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Fatty Acid Composition and Antioxidant Activity of Anise, Fennel and Hemp Seed Extracts

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Abstract

The need for medicinal plants is rising with each passing day. The efficacy of these plants, which have antioxidant activity and many pharmacological properties, in various diseases such as atherosclerosis, diabetes, Alzheimer's, and cancer is being investigated. Anise and fennel, which are widely cultivated and used in our country, are also critical medicinal plants. However, in recent years, hemp has also been shown to have significant therapeutic effects, and many studies have been carried out to determine its efficacy in chronic and metabolic patients. The objective of this research was to determine the fixed oil ratios and components of hexane extracts obtained from seeds of anise, fennel, and hemp populations and investigate the extracts' antioxidant activities that contribute to the therapeutic potential. Fixed seed oils were determined using the GC/MS method. Antioxidant activity was analyzed by 1,1-diphenyl-2-picrylhydrazyl (DPPH) and 2,2'-azino-bis (3-ethylbenzothiazoline-6-sulfonic acid) (ABTS) methods with potential free radical scavenging effect. According to the results obtained, the saturated fatty acid contents of anise, fennel and hemp were 5.84%, 9.51% and 12.03%, respectively, while the unsaturated fatty acid contents were 91.23%, 90% and 87.97%, respectively. In the DPPH results, the highest antioxidant value was found in fennel at a concentration of 7.5 mg/ml at a rate of 93%. In the ABTS method, the highest antioxidant value was found in anise and fennel at a concentration of 5 mg/ml at a rate of 97%. According to the results of both antioxidant activity assays, the seed extracts showed high antioxidant properties. The fatty acid composition of seed extracts is thought to contribute to antioxidant activity.

Keyword: Antioxidant activity, Fatty acid, Fixed oil, Hemp

Özet

Tıbbi bitkilere olan ihtiyaç her geçen gün artmaktadır. Çok sayıda farmakolojik özelliğin yanı sıra antioksidan aktiviteye de sahip olan bu bitkilerin ateroskleroz, diyabet, alzheimer ve kanser gibi çeşitli hastalıklardaki etkinliği araştırılmaktadır. Ülkemizde yetiştiriciliği ve kullanımı yaygın olan anason ve rezene de önemli tıbbi bitkilerdir. Bununla birlikte son yıllarda kenevir bitkisinin de önemli terapötik etkilere sahip olduğu gösterilmiş, kronik ve metabolik hastalardaki etkinliklerinin belirlenmesine yönelik çok sayıda çalışma gerçekleştirilmiştir. Bu çalışmada anason, rezene ve kenevir popülasyonlarına ait tohumlardan elde edilen hekzan ekstraktlarının sabit yağ oranları ile bileşenlerinin belirlenmesi ve ekstraktların terapötik potansiyele katkı sağlayan antioksidan aktivitelerinin araştırılması amaçlanmıştır. Sabit tohum yağları GC/MS metodu ile belirlenmiştir. Antioksidan aktivite ise 1,1-diphenyl-2-picrylhydrazyl (DPPH) ve 2,2'-azino-bis (3-ethylbenzothiazoline-6-sulfonic acid) (ABTS) metotlarıyla potansiyel serbest radikal temizleyici etkisi ile analiz edilmiştir. Elde edilen sonuçlara göre, anason, rezene ve kenevirin doymuş yağ asidi içeriği sırasıyla %5,84, %9,51 ve %12,03 iken, doymamış yağ asidi oranları sırasıyla %91,23, %90 ve %87,97'dir. DPPH sonuçlarında en yüksek antioksidan değer 7,5 mg/ml konsantrasyonunda %93 oranında rezenede bulunmuştur. ABTS yönteminde ise en yüksek antioksidan değer 5 mg/ml konsantrasyonunda %97 oranında anason ve rezenede bulunmuştur. Kullanılan her iki antioksidan aktivite analizi sonucuna göre de tohum ekstraktları yüksek antioksidan özellik göstermektedir. Tohum ekstraktlarının yağ asidi bileşiminin antioksidan aktiviteye katkı sağladığı düşünülmektedir.

Anahtar kelimeler: Antioksidan aktivite, Yağ asidi, Sabit yağ, Kenevir

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1. INTRODUCTION

Throughout history, patients have medicated themselves to relieve pain and cure a variety of ailments. As humankind's knowledge base increased, some medicinal plants' potential to cure was determined, recorded, and transferred to the next generations. Free radicals, which can lead to many diseases, are reactive. Being unstable and reactive, oxygen/nitrogen species (ROS/RNS) can start chain reactions that can induce damage to the cells (Firdous et al., 2025). The condition in which oxidants are not in balance with antioxidants is called oxidative stress "OS". Later studies indicated that OS plays a serious part in the development and/or progression of several conditions, including cancer, neurological disorders, metabolic syndrome, and cardiovascular and inflammatory diseases (Morvaridzadeh et al., 2020). The fact that oxidative stress causes serious health issues is a substantial problem. By 2023, the most predominant chronic diseases will rise dramatically (Zafar et al., 2023). Multiple factors, including dietary, environmental, genetic, radiation, and toxic exposure, may impact the OS balance inside the human. Called "free radical scavengers," antioxidants neutralize free radicals, making them incapable of hurting the body (Gardiki et al., 2025).

Many medicinal plants possess extensive antioxidants, including polyphenols, vital in adsorbing and neutralizing free radicals. They are also instrumental in decomposing peroxides and quenching singlet and triplet oxygen. Most phytochemicals can have remarkable antioxidant properties that can lower some disorders' occurrence and mortality rates (Muscolo et al., 2024). According to the World Health Organization (WHO), a vast majority 80% of people around the world use traditional medicine for immediate healthcare needs, and phytochemicals play an essential role as the primary source of cures for different therapeutical objectives (Tchicaillat-Landou et al., 2018). Because of desirable pharmacological effects, low toxic effects, and low cost, plants have been investigated as therapeutic markers worldwide (Zafar et al., 2023). Due to the current global health crisis, curing or preventing chronic diseases requires unconventional approaches (Chaliha et al., 2020).

An extraordinary plant used across the pharmaceutical, perfumery, and food sectors, anise (*Pimpinella anisum* L.) is a member of the Apiaceae family. Anise seeds and their essential oils exhibit properties such as antispasmodic, antioxidant, antimicrobial, insecticidal, and antifungal effects (Ullah et al., 2003; Al-Wendawi et al., 2021). The essential oil extracted from its seeds ranges from 1.5 to 5.0% and is predominantly composed of volatile phenylpropanoids, notably trans-anethole (Tabanca et al., 2005). Numerous reports exist on using anise oil in modern medicine, including (Mosaffa-Jahromi et al., 2016; Shahrajabian et al., 2019).

Fennel, known in scientific terms as *Foeniculum vulgare* Mill, is a widely recognized perennial herbaceous species utilized in herbal medicine and as a spice globally. It is a member of the Apiaceae family and features a unique umbrella-shaped structure. Fennel is cultivated in every country surrounding the Mediterranean Sea (Gross et al., 2009). It has medicinal, dairy, cosmetic, and health uses (Kaveh et al., 2023). The seed of this plant increases vision and boosts milk in breastfeeding women (Rafieian et al., 2024). Fennel contains phytopharmacological constituents that have been instrumental in treating many medical conditions. Fennel oil is rich in unsaturated fatty acids, including oleic acid, linoleic acid, and linolenic acid. Among these, oleic acid stands out as the most potent fatty acid for reducing cholesterol levels, whereas linoleic acid and linolenic acid help decrease the likelihood of hypertension in heart-related ailments (Akbari et al., 2024). Fennel seeds have anti-inflammatory, analgesic, diuretic, and antispasmodic properties and have historically been consumed (Doğan, 2020; Kaveh et al., 2023; Tanveer et al., 2024). Additionally, they possess anti-cancer and preventive effects against tumors, along with antioxidant, cytoprotective, liver-protective, blood sugar-lowering, and estrogen-like properties (Jadid et al., 2023). Fennel seeds essential oil has significant antioxidant effects. Thanks to its ability to combat oxidation, this herb is used in the management of neurological disorders (Akbari et al., 2023). Fennel (F. vulgare) has been utilized for centuries throughout the Mediterranean region as a fragrant herb, and its essential oil (FEO) is applied in treating pediatric colic and respiratory issues (Javed et al., 2020).

Hemp (*Cannabis sativa* L.) is a member of the Cannabaceae family. Cannabaceae has been the priority of many scientists because it produces secondary metabolites, especially those of medical importance (Williamson and Evans, 2000; Jin et al., 2020; Reichel et al., 2024). Hemp seeds are a promising source of oil 25-35%, protein 25%, and fiber 15% (Callaway, 2004). Hemp seed oil is rich in linoleic acid and α-linolenic acid, which belong to the omega-6 and omega-3 polyunsaturated fatty acid families, respectively. These fatty acids, linoleic and linolenic, are classified as essential fatty acids since our bodies cannot synthesize them and must acquire them through our diets. The supplementation of linoleic and α-linolenic acids is notably effective in lowering LDL cholesterol and controlling high blood pressure. Moreover, the presence of γ-linolenic acid in hemp seed oil enhances its suitability for use in cosmetic formulations such as body oils and lipid-rich creams. Hemp seeds are rich in cannabinoids and alkaloids that help relieve the symptoms of diseases such as cancer and AIDS (Radwan et al., 2021). The hemp plant boasts an abundance of antioxidant elements, encompassing a diverse array of terpenes and phenols. These elements have been extensively researched because of their potential protective effects against neurodegenerative conditions (Moccia et al., 2020). Nonetheless, the identification of hemp-related antioxidant elements remains unfinished, and research on the topic is notably scarce.

Oil seeds are a source of nutrition used in both human and animal foods (Bettaieb Rebey et al., 2019). Oil seeds contain minerals, vitamins, phenolic compounds, and volatile oils, which have health benefits (Bettaieb Rebey et al., 2019). In addition, anise seed has an oil yield of 11%, while fennel seed yields 13%. These oils are rich in monounsaturated fatty acids, including oleic and petroselinic. Hemp seed oil holds high quantities of polyunsaturated fatty acids. Of these polyunsaturated fats, α-linolenic and linoleic acids are not synthesized in the body but are essential sources for numerous metabolic functions (Tura et al., 2022). Hemp seed oil provides positive effects on the human body by decreasing cancer risks, cardiovascular health, inflammation, hypertension, lipid metabolism, immunomodulatory effects, dermatological diseases, and autoimmune diseases (Babiker et al., 2021; Özdemir et al., 2021). Hemp seed oil contains significant amounts of tocopherols and bioactive compounds with profound health-promoting properties (Liang et al., 2015). Such constituents introduce lag in free radical reactions implicated in lipid oxidation and have an essential say in enhancing oxidative stability, nutritional value, and oil acceptability (Babiker et al., 2021).

Natural products have been used throughout history to treat diseases and ailments. They continue to be a unique source for drug discovery and development (Parsaeimehr et al., 2018). Given the role of oxidative stress in disease development, the antioxidant activity of natural products increases their potential as drug candidates. However, antioxidant activity is also influenced by the content of the phytocomplex due to the growing conditions of the plant and the extraction methods used (Caesar et al., 2019). This study aims to determine the fixed oil content, fatty acid composition, and antioxidant activities of the hexane-based soxselet extract obtained from the seeds of anise and fennel, which are important medicinal plants, and hemp, which have attracted attention for their therapeutic potential in recent years.

2. MATERIAL AND METHOD

2.1. Plant Seed Material

Anise, fennel and hemp seeds were used as materials in the study. Hemp seeds were supplied from Yozgat Bozok University Hemp Research Institute in October 2024, in October 2024, anise seeds from Mersin province and fennel seeds from local producers in Konya province.

2.2. Oil Content (%)

2 g of finely ground seed samples were weighed and kept in an oven (Nuve, En055) at 75-80 ºC for 24 hours, then weighed again, and the dry matter was calculated. At the same time, 3-5 g of ground seed samples were analyzed by dissolving them with hexane (Merck) in a soxhlet device (Hydra Sox, 606) for approximately 3 hours. The oil content was

determined by calculation based on the weight loss of the dissolved oil from the amount of sample subject to analysis. It was organized according to the dry matter basis and expressed as a percentage (Leson and Pless, 2002).

2.3. Fatty Acid Component Analysis

Fatty acid components were determined using the C5-C40 n-alkane standard, Rtx-2330 (60 m x 0.25 mm, 0.10 µm) column with GC/MS (Shimadzu, QP2010 ULTRA) device at Yozgat Bozok University Science and Technology Application and Research Center (BILTEM). In the analyses, the oven temperature program was increased by 3 °C per minute from 60 °C to 200 °C and held at this temperature for 4 minutes. The injector temperature was set to 260 °C, and the scanning range was 35-600 m/z. Helium was the carrier gas (1.00 ml/min, split 1:30).

2.4. Antioxidant Activity Assays

The antioxidant activities of hemp, fennel, and anise seed extracts were determined using a DPPH radical scavenging assay and ABTS analysis. Considering the concentrations applied in the literature, the concentrations showing activity were determined in the preliminary trial phase. For the DPPH assay, 100 µL of seed extracts prepared at concentrations of 1 mg/mL, 2 mg/mL, 5 mg/mL, 7.5 mg/mL, and 10 mg/mL were taken, and 100 µL of DPPH solution (TCI) 0.04 mg/mL was added. After 30 minutes, absorbance values were determined at 517 nm in a microplate reader (BMG Labtech, CLARIOstar) (López et al., 2007).

In ABTS analysis, 100 µL of an ABTS (Sigma Aldrich) working solution prepared with seven mM ABTS and 2.45 mM potassium persulfate (Sigma Aldrich) was added to 100 µL extract samples prepared at the same concentrations. Measurements were made in a microplate reader at a 734 nm wavelength (Lee et al., 2015). % inhibition values were calculated according to the formula below. L-ascorbic acid (USP) was used as a positive control in both analyses.

$$\% \text{ inhibition} = (A_{Control} - A_{Sample}) \text{ X } A_{Control} \text{ X } 100$$

IC_{50} values of each seed extract for DPPH and ABTS analyses were calculated using % inhibition values with GraphPad Prism software (version 10.0.2; GraphPad Software, Inc., La Jolla, CA, USA).

3. RESULT AND DISCUSSION

The fixed oil component ratios obtained from anise, fennel, and hemp seeds are given in “Table 1”. 15 compounds representing 100% of the fixed oil components were identified with the help of GC-MS. The highest value was found in oleic acid in fennel 54.50%. Anise reached the second highest value at 51.84%, while the lowest oleic acid value was obtained from hemp seeds at 15.61%. The chemical values of fennel fixed oil were examined, and the oleic acid content was reported to be 22%. Kara et al. (2020) reported that the amount of anise in oleic acid varied between 8-10% when they examined the fixed oils and compounds of anise and fennel plants. The oleic acid content of hemp fixed oil was 12.5% (de Oliveira Carvalho et al., 2024). When the studies were evaluated, all three materials' fixed oil components were lower than ours.

Hemp seed contained the highest linoleicprimaryn component ratio of 54.18%. Anise was followed with a 25.50% ratio, and the lowest linoleic ratio was determined in fennel at 23.86%. In a study, hemp seed fixed oil linoleic acid was found to be 42.4% (de Oliveira Carvalho et al., 2024), and this ratio was found to be 20% in anise and 0.96% in fennel (Kara et al., 2020). Based on previous studies, the approximate amount of components in anise fixed oil was found to be linoleic acid 45%, oleic acid 20%, and palmitoleic acid 13%. In this study, the highest value in anise fixed oil was linoleic acid (Topčagić et al., 2022), while in our study, the highest component of anise was found to be oleic acid 51.84%. When compared with the literature, it was observed that our values were higher. It was observed that hemp seed fixed oil contained four saturated fatty acids and eight unsaturated fatty acids. In comparison, this ratio was three saturated fatty acids in anise and fennel, 6 in anise, and 5 in fennel. The highest saturated fatty acid ratio was determined in hemp seed with 12.03%. This ratio is followed by fennel 9.51% and anise 5.84%, respectively. It has been reported that 87% of the total fatty acids in hemp seeds are unsaturated (Gimeno-Martínez et al., 2023). This is consistent with our finding of 12% saturated fatty acids in hemp seeds. In the studies, the saturated fatty acid content of fennel was found to be 7.24% (Akbari et al., 2024), while the saturated fatty acid content of anise was found to be 13.92% (Topčagić et al., 2022). The unsaturated fatty acid ratios, whose effects on antioxidant activities are investigated, are at the highest level in anise plant with 91.23%, followed by fennel with 90% and hemp with 87.97%. Different studies found the unsaturated fatty acid content of hemp to be 91.12% (Pratap Singh et al., 2020), anise to be 86.08% (Topčagić et al., 2022), and fennel to be 91.87% (Rezaei-Chiyaneh et al., 2020). Thus, it is possible to say that the unsaturated fatty acid content of the plants is close to our study. It is proposed that unsaturated fats might have an indirect connection with antioxidants, mitigating inflammation and lowering the chances of heart disease (Richard et al., 2008).

Table 1. Content and percentage of fixed oil obtained from anise, fennel, and hemp seeds (%)

No	Fatty Acid	Molecular weight	Structure	Systematic name	Formula	Hemp Oil	Anise Oil	Fennel Oil
1	Myristic	228	14:0	Tetradecanoic	$C_{14}H_{28}O_2$	0	0.08	0
2	Palmitic	256	16:0	Hexadecanoic	$C_{16}H_{32}O_2$	8.02	4.70	6.66
3	Palmitoleic	254	16:1	Hexadec-9-enoic	$C_{16}H_{30}O_2$	0.09	0.30	0
4	Stearic	284	18:0	Octadecanoic	$C_{18}H_{36}O_2$	2.86	1.06	2.33
5	Oleic	282	18:1	Cis-9-Octadecenoic	$C_{18}H_{34}O_2$	15.61	51.84	54.50
6	Elaidic	282	18:1	(9E)-9-octadecenoic acid	$C_{18}H_{34}O_2$	0.83	11.78	6.68
7	Vaccenic	282	18:1	(11E)-11-octadecenoic acid	$C_{18}H_{34}O_2$	0	1.42	0.47
8	Linoleic	280	18:2	(9Z,12Z)-octadeca-9,12-dienoic acid	$C_{18}H_{32}O_2$	54.18	25.50	23.86
9	Gamma-Linolenic	278	18:3	All-cis-6,9,12-octadecatrienoic acid	$C_{18}H_{30}O_2$	2.48	0	0
10	alpha-Linolenic	278	18:3	(9Z,12Z,15Z)-octadeca-9,12,15-trienoic acid	$C_{18}H_{30}O_2$	13.55	0.39	4.49
11	Arachidic	312	20:0	Icosanoic acid	$C_{20}H_{40}O_2$	0.68	0	0.52
12	Gondoic	310	20:1	11-eıcosenoıc acıd	$C_{20}H_{38}O_2$	0.38	0	0
13	Eicosatetraenoic	304	20:4	(all-cis)-5,8,11,14-eicosatetraenoic acid	$C_{20}H_{32}O_2$	0.85	0	0
14	Behenic	340	22:0	Docosonoic acid	$C_{22}H_{44}O_2$	0.35	0	0
15	Lignoceric	368	24:0	Tetracosanoic acid	$C_{24}H_{48}O_2$	0.12	0	0
Saturated fatty acids						12.03	5.84	9.51
Monounsaturated fatty acids						16.91	65.34	61.65
Polyunsaturated fatty acids						71.06	25.89	28.35
Total						100	97.07	99.51

To determine the antioxidant potential of oil extracts, a range of assays can be employed, including DPPH and ABTS tests, each relying on distinct antioxidant mechanisms. The DPPH and ABTS techniques are based on combined hydrogen atom transfer (HAT) and single electron transfer (SET) mechanisms to evaluate antiradical efficacy. Both assays utilize spectrophotometry to measure the capability of hydrophilic (water-soluble) or lipophilic (lipid-soluble) antioxidants in oil to neutralize the cationic radical ABTS and the stable radical DPPH. It is crucial to implement multiple tests to accurately assess the antioxidant activity of substances, as different antioxidant pathways are influenced by factors such as the nature of the radical, pH level, solvent type, duration of measurement, and redox potential (Apak et al., 2016). In "Table 2", there was a significant difference in free radical scavenging activities of essential oils. The anise oil showed high activity in DPPH radicals with IC50 (1.416), while fennel and hemp oil had similar antioxidant activity, respectively, with IC50 (2.132) and (2.544). The IC50 value of hemp seed oil was found to be 3.43 in the DPHH experiment (Kalinowska et al., 2022). In our study, this value was found to be 2.132 in hemp seed, which means it has higher antioxidant activity. In a different study conducted with the ABTS method on hemp seeds, the effect of IC_{50} was determined as 0.046 mg/ml in radical scavenging (Gulcin et al., 2024). The highest antioxidant activities were obtained by the ABTS method. Since ABTS is a more sensitive method than the DPPH method, antioxidant activities are similar for all three samples. However, the highest antioxidant activity value is anise (1.005).

In a study, the antioxidant activities of 4 different fractions (PA-RM, PA-SM, PA-UM and PA-RW) formed after sequential extraction of anise seed were determined by the DPPH method. Antioxidant activities were observed with IC_{50} values of 2.63 ± 0.09, 3.16 ± 0.08, 6.19 ± 0.30; and 8.66 ± 0.64 mg/ml for PA-RM, PA-SM, PA-UM and PA-RW, respectively (Topčagić et al., 2022). In the same study, anise extracts showed high antioxidant activity by the ABTS method. Especially, IC_{50} values of 1.09 ± 0.05 and 1.18 ± 0.03 mg/ml were found for PA-SM and PA-UM, respectively (Topčagić et al., 2022). In a study on the antioxidant activity of the extract obtained from anise seed by the Soxhlet method, the IC_{50} value was found to be 0.067 mg/ml by the DPPH method (Nasir et al., 2022). In a different study, it was reported that fennel seed essential oil showed the lowest radical scavenging activity 15.33 mg/ml among three cultures having IC_{50} using the DPPH method (Chang et al., 2016). In a different study, the IC_{50} value of ABTS radical scavenging activity of fennel plant was found to be 87.33±0.17 µg/ml (Khammassi et al., 2023).

Table 2. Antioxidant assay of anise, fennel, and hemp oils

	DPPH (IC_{50} mg/mL)	**ABTS (IC_{50} mg/mL)**
Anise Oil	1.416	1.005
Fennel Oil	2.132	1.059
Hemp Oil	2.544	1.144

Anise, fennel, and hemp have been the subject of many studies in recent years due to their high antioxidant effects. The antioxidant activity values of these plants obtained according to DPPH and ABTS methods are given in “Figure 1”. DPPH. When DPPH results were examined, the highest antioxidant value 93% of fennel oil was found at a concentration of 7.5 mg/ml. In a study, fennel seeds were reported to give DPPH results in the range of 70.26%-95.69% (Noreen et al., 2023). In a different study, when the antioxidant activity of fennel seed extracts in different solvents and various concentrations was evaluated with DPPH radical scavenging activity, it was reported that the highest inhibition rate of fennel seed extract prepared with methanol was 96.2% at a concentration of 1 mg/ml (Goswami and Chatterjee, 2019). It has been reported that hemp extract has a radical scavenging activity ranging from 69.1% to 86.9% at a concentration of 100 µg/ml with the DPPH radical (Yan et al., 2015). Solvents used in the extraction of seeds can affect the contents and antioxidant capacity of the seeds. In a study using DPPH radical, it was reported that anise seed extracted with ethanol and water had a radical scavenging effect of 91.3% and 82.0% at a concentration of 0.3 mg/ml, respectively (Amer and Aly, 2009). In our study, the highest DPPH radical of anise seed extracted with hexane solution was found to be 92% at a concentration of 7.5 mg/ml. The highest DPPH radical 91% was found in hemp at a 5 mg/ml concentration. In one study, the antioxidant activity of hemp was evaluated using the DPPH test, and hemp seed oil was found to have an impressive antioxidant potential of 0.5 mg/ml (Yu et al., 2005).

When the ABTS method was examined, the highest scavenging effect was found in anise 97% and fennel 97% at a concentration of 5 mg/ml. Conversely, hemp showed a scavenging effect of 96% at the 5 mg/ml concentration, similar to other plants. As seen in "Figure 2" in our study, at a 1 mg/ml concentration, the antioxidant potential of fennel seed extracts using hexane measured at 55.31%, as assessed by the ABTS method. In an investigation, at a concentration of 0.5 mg/mL, the antioxidative potential of fennel seed extracts in distilled water, 80% ethanol, and 80% acetone were measured at 48.35%, 45.10%, and 28.45%, respectively, and assessed using the ABTS method (Yu et al., 2005). It has been reported that hemp extract has a radical scavenging activity ranging from 45.3% to 95.1% at a concentration of 100 µg/ml with the ABTS radical (Yan et al., 2015). When the studies are evaluated, it can be said that factors such as the type of seeds used and the growing conditions can change the seed composition, and the different solvents used in the preparation of seed extracts can also affect antioxidant activity.

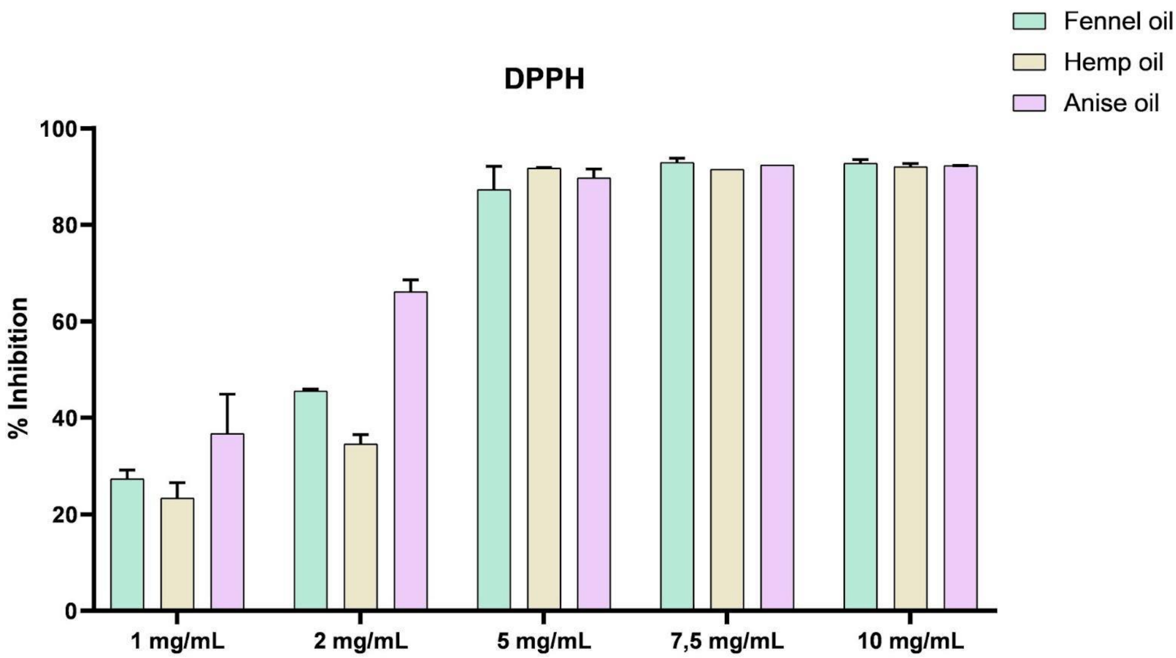

Figure 1. Scavenging effects of anise, fennel, and hemp oils on DPPH radical

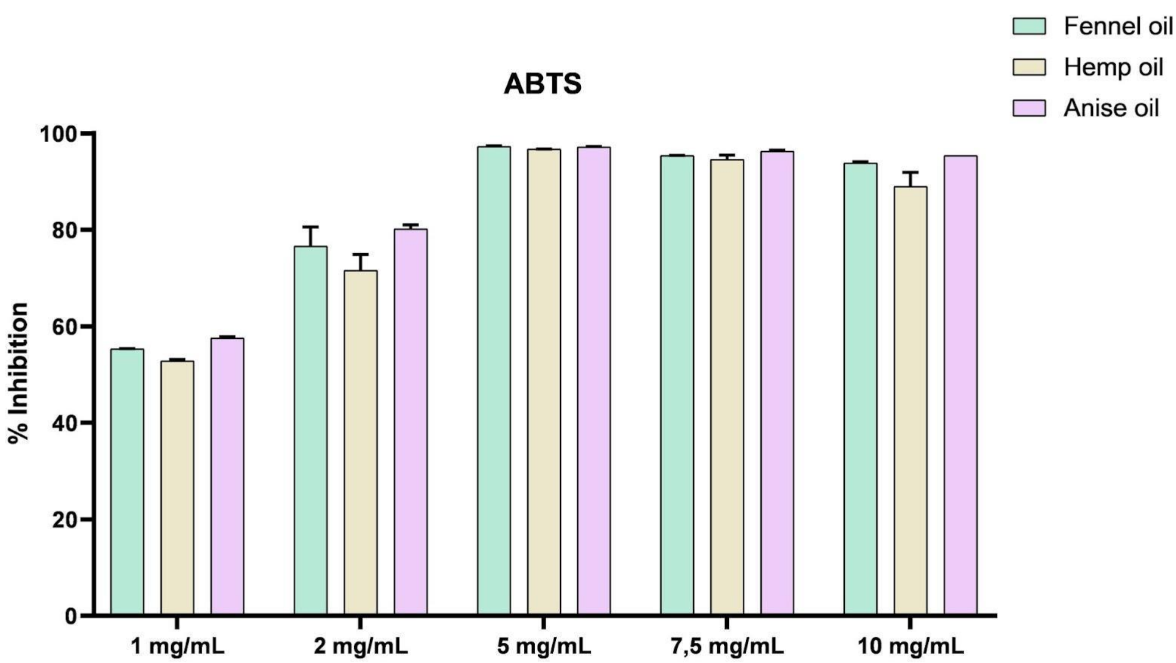

Figure 2. Scavenging effects of anise, fennel, and hemp oils on ABTS radical

4. CONCLUSION

Our study investigated fixed oil ratios, components, and antioxidant activity of anise, fennel, and hemp. Hemp seed oil 12.03% had the highest percentage of saturated fatty acids. Anise oil had the highest monounsaturated fatty acids 65.34%, while hemp oil had the highest proportion of polyunsaturated fatty acids 71.06%. While the highest constituent of hemp oil was linoleic acid 54.18%, the highest constituent of anise and fennel oil was oleic acid 51.84% and 54.50%, respectively. Antioxidant capacity (1mg/ml, 2mg/ml, 5mg/ml, 7.5mg/ml, 10mg/ml) of anise, fennel, and hemp seed extracts was evaluated by DPPH and ABTS methods. Since the ABTS method is more sensitive in detecting both hydrophobic and hydrophilic antioxidants, a better activity was observed in the ABTS method than the DPPH method. There seems to be a relationship between the antioxidant effect and the chemical composition of the oils. There is no strong evidence to support the antioxidant nature of oleic acid and linoleic acid, which are found in high amounts in the plant content. One could argue that the biochemical composition of vegetation, particularly the presence of unsaturated fatty acids, plays a role in promoting antioxidative action.

AUTHORS CONTRIBUTION

ÖDŞ: In the entire experiments and article writing process; KUÇ: In the entire experiments and article writing process.

CONFLICT OF INTEREST

There is no conflict of interest between the authors.

RESEARCH AND PUBLICATION ETHICS

The author declares that this study complies with Research and Publication Ethics.

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