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Comparison of Varieties on Bioactive Properties, Phenolic Compounds and Fatty Acid Compositions of Different Flax Seeds

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ABSTRACT

Flaxseed is a rich food source in terms of linoleic and linolenic acids as well as lignans and especially secoisolarikiresinol diglucoside. Its importance in human nutrition is increasing day by day with this rich content. In this study, the role of varieties on oil contents, bioactive constituents, antioxidant activities, fatty acid science and phenolic compounds of different flaxseed varieties was investigated.

A total of 13 oilseed flax varieties, 1 domestic registered and 12 foreign origin supplied by the Black Sea Agricultural Research Institute, were grown in three replications in order to establish the most suitable variety in terms of yield and quality in irrigated conditions of Konya province.

The oil quantities of flaxseeds were specified to be between 26.40 (Barbara) and 30.00% (Dokota). The total phenolic and flavonoid quantities of the flaxseeds were defined to be between 21.74 (Lirina) and 36.10 mgGAE/100g (Olin) to 31.71 (Norman) and 53.57 mg/100g (Olin), respectively. Antioxidant capacities of the flaxseed genotypes were defined to be between 1.49 (Lirina) and 1.56 mmol/kg (Olin). Quercetin and catechin amounts of the seeds were stated to be between 3.70 (Lirina) and 16.34 mg/100g (Mikael) to 1.91 (Raulin) and 11.32 mg/100g (Lirina), respectively. While rutin quantities of the flaxseeds were established to be between 1.55 (Royal) and 4.96 mg/100g (Linde). Also, 3,4-dihydroxybenzoic acid and kaempferol quantities of the flaxseed genotypes were established to be between 0.09 (Raulin) and 2.72 (Barbara) to 2.69 (Lirina) and 6.43 mg/100g (Midin), respectively. The key fatty acid of the oil was linoleic fatty acid. Linolenic and oleic acid amounts of the oils obtained from flaxseed genotypes were specified to be between 47.98 (Raulin) and 58.92% (Sarı-85) to 18.25 (Sarı-85) and 25.19% (Olin), respectively.

It was observed that genotypes were effective on the chemical properties of flaxseeds. The "Midin" flaxseed genotype can be considered as a good source of rutin, ferulic acid and resveratrol. It is seen that flaxseed genotypes are generally rich in flavonoid compounds. The key fatty acid in flaxseed oils was linolenic fatty acid.

Keywords: flaxseed, oil, bioactive compounds, fenolics, fatty acids.

INTRODUCTION

Flax (*Linum usitatissimum* L.) seeds, which are rich in fiber and oil, show a wide range of biological activities due to its chemical compounds (Özcan and Uslu, 2022; Zare et al., 2023). Flax seeds are widely cultivated in many parts of the world such as Canada, China, India and Russia, and these countries are the main producing countries (Koçak et al., 2023). The genus Linum is widespread in the Mediterranean basin, the southwest and north of America, and the temperate and subtropical regions of Asia (Zohary et al., 2012). Flax, also known as kırbaş seed, siyelek and zeyrek seed among the public, is cultivated for its fiber and the oil obtained from its seed. Flaxseed is a rich food source in terms of linoleic and linolenic acids as well as lignans and especially secoisolarikiresinol diglucoside. Its importance in human nutrition is increasing day by day with this rich content. It is stated that flax is an important source of alpha linolenic acid, a plant-derived fatty acid (Harris et al., 2008; Öksüz et al., 2015). In addition, when looking at the industrial use of the seed, there are many application areas such as the

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preparation of paints, varnishes, soaps (Sulas et al., 2019), "biodiesel production" (Bacenetti et al., 2017) and "food industry" (Pisupati et al., 2021). It was revealed that Canadian brown flax consists of an average of 41% oil, 20% protein, 28% total fiber, 7.7% moisture and 3.4% ash (Morris, 2003). Fast-drying linseed oil has various industrial uses such as cosmetics, paste, paint, reisin (Moawia et al., 2019; Pisupati et al., 2021). Flaxseed oil, rich in omega-3 fatty acid, has been reported to have significant health benefits, including cardiovascular disease (Parikh and Pierce, 2019), cancer (Buckner et al., 2019), and diabetes (Barre et al., 2008). Flaxseed oil, sources of essential fatty acids and linoleic acid that cannot be synthesized in organisms and must be obtained from food by humans, is found in approximately 35-65% of flaxseed and is it has important uses. In addition, flaxseed has been reported to be rich in protein, dietary fiber and lignans (Wang et al., 2020). Phenolic constituents in flaxseeds, which are used as an ingredient in food preparations due to valuable bioactive compounds, exhibit radical scavenging activity (Özkaynak Kanmazand and Ova, 2015; Akl et al., 2020). Flaxseed is a rich food source in terms of linoleic and linolenic acids (Akl et al., 2020; Beema et al., 2022; Koçak, 2024). Flaxseed is a rich food source in terms of linoleic and linolenic acids (Meagher and Beecher 2000; Johnsson et al., 2002; Choo et al., 2007). It has been reported that the bioactive components of flaxseed are affected by various factors such as variety, maturity stage and planting time (Meagher et al., 1999). Flaxseed oil, which has a fat content of 30-45%, contains high amounts of omega-3 (n-3) fatty acids, and the amounts of linoleic, oleic and linoleic fatty acids were determined as 3-21%, 14-60% and 31-72%, respectively (Bloedon and Szapary, 2004; Sell et al., 2015). Since no study has been found on the composition of flax seeds in this concept so far, a comparison of the bioactive compounds, oil contents, fatty acids and phenolics compositions of the seeds was carried out. Flax seeds, a multi-purpose crop, have long been used in human and animal diets and in industry as a source of oil due to its high oil content (36-40%). In addition, interest in this seed has increased due to the probiotic properties of flax and its reported beneficial effects on coronary heart disease, some types of cancer and neurological and hormonal disorders (Simopoulos, 2002). The purpose of this work was to research the role of varieties on oil amounts, bioactive constituents, antioxidant activities, fatty acid science and phenolics of different flaxseed varieties.

MATERIAL AND METHODS

Material

A total of 13 oilseed flax varieties, 1 domestic registered and 12 foreign origin supplied by the Black Sea Agricultural Research Institute, were grown in three replications in order to establish the most suitable variety in terms of yield and quality in irrigated conditions of Konya province. Seeds of each variety obtained from the plots harvested by hand in August 2024 were brought to the laboratory.

Methods

Moisture content

The moisture of flaxseeds was defined by the KERN & SOHN GmbH infrared moisture analyser.

Total oil content

The oil content of flaxseed was defined according to AOAC (1990) method. 10 g of powdered seeds were weighed into a cartridge and placed in the Soxhlet and obtained with petroleum ether in an Soxhlet system at 50°C for 5 h.

Extraction procedure

Flaxseeds were obtained based on the study proposed by Jakopic et al. (2011). After 5 powdered sample were stirred with 15 ml of methanol, the solution was treated in ultrasonic water-bath for 30 min. Then, the solution was centrifuged at 6000 rpm for 10 min. After pretreatments, the remaining extract was dissolved by adding 10 ml of methanol to it.

Total phenolic content

Total phenolic amounts of flaxseeds were specified using the Folin-Ciocalteu chemical based on the study suggested by Yoo et al. (2004).

Total flavonoid content

The total flavonoid quantities of flaxseeds were characterized by using the $NaNO_2$-$AlCl_3$-NaOH assay by Hogan et al. (2009) with minor modification. The results are defined as mg QE/100g.

Antioxidant capacity

The antioxidant capacity of seeds were established using 1,1-diphenyl-2-picrylhydrazyl (DPPH) based on the report recommended by Lee et al. (1998). After preprocessing, the findings were defined as mmol TE/kg.

Determination of phenolic compounds

Chromatographic separation of phenolic constituents of several flaxseed extracts was carried out by HPLC (Shimadzu) equipped with a PDA detector and an Inertsil ODS-3 (5 µm; 4.6 x 250 mm) column.

Fatty acid composition

Gas chromatography (Shimadzu GC-2010) equipped with flame ionization detector (FID) and capillary column was used to analyze fatty acid methyl esters (FAMEs) of flaxseed oils esterified according to Multari et al. (2019) method.

Statistical analysis

JMP version 9.0 (SAS Inst. Inc., Cary, N.C.U.S.A) was used for analysis of variance (ANOVA). The results are mean±standard deviation (MSTAT C) of independent flaxseed varieties.

RESULTS AND DISCUSSION

The chemical and bioactive properties of some flaxseed genotypes

The bioactive constituents and antioxidant activities of some flaxseed genotypes are defined in Table 1. The moisture of flax seeds were defined to be very close to each other and the moisture amounts of the seeds were found to be between 5.70 (Yellow-85) and 6.65% (Mikael). The oil quantities of the flaxseeds were specified to be between 26.40 (Barbara) and 30.00% (Dokota). The total phenolic and flavonoid quantities of the flaxseeds were defined to be between 21.74 (Lirina) and 36.10 mgGAE/100g (Olin) to 31.71 (Norman) and 53.57 mg/100g (Olin), respectively. Antioxidant capacities of the flaxseed genotypes were characterized to be between 1.49 (Lirina) and 1.56 mmol/kg (Olin). The total phenol, flavonoid amounts and antioxidant activities of “Olin” flaxseeds were at the highest levels compared to other genotypes. The antioxidant activities of Atalanta, Dokota, Norman, Royal and Antares flaxseeds were found to be similar. In addition, antioxidant capacities were similar in Raulin and Mikael flaxseeds. It was observed that genotypes were effective on the bioactive properties of flaxseeds. Özkaynak Kanmaz and Ova (2015) determined 37.55% and 45.07% oil in flaxseed samples, and reported significant differences among genotypes ($p<0.05$). Flaxseed contains 35 to 45% oil (Martinchik et al., 2012). Total phenolic amounts of meals of different flaxseed seed genotypes were defined to be between 130 and 220 mg ferulic acid/100g (Wanasundara and Shahidi, 1994). Total phenolic and flavonoid quantities of flaxseeds were characterized to be between 613.6 and 3164.6 mg GAE/g to 176.25 and 689.20 mg QE/g, respectively (Koçak, 2024). Our results regarding total phenol are lower than methanol extract (3164.6 mg GAE/100g) of Atalanta flaxseed (Koçak, 2024).

It was observed that the total flavonoid amounts of the methanol extracts of flaxseeds were higher than in the flaxseed ethanol extract (185.00 mg/g) reported by Punia and Deen (2018). When our results were compared to the last studies, there were some fluctuations. It can be said that the main factors causing these differences are maturity, environment conditions and analytical conditions.

Table 1. Physico-chemical properties of flaxseed varieties

Varieties	Moisture content (%)	Total oil content (%)	Total phenolic conten (mg GAE /100 g)	Total flavonoid content (mg/100 g)	Antioxidant activity (mmol/kg)
Olin	5.78 ± 0.05*fg	27.40 ± 0.85fg	36.10 ± 2.72a	53.57 ± 0.81a	1.56 ± 0.00a
Sarı-85	5.70 ± 0.25gh**	27.50 ± 0.14f	24.97 ± 0.73i	35.57 ± 2.42i	1.50 ± 0.01e
Lirina	5.76 ± 0.05f	28.80 ± 0.28d	21.74 ± 0.42ı	36.43 ± 1.62ı	1.49 ± 0.01f
Atalanta	5.84 ± 0.01f	29.20 ± 0.57b	27.60 ± 0.53h	43.57 ± 2.02b	1.53 ± 0.01d
Raulin	6.07 ± 0.11d	27.10 ± 0.14ef	32.59 ± 0.54cd	42.14 ± 0.81c	1.55 ± 0.00b
Dokota	6.26 ± 0.35bc	30.00 ± 0.28a	27.68 ± 1.01h	36.86 ± 1.01ı	1.53 ± 0.01d
Linde	5.98 ± 0.01e	28.80 ± 0.85d	30.06 ± 0.64e	40.57 ± 2.22e	1.54 ± 0.00c
Barbara	6.07 ± 0.14d	26.40 ± 0.85h	29.93 ± 1.04f	39.14 ± 2.22f	1.54 ± 0.00c
Norman	6.35 ± 0.08b	28.70 ± 1.38e	27.50 ± 0.31h	31.71 ± 0.61k	1.53 ± 0.00d
Royal	5.71 ± 0.10fg	29.10 ± 1.10c	28.55 ± 1.18g	37.71 ± 0.61h	1.53 ± 0.01d
Midin	6.08 ± 0.29d	28.40 ± 1.13f	32.80 ± 0.08c	41.86 ± 0.00d	1.54 ± 0.00c
Mikael	6.65 ± 0.39a	28.90 ± 0.71c	34.13 ± 0.72b	38.86 ± 0.20g	1.55 ± 0.00b
Antares	6.58 ± 0.13a	26.90 ± 0.99c	30.53 ± 1.02e	32.29 ± 0.20j	1.53 ± 0.00d

*standard deviation; ** values within each row followed by different letters are significantly different at p<0.05.

Phenolic constituents of the flaxseeds

Phenolic constituents of the flaxseeds were displayed in Table 2. Quercetin and catechin amounts of flaxseeds were stated to be between 3.70 (Lirina) and 16.34 mg/100g (Mikael) to 1.91 (Raulin) and 11.32 mg/100g (Lirina), respectively. In addition, while rutin amounts of the flaxseeds were established to be between 1.55 (Royal) and 4.96 mg/100g (Linde). Also, 3,4-dihydroxybenzoic acid and kaempferol amounts of the flaxseed genotypes were characterized to be between 0.09 (Raulin) and 2.72 mg/100g (Barbara) to 2.69 (Lirina) and 6.43 mg/100g (Midin), respectively. Resveratrol amounts of the flaxseeds were defined to be between 0.81 (Lirina) and 3.90 mg/100g (Midin). The highest gallic acid amounts were detected in Olin, Sarı-85 and Lirina flaxseed genotypes (1.17, 1.12 and 1.12 mg/100g, respectively). Also, the highest caffeic acid (0.6 mg/100g) and *p*-coumaric acid (0.68 mg/100g) were identified in Olin flaxseed sample. The "Midin" flaxseed genotype can be considered as a good source of rutin, ferulic acid and resveratrol. According to the variance analysis of the results, significant changes in the amounts of phenolic constituents among of flaxdeed were observed (p<0.05). It is seen that flaxseed genotypes are generally rich in flavonoid compounds. This situation also confirms the high total flavonoid values of flaxseeds. Özkaynak Kanmaz and Ova (2015) pointed out oil-free flaxseed meals contained 85.78-249.33 free total phenol, 488.70-959.87 esterified total phenol. In other study, Oomah et al. (1995) determined the free and esterified phenolic quantities of flaxseeds as 300-500 and 500 mg ferulic acid/100g, respectively. In studies on the flavonoid content of flaxseed, the total flavonoid quantity of flaxseed varied between 12.7 and 71 mg/100g (Oomah et al., 1996; Choo et al., 2007). Different varieties of flaxseeds contained 1.29 to 4.56 μg/L quercetin, 0.48 (Florinda) to 10.23 μg/L catechin, 1.33 to 7.09 μg/L, 1.01 to 8.03 μg/L resveratrol, 1.13 to 12.08 μg/L chlorogenic acid (Koçak, 2024). In previous study, p-coumaric, o-coumaric, ferulic, p-hydroxybenzoic, vanillic, and sinapic acids, 4-hidroksibenzoik asit, vanilik asit, secoisolariciresinol, resveratrol, rutin, klorojenik asit, enterolakton ve enterodiol were detected in free and bound forms in flaxseed (Dabrowski and Sosulski, 1984; Rocchetti et al., 2022). When the findings of present study were compared with the results of previous studies, it is thought that the significant fluctuations observed in terms of bioactive properties may be due to genetic, harvest time and sonication processes applied during analysis processes (Gai et al., 2023).

Table 2. Phenolic compounds of flaxseed varieties (mg/100g)

Phenolic compounds	Olin	Sarı-85	Lirina	Atalanta	Raulin	Dokota	Linde
Gallic acid	1.17±0.10*a	1.12±0.22b	1.12±0.14b	0.70±0.05i	0.87±0.26g	0.88±0.38g	1.00±0.06c
3,4-Dihydroxybenzoic acid	1.91±1.08d**	0.74±0.56	2.25±0.00c	0.75±0.27ı	0.09±0.03k	0.71±0.05ıi	1.40±0.39h
Catechin	8.80±1.42b	4.82±0.56g	11.32±0.00a	6.11±1.55d	1.91±0.06j	5.22±0.07ef	6.36±1.83d
Caffeic acid	0.60±0.01a	0.43±0.22b	0.26±0.20de	0.16±0.04fg	0.22±0.13e	0.38±0.01c	0.23±0.09e
Syringic acid	0.82±1.17a	0.31±0.03e	0.61±0.03b	0.11±0.01i	0.26±0.01f	0.44±0.07c	0.16±0.08h
Rutin	3.71±0.97c	4.32±0.07b	1.42±0.00e	0.58±0.03h	0.09±0.10j	0.22±0.04i	2.86±0.42d
p-Coumaric acid	0.68±0.53a	0.37±0.05c	0.28±0.09e	0.14±0.12ı	0.15±0.30	0.19±0.07g	0.26±0.03e
Ferulic acid	1.30±1.08b	0.55±0.01c	0.42±0.08f	0.50±0.09d	0.51±0.01d	0.55±0.05c	0.41±0.06f
Resveratrol	2.31±1.40h	2.63±0.80g	0.81±0.00i	3.82±0.65b	3.03±1.68c	2.92±0.43d	3.03±0.94c
Quercetin	10.43±0.54g	8.98±3.40i	3.70±0.00k	10.36±2.37g	13.84±2.85c	9.34±1.10ı	10.05±1.36h
Cinnamic acid	3.99±0.07e	3.84±0.01ef	2.43±0.00ıi	2.53±0.82ı	4.71±0.23c	4.86±0.10b	4.96±0.34a
Kaempferol	6.08±2.34c	5.07±2.73i	2.69±0.00k	6.11±0.25b	5.28±0.53ı	5.05±0.68	5.41±0.37g

Phenolic compounds	Barbara	Norman	Royal	Midin	Mikael	Antares
Gallic acid	0.47±0.08j	0.86±0.27h	0.83±0.37ı	0.90±0.10f	0.95±0.15d	0.92±0.13e
3,4-Dihydroxybenzoic acid	2.72±1.34a	2.57±0.90b	1.85±1.17e	0.43±0.06j	1.50±1.06fg	1.56±0.39f
Catechin	5.94±0.53e	3.33±1.64i	3.43±2.18ı	8.47±1.15c	4.05±0.86h	6.47±1.67d
Caffeic acid	0.17±0.04fg	0.03±0.01i	0.15±0.08h	0.29±0.23d	0.18±0.08f	0.13±0.06ı
Syringic acid	0.09±0.05j	0.09±0.03j	0.35±0.07d	0.36±0.02d	0.13±0.07ı	0.20±0.03g
Rutin	0.21±0.02i	0.48±0.11ı	1.31±0.15f	5.69±1.92a	0.92±0.67g	0.61±0.07h
p-Coumaric acid	0.31±0.01d	0.25±0.05f	0.27±0.03e	0.49±0.34b	0.17±0.06h	0.08±0.01i
Ferulic acid	0.53±0.04ef	0.42±0.01f	0.53±0.06ef	1.44±0.82a	0.44±0.05ef	0.50±0.35d
Resveratrol	3.83±0.99b	2.72±0.23ef	3.87±0.33a	3.90±2.13a	1.88±1.02i	2.77±0.50e
Quercetin	5.57±3.05j	10.06±4.25h	14.49±1.81b	13.39±1.97cd	16.34±2.53a	10.95±0.98f
Cinnamic acid	3.72±1.25g	4.95±0.95a	1.55±0.27k	2.35±0.29j	3.47±2.09h	4.33±0.39d
Kaempferol	4.79±0.39j	5.69±0.68e	5.37±1.03gh	6.43±2.24a	5.79±0.27d	5.52±0.94f

*standard deviation; ** values within each row followed by different letters are significantly different at p<0.05.

The fatty acid compositions of the oils obtained from several flaxseeds

The fatty acid compositions of the oils extracted by Soxhlet apparatus from several flaxseed genotyps are stated in Table 3. The main fatty acid in oils was linolenic acid. Linolenic and oleic acid amounts of the oils obtained from flaxseed genotypes were specified to be between 47.98 (Raulin) and 58.92% (Sarı-85) to 18.25 (Sarı-85) and 25.19% (Olin), respectively. While palmitic acid quantities of the flaxseed oils change between 5.35 (Antares) and 6.74% (Linde), stearic acid values of the oils extracted from flaxseeds were stated to be between 4.97 (Sarı-85) and 6.87% (Atalanta). Linoleic acid values of the flaxseed oils were defined to be between 11.71 (Sarı-85) and 15.54% (Lirina). The arachidic and behenic acid amounts of flaxseeds were established to be below 0.23%. The amounts of fatty acids in linseed oils varied depending on the variety. The fact that the dominant fatty acid in linseed oils is linolenic fatty acid indicates that these oils are included in the linolenic fatty acid group. Differences in the amounts of fatty acids based on the genotypes are thought to be due to latitude, location, planting time, genetic structure of the seeds, as well as temperature and climatic factors (Broun and Somerville, 1997). High temperatures have a positive effect on the synthesis of linoleic and linolenic acids in plants (Röhbelen et al., 1989). Although there was a study (Anastasi et al., 2000) that determined that temperature changes caused higher variations in the concentration of oleic and linoleic fatty acids in standard hybrids, another study by Salera and Baldini (1998) indicated that high oleic fatty acid genotypes showed higher variation. This situation strengthens the idea that the effect of temperature on the concentration of oleic and linoleic fatty acids in different genotypes depends on the genotypic trait (Karaca and Aytaç, 2007). Since the fatty acids found in flaxseed are polyunsaturated, they can be easily oxidized and cause the oils to spoil quickly. In addition, the high levels of linoleic and linolenic acids found in flaxseed oil indicate that the stability of the oils is very low and that the oils have a bad taste and cause odor (Sekin, 1983). In other study, the oils of yellow-seeded flax varieties TR 73572 and TR 77705 had high α-linolenic acid (55.47% and 54.56%) and low oleic acid (18.95% and 19.30%) levels. In addition, while the TR 77416 flax variety contained the lowest α-linolenic acid (46.37%), a significant increase in the oleic acid content of this oil (25.47%) was observed (Özkaynak Kanmaz and Ova, 2015). Our findings regarding linolenic and oleic acid are consistent with the study of Choo et al. (2007). In previous studies, flaxseed oils contained 39.35-60.11% alpha-linolenic, 12.09-17.45% linoleic, 15.89-26.21% oleic, 6.19-11.64% palmitic and 4.67-7.68% stearic acids (Koçak et al., 2022; Bertoni et al., 2023). Koçak et al. (2023) established 5.64-7.57% palmitic, 4.53-6.53% stearci, 21.33-31.30% oleic, 12.33-19.48% linoleic and 39.02-50.63% α-Linolenik acid in flaxseed (*Linum usitatissimum* L.) varieties. Rodriguez-Leyva et al. (2010) stated that the key fatty acid of flaxseed oil is α-linolenic acid. Our findings regarding linolenic fatty acid from the fatty acid results were found by Bertoni et al. (2023) to be consistent with the highest α-linolenic acid (58.23%) in flaxseed oil. Although the fatty acids defined in flaxseed oil show similarities with literature data, partial differences may depend on environment and agricultural factors and analitical conditions.

Table 3. Fatty acid compositions of flaxseed varieties (%)

Fatty acids	Olin	Sarı-85	Lirina	Atalanta	Raulin	Dokota	Linde
Palmitic	6.33±0.09*e	5.82±0.01g	5.69±0.02ı	6.38±0.57d	5.76±0.07h	6.12±0.35	6.74±0.15a
Stearic	5.27±0.04h**	4.97±0.00i	5.06±0.00ı	6.87±0.10a	6.58±0.01c	6.22±0.73e	6.49±0.03d
Oleic	25.19±0.03a	18.25±0.01j	21.85±0.01i	23.60±0.11c	24.79±0.08b	22.90±0.58h	23.35±0.04d
Linoleic	14.54±0.01d	11.71±0.01k	15.54±0.01a	13.20±0.04h	14.46±0.04e	13.71±1.00g	13.06±0.01ı
Arachidic	0.18±0.01d	0.16±0.01f	0.15±0.01fg	0.22±0.01a	0.23±0.01a	0.20±0.03bc	0.17±0.00de
Linolenic	48.36±0.02h	58.92±0.00a	51.58±0.00b	49.53±0.32f	47.98±0.14ı	51.68±0.69bc	50.03±0.07c
Behenic	0.13±0.00f	0.16±0.00c	0.13±0.01f	0.20±0.00a	0.20±0.04a	0.18±0.03b	0.15±0.00d

Fatty acids	Barbara	Norman	Royal	Midin	Mikael	Antares	
Palmitic	6.24±0.11f	6.39±0.06d	6.57±0.20b	6.55±0.04c	6.32±0.14e	5.35±0.28i	
Stearic	6.49±0.03d	5.76±0.01f	5.40±0.02g	5.34±0.01gh	5.76±0.06f	6.64±0.04b	
Oleic	23.40±0.04d	22.25±0.03ı	22.95±0.05h	24.74±0.01b	22.93±0.05h	23.27±0.01d	
Linoleic	14.11±0.00f	12.65±0.00j	13.74±0.03g	12.78±0.01i	14.91±0.01b	14.68±0.02c	
Arachidic	0.20±0.00bc	0.17±0.01de	0.15±0.01fg	0.16±0.00f	0.18±0.01d	0.21±0.01b	
Linolenic	49.38±0.02g	52.64±0.04b	51.06±0.12b	50.31±0.06c	49.77±0.02d	49.67±0.21e	
Behenic	0.18±0.02b	0.13±0.01f	0.14±0.01e	0.12±0.00g	0.15±0.01d	0.18±0.00b	

*standard deviation; ** values within each row followed by different letters are significantly different at p<0.05.

CONCLUSIONS

It was observed that the total phenol, flavonoid amounts and antioxidant capacities of "Olin" flaxseeds were at the highest levels compared to other genotypes. The antioxidant activity of Atalanta, Dokota, Norman, Royal and Antares flaxseeds were found to be similar, as were the activities of Raulin and Mikael flaxseeds. It was observed that genotypes were effective on the chemical properties of flaxseeds. The "Midin" flaxseed genotype can be considered as a good source of rutin, ferulic acid and resveratrol. It is seen that flaxseed genotypes are generally rich in flavonoid compounds. The key fatty acid in flaxseed oils was linolenic fatty acid. The fact that the main fatty acid in linseed oils is linolenic fatty acid indicates that these oils are included in the linolenic fatty acid group. The values of fatty acids in linseed oils varied depending on the variety.

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