Chemistry of Natural Compounds, Vol. 45, No. 6, 2009

FAT AND FATTY ACID COMPOSITION OF STRAWBERRY CULTIVARS

E. Kafkas,[1*] S. Gunaydin,[1] S. Ercisli,[2] Y. Ozogul,[3] and M. A. Unlu[4]

UDC 547.915

Strawberries (*Fragaria* × *ananassa* Duch.) are unique with a highly desirable taste and flavor. They are excellent dietary sources of ascorbic acid, potassium, fiber, and other secondary metabolites and are also simple sugar sources of energy [1, 2].

Consumers purchase strawberries mainly for an enjoyable eating experience, and good quality fresh fruit is in great demand. The cultivar used is the main factor that can affect the taste and quality of strawberry fruits [3].

Recent studies indicate that reducing the dietary ratio of n-6 to n-3 fatty acids (FAs) might play a role in decreasing the risk of heart disease and cancer [4]. Fruits, particularly seeds of fruit, are one of the important sources of n-6 to n-3 fatty acids. In general, seeds of fruits are the major by-product in the manufacture of fruit juice [5].

Although there are some studies related to the fatty acid content of berries such as marionberry, boysenberry, red raspberry, cranberry, and blueberry to evaluate the potential use of these berry seed oils in food products [6–8], there have been no studies related to the oil and fatty acid content of strawberry fruits. Therefore, this study is the first in this area. In addition, this study also shows that the cultivar determines the oil and fatty acid profile of strawberry fruits.

Here we report on the oil and fatty acid compositions of nine strawberry cultivars, namely Call-Giant4, Camarosa, Fern, Festival, Kabarla, Redlans Hope, Sweet Charlie, Whitney, and Gianna.

The oil and fatty acid composition of the seeds was analyzed according to a previous method [9, 10], and the results are given in Table 1. The yield of seed oil was between 0.06% (Festival) and 0.14% (Fern). Fatty acid components representing about 98.20% (Call-giant4) to 99.46% (Kabarla) of total oil were characterized. The amount of saturated and unsaturated fatty acids in seed oils was found to be 8.77% (Kabarla) to 14.85% (Festival) and 84.23% (Festival) and 90.69% (Kabarla), respectively. ΣPUFA in the oil from samples are the predominant constituents (55.26%, Whitney and 73.08%, Kabarla), followed by ΣMUFA (17.59%, Kabarla and 29.87%, Whitney) and ΣSFA (8.77%, Kabarla and 14.85%, Festival). Previously it was reported that ΣPUFA was the main fatty acid in blueberry (68.6%) [6] and red raspberry (62.85–85.5%) [6, 7].

Fatty acid analysis has shown that the nine strawberry cultivars studied contained twenty-one major compounds, and a much greater variation of fatty acids was found among strawberry cultivars (Table 1). Linoleic acid (31.17–40.62%) was the main fatty acid for Call-giant4, Camarosa, Fern, Festival, Sweet Charlie, Whitney, and Gianna, while linolenic acid (32.41–36.67%) was the dominant fatty acid for Kabarla and Redlans Hope (Table 1). In previous studies conducted on mulberry, red raspberry, marionberry, boysenberry, and blueberry seeds, the main fatty acids were found to be linoleic and linolenic acids [6, 11], in agreement with our present study. A high content of linoleic and linolenic acids (polyunsaturated fatty acids) is favorable for medicinal (prophylaxis and treatment of arteriosclerosis, eczema) and nutritional applications since these components, particularly linolenic acid, are responsible for cardioprotective, antidiabetic, and antimicrobial activities [12–15].

C13:0 was detected only in cv. Redlans hope in trace amounts (0.035%). C22:2*cis* was detected only in cvs. Camarosa and Sweet Charlie in trace amounts (0.035–0.085%). In addition C22:6n3 was detected only in cv. Camarosa (0.03%) and cv. Whitney (0.034%) in trace amounts. All cultivars had various trace amounts (0.06–0.12%) of C17:0 (margaric acid) except cv. Call-giant4. In addition, cv. Kabarla did not include C20:2*cis* (Table 1).

1) University of Cukurova, Subtropical Fruits Research and Experimental Center, 01330 Balcali, Adana, Turkey, fax: +90 3223386740, e-mail:ebru@cu.edu.tr; 2) University of Ataturk, Faculty of Agriculture, Department of Horticulture, 25240 Erzurum, Turkey; 3) University of Cukurova, Faculty of Fisheries, Department of Fishing and Processing Technology, 01330 Balcali, Adana, Turkey; 4) Yaltir A. S. Sarihuglar Village, P. K. 01000, Seyhan Adana, Turkey. Published in Khimiya Prirodnykh Soedinenii, No. 6, pp. 723–724, November–December, 2009. Original article submitted May 3, 2008.

0009-3130/09/4506-0861

TABLE 1. Lipid Percentage and Fatty Acid Composition of Strawberry Cultivars

	Call-giant4	Camarosa	Fern	Festival	Kabarla
% lipid	0.10±0.02	0.12±0.02	0.14±0.02	0.06±0.00	0.12±0.02
8:0	0.01±0.00	0.03±0.00	0.04±0.00	0.04±0.00	N.d.
10:0	0.14±0.01	0.02±0.00	0.02±0.00	0.04±0.01	0.01±0.00
12:0	0.29±0.02	0.07±0.01	0.07±0.00	0.11±0.02	0.05±0.00
14:0	N.d.	0.64±0.03	0.19±0.07	0.35±0.05	0.31±0.02
15:0	0.22±0.01	0.13±0.03	0.09±0.07	0.12±0.02	0.10±0.01
16:0	8.93±0.37	8.43±0.06	10.71±0.26	10.19±0.60	5.75±0.33
17:0	N.d.	0.15±0.01	0.10±0.00	0.11±0.00	0.09±0.01
18:0	1.69±0.02	2.24±0.04	1.66±0.02	2.01±0.04	1.52±0.04
20:0	0.65±0.01	1.04±0.02	0.93±0.09	1.55±0.04	0.68±0.00
22:0	0.32±0.01	0.65±0.06	0.49±0.10	0.61±0.02	0.27±0.00
24:0	N.d.	0.18±0.00	0.11±0.01	0.13±0.01	N.d.
ΣSFA	12.25±0.05	13.58±0.02	14.41±0.04	15.26±0.07	8.77±0.03
14:1	N.d.	N.d.	N.d.	N.d.	0.02±0.02
16:1	0.85±0.12	0.85±0.03	0.51±0.16	0.65±0.02	0.33±0.05
17:1	N.d.	0.06±0.00	0.09±0.02	N.d.	0.07±0.02
18:1n9	20.81±0.50	23.06±0.09	27.05±1.60	19.95±0.20	16.96±0.07
20:1	0.12±0.01	0.45±0.02	0.35±0.01	0.31±0.00	0.21±0.07
ΣMUFA	21.78±0.21	24.42±0.03	28.00±0.45	20.91±0.07	17.59±0.04
18:2n6	38.40±1.08	33.48±1.55	31.17±0.32	35.03±0.22	36.35±0.47
18:3n3	25.59±0.29	27.36±0.06	25.53±0.73	27.90±0.24	36.67±0.84
20:2*cis*	0.11±0.01	0.20±0.01	0.13±0.04	0.30±0.01	N.d.
20:4n6	N.d.	0.10±0.00	0.06±0.01	0.07±0.00	0.03±0.00
20:5n3	N.d.	N.d.	N.d.	0.04±0.00	0.03±0.04
ΣPUFA	64.10±0.46	61.14±0.40	56.89±0.27	63.34±0.11	73.08±0.33

	Redlans Hope	Sweet Charlie	Whitney	Festival
% lipid	0.09±0.01	0.09±0.02	0.09±0.01	0.13±0.02
8:0	N.d.	0.02±0.00	N.d.	N.d.
10:0	0.50±0.01	0.03±0.00	0.03±0.00	0.10±0.00
12:0	0.60±0.00	0.08±0.01	0.09±0.00	0.22±0.02
14:0	1.72±0.08	0.34±0.02	0.51±0.03	0.15±0.00
15:0	0.27±0.02	0.11±0.02	0.15±0.03	N.d.
16:0	9.42±0.97	8.95±0.14	8.85±0.50	7.13±0.03
17:0	0.10±0.02	0.12±0.07	0.11±0.02	0.06±0.01
18:0	1.79±0.05	1.82±0.01	2.54±0.35	1.44±0.03
20:0	0.40±0.01	1.12±0.02	0.78±0.02	0.74±0.02
22:0	0.13±0.04	0.71±0.07	0.18±0.00	0.43±0.07
24:0	N.d.	0.16±0.02	0.75±0.10	N.d.
ΣSFA	14.93±0.13	13.46±0.03	13.84±0.10	10.27±0.02
14:1	0.09±0.02	N.d.	N.d.	0.06±0.00
16:1	0.26±0.08	0.63±0.02	0.85±0.50	0.15±0.02
17:1	0.03±0.00	0.07±0.01	0.05±0.02	0.08±0.01
18:1n9	19.85±0.96	21.79±0.06	28.48±0.40	24.72±0.01
20:1	0.25±0.01	0.43±0.00	0.49±0.19	0.32±0.02
ΣMUFA	20.48±0.21	22.92±0.02	29.87±0.28	25.33±0.01
18:2n6	31.46±0.06	34.70±0.17	31.43±1.30	40.62±0.02
18:3n3	32.40±2.03	27.44±0.16	23.41±3.07	22.35±0.03
20:2*cis*	0.07±0.01	0.25±0.00	0.22±0.07	0.12±0.02
20:4n6	N.d.	0.09±0.00	0.07±0.00	0.02±0.00
20:5n3	N.d.	N.d.	0.13±0.01	0.03±0.00
ΣPUFA	63.93±0.70	62.48±0.08	55.26±0.89	63.14±0.01

N.d.: non determined.

Plant Material. Strawberries were grown in the implemental area of the biggest private company of Adana provinces of Turkey (Yaltir A. S.). Nine varieties (Call-giant4, Camarosa, Fern, Festival, Kabarla, Redlans Hope, Sweet Charlie, Whitney and Gianna) were used as plant materials. The experiment was designed as a complete randomized block with three replicates, and 30 plants were used in each replicate. The fruits of experimental genotypes were harvested at commercial maturation stages, then immediately extracted for oil and fatty acid analysis.

Oil Extraction. Oil extraction was carried out according to Bligh and Dyer [9]. Boron trifluoride–methanol was used for preparation of fatty acid methyl esters [10].

Gas Chromatographic Condition. The fatty acid composition was analyzed by a GC Clarus 500 instrument with autosampler (Perkin–Elmer, USA) equipped with a flame ionization detector and a fused silica capillary SGE column (30 m × 0.32 mm, ID × 0.25 μm, BP20 0.25 UM, USA). The oven temperature was 140°C, held 5 min, raised to 200°C at a rate of 4°C/min, and to 220°C at a rate of 1°C/min, while the injector and the detector temperature were set at 220°C and 280°C, respectively. The sample size was 1 μL, and the carrier gas was controlled at 16 psi. The split ratio was 1:100. Fatty acids were identified by comparing the retention times of FAME with a standard 37-component FAME mixture (Supelco). Triplicate GC analyses were performed, and the results were expressed in GC area % as the mean value ± standard deviation.

REFERENCES

1. S. Y. Wang and G. J. Galletta, *Acta Hort*., **567**, 815 (2002).
2. A. Perez, R. Olias, J. Espada, J. M. Olias, and C. Sanz, *J. Agric. Food Chem*., **45**, 3545 (1997).
3. E. Kafkas, M. Kosar, S. Paydas, and K. H. C. Baser, *Food Chem.*, **100** (3), 1229 (2007).
4. H. Iso, S. Sato, U. Umemura, M. Kudo, K. Koike, A. Kitamura, H. Imano, T. Okamura, Y. Naito, and T. Shimamoto, *Stroke*, **33**, 2086 (2002).
5. B. D. Oomah, S. Ladet, D. V. Godfrey, J. Liang, and G. Benoit, *Food Chem*., **69**, 187 (2000).
6. J. Parry, L. Su, M. Luther, K. Zhou, P. Yurawecz, P. Whitaker, and L. Yu, *J. Agric. Food Chem*., **53**, 566 (2005).
7. E. Kafkas, M. Ozgen, Y. Ozogul, and N. Turemis, *J. Food Quality*, **31**, 67 (2008).
8. T. Heeg, US Patent 6, 733, 798 (2004).
9. E. C. Bligh and W. J. Dyer, *Can. J. Biochem. Phys.*, **37**, 911 (1959).
10. AOAC (Association of Official Agricultural Chemists), 1990. Official methods of Analysis, 15th edition. AOAC, Washington, DC.
11. S. Ercisli and E. Orhan, *Food Chem*., **103**, 1380 (2007).
12. U. N. Das, *Prostag, Leukotr. Ess*., **63**, 351 (2000).
13. P. Geissberger and U. Squin, *Acta Trop*., **48**, 251 (1991).
14. M. Kato, T. Miura, M. Nakao, N. Iwamoto, T. Ashida, and L. Tanigawa, *J. Health Sci*., **46**, 489 (2000).
15. M. Worm and B. M. Henz, *Dermatology*, **201**, 191 (2000).