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The crude oil percentage and fatty acid profile of turnip rape in continental climate conditions

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Abstract

Türkiye is an importer of vegetable oil and oilseeds. The necessity of mixing biodiesel produced from domestic agricultural products and/or waste vegetable oils into diesel fuel further increases our need for vegetable oils and oilseeds. Therefore, it is important to determine the potential of alternative plant sources that cannot be used in food in terms of supplying raw materials for biodiesel. *Brassica rapa* ssp. *oleifera* is a species with high commercial potential used as industrial seed oil. This study was done in the fall sowing of 2020 in Ankara according to a randomized block design and was established with 4 replications. It was aimed to detect the crude oil percentage and fatty acid profiles of the Tekirdag, Bursa and Tokat origin lines of this species. In terms of study findings, significant differences were found among the lines with regards to the examined traits. Crude oil percentage was detected as 26.93-36.60% in *B. rapa* ssp. *oleifera* lines. It can be stated that local turnip rapeseed lines are rich in unsaturated fatty acids and crude oil percentage, especially in monounsaturated fatty acids such as oleic (16.24-18.65%) and erucic acid (35.66-42.97%), which are the most important factors affecting biodiesel quality, and this species has an important potential as a biodiesel raw material. According to the results obtained from this study, it was detected that Bursa origin Br2 line with Tekirdag origin Br3 and Br6 lines had higher crude oil percentage than other lines. Therefore, it is recommended that these lines be further evaluated for sustainable biodiesel production.

Key Words: *Brassica rapa* ssp. *oleifera, Some quality traits, Oleic acid, Erucic acid*

Introduction

Türkiye is 60-70% dependent on foreign sources for the supply of vegetable oil raw materials. The only agricultural product group in the top 10 among Türkiye's import items is oilseeds and their derivatives. Between 2015 and 2023, 3.041.000-4.320.000 tons of oilseeds (sunflower, soybean, cotton, rapeseed and safflower) and 1.214.000-2.639.000 tons of crude oil were imported. In addition, 1.368.000-2.513.000 tons of oilseed meal are imported from abroad each year (Başalma et al., 2025). The requirement to blend at least 0.5% of biodiesel produced from domestic agricultural products and/or vegetable waste oils into diesel fuel further increases our existing need for vegetable oil and oilseeds (Official Gazette, 2017).

Brassica rapa ssp. *oleifera*, from the *Brassicaceae* family, is among the economically important oilseed crops (Aydin et al., 2024). This species grows as a weed under natural conditions in Türkiye (Kayaçetin et al., 2023). Field mustard (turnip rape), which originates from Asia and Europe, is a species that is more resistant to cold than rapeseed and has annual and biennial genotypes. Its winter genotypes are mostly grown in Europe, while its summer genotypes are grown in Canada, China and India (Aslan, 2023). Seed and seed oil are used as lubricants, in the production of insecticides, in pharmacy, medicine and cosmetics (Li et al., 2021). In addition, seed oil is suitable for biodiesel production and has a high potential for the production of efficient and high-quality biodiesel raw materials (Kayaçetin, 2023). This species, which can grow to 100-150 cm in length, has quadruple bright yellow flowers. According to studies conducted in Türkiye, this species is earlier than brown mustard, rapeseed and black mustard (Kayaçetin, 2019). Its seeds are almost round and are reddish gray to black (Kayaçetin, 2020). The quality characteristics of the oil, such as the ratio of seed oil and fatty acid components, are important factors determining the areas of use of the oil. Although the seeds of this species contain 25-35% fixed oil, they are not appropriate for direct use as human food because of the possible harm to human health owing to the high amount of erucic acid (30-40%) in the fixed fatty acid profile (Poddar et al., 2022), and are among the industrially important oils. The seed oils of this species, which cannot be used as food, can be used as potential low-cost sources for biodiesel production due to high erucic acid.

B. rapa ssp. *oleifera* fatty acid composition and fixed oil ratio may vary depending on genetic and environmental factors (Kayaçetin et al., 2018, Rai et al., 2018; Shyam et al., 2022). Therefore, determining the differences between genotypes allows the selection of genotypes according to the desired characteristics in breeding studies. The goal of this study was to detect the crude oil ratio and fatty acid profile of the seeds of 6 settled lines of the turnip rape lines.

Materials and Methods

In this study, 6 turnip rape settled lines were used as material. Seeds were obtained from the Field Crops Central Research Institute. All turnip rape lines used in this study are strictly winter.

Field trials were carried out in Ankara in the experimental area of the Central Field Crops Research Institute in the autumn growing season of 2019-2020 at 39°12′ – 43°6′ N, 35°58′ – 37°44′ E and 925 m above sea level, based on the randomized block design with four replications. The soils of the trial area are low in organic matter, clayey loam and slightly alkaline. 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 and relative humidity values for long years and the trial year were 10.5 °C, 40.4 °C, –17.9 °C, 63.9% and 10.5 °C, 35.5 °C, –12.2 °C, 58.3%, in the same order (Figure 1).

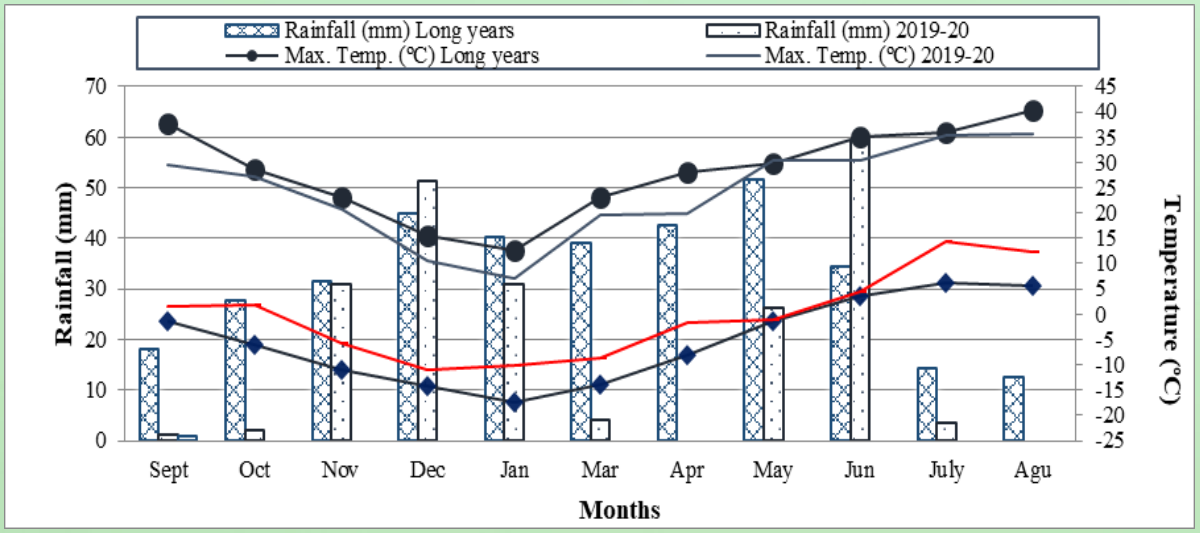

Figure 1. Monthly meteorological data of turnip rape of vegetation period (September to August)

The crude oil ratio and oil profile analyses of turnip rape lines were performed in 4 replications at the DB Agricultural Energy Biofuel Laboratory.

Crude oil percentage (%): The glass beakers to be used during the soxelet extraction process were dried in the drying oven until they reached a constant weight. The tare weight of the beakers was recorded. After the drying process was completed, approximately 5 g of the ground sample was weighed and placed in the soxelet cartridge. After the cartridge was placed in the soxelet extraction system, 140 mL of petroleum ether was added to the flask in the soxelet extraction system and the extraction process was performed. After the extraction process was completed, the extraction flask was kept in the drying oven at 80 °C for 1 hour. After the glass beaker removed from the drying oven was cooled in a desiccator, it was weighed and the amount of oil in the sample was calculated as a percentage (%) (Gölükçü et al., 2016).

Fatty acid profile (%): 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 turnip rape lines 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 percentage of moisture in the seed, the percentage of crude oil in the moist seed and dried seed, palmitic, stearic, oleic, linoleic, linolenic, eicosenoic, erucic turnip rapeseed lines are presented in Table 3. Although the percentage of moisture in the seed and the ratio of stearic acid did not show statistically different according to the lines, other examined traits were found to be significant (Table 1). The maximum and minimum crude oil percentage in moist seed were detected 36.60% and 26.93%, in in he same order and in dried seed were determined 38,80% and 28,69% Br2 and Br1 lines, respectively. The maximum palmitic, oleic, linoleic, linolenic, eicosenoic, erucic (2.62, 18.65, 15.33, 11.57, 12.65 and 42.97%) were detected in Br5, Br6, Br5, Br3, and Br1lines, in the same order. The minimum values of 2.23, 16.24, 13.44, 10.10, 11.05, and 35.66 % were noted in Br1, Br1, Br1, Br1, Br3, and Br6 lines, respectively.

Table 1. The crude oil ratio and fatty acid component of turnip rape lines

	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)
Tekirdağ1 pureline (Br1)	5.74	26.93c	28.69b	2.23d	1.08	16.24d	13.44c	10.10c	11.20b	42.97a
Bursa pureline (Br2)	5.71	36.60a	38.80a	2.48b	1.14	16.57cd	14.60b	10.71bc	11.11b	40.56bc
Tekirdağ2 pureline (Br3)	5.65	34.66a	36.58a	2.42c	1.16	17.05c	14.93ab	11.57a	11.05b	39.25cd
Türkiye pureline (Br4)	5.65	30.01b	31.67b	2.49b	1.07	16.30d	13.69c	10.96ab	11.51b	41.55ab
Tokat pureline (Br5)	5.53	30.03b	31.75b	2.62a	1.22	17.80b	15.33a	11.23ab	12.19a	37.21de
Tekirdağ3 pureline (Br6)	5.77	35.88a	37.95a	2.50b	1.21	18.65a	15.26a	11.54a	12.65a	35.66e
Source of variation (%)	3.13	6.00	6.25	1.41	6.13	2.73	2.78	3.35	2.97	3.84
LSD (0.05) = 2.10 (24 df)	ns	**	**	**	ns	**	**	**	**	**

Sharafi et al. (2015) in their study evaluating 20 genotypes of different *Brassica* species including turnip rape, found that the crude oil percentage varied between 21% and 46%; palmitic, oleic, linolenic, linoleic, erucic and stearic acids constituted 89%-94% of the main fatty acids in this species. It has been reported that there are high genetic differences in crude oil percentage and fatty acid compositions among species and genotypes. Rai et al. (2018) in their study examining 5 different turnip genotypes, reported that the crude oil percentage of the genotypes varied between 40.35% and 41.43%. While the linoleic acid content varied between 14.08%-18.18% in turnip rape genotypes, the linolenic acid percentage changed between 9.82%-26.66%. Studies have shown that seed crude oil content and fatty acid composition of genotypes from different *Braasica* species are significantly affected by genotypic and environmental conditions (Da Silva Medeiros et al., 2022; Khan et al., 2022; Kayaçetin, 2023; Sachan et al., 2024).

According to Öğüt and Oğuz (2006), the supply of biodiesel raw materials from non-food oils should be a priority for sustainable biodiesel production. In order to meet both the food and energy demands of the increasing population, the use of fixed oils that cannot be used directly in food for energy purposes is important. It is thought that *B. rapa* ssp. *oleifera* lines, which are not appropriate for direct cooking oil use owing to the erucic acid content in seed fatty acids, can be used appropriately for industrial purposes in terms of fatty acids and can be evaluated as an alternative plant source for biodiesel due to their high adaptation to Türkiye conditions (Kayaçetin, 2023).

B. rapa ssp. *oleifera* lines used in this study exhibited an important level of diversity for the crude oil percentage and fatty acid profile. Although the fatty acid profile of oil turnip limits its use as direct human food, it may pose significant potential for different industrial areas. Based on the results obtained from this study, it was determined that the Bursa origin Br2 line with Tekirdag origin Br3 and Br6 lines had higher crude oil percentage compared to other lines. Therefore, particularly this lines were suggested for further evaluation for sustainable to obtain biofuel.

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