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The some quality traits of oriental mustard lines in Ankara conditions

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Abstract

The environmental impacts of fossil fuel use make research and development studies for sustainable alternative solutions from renewable sources important. Thuse, there is a need to determine inexhaustible, renewable and sustainable biodiesel resources for biodiesel production from fixed oils obtained from plant sources. Oriental mustard is a species that contains a significant amount of fixed oil in its seeds. This study was carried out in 2020 in Ankara, Türkiye, in order to determine and compare some quality traits of five oriental mustard purelines in autumn sowing conditions under continental climate conditions. Oriental mustard lines used in this study were get from USDA gene bank and bred by pure line selection method. Field studies were carried out according to randomized block design with four replications. According to the results, it was shown that all oriental mustard purelines were statistically significant for moisture percentage in seed, crude oil percentage in moist seed, crude oil percentage in dried seed, palmitic, stearic, oleic, linoleic, linolenic, eicosenoic and erucic acids. Erucic acid (20.01-24.41%), oleic acid (21.60-24.23%) and linoleic acid (20.11-22.24%) were determined as the main fatty acids. Fixed oil ratio of purelines varied between 27.83 and 42.10%. The results determined showed the potential of using in future breeding programs for alternative medicine, paint, food and biodiesel industry. It is thought that the crude oil content of Bjo3, Bjo4 and Bjo5 stages is quite high and can be evaluated in variety breeding studies for a more economical production in the supply of raw materials to different industries.

Key Words: *Brassica juncea, Crude oil ratio, Fatty acid component*

Introduction

The increasing energy demand due to the effects of increasing population, industrialization and urbanization has caused the negative effects of fossil fuels on the environment to increase (Nayak et al., 2019). Sustainable and renewable biodiesel raw materials are attracting attention in order to secure future energy demands. Oilseed crops, animal oils and cooking oil wastes are used as biodiesel raw materials (Gómez-Trejo-López et al., 2022; Ishak et al., 2022). Oils with high erucic acid percentage obtained from different *Brassica* species are not appropriate for people utilization because of their possible harm to human health (Poddar et al., 2022) and are considered inedible oils. Inedible oils can be used as potential low-cost sources for biodiesel production due to their high erucic acid percentage (30-40%) (Yeşilyurt et al., 2019; Kayaçetin and Khawar, 2023).

Brown mustard is an amphidiploid species that was formed in nature by crossbreeding diploid species (*B. nigra* and *B. rapa*) through different factors (Malek et al. 2012). This species has two types of seed color, brown and yellow (oriental), has a one-year vegetation period and is a multi-branched plant originating from South and East Asia (Rahman et al., 2018; Kayaçetin, 2020). It is thought that this species originally existed in East India, the Caucasus, and China, and later spread to Europe, Africa, North America, and Asia (Szőllősi, 2020).

Although they contain different compounds such as glycosides, arachidic acid, sinabine, lignoceric acid, erucic acid in their oils, and these types with high erucic acid are not suitable for direct food use, they are used for different purposes in the spice, pharmaceutical and cosmetic industries, green manure, soil remediation, biofuel raw material, beekeeping, animal feed and different industrial branches (Tonguç and Erbaş, 2012; Rahman et al., 2018; Kayaçetin, 2020; Kayaçetin and Khawar, 2023). The above-ground organs of the plant are used for medical, food, feed and industrial purposes (Divakaran and Babu, 2015; Kayaçetin, 2020; Aslan, 2023;).

Oriental mustard (*Brassicaceae* family), is among the most economically significant oilseed crops (Rahman et al., 2018). The oils extracted from this crops serve as valuable sources of edible oil, biofuel, and industrial feedstocks (Sachan et al., 2024). Moreover, they contribute significantly to global agriculture and food-energy security due to their adaptability to diverse agro-climatic conditions and high oil yields per unit area (Kayaçetin, 2023). The fixed fatty acid components such as oleic acid, erucic acid and linoleic acid determine the suitability of oil for industrial or food use (Sachan et al., 2024).

This research was carried out in 2020 in Ankara, Türkiye, in order to detect and compare some quality traits of five purelines in autumn sowing under continental climate conditions.

Materials and Methods

Five oriental mustard lines obtained from the USDA gene bank and characterized by the Field Crops Central Research Institute, Ankara, Turkey were used in the study.

Field trials were carried out in Ankara in the experimental area of the Institute in the autumn growing season of 2019-2020 and 925 m above sea level, based on the randomized block design with four replications. Oriental mustard seeds were sown on September 15, 2019, in 6-row plots with 30 cm row spacing and 6 m length, with 200 plants per m^2 in autumn sowing. It was harvested on July 1, 2020 during the ripening period.

The soils where field studies are carried out have a very low amount of organic matter and are slightly alkaline, and have a clayey loam texture. When the climate data were evaluated; the average total precipitation for long years and the trial year was 391.9 mm and 269.6 mm. The max. and min. temperatures for long years and the trial year were 40.4 °C, –17.9 °C, and 35.5 °C, –12.2 °C, in the same order (Table 1).

Table 1. Monthly meteorological data of oriental mustard of vegetation period (September to August)

Climatic factors	Years/Months	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	July	Agu
Rainfall (mm)	Long years	18	27,7	31,5	44,9	40,2	35,1	39,1	42,5	51,5	34,4	14,3	12,7
	2019-20	1,2	2,2	31	51,4	31	59,4	4,2	0	26,4	59,4	3,4	0
Max. Temp. (ºC)	Long years	37,7	28,5	23,1	15,5	12,5	19	23,1	28	29,7	35	36	40,4
	2019-20	29,4	27,2	20,7	10,6	7,2	10,2	19,5	20	30,4	30,5	35,4	35,5
Min. Temp. (ºC)	Long years	-1,5	-6	-11	-14,2	-17,5	-17,9	-13,8	-8	-1,5	3,5	6,3	5,5
	2019-20	1,6	1,9	-5,8	-11,1	-10,1	-12,2	-8,6	-1,7	-1	4,4	14,5	12,2

The crude oil ratio and oil profile analyses of oriental mustard purelines were performed in 4 replications at the DB Agricultural Energy Biofuel Laboratory. The fatty acid profile of lines oil in relation to TS 4664 and EN ISO 5508 was determined by gas chromatography-GC (Kayaçetin, 2023).

Data on seed crude oil percentage and fatty acid profiles of oriental mustard purelines were analyzed using Statistical Analysis Software JMP®13.2.1 using analysis of variance (ANOVA). Differences among means were separated using LSD tests ($p<0.05$).

Results and Discussion

The oil percentage and fatty acid components of oriental mustard pure lines were investigated in this study. Statistically significant variations were determined in terms of the investigated features including moisture percentage in seed, crude oil percentage in moist seed, crude oil percentage in dried seed, palmitic, stearic, oleic, linoleic, linolenic, eicosenoic, erucic acids (Table 2).

The maximum and minimum moisture percentage in seed of 6.09% and 4.64% was detected in Bjo1 and Bjo4, respectively. The maximum crude oil percentage in moist seed (42,10%) and in dried seed (43,76%) were detected in Bjo4 whereas the minimum crude oil percentage in moist seed (27,83%) and in dried seed (29.68%) were detected in Bjo2, in the same as. While the maximum palmitic (3.13%), stearic (1.51%), oleic (24.23%), linoleic (22.24%), linolenic (12.88%), eicosenoic (14.27%), erucic (27.41%) acids were detected in Bjo4, Bjo1, Bjo2, Bjo1, Bjo3, Bjo2, and Bjo5, the minimum palmitic (2.85%), stearic (1.28%), oleic (21.60%), linoleic (20.11%), linolenic (10.35%), eicosenoic (12.01%), erucic (20.01%) acids were detected in Bjo5, Bjo2, Bjo4, Bjo3, Bjo5, Bjo5, and Bjo1, respectively. The differences among the examined traits are thought to be due to genotypes (Table 2).

Table 2. The varied examined traits of oriental mustard purelines

	Moisture percentage in seed (%)	Crude oil percentage in moist seed (%)	Crude oil percentage in dried seed (%)	Palmitic (C 16:0)	Stearic (C 18:0)	Oleic (C 18:1)	Linoleic (C 18:2)	Linolenic (C 18:3)	Eicosenoic (C 20:1)	Erucic (C 22:1)
Russian Federation pureline (Bjo1)	6,09a	29,87c	31,88d	3,11a	1,51a	23,93a	22,24a	12,53a	13,73ab	20,01c
United States pureline (Bjo2)	5,53ab	27,83d	29,68e	3,06a	1,28d	24,23a	20,98b	12,46a	14,27a	21,33c
India pureline (Bjo3)	5,29b	35,81b	37,80b	3,05a	1,37b	21,76bc	20,11b	12,88a	13,21b	24,39b
Canada pureline (Bjo4)	4,64c	42,10a	43,76a	3,13a	1,33c	21,60c	20,59b	12,69a	13,91a	24,27b
China pureline (Bjo5)	5,08bc	34,11b	35,81c	2,85b	1,41b	23,03ab	20,19b	10,35b	12,01c	27,41a
Source of variation (%)	6,48	3,66	3,66	3,19	2,11	3,70	3,65	3,52	2,97	5,57
LSD (0.05) = 2.13 (20 df)	**	**	**	**	**	**	**	**	**	**

Various research articles have reported that the fatty acid profile of oriental mustard genotypes/lines/varieties depending on the genotypes and that the fatty acid profile of this species is rich in monounsaturated fatty acids such as oleic, erucic and eicosenoic and polyunsaturated fatty acids such as linolic and linolenic. (Sharafi et al., 2015; Kayaçetin et al., 2018; Rai et al., 2018; Alpaslan, 2019; Shyam et al., 2022; Kayaçetin., 2023; Sachan et al., 2024).

For sustainable biofuel production, obtaining raw materials from plants that cannot be used in food is very important in order not to increase Türkiye's existing crude oil and oilseed deficit (Başalma et al., 2025). Although it is not possible to use the seed oil directly in food due to its high erucic acid content, the fact that oriental mustard contains rich monounsaturated fatty acids such as oleic, erucic and eicosenoic in its crude fatty acid content shows that it can be used appropriately for industrial purposes (Kayaçetin, 2023).

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