



DETERMINATION OF FATTY ACID COMPOSITION AND ANTIOXIDANT ACTIVITY OF FIG SEED OIL

 Zeynep Ergün^{1*},  Taner Bozkurt²

¹Adana Alparslan Türkeş Science and Technology University, Faculty of Engineering,
 Department of Bioengineering, Adana, Turkey

²Bozkurt Biotechnology R&D Services Industry and Trade Limited Company, Adana, Turkey

*Corresponding Author:
 E-mail: zergun@atu.edu.tr

(Received 01st July 2020; accepted 25th August 2020)

ABSTRACT. *Ficus carica* is a tree that grows in the Eastern Mediterranean and Southwest Asia. It is among the first cultivated plants by humans. *Ficus carica*, called figs, has a very large family and more than 700 known species. Different parts of the plant like its fruit, latex, leaves, and seeds have a very important medical value. However, studies on fig seed oils are very limited. In this study, the fatty acid composition of fig seed oils was determined by gas chromatography/mass spectrophotometry (GC/MS). Total antioxidant activity analysis was made through DPPH (2,2-diphenyl-1-picrylhydrazyl) method and antioxidant activity value was determined as trolox equivalent (TE). While the total oil yield was determined as 14.08%, the antioxidant capacity was determined to be 140.19 mg TE/100 g. According to GC/MS analysis, it was determined that the highest fatty acid was α -Linolenic acid (26.31%), followed by linoleic acid (24.27%) and oleic acid (19.65%). With these results and limited literature information, it is clear that figs can be evaluated outside of common consumption.

Keywords: *Ficus carica*, fatty acid, seed oil, antioxidant capacity, DPPH, fig

INTRODUCTION

The genus *Ficus* is one of the largest medicinal plants, with more than 750 woody plants, trees, and shrubs that can grow in subtropical and tropical areas of the World [1]. *Ficus* is an essential source of genes owing to its nutritional value and high economic and is a substantial part of biodiversity in the rain forest ecosystem [2, 3].

Ficus carica L., also called as fig, is one of the important members of the genus *Ficus*. Fig is one of the first plants that are native to Southwest Asia and the Eastern Mediterranean and cultivated by humans [4]. Because figs are practical to use and belief objects, they have special importance for tropical regions. Besides, these plants attract the attention of many researchers with their biological activities. In traditional medical systems such as Ayurveda, Unani, Homoeopathy, and Siddha, the therapeutic benefits of *F. carica* L. have been emphasized. It is known that these traditional medicine systems are used in the treatment of many diseases such as cardiovascular, hypertensive, ulcerative, infectious, and cancer diseases [5, 6].

F. carica L. continues to be cultivated due to its edible fruits. According to TUIK (Turkish statistical institute) data, it is known that the production in our country was 306.499 tons in 2018. Moreover, according to FAO (Food and Agriculture Organization) data of 2017 [7], the world fig production in Turkey is in first place with 305 689 tonnes of world production. This is followed by Egypt (177.135 tons), Morocco (137.934 tons) and Algeria (128.684 tons), respectively. More detailed data can be found in Fig 1.

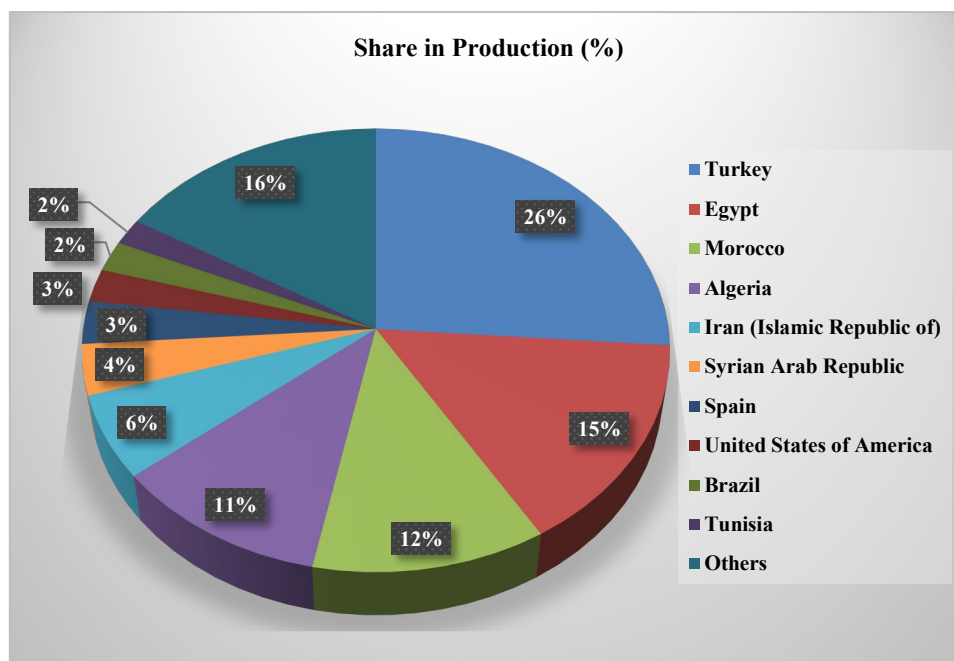


Fig. 1. Distribution of fig production in the world by country (2017) [7]

In the world, fig consumption is in the form of dry and table fresh consumption. Both dried and fresh figs have high levels of fiber and polyphenols [8, 9]. Besides, it has been reported by many researchers that dried fruits are an important source of sugar, vitamins, minerals, protein, organic acid, carbohydrates, and phenolic compounds [10, 11, 12, 13]. Due to these properties, fig has a substantial place among foods and a very large consumption area. It also has very important antioxidant activities for human health in terms of many compounds it contains.

Antioxidants are defined as compounds that take place under the effect of atmospheric oxygen or reactive oxygen species, which can delay or inhibit oxidation processes. They are employed to stabilize the polymeric products of cosmetics, pharmaceuticals, petrochemicals, and food items [14].

One of the parts of figs that makes them important both in terms of nutritional values and health is seeds. These seeds can be large, medium and small, and the number of seeds per fruit (30 to 1600) varies. There are many edible seeds in one fig and the seeds are hollow unless pollinated. On the other hand, pollinated seeds give the characteristic nutty taste of fig. Fig seeds attract researchers' interest due to the rich chemical compounds they contain [15, 16].

In this study, it is aimed to determine the composition of fig core fatty acids by gas chromatography/mass spectrophotometry (GC/MS). Moreover, it is predicted that determining antioxidant capacity will contribute to the literature.

MATERIALS AND METHODS

Material

Fig seeds used in this study were obtained from local companies and kept at room temperature until analysis.

Method

Fatty Acid Analysis

The oil extraction of the fig seeds we preserved was made with n-hexane. Analysis of fatty acids was done according to the method of IUPAC IID19 [17]. Gas chromatography (GC; Perkin Elmer, Shelton, USA) was used to determine the fatty acid composition. Flame ionization detector (FID) and column (30 m × 0.25 mm ID, 0.25- μ m film thickness) were used for chromatographic separation. The oven temperature was raised to 120°C (2 min) and 220°C with 5°C / minute and kept for 10 minutes; Injector and detector temperatures were set at 280°C and 260°C, respectively. The results are calculated in % with their average deviations.

Total Antioxidant Activity Analysis

Total antioxidant activity analysis in fig seeds was done using DPPH (2,2-diphenyl-1-picrylhydrazyl) method. Readings were made using a spectrophotometer at a wavelength of 515nm. The antioxidant capacity of fig seed oil was calculated as trolox equivalent.

Statistical Analysis

The fatty acid analysis was performed in three replications according to random plot trial design. The data obtained were analyzed by employing the SAS-JMP statistical program (SAS Institute Inc., Cary, NC) and variance analysis was performed. The differences between them are compared with the LSD multiple comparison test.

RESULTS AND DISCUSSION

In this study, analysis of total oil amount, fatty acid composition, and total antioxidant activity in *F. carica* L. seeds were performed. According to the obtained results, the total amount of fat was determined as 14.08%. In the study, the fatty acid composition was determined by Gas Chromatography (GC) and presented in detail in Table 1.

Accordingly, it was determined that the highest fatty acid was α -Linolenic acid (26.31%) followed by linoleic acid (24.27%) and oleic acid (19.65%). All three together constitute 70% of the total core oil. α -Linolenic acid is an important herbal Omega-3 source. Omega-3 is a very important fatty acid in terms of health and reduces risk factors for many diseases. Omega-3 fatty acids are defined as anti-inflammatory and structural essential dietary oils for retinal photoreceptors and nerve tissue [18]. It has been determined in the analysis that fig seed oil is a vital α -Linolenic acid source and it has been observed that there are very limited studies in this context. It has been reported that the amount of α -linolenic acid in other plants is 55% for flaxseed, 10% for canola oil and 10% for walnut [19, 20].

Table 1. Fatty acid composition of *F. carica* L. Seed (Figures in parentheses are angular transformation values of percentage of response)

	Fatty Acid	Percentage (%)
1	Palmitic Acid (C16: 0)	15.10 ^d (22.86)
2	Palmitoleic Acid (C16: 1)	0.07 ^k (1.51)
3	Stearic Acid (C18: 0)	5.89 ^c (14.04)
4	Oleic Acid (C18: 1n9c)	19.65 ^c (26.31)
5	Eleaidic Acid (C18: 1n9t)	0.04 ^l (1.14)
6	Linoleic Acid (C18: 2n6c)	24.27 ^b (29.51)
7	α -Linolenic Acid (C18: 3n3)	26.31 ^a (30.85)
8	γ -Linolenic Acid (C18: 3n6)	0.11 ^j (1.90)
9	Arachidic Acid (C20: 0)	0.37 ^g (3.48)
10	Eicosenoic Acid (C20: 1n9c)	0.29 ^h (3.08)
11	Behenic Acid (C22: 0)	0.17 ⁱ (2,36)
12	Caproic Acid (C6: 0)	0.13 ^j (2.06)
13	Lignoceric Acid (C24: 0)	0.08 ^k (1.62)
14	Caprylic Acid (C8: 0)	0.56 ^f (4.29)
15	Capric Acid (C10: 0)	0.04 ^l (1.14)
16	Myristic Acid (C14: 0)	0.12 ^j (1.98)
17	Undecanoic Acid (C17: 0)	0.08 ^k (1.62)
18	Heptadecanoic Acid (C17: 0)	0.16 ⁱ (2.29)
19	Pentadecanoic Acid (C15: 0)	0.04 ^l (1.14)

LSD: 0,17***, $P < 0.05$ *, $P < 0.01$ ** , $P < 0.001$ ***

In a study on dried figs, Jeong and Lachance found that the most dominant fatty acid in milled fruits was linolenic acid (53.1%), followed by linolenic acid (21.1%), palmitic acid (13.8%) and oleic acid (9.8%) have determined that [10]. Similarly, Yarosh and Umarov [21] obtained high linolenic acid (trienic acid) amount from ground fig seeds.

Linoleic acid, one of the other essential fatty acids, is an omega-6 fatty acid. It is one of the fatty acids very important in determining oil quality. The percentage amounts of linoleic (omega-6), oleic (omega-9), and linolenic (omega-3) acids among fatty acids in oil quality are very important. It has been reported that oleic acid is effective in having the desired frying properties [22] and linoleic acid decreases the level of cholesterol in the blood [23, 24]. Since oleic acid provides long stability, it has an area of use in the chemical industry, especially in the food and cosmetics sector [25].

As with many seeds, the total oil yield is very important in fig seeds. Kim et al. [20] reported the amount of oil in 2 different local fig varieties as 0.31-0.27%. It is a very low value compared to the fig seed used in this study. It is thought that this difference in the amount of oil is due to the locality, harvest time, and the variety of figs studied.

In a different study, Hssaini et al. [26] obtained the highest oil content from local varieties 'C7A14' (29.65 \pm 1.21%) and 'C11A21' (28.96 \pm 0.62%). The lowest oil

content was observed in 'Borjassoute Noir' ($21.54 \pm 1.71\%$) and 'White Adriatic' ($24.71 \pm 2.14\%$) varieties.

Berry [27] determined that the oil content in fresh and boiled durian (*Durio zibethinus* Murr) Seeds was 1.8%. He found that about 82% of all seed oil consists of unsaturated fatty acids.

Taoufik et al. [28] investigated *Opuntia ficus indica* cactus seed oils of different origins. They found the oil yields of a total of 17 cactus seeds between 5.4% and 9.9%. They emphasized that the main fatty acids of cactus oil are palmitic acid (11.6–12.4g / 100g), oleic acid (18.2–22.3g / 100g), and linoleic acid (60.2–64.6g / 100g).

In a review covering the nutritional values of 10 different fruit seed oils, it was reported that the oil content in the seeds was between 1.8% and 49.0%, and the protein content was 6% to 40.0%. As in our determination, it has been emphasized in this review that the varying oil content may be due to differences in plant varieties and geographical differences [29].

According to the total antioxidant activity analysis, the antioxidant capacity of fig seed oils was observed to be 140.19 mg TE / 100 g. With the antioxidant capacity value obtained, it has been proven that it is precious in this respect as well. However, this value is not stable and may change with many factors. A different study conducted proves this; while researchers working on light and dark fig fruits found the highest antioxidant (DPPH) value in the dark-colored Bouankik (45.25%) variety, they determined the lowest amount in Taghanimt (28.33%) [30]. Accordingly, it is seen that colors, types, and methods have different effects on antioxidant amounts. In different studies; It has been emphasized that fruits, for instance, blueberries, blackberries, and strawberries have high levels of antioxidant capacity due to the high levels of polyphenol and anthocyanin they contain [31, 32]. Turkey to performing work on Smyrna figs Halvorsen et al. [33] the total antioxidant amount 0.73 mmol / 100g been found not. Accordingly, it has been determined that fig seed has less total antioxidant capacity than pomegranate, grape, and plum, but higher than papaya, mango, apple, apricot, and banana.

Hssaini et al. [34] compared the morphological and biochemical characteristics of 11 local fig varieties grown in the Moroccan climate. According to DPPH free radical scavenging capacity, the highest antioxidant value is in 'Nabout' [88.1 ± 3.37 mmol TE / g dw (dry weight)] and 'Breval Blanca' (83.16 ± 6.93 mmol TE / g dw) varieties, while the lowest values are in 'El Quoti Lbied' and They have been observed in "Snowden" (14.28 ± 1.42 and 14.76 ± 1.61 mmol TE / g dw, respectively). The highest antioxidant activity was obtained with DPPH test.

Having researched the antioxidant activity of different fruits, Reddy et al. [35] observed that fresh fruits ranged from 32 to 891mg TE / 100g as a result of DPPH radical scavenging, while the highest antioxidant activity was seen in guava (*Psidium guajava*) (891) and the lowest in watermelon (*Citrullus lanatus*) (32). In dried fruits, the highest activity was found in walnut (*Juglans regia*) (1541 mg TE / 100 g) and the lowest activity in piyal (*Pistacia vera*) seeds (271 mg TE / 100 g). These results are quite high compared to our study.

CONCLUSION

In this study, fig seed oil yield was determined as 14.08%. As a result of the analysis of the fatty acid composition, it was determined that the highest fatty acids were α -

Linolenic acid, linoleic acid and oleic acid, respectively. It is expected that this study will be very useful due to the limited number of studies on fig seed fatty acids. It is very important in terms of completing the deficiency in the literature and providing data on how fig seed fatty acids can be evaluated in the future. It is suggested that a separate window should be opened for the seeds of fig fruits, which are mostly evaluated for human consumption and health. It should not be forgotten that it can be an alternative source of linolenic acid to other animal and vegetable oils.

REFERENCES

- [1] Joseph, B., & Raj, S. J. (2011): Pharmacognostic and phytochemical properties of *Ficus carica* Linn–An overview. International journal of pharmtech research 3(1): 8-12.
- [2] Rønsted, N., Salvo, G., & Savolainen, V. (2007): Biogeographical and phylogenetic origins of African fig species (*Ficus* section Galoglychia). Molecular phylogenetics and Evolution 43(1): 190-201.
- [3] Mawa, S., Husain, K., & Jantan, I. (2013): *Ficus carica* L.(Moraceae): phytochemistry, traditional uses and biological activities. Evidence-Based Complementary and Alternative Medicine 2013: 8
- [4] Dueñas, M., Pérez-Alonso, J. J., Santos-Buelga, C., & Escribano-Bailón, T. (2008): Anthocyanin composition in fig (*Ficus carica* L.). Journal of Food Composition and Analysis 21(2): 107-115.
- [5] Badgajar, S. B., Patel, V. V., Bandivdekar, A. H., & Mahajan, R. T. (2014): Traditional uses, phytochemistry and pharmacology of *Ficus carica*: A review. Pharmaceutical biology 52(11): 1487-1503.
- [6] Prasad, P. V., Subhaktha, P. K., Narayana, A., & Rao, M. M. (2006): Medico-historical study of "aśvattha" (sacred fig tree). Bulletin of the Indian Institute of History of Medicine (Hyderabad) 36(1): 1-20.
- [7] FAO, (2020): Food and Agriculture Organization of The United Nations, <http://faostat3.fao.org/download/Q/QC/E>, (Date of access:06.07.2020)
- [8] Vinson, J. A. (1999): The functional food properties of figs. Cereal foods world 44(2): 82-87.
- [9] Vinson, J. A., Zubik, L., Bose, P., Samman, N., Proch, J. (2005): Dried fruits: excellent in vitro and in vivo antioxidants. Journal of the American College of Nutrition 24(1): 44-50.
- [10] Jeong, W. S., Lachance, P. A. (2001): Phytosterols and fatty acids in fig (*Ficus carica* var. Mission) fruit and tree components. Journal of food science 66(2): 278-281.
- [11] Veberic, R., Jakopic, J., Stampar, F. (2008): Internal fruit quality of figs (*Ficus carica* L.) in the Northern Mediterranean Region. Italian Journal of Food Science 20(2): 255-262.
- [12] Mawa, S., Husain, K., Jantan, I. (2013): *Ficus carica* L. (Moraceae): phytochemistry, traditional uses and biological activities. Evidence-Based Complementary and Alternative Medicine 2013.
- [13] Oliveira, A. P., Valentão, P., Pereira, J. A., Silva, B. M., Tavares, F., Andrade, P. B. (2009): *Ficus carica* L.: Metabolic and biological screening. Food and Chemical Toxicology 47(11): 2841-2846.
- [14] Pisoschi, A. M., Negulescu, G. P. (2011): Methods for total antioxidant activity determination: a review. Biochem Anal Biochem 1(1): 106.
- [15] Badgajar, S. B., Patel, V. V., Bandivdekar, A. H., Mahajan, R. T. (2014): Traditional uses, phytochemistry and pharmacology of *Ficus carica*: A review. Pharmaceutical biology 52(11): 1487-1503.
- [16] Joseph B., Raj S.J. (2011): Pharmacognostic and phytochemical properties of *Ficus carica* Linn –An overview, Int.J. PharmTech Res 3(1): 8-12
- [17] IUPAC - International Union of Pure and Applied Chemistry. (1987): IUPAC standard method 2.507. In: Standart methods for the analysis of oils, fats and derivatives. 7th ed.

- IUPAC IID19. The International Union of Pure and Applied Chemistry, Blackwell, Oxford.
- [18] Richer, S., Ulanski, L., Popenko, N. A., Pratt, S. G., Hitchmoth, D., Chous, P., ... & Sardi, B. (2016): Age-related Macular Degeneration Beyond the Age-related Eye Disease Study II. *Advances in Ophthalmology and Optometry* 1(1): 335-369.
- [19] İşleroğlu, H., Yıldırım, Z., Yıldırım, M. (2005): Fonksiyonel bir gıda olarak keten tohumu. *Gaziosmanpaşa Üniversitesi Ziraat Fakültesi Dergisi* 22(2): 23-30.
- [20] Kim, S. S., Lee, C. H., Oh, S. L., Chung, D. H. (1992): Chemical components in the two cultivars of Korean figs (*Ficus carica* L.). *Applied Biological Chemistry* 35(1): 51-54.
- [21] Yarosh E. A., Umarov A.U. (1971): A study of the oil of the seeds of *Ficus carica*. *Chem Nat Compd Engl Transl* 71(1): 99.
- [22] Yeilaghi, H., Arzani A., Ghaderian M., Fotovat R., Feizi M., Pourdad S.S. (2012): Effect of salinity on seed oil content and fatty acid composition of safflower (*Carthamus tinctorius* L.) genotypes. *Food Chemistry J* 130: 618–625.
- [23] Mohsennia, O., Jalilian, J. (2012): Response of safflower seed quality characteristics to different soil fertility systems and irrigation disruption. *International Research Journal of Applied and Basic Sciences* 3(5): 968-976
- [24] Wilson, T. A., Nicolosi, R. J., Saati, A., Kotyla, T., Kritchevsky, D. (2006): Conjugated linoleic acid isomers reduce blood cholesterol levels but not aortic cholesterol accumulation in hypercholesterolemic hamsters. *Lipids J* 41: 41–48.
- [25] Duru, S., Konoşkan, D. B. (2014): Bitkisel Yağlarda Oleik Asit Miktarının Arttırılması ve Yağ Kalitesi Üzerine Etkileri. *GIDA* 39(6).
- [26] Hssaini, L., Hanine, H., Charafi, J., Razouk, R., Elantari, A., Ennahli, S., ... & Ouaabou, R. (2020): First report on fatty acids composition, total phenolics and antioxidant activity in seeds oil of four fig cultivars (*Ficus carica* L.) grown in Morocco. *OCL* 27: 8.
- [27] Berry, S. K. (1980): Cyclopropene fatty acids in some Malaysian edible seeds and nuts: I. Durian (*Durio zibethinus* Murr.). *Lipids*, 15(6): 452-455.
- [28] Taoufik, F., Zine, S., El Hadek, M., Idrissi Hassani, L. M., Gharby, S., Harhar, H., & Matthäus, B. (2015): Oil content and main constituents of cactus seed oils *Opuntia Ficus Indica* of different origin in Morocco. *Mediterranean Journal of Nutrition and Metabolism* 8(2): 85-92.
- [29] Raihana, A. N., Marikkar, J. M. N., Amin, I., Shuhaimi, M. (2015): A review on food values of selected tropical fruits' seeds. *International Journal of Food Properties* 18(11): 2380-2392.
- [30] Bey, M. B., Louaileche, H. (2015): A comparative study of phytochemical profile and *in vitro* antioxidant activities of dark and light dried fig (*Ficus carica* L.) varieties. *The J. Phyto* 4(1): 41-48.
- [31] Sellappan, S., Akoh, C. C., Krewer, G. (2002): Phenolic compounds and antioxidant capacity of Georgia-grown blueberries and blackberries. *Journal of agricultural and food chemistry* 50(8): 2432-2438.
- [32] Rababah, T. M., Ereifej, K. I., Howard, L. (2005): Effect of ascorbic acid and dehydration on concentrations of total phenolics, antioxidant capacity, anthocyanins, and color in fruits. *Journal of agricultural and food chemistry* 53(11): 4444-4447.
- [33] Halvorsen, B. L., Holte, K., Myhrstad, M. C., Barikmo, I., Hvattum, E., Remberg, S. F., ... & Moskaug, Ø. (2002): A systematic screening of total antioxidants in dietary plants. *The Journal of nutrition* 132(3): 461-471.
- [34] Hssaini, L., Charafi, J., Razouk, R., Hernández, F., Fauconnier, M. L., Ennahli, S., Hanine, H. (2020): Assessment of Morphological Traits and Fruit Metabolites in Eleven Fig Varieties (*Ficus carica* L.). *International Journal of Fruit Science* 1-21.
- [35] Reddy, C. V. K., Sreeramulu, D., Raghunath, M. (2010): Antioxidant activity of fresh and dry fruits commonly consumed in India. *Food research international* 43(1): 285-288.