Fatty Acid Composition of Capsicum Oils by Gas Liquid Chromatography[1]

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ABSTRACT

The fatty acid composition of oils extracted from various parts (pericarp, seeds and stem) of the fruit of *Capsicum* and from samples of Greek red pepper itself were obtained by gas liquid chromatography. Samples from three different varieties of *Capsicum annuum*, cultivated in the region of Almopia, Greece, were taken from two crops (1967, 1968) and examined. The results are discussed. No characteristic differences in fatty acid composition of the corresponding samples of the parts of *Capsicum* fruit of the three Greek varieties were noticed and there was no difference between the two crops. However, considerable differences in fatty acid composition between Greek and American varieties were observed, probably due to climatic conditions.

INTRODUCTION

In our previous papers (1,2), the oil content and its analytical constants of the Greek "sweet" and "hot" pepper, the composition of dried fruit of *Capsicum annuum* cultivated in Greece for the production of red pepper and the oil content of the different parts of the latter were reported.

On the average, Greek "sweet" red pepper (variety A) was found to contain 12.9% oil and Greek "hot" pepper (variety C), 15.6% oil (1). Variety A fruit consisted of an average of 57.8% pericarp, 33.9% seed and 7.0% stem with calyces and variety C, of an average of 50.7%, 40.9% and 7.4% respectively. The average oil content of the pericarp was 6.8% of the seed, 25.4% and of the stem and calices, 1.7% (1).

The fatty acid composition of the above oils is investigated in this paper.

EXPERIMENTAL PROCEDURES

Several samples of Greek red pepper from the same crop and variety were received from two processing plants. The samples of pericarps, seeds and stems with the calyces were obtained from various samples of whole dried fruits by separating them quantitatively by hand in the laboratory. The fruits were dried in an industrial air drier at 65 C. All the samples were stored in polyethylene bags in a dark place for a period of about six months, mean storage time before consumption, and then ground in a mill.

Extraction of Oil

About 20 g of each sample were extracted for 10 hr with petroleum ether (60-80 C bp) in a continuous extractor. The oil was recovered by evaporation of the solvent on a steam bath under a nitrogen stream. Oil and methyl ester samples were kept in a nitrogen atmosphere in a refrigerator.

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TABLE I

Area Correction Factors

Fatty acid	Correction factor
8:0	0.90
12:0	0.83
14:0	0.82
16:0	0.84
18:0	0.90
18:1	0.90
18:2	1.10
18:3	1.00

Preparation of Methyl Esters

Seed oils were subjected to methanolysis (3). Methyl esters of pericarp, stem with calyces and red pepper oils were prepared by esterification (4) of their free fatty acids, after saponification (5,6).

Gas Chromatography

The instrument used was an Aerograph Model A 90 P with a thermal conductivity detector (200 mA). An 8 ft column, 1/4 in. O.D., with 15% succinate ethylene glycol on Chromosorb W 60-80 mesh, was used under the following conditions: column temperature, 195 C, detector, 310 C, helium flow rate, 60 ml/min, samples injected, 1-1,5 μl.

Identification of fatty acids was obtained by injecting authentic samples of methylesters and by removing the peak corresponding to 18:3 by hydrogenation. In this way, the coincidence of retention times of 18:3 and 20:0 was revealed because peaks corresponding to unsaturated methyl esters were removed after complete hydrogenation of the sample.

Hydrogenation

About 40 mg of methylesters, 6 ml of cyclohexane and 400 mg of Adam's catalyst (platinum oxide) were placed in the vessel of a micro-hydrogenation apparatus. After the removal of the air by a hydrogen stream, the solution was agitated until the absorption of hydrogen could no longer be observed through the graduated burette. Hydrogenation was carried out at room temperature under a pressure of about 1 psi. The catalyst was separated by filtration and the filtrate was evaporated on a steam bath under a nitrogen stream (7).

Determination of Area Correction Factors and Fatty Acid Composition

A mixture of authentic samples of caprylate, laurate, myristate, palmitate, stearate (Fluka AG, Puriss, Buchs, Switzerland), oleate, linoleate (Carlo Erba, Gas-Cromatografico, Milano, Italy) and linolenate (Koch Light Labor. Ltd., Puriss, Colndrook Burkinghamshire, England) methylester was prepared; its composition was similar to that of analyzed oils. By chromatographing this standard mixture four times under the operating conditions, the area correction factors (8) were obtained (Table I).

The peak areas were obtained by triangulation, and the corrected area percentages were converted to free fatty acid percentages by calculation.

TABLE II

Fatty Acid Composition of Oil *Capsicum* Seeds, Pericarp and Stem With Calyces and of Oil of Greek Red Pepper

Year of crop seed oil	Variety	Fatty acid[a], %															
		8:0	10:0	12:0	14:0	14:1	?:0	15:0	?:0	16:0	16:1	17:0	18:0	18:1	18:2	18:3 + 20:0	20:0
1968	A[b]	Trace	—	Trace	0.1	—	—	Trace	—	9.8	0.2	Trace	2.2	8.5	79.1	Trace	
1967	A	Trace	Trace	—	Trace	—	—	—	—	10.3	0.3	Trace	1.7	8.5	79.0	Trace	
1968	B[c]	Trace	Trace	Trace	Trace	—	—	Trace	—	9.5	0.2	Trace	2.2	8.1	79.8	0.1	
1967	B	Trace	—	—	Trace	—	—	Trace	—	9.3	0.2	Trace	2.2	8.1	79.9	Trace	
1968	C[d]	Trace	—	Trace	Trace	—	—	Trace	—	9.9	0.2	Trace	2.1	8.4	79.1	0.1	Trace
1967	C	Trace	—	—	Trace	—	—	—	—	9.9	0.2	Trace	2.3	8.0	79.4	Trace	
Pericarp oil																	
1968	A	Trace	Trace	1.9	5.5	—	—	Trace	—	18.0	1.2	0.1	3.3	6.9	45.6	17.3	0.4
1967	A	0.1	0.1	2.4	5.9	Trace	—	Trace	—	16.6	1.0	Trace	3.3	7.2	49.2	13.6	
1968	B	Trace	Trace	1.8	4.7	Trace	—	Trace	—	15.2	1.0	0.1	3.0	6.1	51.2	16.8	0.2
1967	B	0.1	0.1	2.7	6.0	Trace	—	Trace	—	15.0	0.9	Trace	3.3	6.3	49.5	15.9	
1968	C	Trace	Trace	1.5	4.4	Trace	—	Trace	—	16.3	0.9	0.1	2.9	9.5	50.3	13.9	0.7
1967	C	Trace	0.1	2.5	6.2	Trace	—	Trace	—	16.0	0.9	Trace	3.7	7.8	48.4	14.4	
Stem and Calyces oil																	
1968	A	Trace	Trace	0.7	2.3	—	—	0.1	0.2	14.4	0.4	0.3	4.3	4.7	60.1	12.3	
1968	B	Trace	Trace	1.1	3.0	—	0.5	0.2	0.2	15.6	0.8	0.8	4.8	3.9	51.3	17.7	1.0
1968	C	Trace	Trace	1.1	3.3	—	0.1	0.2	0.2	15.3	0.6	0.4	3.9	5.2	55.4	14.3	
Red Pepper Oil																	
1968	A	Trace	Trace	0.4	1.1	—	—	—	—	10.8	0.3	Trace	2.2	8.3	73.0	3.5	0.1
1967	A	0.1	Trace	0.4	1.2	Trace	—	Trace	—	11.5	0.3	Trace	2.4	8.1	72.9	3.0	
1965[e]	A[f]	0.1	—	0.2	1.2	—	—	Trace	—	11.9	0.3	Trace	2.4	8.3	72.2	3.4	
1968	B	Trace	Trace	0.5	1.3	Trace	—	—	—	11.2	0.5	Trace	2.4	8.3	71.2	4.3	0.4
1968	C	Trace	Trace	0.3	1.0	—	—	—	—	10.8	0.3	Trace	2.0	8.2	74.5	2.7	0.2
1967	C	Trace	—	0.3	0.7	Trace	—	—	—	11.1	0.3	—	2.0	7.0	75.8	1.9	
1964[g]	C	Trace	—	0.3	1.1	—	—	—	—	11.5	0.2	Trace	2.1	8.2	75.0	2.5	

[a]Carbon chain length: number of double bonds.
[b]A, "Sweet" Typical of Almopia.
[c]B, "Sweet" New.
[d]C, "Hot" Typical of Almopia.
[e]Additional storage time, 2 yr in sacks.
[f]"Fire" drying method (1).
[g]Additional storage time, 3 yr in sacks.

RESULTS AND CONCLUSIONS

No characteristic differences in fatty acid composition of seed oils between the several varieties and the two crops were observed (Table II). Linoleic acid is the main fatty acid of *Capsicum* seed oil and its percentage (79%) is among the highest observed in numerous vegetable oils (9-12). This fact and the relation observed (13) between linoleic acid and the tocoferol content of an oil lead to the supposition that *Capsicum* seed oil must be rich in this vitamin. This hypothesis is the subject of our next investigation the results of which will appear in another paper.

There seem to be some differences in fatty acid composition between seed oils from Greek and from Italian varieties of *Capsicum* (10). The apparent differences between our data and those of Grieco et al. (11) are due to the fact that they did not apply area correction factors; their data are almost similar to our uncorrected ones.

Greek *Capsicum* seed oil, in comparison to an American one (14) derived from a different variety, contains considerably more linoleic acid. This great difference in composition must be mainly due to climatic conditions, since the formation of more unsaturated acids is favoured in a cooler climate (15).

The fatty acid composition of stem oil somewhat resembles that of pericarp. Stem oil, in particular, contains two acids the peaks of which appear on both sides of the peak of pentadecanoic acid. These acids must be saturated, probably branched-chained, because of their recording even after the complete hydrogenation of the analyzed samples. Complete hydrogenation was assured by succesive hydrogenations and the absence afterwards of the characteristic absorption (t=4,6) of ethylenic hydrogen in an NMR spectrum, obtained in a deutero-chloroform solution with a Varian A 60 A spectrometer and with tetramethylsilane as internal standard. Such acids with analogous retention times, nonidentified, have also been detected (15) in the oil of roots and shoots of *Capsicum*.

The red pepper oil is the oil extracted from the entire fruit of *Capsicum annuum*. The fatty acid composition of this oil given in Table II does not agree with the average of the corresponding data for the oil from the individual parts of the fruit because of the highly unsaponifiable matter of pericarp oil. Pericarp oil contains 13.8% unsaponifiable matter; seed oil contains only 1.8%. This is the reason why the contribution in fatty acids of the different parts of the fruit is not quite analogous to their oil content.

Finally, the data in Table II seem to indicate that pepper oils show no characteristic difference in fatty acid composition with additional storage time of the red pepper.

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