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ORIGINAL ARTICLE

Capsaicin Contents of Different *Capsicum* (Red Peppers) Populations and Varieties

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ABSTRACT

Red peppers are of the important vegetable and spice crops all over the world. They are also an important part of delicious Turkish cousins for centuries, as well. Turkey is one of the most important producers for these special crops. Because of their chemical compositions, red peppers have a special importance for daily diets. Red peppers are important sources for vitamin C both unripe green form and ripped red form. Besides their food purposes they have recently been used in pharmaceutical products. Recent scientific studies have also proven their anti-cancerous properties. The main therapeutic component of red peppers is capsaicin where synthesized in the placenta of the ripe pepper fruit. In this mean, red peppers with high capsaicin content are desired in pharmaceutical industry. In the present study, thirtythree introduced red peppers varieties from different countries and local red peppers populations were compared for their capsaicin contents. Capsaicin contents of the investigated red peppers varied from 0.04 mg/g to 4.05 mg/g. The lowest capsaicin content was obtained from the varieties *C. frutescens* 24 and *C.* sp.7, the highest value determined in the local population Acı Cicek 52.

Key words: Capsaicin, pharmaceutical industry, red peppers, varieties.

Introduction

The *Capsicum* sp. plant, which has been used by humans both as food and medicine over centuries, is one of the crops that is gradually rising in importance. The *Capsicum* genus, within the family Solanacea, comprises approximately 20 species found in tropical and subtropical regions of the new world [5].

The *Capsicum* genus is widely grown in various regions of the world. It has different types, such as long green, bell, charleston, big square and conical. Bitterness depends on the "*capsaicin*" ($C_{18}H_{27}O_3N$) content and composition of the fruit, which is located in the placenta section. Capsaicin content in fresh red pepper is two to three times more than in green pepper. *Capsicum* is a good food vegetable for its food value and is especially rich in vitamin C (103 mg/100 g). The composition of *Capsicum* species also includes volatile oil and fixed oil [1,3,4,8,11,15,17].

Bitter red pepper stimulates gastric secretions and induces salivary flow when taken fresh. Besides its appetitive characteristic, it also has a disinfecting effect in the digestive system; It increases body temperature, alleviates cramp, eases digestion, beautifies the skin, eliminates drunkenness, helps relieve headache, may be used for gout disease, helps for cough and sore throat, calms the temper, and is efficient in rheumatic pains. Moreover, the red carotenoid substance in capsaicin has a cancer-preventing characteristic [6,9,14].

The purpose of this study is to examine the adaptation of various species and lines of *Capsicum*

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brought from abroad to the conditions of the Çukurova Region of Turkey, and to identify capsaicin contents, in order to improve the type and seed quality, which are the most important issues for agricultural *Capsicum* production in Turkey. Also in the present study, thirtythree introduced red peppers varieties from different countries and local red peppers populations were compared for their capsaicin contents.

Materials and Methods

The experiment was conducted during 2002, at the testing area of Çukurova University Faculty of Agriculture Department of Field Crops. The experiments were arranged with three replications according to the randomized block experimental design. The rows were arranged with 50 cm interval, and 50 cm row top. The test plots used 12 plants in each row and each recurrence area was 105 m^2. Total trial area was 18.5 × 20 = 370 m^2 including access paths.

During the experiment, in the vegetation period of 2002 (May-October), the average temperature was 25.7°C, total rainfall was 68.2 mm, and average humidity was 66.1% [2]. The soil within the experimental area had a clayey-loam texture. The pH of the soil varied within the range 7.50 to 7.60 by soil depth. The useful phosphor value, total nitrogen content and lime content of the soil varied within the ranges 55.3-96.2 kg/ha, 0.10-0.15% and 24-28%, respectively [12].

Thirty-three different plant materials from various countries were used as test materials, 23 of which belonged to the *Capsicum frutescens* species, 4 of which belonged to *Capsicum annum* species, 2 of which belonged to *Capsicum chinense*, 1 of which belonged to *Capsicum baccatum* species, 2 of which belonged to Kahramanmaras population and 1 of which belonged to *Capsicum* sp. The lines of Acı Çiçek 52 and Acı Süs Biberi 48, which are Kahramanmaras populations, are classified within the *C. frutescens* species.

The seeds of the experiment materials were inseminated in March in the viols in glass greenhouse; along with the beginning of germination, the required irrigation and care procedures were conducted. Seedlings that reached planting maturity transplanted to the field, starting at the beginning of May, under appropriate springtime climatic conditions.

The fields were deep ploughed in the fall, and were re-processed in spring to prepare them for planting. Before transplantation of seedlings, 20 kg/ha NPK(15-15-15) was applied to the plots as a base fertilizer. After transplantation, nitrogenous fertilizer as Urea (in total 20 kg/ha) was applied to the plants in July. Chelated foliar fertilizer with bio fertil combi and micronutrients was applied at 1000 g/ha at the end of July. For the mycosis having emerged in July, Safacol 70 WP (with 70% Propineb active substance) fungicide was applied at the rate of 200 g per 100 lt water; for *Spodoptera littoralis* encountered in October, Match 050 EC 30 cc/da with Lufenuron active substance was applied. According to weather conditions, irrigation was performed by 4-5-day interval until flowering and by 6-7-day interval after flowering. The irrigation of the plants was performed by sprinkling until flowering, and by furrow irrigation during later periods. The work schedule during the experimental years is given in Table 1.

Pomological Features:

Flower Color:

The colors of flowers were determined as white-yellow, light yellow-green and green.

Fruit Shape:

The fruits were classified according to their shapes (thin sharp, thick sharp, conical and fit for stuffing) and according to their types of fruit ends (sharp ended and blunt ended).

Fruit Length (cm):

Ten plants were selected randomly from each parcel after the harvest. The average fruit length was calculated by measuring all of the fruits from the stem to the end of the fruit.

Fruit Breadth (cm):

Ten plants were selected randomly from each parcel after the harvest. The fruit widths were determined by measuring all of the fruits at the widest point, close to the stem.

Herbal Features:

Position of the Fruit according to Plant or Stem:

The positions of the fruits were determined as vertical, horizontal or lateral to the main stem or on the main branch, as a single or multiple fruit formation.

Plant Length (cm):

The values taken by measuring the range from the soil to the top of ten plants randomly selected from each parcel after the harvest by a metre was averaged.

Table 1: Detailed Work Schedule During Experiment Year.

Works Performed	2002
Sowing in the greenhouse	27.03.2002
Placing seedlings to the field	15.05.2002
Base fertilizer application	15.05.2002
Top fertilizer application-I	04.07.2002
Top fertilizer application-II	26.07.2002
Fungucide application	24.07.2002
Insecticide application	26.10.2002
Harvest 1	27.08.2002
Harvest 2	16.09.2002
Harvest 3	28.10.2002

Examined features schedules of the field studies are given in below.

Number of Branches (piece/plant):

The number of main branches coming out of the stem was determined and averaged for 10 plants randomly selected from each parcel after the harvest.

Determination of Fruit Capsaicin Contents:

Plants were harvested by hand when the fruits reached redness maturity, and in three phases in total. All fruits harvested from each parcel were dried in a power-operated cabinet drier at 40 °C. The materials prepared for the capsaicin analysis were obtained from the mixture of three harvests. The *capsaicin* content was analyzed at BASEL University, Faculty of Pharmacy, Department of Botany. Dried red peppers were stored at -20 ºC' and were later homogenized in 80% ethanol solution. To obtain the *capsaicinoid* fraction, the lipophilic fraction was isolated from ethanol extract in a Sep-Pak C_{18} type column containing 70% methanol. In the obtained *capsaicinoid* fraction, the *capsaicin* and *dihydrocapsaicin contents* were determined using the HPLC method in Knauer–WellChrom chromatography.

HPLC Device:

Knauer–WellChrom Chromatography – with a Spectrophotometric Detector

Column:

C 18, Vertex 300×4 mm - precolumn, Eurosil-Bioselect 300 Å; 5 µm

Division, Confirmation and Solvent Mixture:

Acetonitrile –Water (55:45 v/v) [13].

Results and Discussion

The Capsaicin Content of in Different Capsicum Species and Lines;

In Table 2, the capsaicin content was seen to range between 0.04 -4.05 mg/g in different *Capsicum* species and lines. While the highest capsaicin content was taken from the Acı Cicek 52 (4.05 mg/g), the lowest capsaicin content was found in *C. frutescens* 24 and *C.* sp. 7 lines with 0.04 mg/g (Table 2).

The literature indicates that the capsaicin content of pepper fruits varied according to ontogenetic variety and to the ecological conditions of its habitat [6,10]. Hundal and Khanna [10] reported that CH3 species, which is a Chili culture, had 0.52% capsaicin. El-Saeid [7] found that the capsaicin concentration in bitter pepper types increased with the maturity and reached 230 mg in 100 g fruit. Shakhidoyatov and Sagdullaev [16] dried samples of red pepper (*C. annum*) types that they collected from various regions of Uzbekistan at between 25-30 °C. They analyzed the capsaicin content in HPLC and reported that the capsaicin content ranged between 0.175-0.325% depending on the habitat of the plant.

In the present study, higher capsaicin contents were found than those reported by other researchers. This may result from the genetic structures, weather conditions and growing conditions [6].

Herbal and Pomological Features of different Capsicum Species and Lines:

It was found that there were variations among the species and lines tested in terms of their herbal and pomological features and most of the plant materials made good improvement. It was determined that the features analyzed among the lines included in the same species showed similar results (Table 3)

Conclusion:

While the active substance is more important and effective in medicinal and aromatic plants compared to other efficiency and efficiency features, the capsaicin content found in different *Capsicum* species and lines has the greatest importance. The importance of capsaicin active substance is gradually increasing due to its use in medicinal applications and the intensive areas of use of *Capsicum* sp. as a food complement. The capsaicin rate in different *Capsicum* species and lines used in the present study varied significantly.

Table 2: Fruit Capsaicin Content of Different *Capsicum* Species and Lines.

Species and Lines	Capsaicin (mg/g)	Species and Lines	Capsaicin (mg/g)
C. annum 1	0.35	*C. frutescens* 26	2.21
C. annum 2	0.55	*C. frutescens* 28	0.85
C. annum 3	0.91	*C. frutescens* 29	1.29
C. frutescens 4	1.45	*C. annum* 30	0.21
C. frutescens 6	0.14	*C. frutescens* 33	0.87
C. sp. 7	0.04	*C. frutescens* 34	1.06
C. chinense 11	0.46	*C. frutescens* 35	1.77
C. frutescens 12	2.35	*C. frutescens* 36	1.77
C. frutescens 13	0.78	*C. frutescens* 37	0.75
C. frutescens 15	0.79	*C. chinense* 38	2.06
C. frutescens 18	0.22	*C. baccatum* 39	0.11
C. frutescens 19	1.66	*C. frutescens* 42	0.50
C. frutescens 20	0.89	*C. frutescens* 44	1.85
C. frutescens 21	0.72	*C. frutescens* 45	1.19
C. frutescens 22	0.23	Acı Çiçek 52	4.05
C. frutescens 24	0.04	Acı Süs Biberi 48	3.02
C. frutescens 25	1.19		

Table 3: Some Botanical Properties of *Capsicum* Species and Local Populations .

Species and Local Populations	Flower Color	Fruit Type	Position of the Fruit according to Plant or Stem	Fruit Color	Plant Length (cm)	Branch Number (Number/ Plant)	Fruit Length (cm)	Fruit Breadth (cm)
C. annum 1	White-yellow	Thin long, sharp-pointed	Vertically erect and multiple over the main and side	Red	40-50	9-11	4.0-6.3	0.4-0.5
C. annum 2	White-yellow	Thick conic, stub-pointed	Vertically down and single over the main and side branches	Red	40-48	9-10	6.0-7.0	0.6-0.7
C. annum 3	White-yellow	Thin long, sharp pointed.	Horizontal and single over the main and side branches	Red	74-82	9-13	6.2-7.5	0.7-0.9
C. sp. 7	White-yellow	Thick sharp, stub-pointed	Vertically erect and single over the main and side	Red	32-44	9-11	3.5-4.2	0.7-0.8
C. chinense 11	White-yellow	Thick sharp, stub-pointed	Vertically erect and single over the main and side	Red	60-64	8-12	4.0-5.6	1.2-1.6
C. chinense 38	White-yellow	Bell, partitioned-pointed.	Vertically erect and single over the main and side	Red	85-100	9-10	2.0-4.0	1.5-2.5
C. frutescens 4	White-yellow	Thin long, sharp pointed.	Horizontal and single over the main and side branches	Red	62-70	8-11	4.8-6.0	0.8-0.9
C. frutescens 6	White-yellow	Thick conic, stub-pointed	Vertically erect and multiple over the main and side	Red	60-65	10-13	4.0-5.5	1.2-1.4
C. frutescens 12	Light yellow-green	Thick pointed, partitioned blunt-pointed.	Horizontal and single over the main and side branches.	Red	70-90	7-12	5.0-7.0	0.5-0.7
C. frutescens 13	White-yellow	Thin long, sharp pointed	Vertically down and single over the main and side branches	Red	55-65	11-13	2.0-3.5	0.6 -0.7
C. frutescens 15	White-yellow	Thick conic, stub-pointed	Horizontal and single over the main and side branches	Red	60-68	11-14	3.0-4.5	0.9-1.0
C. frutescens 18	White-yellow	Thin long, sharp pointed	Horizontal and single over the main and side branches	Red	70-75	12-15	6.0-7.2	0.7-0.8
C. frutescens 19	White-yellow	Thin long, sharp pointed	Horizontal and single over the main and side branches	Red	60-77	12-14	6.0-7.3	0.7-0.9
C. frutescens 20	White-yellow	Thin long, sharp pointed	Horizontal and single over the main and side branches	Red	55-70	9-13	7.0-8.0	0.7-0.8
C. frutescens 21	White-yellow	Thick long, sharp pointed	Horizontal and single over the main and side branches	Red	60-70	13-15	2.0-2.5	0.8-0.9
C. frutescens 26	White-yellow	Thin long, sharp-pointed	Vertically erect and multiple over the main and side	Red	70-80	11-13	4.5-6.0	0.6-1.0
C. frutescens 28	White-yellow	Thin long, sharp pointed	Vertically down and single over the main and side branches	Red	100-118	12-14	5.0-6.3	0.5-0.7
C. frutescens 29	White-yellow	Thin long, sharp pointed	Vertically down and single over the main and side branches	Red	70-90	10-13	8.0-9.0	0.7-0.8
C. annum 30	White-yellow	Thick long, sharp pointed	Vertically erect and single over the main and side	Red	70-77	4-7	4.0-5.2	1.6-1.9
C. frutescens 33	White-yellow	Thin long, sharp pointed	Vertically down and single over the main and side branches	Red	50-63	9-12	5.0-6.7	0.2-0.3
C. frutescens 34	White-yellow	Thin long, sharp pointed	Vertically down and single over the main and side branches	Red	50-60	12-13	9.0-10.0	0.9-1.0
C. frutescens 35	White-yellow	Thin long, sharp pointed.	Vertically erect and multiple over the main and side	Red	50-70	9-11	4.5-6.5	0.4-0.7
C. frutescens 36	White-yellow	Thin long, sharp pointed	Vertically erect and multiple over the main and side	Red	92-110	12-15	5.0-6.4	0.7-0.8
C. frutescens 37	White-yellow	Thin long, sharp pointed	Vertically down and single over the main and side branches	Red	70-75	10-12	5.5-7.0	0.6-0.8
C. baccatum 39	White-yellow	Thin long, sharp pointed	Vertically down and single over the main and side branches	Orange	73-85	7-10	7.0-7.5	1.8-2.0
C. frutescens 42	White-yellow	Thin long, sharp pointed	Horizontal and single over the main and side branches	Red	45-60	9-12	6.0-6.9	0.7-0.9
C. frutescens 35	White-yellow	Thin long, sharp pointed	Vertically erect and multiple over the main and side	Red	60-66	10-12	8.7-9.4	0.6-0.8
Acı Süs Bib. 48	White-yellow	Thin long, sharp pointed	Vertically erect and multiple over the main and side	Red	45-70	9-10	3.0-6.0	0.4-0.7
Acı Çiçek 52	White-yellow	Thin long, sharp pointed	Vertically erect and single over the main and side	Red	50-60	5-9	5.0-6.5	0.5-0.9

Considering all the data obtained from this study, of the *Capsicum* species and lines investigated, *Capsicum frutescens* could be recommended for high capsaicin yield under ecological conditions found in the Cukurova region of Turkey. According to experimental data, the Acı Cicek 52 *Capsicum* line is suggested for high capsaicin yield.

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