Chemistry of Natural Compounds, Vol. 42, No. 6, 2006

FATTY ACID COMPOSITION OF SOME *Astragalus* SPECIES FROM TURKEY

Eyup Bagci

UDC 665.325

In this study, the fatty acid contents of some Astragalus *L. (Fabaceae) species from Turkey were determined by GC and GC-MS techniques. The seed oils of* Astragalus *sp. (*A. echinops *Aucher ex. Boiss.,* A. subrobustos *Boriss.,* A. jodostachys, *Boiss. & Buhse.,* A. falcatus *Lam.,* A. fraxinifolius *DC.) contained linolenic (between 23–41.%), linoleic (23–37%), and oleic acids (8–19%) as the major components. Fatty acid composition of the studied* Astragalus *taxa showed uniform fatty acid patterns. Palmitic and stearic acids were the major saturated fatty acids in the seed oils. The amounts of unsaturated fatty acids were higher than saturated fatty acids.*

Key words: *Astragalus* L., Fabaceae, fatty acid, chemotaxonomy.

The Fabaceae (Leguminosae) is a family of flowering plants comprising about 269 genera and 5100 species [1] and is one of the largest plant families in the world and also in Turkey. It has 68 genera and more than 900 species in Flora of Turkey [2–4]. This is a more important family of food plants, especially pulses (beans, gram, peas) and oil (soya, ground nut), but also tanbarks, timber, copal, gums, insecticides and cultivated ornamentals, as well as medicinal plants [5, 6]. *Astragalus* is also considered to be the largest genus in angiosperms in Turkey, with more than about 450 taxa [2, 7].

Leguminosae is well suited with respect to chemical components. Lipids from some more common legumes have been investigated to some extent; other legume lipids have not been studied in any great detail because of their low lipid content and limited or negligible use for oil purposes [8–10]. But there are few reports on the Turkish Fabaceae, particularly on *Astragalus* genus [11, 12]. The storage lipids of legume seeds are a major of dietary fat [13]. Omega 3- fatty acids are polyunsaturated fatty acids that are associated with many health benefits [14].

In this study, the fatty acid content of some *Astragalus* species (*A. echinops* Aucher ex. Boiss., *A. subrobustos* Boriss., *A. jodostachys*, *A. falcatus* Lam., *A. fraxinifolius* DC.) from Turkey were investigated.

In this study, the fatty acid compositions of some *Astragalus* patterns from Turkey were determined. The results of the fatty acid analysis and the oil yield of the taxa are shown in Table 1. The total lipid contents of the studied *Astragalus* species were found to be between 28.9% (*A. echinops*) and 36.1%, with *A. falcatus* showing the highest oil content (Table 1). The fatty acid (FA) composition of the studied *Astragalus* taxa was uniform. However, small quantitative differences were also found.

Saturated acid components of the seed oils such as lauric, myristic, and pentadecanoic acids were absent or present in trace amounts. Palmitic acid (16:0) is the highest in *A. falcatus* (10.3%) and *A. echinops* (9.60%). This fatty acid is a constant constituent in most of the Leguminous genera seed oil, present at medium levels (ca. 5%), when considering *Hedysarum cappadocicum* (5.62%) and *Onobrychis huetiana* (4.9%) [11, 15]. Some *Lathyrus* sp. has palmitic acid more than 10% in the seed oils [11].

Stearic acid (18:0) was found at low levels in *Astragalus* seed oil (between 1.91 and 3.48%), but there are some reports on legume seed oils from different genera. *Onobrychis hypargyrea* (4.20%), *Vicia cappadocica* (3.91%), *Lupinus* (3.77%), and *Trigonella* (3.63%) have higher concentrations, and *V. peregrina* L. (7.26%) and *V. hybrida* L. (9.13%) [12]have higher ratios. On the other hand, this fatty acid is reported in a lower quantity in some *Vicia* sp.- *Vicia faba* (1.40%) [16] and *V. sativa* (1.30%) [17]. *Colutea melanocalyx* (1.38%) and *Onobrychis altissima* (1.79%) have very small stearic acid content [15].

Firat University, Science & Letter Faculty, Biology Department, Plant Products and Biotechnology Res. Lab., Elazig, Turkey, fax 90 424 2330062, e-mail: ebagci@firat.edu.tr. Published in Khimiya Prirodnykh Soedinenii, No. 6, pp. 526-528, November-December, 2006. Original article submitted October 31, 2005.

0009-3130/06/4206-0645

TABLE 1. Fatty Acid Composition and Oil Content of Some *Astragalus* sp. Studied

Fatty acid	Plants				
	A. jodostachys	*A. echinops*	*A. falcatus*	*A. fraxinifolius*	*A. subrobustos*
14:0	0.20	0.1	-	0.1	0.1
16:0	7.5	9.6	10.3	8.0	6.6
*cis*7-16:1	0.1	0.1	-	Tr.	0.8
*cis*9-16:1	0.4	0.7	-	0.1	-
17:0	0.1	0.20	-	0.1	0.2
18:0	2.1	1.9	3.5	2.0	2.5
*cis*9-18:1	13.8	19.3	19.3	8.6	13.6
*cis*11-18:1	0.3	2.6	1.2	0.7	1.3
*cis*9,12-18:2	24.7	37.4	34.2	35.2	23.9
*cis*9,12,15-18:3	33.1	23.4	34.7	41.1	35.7
20:0	0.4	0.4	0.5	0.2	0.4
*cis*11-20:1	0.6	0.4	0.7	0.3	0.5
22:0	-	-	-	0.1	-
22:1	-	0.7	0.7	0.2	1.2
24:0	-	-	-	0.1	-
*cis*15-24:1	-	-	-	0.1	-
TSFA	10.3	12.2	14.3	10.7	9.8
TUSFA	73.0	84.6	85.1	86.1	77.0
Oil content (in wt%)	31.05	28.9	36.1	32.1	30.02

_____

Saturated acids (SFA) and unsaturated fatty acids (USFA). a: Data shown are peak area (%) from GLC.

From unsaturated acid (USFA), linoleic and linolenic acids were the major constituents of the studied *Astragalus* seed oil. The highest linolenic acid was found in *A. fraxinifolius* (41.13%) and *A. subrobustos* (35.7%). It was found at the lowest level in *A. echinops* (23.4%) (Table 1). This fatty acid was reported to constitute 34 and 7.8% in *A. pycnocephalus* and *A. condensatus*, respectively [18]. Thus it is possible to say that this FA varies in these sections and species in *Astragalus* genus. In general, this unsaturated fatty acid comprises less than 10% of the oil in *Onobrychis hypargyrea* (7.8%), *Gonocytisus dirmilensis* (2.1%), *Colutea melanocalyx* (8.5%), *Trigonella cretica* (3.5%), and most of the *Lathyrus* taxa reported (*L. tuberosus* (4.71%), *L. roseus* (4.30%)) except for a few leguminous patterns like *Hedysarum cappadocicum* (21.10%), *Vicia michauxii* var. *michauxii* (39.1%), *Lathyrus laxiflorus* subsp. *laxiflorus* (16.5%), *Onobrychis huetiana* (18.25%), and *Lathyrus vinealis* (11.5%) [15, 19].

At the same kind, linoleic acid *cis* 9,12-(18:2) was the second major fatty acid in the *Astragalus* studied. It was found to be very high in the seed oil, 23.9 and 37.4% in *A. subrobustos* and *A. falcatus*, respectively. This FA was reported to be higher than that in *A. pycnocephalus* and *A. condensatus*, respectively (35 and 53%) [18]. The high content of this component is characteristic for the some legume seed oil. This fatty acid was reported to very high in some legume seed oil like in *Colutea melanocalyx* (62.76%), *Gonocytisus dirmilensis* (67.4%), *Lupinus varius* (57.80 %), *Vicia cappadocica* (50.9%), and *Onobrychis major* (51.74%) [15]. The amount of linoleic acid is important with respect to the quality of the oils consumed as a food resource with the oleic acid. Bailey [20] and Hemavathy and Prabhakar [21] reported that these are the most adaptable of all oils and are excellent edible oils. GC analysis of the methyl esters of fatty acids showed that linoleic and linolenic acids were the most prominent constituents of the oil, respectively 33 and 27% in *Ononis natrix* L. (Fabaceae) [22].

The highest oleic acid content was found to be between 8.55 and 19.28% in *A. fraxinifolius* and *A. echinops* (Table 1). It was found to be 14.5 and 7.7% in *A. pycnocephalus* and *A. condensatus*, respectively [18]. It was reported in *Trigonella cretica* to be 46.9%; in *Onobrychis hypargyrea*, 34.4%; and in *Lathyrus laxiflorus* subsp. *laxiflorus*, 30.4% [15]. But some of the seed oil of the Fabaceae family showed similar results to the studied *Astragalus* sp., *Vicia michauxii* var. *stenophylla* (12.34%), *Colutea melanocalyx* (12.70%), *Gonocytisus dirmilensis* (13.19%), and *Onobrychis huetiana* (13.3%) [15]. On the other hand, oleic and linoleic acids were determined to be the major unsaturated fatty acid in the oil of *Psophocarpus tetragonolobus* (L.) (Fabaceae) DC, which is used as a winged bean in some countries [23].

The content of the other fatty acids of *Astragalus* seed oils (between 20:0 and 24:0 arachidic and lignoceric acid and their unsaturated forms) was found to be less than 1% except for *A. subrobustos* for the 22:1 fatty acid (1.17%). There are some reports on the poisonous effect of erucic acid (22:1) content on animals and humans. Some researchers have indicated that oils with high levels of behenic acid (22:0) may be difficult for humans and animals to digest [12, 24, 25]; it was absent or in trace levels in the *Astragalus* species studied (Table 1).

As far as the unsaturated fatty acid content is concerned, the present study is supported by previous *Leguminous studies* [26–30]. All these studies showed that the saturated and particularly unsaturated FA contents of Fabaceae seed oils are closely related to each other and that the amount of unsaturated fatty acids is higher than that in saturated fatty acids.

The results obtained from this study show that *Astragalus* seed oils are of the linolenic–linoleic type. Also, oleic and palmitic type fatty acids are the predominant oils. It is reported that linoleic and oleic acid are abundant components of most of the leguminous genera (*Vicia faba* [16], *Hedysarum cappadocicum*, some *Lathyrus* sp., such as *Lathyrus inconspicuus*, *Lupinus varius*, *Trigonella cretica*, *Vicia freyniana*, and *Onobrychis* sp. reported in Bagci et al., [15]). But some results showed that linoleic–palmitic type FA is typical for some genera like *Cassia nodosa*, *Berlinia auriculata*, *Bauhinia monandra*, *Parkia clappertoniana* [24], some *Astragalus* sp. [18], and some *Ebenus* species reported from Turkey [31]. The seed oils of all leguminous members contain very low levels of linolenic acid, as reported by Bagci et al., [15] and from the literature [21, 25]. The seeds oils of *Crotalaria* species are of the simple linoleic-oleic-palmitic type [32]. Garcia-Lopez et al. [33] reported that some *Lupinus* sp. oils contained a high concentration of palmitic and linoleic acid. The evaluation of fatty acids in a wider range of species in Fabaceae, particularly *Astragalus* genus, is a powerful tool that might contribute to the characterization of new renewable resource and evolutionary relationships among the genus of this family.

EXPERIMENTAL

Plant Materials. Seed specimens (natural) were obtained from the seed bank in the Aegean Agricultural Research Institute, Izmir. The accessions of the plant samples are: *A. echinops*, *A. subrobustos*, *A. jodostachys* from Van, and *A. falcatus* and *A. fraxinifolius* from Erzurum; both localities are in the Eastern Anatolian region.

Oil Extraction and Preparation of Fatty Acid Methyl Esters (FAME). Impurities were removed from the seeds and the cleaned seeds were ground into powder using a ball mill. Lipids were extracted with heptane in a straight–through extractor. The triglycerides were transesterified to methyl esters with potassium hydroxide in methanol according to ISO method 5509.

Capillary GLC. The fatty acid methyl ester composition was determined on two different gas chromatographs, Hewlett-Packard HP5890 (A) and HP6890 (B), each equipped with a fused silica WCOT capillary and FID (Institue of Physics and Chemistry of Lipids, Munster, Germany) and retested with the Agilent 5973 N HP GC-MS system in the Plant Products and Biotechnology Research Lab. (BUBAL) in Elazig.

a) Silar 5 CP, 50 m × 0.25 mm ID, 0.24 μm film thickness, nitrogen as carrier gas, 1:50 split ratio, pressure 160 kPa, oven temp.: 5 min isothermal at 163°C, then 163 to 205°C at 1°C/min; Inj.= 230°C, Det. 260°C.

b) DB-23, 60 m × 0.32 μm (J&W), 0.25 μm film thickness , hydrogen as carrier gas, 1:50 split ratio, pressure 69 kPa, oven temp.: 1 min isothermal at 80°C, then 80 to 150°C at 25°C/min, then 150 to 240°C at 3°C/ min, 5 min isothermal, PTV-Inj. 80°C, 12°C/s to 250°C, 5 min isothermal, Det. 250°C.

Data analysis was done with a chromato-integrator D 2500 (Merck-Hitachi) and Chemstation integration software, respectively. Peak identification was achieved by comparison of relative retention times with those obtained from test mixtures of known composition on two different columns.

ACKNOWLEDGMENT

The author is grateful to the TUBITAK–DFG for the research grant during the course of part of this investigation at the Institute for Chemistry and Physics of Lipids, Munster, Germany. Also the author is thankful to the Aegean Agricultural Research Institute, Izmir, Turkey, and the State Planning Organization of Turkey for the establishment of the Plant Products and Biotechnology Research Lab.

REFERENCES

1. D. J. Mabberly, *The Plant Book*, Cambridge University Press, Cambridge, 1997, 320 pp.
2. P. H. Davis, *Flora of Turkey and the East Aegean Island*, 3, Edinburgh University Press, 1970, 628 pp.
3. P. H. Davis, *Flora of Turkey and the East Aegean Island*, 10, Edinburgh University Press, 1988, 590 pp.
4. A. Guner, N. Ozhatay, T. Ekim, and K. H. C. Baser, *Flora of Turkey and the East Aegean Island*, 11, Suppl. Edinburgh University Press, 2000, 656 pp.
5. O. Secmen, Y. Gemici, E. Leblebici, G. Gork, and L. Bekat, *Tohumlu Bitkiler Sistematigi*, Ege Univ. Fen Fak., Kitaplar Ser., No: 116. Izmir, 1989, 393 pp.
6. N. Tseveguren, K. Aitzetmuller, and O. H. Otgonbayar, In: *Reports of the Institute of Chemistry and Chemical Technology* (Mongolian Academy of Sciences), Ulaanbaatar. 104 (1998).
7. A. A. Maassumi, *Astragalus* in the Old World, Check List. Iran: Research Institute of Forest and Rangelands, 1998.
8. F. D. Gunstone, S. R. Steward, J. A. Cornelius, and T. W. Hammonds, *J. Sci. Fd. Agric.*, **23**, 52, (1972).
9. R. Kleiman, in *Proceedings, World Conference on Biotechnology for the Fats and Oils Industry*, Ed. T. H. Applewhite, 73 (1988).
10. E. R. Grela and K. D. Gunter, *Anim. Feed Sci. Technol.*, **52**, 325 (1995).
11. E. Bagci, H. Genc, and A. Sahin, *Pakistan J. Biol.*, **4**, 842 (2001).
12. N. Akpinar, M. A. Akpinar, and M. A. Turkoglu, *Food Chem.*, **74**, 449 (2001).
13. H. E. Patte, D. K. Salunkhe, S. K. Sathe, and N. R. Reddy, *Crit. Rev. Food Sci. Nutr.*, **17**, 97 (1982).
14. M. P. Freeman, *Ann. Clin Psychiatry*, **12**, 159 (2000).
15. E. Bagci, L. Bruehl, H. Ozcelik, K. Aitzetmuller, M. Vural, and A. Sahin, *Grases Aceites*, **55**, 378 (2004).
16. W. Wan Pee, *Riv. Ital. Sostanze Grasse*, **56**, 293 (1979).
17. S. K. Husain, *Fette Seifen Anstrichm.*, **80**, 225 (1978).
18. E. Bagci and M. Vural, *J. Inst. Sci. Tech. Gazi Univ.*, **14**, 1305 (2001).
19. E. Bagci and A. Sahin, *Pakistan J. Bot.*, **36**, 403 (2004).
20. A. Bailey, *Industrial Oil and Fat Products* (2 nd Edit), Interscience Publishers Inc., New York, 1951.
21. J. Hemevathy and J. V. Prabhakar, *Food Chem.*, **31**, 1 (1989).
22. B. Chebli, L M. I. Hassani, and M. Hmamouchi, *Acta Bot. Gallica*, **148**, 333 (2003).
23. M. Higuchi, J. Terao, and K. Jwai, *J. Nutr. Sci. Vitaminol.*,**28**, 511 (1982).
24. T. P. Hilditch, P. N. Williams, *The Chemical Constituents of Natural Fats* (4 th edn). 304, Chapman and Hall, London, 1964.
25. A. M. Balogun and B. I. Fetuga, *Food Chem.*, **17**, 175 (1985).
26. A. Sengupta and S. Basu, *J. Am. Sci. Fd. Agric.*, **29**, 677 (1978).
27. C. D. Daulatab, K. M. Hosamani, V. A. Deasi, and K. R. Alagawadi, *JAOCS*, **64**, 1423 (1987).
28. S. M. Tharib and G. B. A. Veitch, *Int. J. Crude Drug. Res.*, **21**, 73 (1983).
29. M. Hamberg and P. Fahlstadius, *Plant Physiol.*, **99**, 987 (1992).
30. K. Liu, E. A. Brown, and F. Orthoefer, *J. Agric. Food Chem.*, **43**, 381 (1995).
31. N. Azcan, S. Saricoban, B. Demirci, Z. Aytac, and K. H. C. Baser, *Chem. Nat. Comp.*, **37**, 253 (2001).
32. A. R. Chowdury and R. Banerjii, *Fat Sci. Technol.*, **97**, 457 (1995).
33. P. M. Garcia- Lopez, M. A. Muzquiz, M. A. Lopez-Ruiz, J. F. Zamora-Natera, C. Burbano, M. M. Pedrosa, C. Cuadrado, and P. Garzon-De la Mora, *J. Food Comp. Anal.*, **14**, 645 (2001).