000002	0.21	0.03	0.10	0.14	0.10	3.21	364.95	12.13
Mean		57.23	14.49	2.59	139.18	3.76	1.470	22.17	4.92	113.68	6.13	5.92	21.26	458.89	30.48
Heritability		97.87 %	88.67 %	97.02%	92.27%	96.51 %	82.85%	92.12%	82.14 %	98.80 %	96.30%	93.31%	83.63 %	96.96%	63.99 %

Where, * and ** significant and highly significant at 5% and 1% levels of probability. The highly heritability values which recorded for almost studied traits brief that all these lines are very stable and the differences between them back to the genetic differences and lowest effect for environment on them (Abate *et al*., 2015 and Bedawy and Mohamed 2018). The mean performance for all studied genotypes and traits were presented in Table 2. Results showed that six lines (6, 12, 33, 34, 39 and 40) had seed yield higher than 17 g per plant. All lines had high seed yield per plant compared with examined varieties except lines number 7 and number 58. Meanwhile, the capsule number per plant varied from 113.67 for the variety Shandaweil3 to 159.33 for lines number 12 and 40. Wide range was found in capsule length trait 2.34 to 3.17 cm. Five lines (7, 12, 33, 34 and 58) and two varieties (Shandaweil3 and Toshka1) had mean values for thousand seed weight trait exceeded 4 g. Seven out of 22 tested lines had oil % mean values exceeded 60% and higher than all examined varieties, there were lines 6, 7, 33, 34, 39, 41 and 62. These results are matching with to those obtained by Hika *et al.,* 2015 and Bedawy and Mohamed 2018.

Table 2 Mean performance of studied genotypes for the seed yield and quality traits

Genotype	Seed yield, g	Capsule number	Capsule length, cm	1000 seed weight, g	Oil%	RF index	Viscosity	pH	Iodine V	PV	Acid V	Total Phe	T Tocophe	%DPPH
L6	17.90	155.00	2.58	3.81	61.61	1.47	23.31	4.63	109.15	7.51	4.96	24.29	561.98	33.77
L7	12.99	143.00	2.48	4.23	61.11	1.47	22.50	4.73	108.46	8.51	4.55	15.52	322.44	27.64
L12	16.45	159.33	2.41	4.04	59.04	1.47	23.79	4.48	117.18	3.92	5.59	19.09	355.94	27.82
L13	14.34	149.00	2.34	3.80	57.78	1.47	21.27	4.62	114.51	5.74	6.83	20.49	463.56	20.98
L33	17.14	147.00	2.57	4.07	61.40	1.47	22.11	4.37	111.73	2.58	4.23	24.11	332.81	28.20
L34	16.08	146.00	2.68	4.57	60.18	1.47	21.80	5.49	111.76	8.07	6.34	26.60	437.88	31.72
L38	14.60	139.00	2.46	3.64	59.40	1.47	20.03	5.23	115.22	7.65	5.50	21.32	432.65	35.13
L39	16.56	153.67	2.54	3.07	61.85	1.47	24.24	5.27	110.16	6.45	7.40	22.07	491.50	26.51
L40	16.51	159.33	2.57	3.35	57.25	1.47	20.25	5.29	114.38	3.44	7.84	21.63	526.43	30.80
L41	14.49	138.67	2.43	3.35	61.01	1.47	24.06	5.35	112.07	6.91	6.55	21.96	511.74	32.10
L45	14.27	142.33	2.58	3.64	46.73	1.47	20.96	4.45	113.11	6.40	4.56	23.46	552.02	36.72
L46	14.03	142.67	2.55	3.45	47.02	1.47	22.13	4.57	115.77	2.91	6.88	19.14	474.34	28.80
L56	15.70	137.00	2.59	3.71	54.86	1.47	20.00	4.83	112.56	5.77	5.47	22.10	467.73	33.52
L58	11.89	127.67	2.60	4.06	58.66	1.47	24.94	4.70	114.23	7.92	4.76	10.69	287.39	27.29
L61	14.14	142.00	2.63	3.47	58.77	1.47	21.46	5.16	117.16	4.36	4.55	18.22	311.80	25.75
L62	13.48	143.00	2.53	3.55	60.07	1.47	23.19	5.17	109.54	4.23	4.80	15.00	315.18	23.53
Intr. No. 153515	13.37	117.67	2.40	3.59	58.13	1.48	24.15	5.44	118.07	7.92	7.94	26.72	644.68	41.11
Intr. No. 158071	11.15	132.33	2.75	3.61	52.33	1.47	23.60	5.25	117.44	8.44	7.95	27.54	630.95	38.32
Giza25	12.99	128.00	2.71	3.73	53.51	1.47	20.82	4.47	114.74	6.43	6.91	25.85	608.38	36.60
Giza32	13.09	130.33	2.47	3.58	55.21	1.47	20.57	4.30	115.36	7.61	5.38	24.28	548.89	30.25
Shandaweil3	13.64	113.67	3.03	4.14	54.01	1.47	19.79	5.38	115.99	7.81	5.65	18.84	433.37	28.71
Toshka1	13.88	115.33	3.17	4.29	59.17	1.47	22.71	5.13	112.47	4.20	5.66	18.86	383.94	25.27
L.S.D 0.05	**1.028**	**0.057**	**6.341**	**0.115**	**1.078**	**0.001**	**0.776**	**0.303**	**0.524**	**0.633**	**0.539**	**3.035**	**32.386**	**5.904**
L.S.D 0.01	**1.467**	**0.078**	**8.630**	**0.157**	**1.399**	**0.001**	**1.056**	**0.412**	**0.713**	**0.861**	**0.733**	**4.131**	**44.079**	**8.035**

They found a highly significant differences among the studied genotypes for seed yield and other studied traits**.** Figure (1) represents a simple comparison between studied genotypes in two important traits; seed yield and oil %, it is clearly shown that lines 6, 33, 34 and 39 have the best mean values for both traits at the same time.

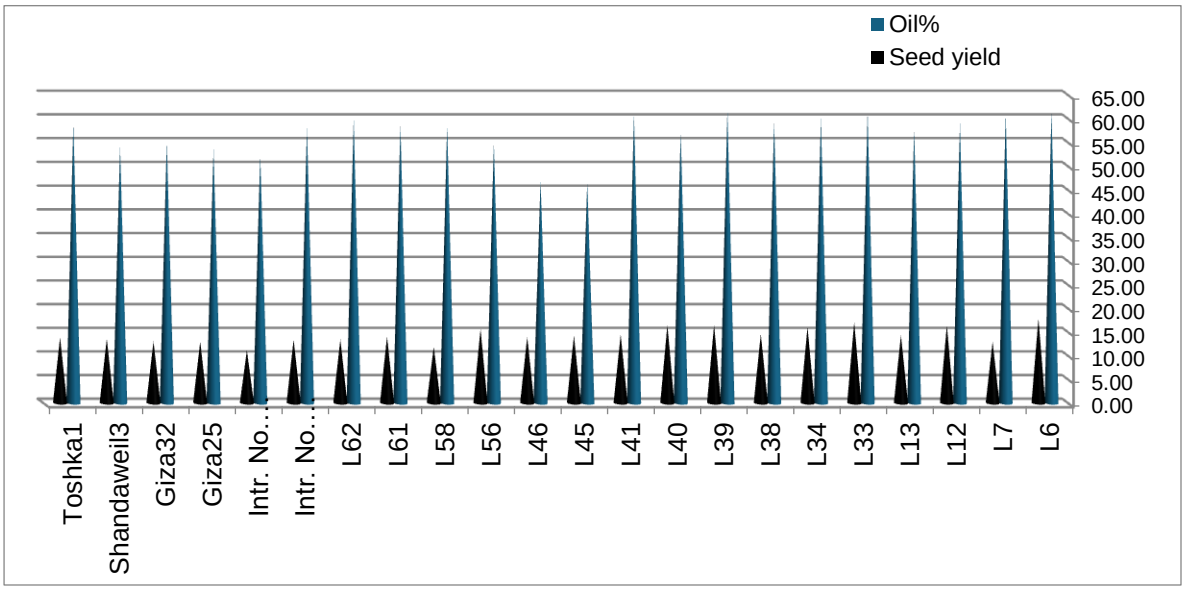

Fig. 1 Means of genotypes for Seed yield and oil % traits

Table (2) displays also the mean values of some physical, chemical and phytochemical characteristics of the studied sesame genotypes under the current investigation. The oil content of sesame seeds ranged from 46.7 up 61.85% for L45 and L39, respectively. These oil levels align with those reported by El Khier et al. (2008) in their study on 10 sesame seed varieties cultivated in Sudan. The genetic characteristics of each variety may account for the variation in oil content percentage as suggested by Wei et al. (2015, 2017). The physical characteristics of the extracted oil from all the studied varieties demonstrate comparable refractive index values (1.472 – 1.476), consistent with the findings reported by Olaleye et al. (2019). The viscosity of sesame oil ranged from 19.79 cps for Shandaweil3 variety to 24.24 cps for the L39 variety, consistent with the findings of El Khier et al. (2008) for Sudanese genotypes of sesame and Olasunkanmi, et al. (2017) for Nigerian genotype. The pH values also ranged between 4.30 and 5.49 for Giza32 and L34 varieties respectively, which are in line with the trend observed in the Sudanese genotypes reported by El Khier et al. (2008).

The iodine number ranged from 108.46 g/100g for the L7 variety to 118.07 g/100g for the Intr. No. 153515 varieties. Although these results were slightly higher than the values reported for Sudanese varieties by El Tinay (1989) and El Khier et al. (2008), they were consistent with the FAO recommendations as reported by Gunnarsdottir, and Dahl, (2012). The peroxide value, representing the oxidative stability of the sesame oil samples under study, spanned from 2.91 up to 8.51 for L46 and L7. Analysis revealed significant variations ($p < 0.05$) in both peroxide value and acid value (ranging from 4.23 to 7.95 mg/g) across different sesame seed cultivars. These findings are consistent with those reported by Naz et al. (2019) and Yu et al. (2021). Notably, the acid values of some cultivars exceeded the FAO-recommended threshold of 6 mg/g, potentially influenced by genetic factors and/or environmental conditions during cultivation as suggested by Sun et al. (2018). The phytochemical content of the examined sesame oil varieties is detailed in Table (2). The highest DPPH scavenging activity observed was 38.32% for the Intr. No. 158071 variety, with the lowest recorded as 20.98% for

the L13 variety. In comparison, our findings showed lower DPPH activity than that reported in the study by Pathak et al. (2020), where percentages of 55.73% and 61.16% were found for the antioxidant activity of sesame seeds. Additionally, the data presented in our study demonstrated DPPH scavenging activity lower than the values reported by Rizki et al. (2014), who characterized the antioxidant potential of 35 sesame seed cultivars and observed DPPH scavenging activities between 60-63% for Moroccan cultivars of sesame. The tocopherol content of the studied varieties revealed the highest level in the Intr. No. 158071 variety at 630.95 mg/kg, while the lowest level was found in the L58 variety at 287.39 mg/kg. This aligns with the findings reported by Haji et al. (2008), which ranged from 563 to 1095 mg/kg for seven cultivars of Iranian sesame. Total phenol content (TPC) ranged from 10.69 Up to 27.54 mg GAE/kg for L58 and Intr. No158071 variety. These findings were lower than those reported by Dravie et al. (2020), but the amounts were deemed adequate for safeguarding the oxidative stability of fatty foods, as noted by Ramadan et al. (2012). The simple correlation values which calculated among studied traits (Table 3) revealed that oil % correlated positively and significantly correlated with seed yield and Viscosity and negatively with Iodine V, T Tocophe and %DPPH traits. Seed yield trait had a positive and significant correlation with trait capsule number and a negative correlation with Iodine V and PV traits. Moreover, a positive correlation value (r= 0.407) was found between capsule length and thousand seed weight traits. The capsule number trait had a reverse correlation with three traits RF index, Iodine V and PV. As well as the thousand seed weight trait correlated negatively and significantly with traits acid V and T Tocophe. On the other hand, the correlation between chemical and … traits were positively and significant. The highest correlation value r= 0.795 was recorded between total phe and T Tocopherol traits.

Table 3 Simple correlation coefficient values between all studied traits

Trait	Oil%	Seed yield	Capsule length	Capsule number	1000 seed weight	RF index	Viscosity	pH	Iodine V	PV	Acid V	Total Phe	T Tocophe
Seed yield	0.384*												
Capsule length	-0.165	-0.180											
Capsule number	0.242	0.673**	-0.562**										
1000 seed weight	0.184	-0.0128	0.407*	-0.238									
RF index	0.046	-0.144	-0.224	-0.366*	-0.106								
Viscosity	0.382*	-0.091	-0.176	0.060	-0.05	0.279							
pH	0.291	-0.058	0.257	-0.213	-0.099	0.291	0.115						
Iodine V	-0.454**	-0.372*	0.016	-0.335*	-0.147	0.348*	-0.154	0.061					
PV	0.068	-0.397*	-0.015	-0.364*	0.174	0.209	0.103	0.248	-0.032				
Acid V	-0.172	-0.099	-0.054	-0.042	-0.395*	0.375*	0.116	0.436*	0.379*	0.099			
Total Phe	-0.174	0.230	-0.038	0.017	-0.137	0.292	-0.186	0.075	0.187	0.189	0.481*		
T Tocophe	-0.412*	-0.064	-0.072	-0.137	-0.408*	0.382	-0.097	0.074	0.272	0.341*	0.676**	0.795**	
%DPPH	-0.342*	-0.117	-0.047	-0.246	-0.148	0.469*	-0.058	0.124	0.295	0.450*	0.337	0.677**	0.743**

Where, * and ** significant and highly significant at 5% and 1% levels of probability.

The conducted principal component analysis figure which is done using all studied traits (Figure 2), separated studied genotypes into four main groups. Group number 1 had 11 lines which had the higher means for important traits like seed yield per plant, capsules number and oil percentage. Second group had four genotypes two varieties and two introduced (Intr. No. 153515, Intr. No. 158071, Giza25 and Giza32). Moreover, the third one had only two varieties (Shandaweil3 and Toshka1). The fourth group had five lines (12, 33, 58, 61 and 62). It easily showed that the best and most important lines in this work are in group one.

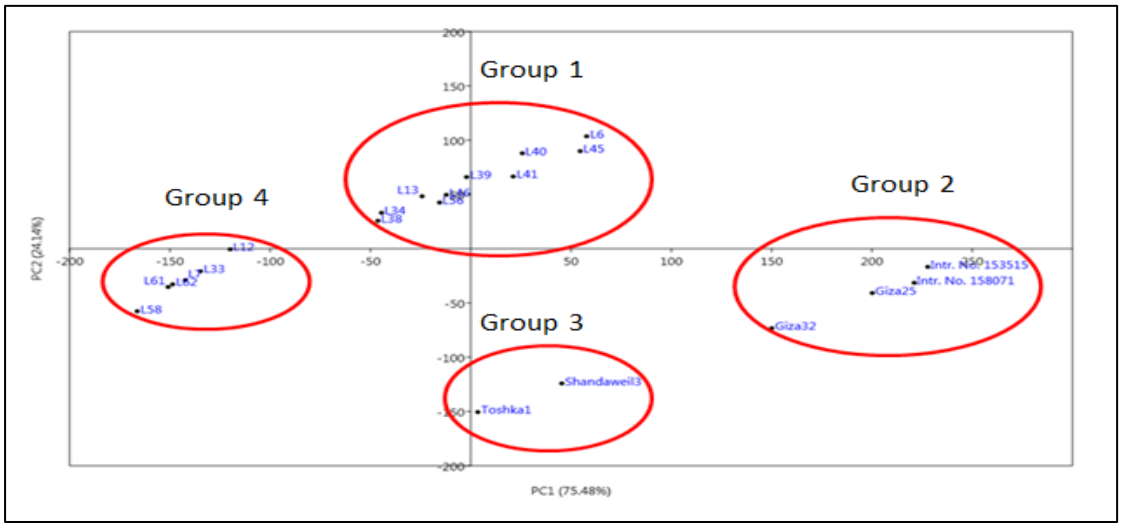

Figure 2. Principal component analysis for studied genotype based on all studied traits

CONCLUSION

The analysis of various physical, chemical, and phytochemical characteristics of the studied sesame varieties offers valuable insights. The differing oil content, physical properties, iodine numbers, peroxide values, and phytoch mical content across the varieties highlight the diverse nature of sesame seeds. The findings align with previous studies, shedding light on the genetic influences and environmental factors affecting these characteristics. While some results diverge from prior research, the observed levels of DPPH scavenging activity, tocopherol content, and total phenol content provide significant information about the antioxidant potential and oxidative stability of the examined sesame oil varieties. This comprehensive exploration contributes to a deeper understanding of the unique properties and potential applications of different sesame cultivars.

REFERENCES

Abate, M., Mekbib, F., Ayana, A., & Nigussie, M. (2015). Genetic variability and association of traits in mid-altitude sesame (*Sesamum indicum L.*) germplasm of Ethiopia. *American Journal of Experimental Agriculture*, *9*(3), 1-14.

Anilakumar, K. R., Pal, A., Khanum, F., & Bawa, A. S. (2010). Nutritional, medicinal and industrial uses of sesame (*Sesamum indicum L.*) seeds-an overview. *Agriculturae Conspectus Scientificus*, *75*(4), 159-168.

AOAC 2000. Association of Official Analytical Chemists, 17th Ed. of A.O.A.C. International. Published by A.O.A.C. International. Maryland, U.S.A., 1250 pp.

Arslan, Ç., Uzun, B., Ülger, S., & İlhan Çağırgan, M. (2007). Determination of oil content and fatty acid composition of sesame

mutants suited for intensive management conditions. *Journal of the American Oil Chemists' Society*, *84*, 917-920.

Ashri., A. (1998) Sesame breeding. *Plant Breed Rev* 16:179–228

Bedawy, I. M. A., & Moharam, M. H. A. (2018). Performace of some Sesame (*Sesamum indicum L.*) Genotypes for Resistance to Wilt Disease Caused by Fusarium oxysporum f. sp. Sesami. *Journal of Plant Production*, *9*(12), 1063-1068.

Bedawy, I. M., & Mohamed, N. E. (2018). Phenotypic and genotypic variability in a set of Sesame (*Sesamum indicum L.*) genotypes. *Egyptian Journal of Agronomy*, *40*(3), 193-205.

Bedawy, I., & Moharm, M. (2019). Reaction and performance of some sesame genotypes for resistance to Macrophomina phaseolina, the incitant of charcoal rot disease. *Alexandria Science Exchange Journal*, *40*(JANUARY-MARCH), 12-18.

Bedigian, D. (2004). Slimy leaves and oily seeds: distribution and use of wild relatives of sesame in Africa. *Economic Botany*, *58*(1), S3-S33.

Boureima, S., Diouf, S., Amoukou, M., & Van Damme, P. (2016). Screening for sources of tolerance to drought in sesame induced mutants: Assessment of indirect selection criteria for seed yield. *International Journal of Pure and Applied Bioscience*, *4*(1), 45-60.

Davidson, A. (1999) The Oxford companion to food. Oxford University Press, London, UK.

Dravie, E. E., Kortei, N. K., Essuman, E. K., Tettey, C. O., Boakye, A. A., & Hunkpe, G. (2020). Antioxidant, phytochemical and physicochemical properties of sesame seed (*Sesamum indicum L*). *Scientific African*, *8*, e00349.

El Khier, M. K. S., Ishag, K. E. A., & Yagoub, A. A. (2008). Chemical composition and oil characteristics of sesame seed cultivars grown in Sudan. *Research Journal of Agriculture and Biological Sciences*, *4*(6), 761-766.

El Tinay, A.H., A.H. Khatab and M.O. Khidir, 1989. Protein and oil composition of sesame seed. J. AOAC, 53: 648-653.

Gunnarsdottir, I., & Dahl, L. (2012). Iodine intake in human nutrition: a systematic literature review. *Food & nutrition research*, *56*(1), 19731.

Haji, M. M., Oveysi, M., Sadeghi, N., Janat, B., BAHA, A. Z., & Mansouri, S. (2008). Gamma tocopherol content of Iranian sesame seeds.

Hamza, M., & Abd El-Salam, R. M. (2015). Optimum planting date for three sesame cultivars growing under sandy soil conditions in Egypt. *American-Eurasian Journal of Agriculture and Environmental Science*, *15*(5), 868-877.

Hika, G., Geleta, N., & Jaleta, Z. (2015). Genetic variability, heritability and genetic advance for the phenotypic traits in sesame (Sesamum indicum L.) populations from Ethiopia. *Science, Technology and Arts Research Journal*, *4*(1), 20-26.

Idowu, A. O., Alashi, A. M., Nwachukwu, I. D., Fagbemi, T. N., & Aluko, R. E. (2021). Functional properties of sesame (Sesamum indicum Linn) seed protein fractions. *Food Production, Processing and Nutrition*, *3*, 1-16.

Kelany, M. A., Limam, S. A., & Toweir, M. A. (2024). Impact of Date Seed Powder as A Natural Antioxidant for Improving Oxidative Stability of Beef and Chicken Burgers. *Assiut Journal of Agricultural Sciences*, *55*(2), 111-124.

Liu, C., Wang, N., Wu, D., Wang, L., Zhu, X., & Yu, D. (2024). The effect of the fatty acid composition of fried oil on the oil-absorbing capacity of tofu puffs. *LWT*, *203*, 116406.

Mahdy, E. E., Bakheit, B. R., Motawea, M. M., and Bedawy, I.M. (2005 a) Pedigree selection for resistance to *Sclerotium bataticola* in three sesame populations. *Assiut Journal of Agricultural Sciences,* 63(1): 57-72.

Mahdy, E. E., Bakheit, B. R., Motawea, M. M., and Bedawy, I. M. (2005 b) Pedigree selection for resistance to *Fusarium oxysporum* in three sesame populations. *Assiut Journal of Agricultural Sciences,* 63(1): 141-157.

Matthäus, B., & Özcan, M. M. (2018). Fatty acid composition and tocopherol contents of some sesame seed oils. *Iranian Journal of Chemistry and Chemical Engineering*, *37*(5), 151-155.

Mbaebie, B., Omosun, G., Uti, A., & Oyedemi, S. (2010). Chemical composition of *Sesamum indicum L.* (Sesame) grown in southeastern

Nigeria and the physicochemical properties of the seed oil. *Seed science and biotechnology*, *4*(1), 69-72.

Naz, S., Shabbir, M. A., Khan, M. R., & Shahid, M. (2019). Comparison of flaxseed oil characteristics of three Pakistani varieties obtained by supercritical CO 2 and two conventional extraction methods. *International food research journal*, *26*(5).

Oboulbiga, E. B., Douamba, Z., Compaoré-Sérémé, D., Semporé, J. N., Dabo, R., Semde, Z., ... & Dicko, M. H. (2023). Physicochemical, potential nutritional, antioxidant and health properties of sesame seed oil: a review. *Frontiers in Nutrition*, *10*, 1127926.

Olaleye, A. A., Adamu, Y. A., & Lawan, U. (2019). Effects of temperature change on the physico-Chemical Properties of sesame seed oil. *Science*, *7*(1), 13-20.

Olaleye, A. A., Adamu, Y. A., & Lawan, U. (2019). Effects of temperature change on the physico-Chemical Properties of sesame seed oil. *Science*, *7*(1), 13-20.

Olaleye, O. O., Eke, M. O., & Aondo, T. O. (2018). Extraction, physicochemical and phytochemical characterization of oil from sesame seed. *Asian Food Science Journal*, *1*(4), 1-12.

Olasunkanmi, G. S., Omolayo, F. T., & Olusegun, O. T. (2017). Fatty acid profile, physico-chemical and functional properties of oil and protein isolate simultaneously extracted from sesame (*Sesamum indicum*) seed. *Annals: Food Science & Technology*, *18*(1).

Olasunkanmi, G. S., Omolayo, F. T., & Olusegun, O. T. (2017). Fatty acid profile, physico-chemical and functional properties of oil and protein isolate simultaneously extracted from sesame (*Sesamum indicum L.*) seed. *Annals: Food Science & Technology*, *18*(1).

Pathak, N., Verma, N., Singh, A., Bhat, K. V., & Lakhanpaul, S. (2020). Investigations on diverse sesame (S. indicum L.) germplasm and its wild allies reveal wide variation in antioxidant potential. *Physiology and molecular biology of plants*, *26*, 697-704.

Petersen, R. G. (1985) Design and analysis of experiments. Marcel Dekker, Inc. New York. 436 pp.

Ramadan, B. R., Sorour, M. A., & Kelany, M. A. (2012). Changes in total phenolics and DPPH scavenging activity during domestic processing in some cereal grains. *Annals Food Science & Technology*, *13*, 190-196.

Rizki, H., Kzaiber, F., Elharfi, M., Latrache, H., Zahir, H., & Hanine, H. (2014). Physicochemical characterization and in vitro antioxidant capacity of 35 cultivars of sesame (*Sesamum indicum L.*) from different areas in Morocco. *Int J Sci Res*, *3*, 2306-2311.

SAS Institute (2008) The SAS system for Windows, release 9.2. SAS Institute, Cary, N.C. USA.

Sun, S., Jin, Y., Hong, Y., Gu, Z., Cheng, L., Li, Z., & Li, C. (2021). Effects of fatty acids with various chain lengths and degrees of unsaturation on the structure, physicochemical properties and digestibility of maize starch-fatty acid complexes. *Food Hydrocolloids*, *110*, 106224.

Wei, X., Gong, H., Yu, J., Liu, P., Wang, L., Zhang, Y., & Zhang, X. (2017). SesameFG: an integrated database for the functional genomics of sesame. *Scientific reports*, *7*(1), 2342.

Wei, X., Liu, K., Zhang, Y., Feng, Q., Wang, L., Zhao, Y., ... & Zhang, X. (2015). Genetic discovery for oil production and quality in sesame. *Nature communications*, *6*(1), 8609.

Weiss, E.A., 2000. Oilseed Crops, 2 Ed, Blackwell Science, Oxford, Ch., 5: 131-164.

Yu, Q., Ma, Y. X., Qin, Z., Luo, X. R., Liu, H. M., & Wang, X. D. (2021). Using solid acid catalysts to improve the oxidative stability of cold-pressed sesame oil. *Lwt*, *141*, 110928.

Zebib, H., Bultosa, G., & Abera, S. (2015). Physico-chemical properties of sesame (*Sesamum indicum L.*) varieties grown in Northern Area, Ethiopia. *Agricultural Sciences*, *6*(02), 238.