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Induction of variability in fatty acid profile in sesame (*Sesamum indicum* L.)

K.D. Savant[1] and V.S.Kothekar[2]

[1]Department of Botany, Rajarshi Shahu Mahavidyalaya, Latur, Maharastra,India
[2]Department of Botany, Dr.B.A.M.U.,Aurangabad. Maharastra, India

Abstract
Among oilseed crops, sesame (*Sesamum indicum* L.) is the most ancient oilseed known and grown by humans. It has been demonstrated that the oil content of sesame and its fatty acid composition are influenced by the genetic characteristics of variety and environmental factors during oil accumulation. Transgenic, induced mutations, natural mutations, and combining two or more genes for enhanced oil traits have been the approaches used in breeding for improved oil content. The present study aimed to compare five macro mutants of sesame variety JLT-7 with their control in regard to oil content / fatty acid composition. In present investigation seeds of sesame were treated with mutagens and five macro mutants were isolated. The seeds from such mutants and control were subjected to oil extraction by Soxhlet method and the subsequent fatty acid analysis using gas chromatography. Mutagenic treatments tried in present studies have induced variation in oil content and fatty acid composition in oil of different mutants as compared with their control. The mutants revealing enhancement in seed oil content comprised late maturing tall mutant. Some mutants had saturated fatty acids higher than control besides lower concentration of polyunsaturated fatty acids. As regards the oleic acid, the high yielding/branched mutant could reveal the highest oleic acid content.

Keywords: Mutagens, EMS, SA, Fatty acid composition

INTRODUCTION

The mutation breeding has become an alternative to conventional breeding since last few decades with the sole objective of developing better cultivars of economically important crops. During the recent decade, mutation techniques are no longer used only as a tool for crop improvement of traditional traits, e.g. yield, resistance to disease and pests, but more frequently for diversified uses of crop end-products, enhancing quality and nutritional values and tolerances to abiotic stresses. Sesame oil contains more unusual minor components and exhibits more unusual physiological properties than any other common edible oil. Most oilseed crops accumulate a limited range of fatty acids in their seed oil. Just six fatty acids contribute more than 95% of world production. Many other fatty acids are of considerable interest as renewable feedstocks for chemical industries. These include the VLCFAs behenic (20:0), eicosenoic (20:1), and erucic (22:1) . Sesame seed is a rich source of oil, protein, calcium and phosphorus. Among oil seed crops sesame ranks first for having the highest oil content (40-60 %) and dietary energy (635 Kcal/ Kg) in Seeds[1] .

In general sesame oil contains 35 to 43 % oleic acid (C18:1) 37-47% linoleic acid (C18:2), 9 to 11 % palmitic acid (C16:0), 5 to 10 % stearic acid (C18:0), and 0.7 % arachidic acid (C20:0)[2]. But the sowing date is also known to influence fatty acid composition of sesame by decreasing linoleic acid and increasing oleic / stearic acid contents as the sowing gets delayed[3].Moreover, the maturity of sesame seeds may also lead to changes in fatty acid[4]. Not only these conditions affect fatty acid composition but the genetic components play an important role in the process. The improvement aspects like quality and quantity of oil and protein have been successfully attained by several researchers through mutation breeding in oil crops like Soybean [5]and Safflower [6-7].

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*Corresponding Author

K.D. Savant
Department of Botany, Rajarshi Shahu Mahavidyalaya, Latur,Maharastra, India

Tel: +91-9421338734
Email: kdsavant_botany@yahoo.co.in

MATERIAL AND METHODS

The seeds of sesame (*Sesamum indicum* L.) variety JLT-7 were treated with different concentrations of two chemical mutagens, namely ethyl methanesulphonate (EMS) and sodium azide (SA) at room temperature. The concentrations of mutagenic solutions were 0.05%, 0.10% and 0.15% for EMS and 0.01%, 0.02% and 0.03% for the SA. Approximately 180 seeds from each treatment were sown in July 2007 at Botanical garden of Dr. Babasaheb Ambedkar Marathawada University, Aurangabad, India, by following RBD to raise M1 generation. A total of 868 individual M1 plants were harvested separately. Harvested seeds were sown in next season to raise M2 generation on plant to a row basis. The progenies of the M2 plants were screened carefully to detect macro mutants.

The viable mutants from M2 generation were harvested separately and raised again for the field-testing.The viable mutants/macromutants were carefully screened from the population and the classification of the mutants was carried out on the basis of morphological characters [8]. The seed oil content of selected mutants of M2 and M3 generations was estimated by the Soxhlet method in Soxtec System-HT(1043). The oil content was expressed in terms of percentage. The fatty acid analysis of seeds from control and selected mutants of M2 and M3 generations was carried out by using gas chromatographic analysis. Sesame oil was etherified according to the method of Marguard [9]. 1 ml sample of oil was placed into a tube and 1 ml of Na-methylate was added to the mixture. The sample was left at room temperature overnight, and then 0.25 ml of isooctane was added to it. 0.5 µl sample of the mixture was injected into the gas chromatographer. The composition of fatty acids was determined by gas liquid chromatography (GC) performed on a Fison GC equipped with a flame ionization detector (FID), and fitted with a fused capillary column FFAP-DF (25 m x 0.25 mm ID). The detector was operated at 260º C and the injector at 250ºC. The column was ballistically heated at 150 to 200º C at the rate of 5º C min-1. The carrier gas (helium) inlet pressure was 0.15 MPa and the flow rate was 1 ml/min. The fatty acid identification was carried out by comparing the retention time of standards(Sigma Co.) and the area under each peak by automatic integrator to give relative comparison using software.

RESULTS AND DISCUSSION

The objective of this work was the identification of altered oil content and fatty acid composition among the mutants of sesame developed after mutagenic treatment. The values for oil yield, and different fatty acids like arachidic, oleic, linoleic, palmitic and stearic acid content of mutants and control of sesame variety JLT-7 are given in Table -1 The seed oil content in control of variety JLT-7 was 51.45. Majority of mutants of this variety revealed enhancement in seed oil content excepting high yielding branched (50.42 %) and closed capsule (51.24 %) mutants. The mutants revealing enhancement in seed oil content comprised late maturing (55.24%), dwarf with determinate growth habit (52.36), and long capsule (51.72). The variety JLT-7 demonstrated significant superiority as regards oil content in several of its mutants and recorded the highest oil content (55.24 %) in late maturing tall mutant.

Table 1. The values for oil yield, and different fatty acids

Component Name	Control	LM/T	D/Dt.G	HY/B	LC	CC
Oil (%)	51.45	54.24	52.36	50.42	51.72	51.24
Palmitic (C16:0)	8.910	10.418	9..427	7.424	8.935	8.989
Palmitolic (C16: 1)	0.08	0.138	0.105	0.135	0.112	0.105
Stearic (C18:0)	5.019	4.362	5.7895	4.703	4.539	5.243
Oleic (C18:1)	42.603	42.954	42..404	49.955	42.201	42.631
Linoleic (C18:2)	42.014	40.993	41.596	36.393	41.917	41.681
Linoleneic (C18:3)	0.232	0.278	0.253	0.255	0.284	0.270
Arachidic (C20:0)	0.673	0.446	0.572	0.573	0.683	0.603

LM/T- Late maturing tall, D/Dt.G- Dwarf with determinant growth, HY/B- High yielding branched, LC-Long capsule, CC-closed capsule

The present study revealed that the oleic/linoleic balance was strongly affected by mutagenic treatments. The values for arachidic, oleic, linoleic, palmitic and stearic acid content of different mutants and control of sesame variety JLT-7 are given in Table-1. Data in this table indicate significant differences in fatty acid composition between control and some mutants. Considering the mutants for oleic acid, the high yielding / branched mutant had highest oleic acid content (49.955%) than all other mutants. The oleic acid content in control was 42.603%. The highest linoleic acid content (41.91 %) could be detected in long capsule mutant which is lower than control. There was no significant difference in mutants for arachidic acid. A large variation was observed for palmitic acid content among the mutants and it ranged from 7.242 % (in high yielding/branched) to 10.418 % (in late maturing tall mutant). The values for arachidic, oleic, linoleic, palmitic and stearic acid content of different mutants and control of sesame variety JLT-7 are given in chromatographs 1 to 6. Data in these chromatographs have shown significant differences in regard to fatty acid composition between control and its different mutants Considering the amount of oleic and linoleic acids in different mutants, the oleic acid content of almost all the mutants revealed a higher percentage than the linoleic acid content.

Mutations, both spontaneous and induced, have been successful in changing the oil content and fatty acid composition of several oilseed crops *viz*., soyabean [10], soybean [11] and rapeseed [12] . However such efforts are very negligible in sesame. In the present investigation the total oil content in different viable mutants of variety JLT-7 has been studied. Among the macro mutants, the mutant late maturing/ tall with indeterminate growth could be recorded as a high oil mutant of variety JLT-7.The dwarf with determinate growth and long capsule mutants were also found to contain better oil level than control. An enhancement in seed oil level after mutagenic treatment has been reported by different researchers in different crops like groundnut [13], *Brassica napus* L. [14] and Mustard [15]. Several researchers recorded variation in oil content in mutants of sesame.[16 – 18]. Although no large differences were found among these mutants for the fatty acid composition some mutants showed elevation as well as reduction in some fatty acid content in comparison with their control due to the Mutagenic treatments tried in present studies. Some mutants had higher monounsaturated fatty acids than control besides lower concentration of polyunsaturated fatty acids. One elevated oleic acid mutant was reported. In high yielding branched mutant, high amount of oleic acid (C18:1) is accompanied with low levels of stearic acid and linoleic acid. The high yielding branched mutant was mainly characterized by a reduction in the palmitic acid (C16:0), while the stearic acid(C18:0) was also reduced.

was also recorded in late maturing tall mutant with slight reduction in stearic acid content. The change in fatty acid profile after mutagenic treatment has been reported by different researchers [19 – 21] in different oil seed crops. In the present study, induced mutant with altered fatty acid composition could be isolated using SA & EMS induced muatgenesis. Similar mutants with altered fatty acid composition were isolated in sesame by [22] &[18].

CONCLUSION

Mutation breeding has become a powerful tool for manipulating the composition of plant products. In oilseeds, this has significantly extended the capability to achieve major alterations in the relative proportions of the fatty acids present in the oil, for the purposes of improving nutritional value without compromising functionality. Increased oleic acid (C18:1) in sesame oil is important because of health benefits and increased oxidative stability. A diet in which fat consumption is high with oleic acid (C18:1) is associated with reduced cholesterol, arteriosclerosis, and heart disease [23]. High oleic acid as increased in high yielding branched mutant also increases oxidative stability and extends the utility of sesame oil at high cooking temperatures. On the other hand, decreased palmitic acid (C16:0) and stearic acid(C18:0) in high yielding branched mutant would make sesame oil more attractive to food manufacturers and health-conscious consumers and will improve the quality of oil.

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