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Chemical composition of Padrón peppers (*Capsicum annuum L.*) grown in Galicia (N.W. Spain)

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The water, neutral-detergent fibre, D-glucose, D-fructose, sucrose, vitamin C, organic acid, starch, pectin and major pigment contents of *Capsicum annuum L.* var. Longum grown in Galicia (N.W. Spain) are determined. After water, insoluble fibre was the most abundant component of these peppers (NDF 2.2 g/100 g of fresh fruit). Their vitamin C content was rather low (24 mg/100 g). Copyright © 1996 Elsevier Science Ltd

INTRODUCTION

The climate and isolated nature of the Atlantic coastal region around Padrón in Galicia (N.W. Spain) have proved ideal for cultivation of several small varieties of green peppers (*Capsicum annuum L.*) belonging to the Solanaceae family (Bayley, 1964). These peppers, cultivated in the Padrón region or elsewhere in Spain, are denominated 'Padrón type peppers'. They are generally shaped like a cone or truncated cone and marked with three or four ridges that converge towards the apex. They are slightly rugose and have shiny green skin.

Padrón type peppers are commercialized and eaten when immature and between 3 and 5 cm in length and 1 and 2 cm in breadth at the base. They have a characteristic flavour that is probably a consequence of e.g. climate, careful seed selection and/or the cultivation methods used. Their flavour is generally not hot, although some varieties and cultivars contain higher levels of capsaicin, which forms during fruit maturation and is the principal hot component of peppers.

Peppers are generally considered a balanced source of most of the essential nutrients. For example, the larger varieties known as sweet peppers contain proteins, minerals, vitamin C, sugars and fats, as well as several natural pigments and aromas (Rico Avila, 1983). In the case of Padrón type peppers, the crude peppers are lightly fried in oil before consumption, inevitably leading to an increase in their lipid content.

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In this work we determined the water, neutral-detergent fibre, D-glucose, D-fructose, sucrose, vitamin C, organic acid, starch, pectin and major pigment contents of *Capsicum annuum L.* var. Longum grown in Galicia (N.W. Spain). As far as we know, there are no composition data for these peppers in the literature.

MATERIALS AND METHODS

Samples

Padrón type peppers (*Capsicum annuum L.* var. Longum) were obtained from a commercial plantation in northwest Spain (Herbón, Pontevedra). They were planted in open fields in March and harvested during June–August 1994. During the production cycle, five harvestings were made (the Padrón pepper is a plant with undetermined growth and so multiple harvestings are usual). At each harvesting, approximately 1 kg of fruit was collected. Each sample was homogenized using a pestle and mortar and then sub-samples of this homogenate were used for determination (in triplicate) of the components of interest.

Analytical determinations

Water determination

Water was determined gravimetrically by recording the mass of the homogenate before and after lyophilization using a Liolabore 3 Telstar apparatus operating at 0.01 mm Hg and from −40°C to +30°C.

Organic acids and vitamin C determination

Organic acids (malic, oxalic, quinic, citric and fumaric acids) and vitamin C (ascorbic acid) were determined by HPLC as per Vázquez-Oderiz *et al.* (1994). To extract the acid components, 20 g of homogenate was stirred mechanically in 60 ml of a 4.5% (w/v) solution of metaphosphoric acid for 15 min. The mixture was filtered (Whatman no. 541) and the filtrate was diluted to 100 ml with HPLC grade water. An aliquot of the acid extract was then filtered through a 0.45 μm millipore filter prior to injection onto the chromatographic column.

The HPLC apparatus used consisted of a spectra physics liquid chromatograph equipped with a SP8800 ternary pump, a rheodyne 20 μl injection loop and a spectra focus UV-Vis forward optical scanning detector controlled by spectra focus software. The column was a Tracer ODS2 C_{18} reverse-phase column (250×4 mm) of particle size 5 μm (Teknokromc, Vigo, Spain) and was used with a precolumn (Teknokromc TR-015326) packed with the same material. The mobile phase was HPLC grade water brought to pH 2.2 with metaphosphoric acid; the flow rate was 0.5 ml min^{-1}. The detection wavelengths were 245 nm for oxalic acid and vitamin C and 215 nm for malic acid, quinic acid, citric acid and fumaric acid. Quantitation used the external standard method.

Pigments determination

Pigments (chlorophyll a, chlorophyll b, *all-trans*-lutein and *all-trans*-β-carotene) were determined by HPLC as per López-Hernández *et al.* (1993). To extract them 10 g of homogenate was ground with 1 g of calcium carbonate, 20 g of anhydrous sodium sulphate and a small amount of sea sand. Small volumes of 50:50 acetone/petroleum ether were added to this preparation and collected by filtration (Whatman 541) under vacuum, until the residue was colourless. The pooled filtrates were then diluted to 100 ml, and 10 ml of this extract was evaporated to dryness in a water bath at 37°C under a nitrogen stream. The dry residue was redissolved in 2 ml of hexane; this solution was then filtered (millipore 0.22 μm pore-size membrane) to remove insoluble particles prior to injection.

The HPLC apparatus was the same as that used for determination of the organic acids, except that the column was a spherisorb ODS2 C18 column (250×4.6 mm) of particle size 5 μm (Sugelabor, Madrid, Spain). The UV detector was set at 430 nm for chlorophyll a, 450 nm for *all-trans*-lutein and *all-trans*-β-carotene and 460 nm for chlorophyll b. The chromatographic procedure was: isocratic elution for 9 min with a mixture of methanol (15%), acetonitrile (75%) and 1:1 dichloromethane/hexane (10%), then until 16 min postloading (pl), a gradient leading to final composition 15% methanol, 40% acetonitrile and 45% 1:1 dichloromethane/hexane; isocratic elution with this mixture was continued until 24 min pl. Flow rate was maintained constant at 0.8 ml min^{-1}. Following each run the column was re-equilibrated with the initial eluent for 20 min at 2 ml min^{-1}. Quantitation used the external standard method.

Sugars, starch and pectin determination

Sugars (fructose and glucose) and starch (as glucose) were determined by HPLC as per López-Hernández *et al.* (1994); pectin (as galacturonic acid) was determined by HPLC as per Vázquez-Blanco *et al.* (1995). To extract the components of interest, first 30 g of homogenate was extracted by refluxing it for 45 min with 160 ml of 80% ethanol. The extract was vacuum-filtered (Whatman no. 541) and the residue (alcohol-insoluble solids, AIS) was dried at 37°C for 24 h and reserved for determination of starch and pectin. The filtrate was made up to 200 ml with ethanol and used for determination of soluble sugars. A 5 ml aliquot of this solution was passed through a Waters sep-pak C18 cartridge, filtered (0.45 μm pore-size membrane) and then injected onto the chromatograph.

For starch determination, 700 mg of AIS were refluxed in 40 ml of water for 2 h to gelatinize the starch. This mixture was cooled to 40°C, then 50 ml of citrate/phosphate buffer (pH 4.6) and 20 mg (120 units) of amyloglucosidase were mixed in and the solution was incubated overnight at 55–58°C to hydrolyse the starch to glucose. For pectin determination, 300 mg of AIS in 30 ml of water was adjusted to about pH 9.5 with 0.1N sodium hydroxide. The mixture was shaken, left at 4°C for 20 h, then adjusted to pH 4.5 with acetic acid before adding cellulase (60 mg, 400 units) and pectinase (0.18 ml, 66 units) and incubating it at 55–58°C for 20 h to hydrolyse the pectin to galacturonic acid. At the end of incubation, both these mixtures were cooled, vacuum-filtered (Whatman no. 541) and made up to 100 ml (starch) and to 50 ml (pectin) with water. The resulting solutions were filtered again (0.45 μm pore-size membrane) and injected onto the chromatograph.

The HPLC apparatus consisted of a spectra physics 8700 XR pump, a rheodyne 20 μl injection loop, an SP 8792 column heater, a 4290 integrator connected via Labnet to a PC running Winner data processing software and a shodex-71 refractive index detector. Separation was carried out on a NH_2 spherisorb column (250×4.6 mm) of 5 μm particle size (Sugelabor, Madrid, Spain). For sugars and starch the mobile phase was 90:10 (v/v) acetonitrile/water at 1.4 ml min^{-1} and the column temperature was maintained at 28°C. For pectin the mobil phase was 0.1 M sodium acetate solution that had previously been filtered (0.45 μm pore-size membrane) and adjusted to pH 4.6 with acetic acid. Flow rate was 0.8 ml min^{-1}. Quantitation used the external standard method.

Insoluble fibre determination

Insoluble fibre was determined in a Fibertec System, Dosi fiber apparatus by refluxing 1 g of lyophilized

Table 1. Chemical composition of *Capsicum annuum, L.*

Component	$\bar{X}$(g/100 g fresh fruit) ± SD
Water	91 ± 0.6
Glucose	0.85 ± 0.1
Fructose	0.75 ± 0.1
Sucrose	Not detected
Starch	0.81 ± 0.2
Fibre	2.2 ± 0.3
Pectin	0.73 ± 0.1
	$\bar{X}$(mg/100 g fresh fruit) ± SD
Citric acid	28 ± 12
Fumaric acid	1.1 ± 0.4
Malic acid	208 ± 18
Oxalic acid	140 ± 24
Quinic acid	183 ± 62
Vitamin C	24 ± 12
Chlorophyll a	7.9 ± 2
Chlorophyll b	3.4 ± 0.6
all-trans-lutein	1.6 ± 0.3
all-trans-β-carotene	0.92 ± 0.4

sample in aqueous solution of neutral detergent for 1 h and then filtering out the solids. This residue was dried at 100°C for 8 h, weighed (IF + insoluble ash), incinerated at 550°C and then reweighed (insoluble ash). IF (cellulose, hemicellulose, lignin, cutin and silica) was calculated as the difference in mass (Van Soest & Wine, 1967).

RESULTS AND DISCUSSION

The composition (mean ± standard deviation) of *Capsicum annuum, L.* var Longum is given in Table 1. After water, insoluble fibre (cellulose, hemicellulose, lignin, cutin and silica) was the most abundant component of these peppers (NDF content 2.2 g/100 g of fresh fruit). Among the monosaccharides, D-glucose was the most abundant (0.85 g/100 g), while sucrose was not detected at all. The predominant organic acid was malic acid (208 mg/100 g). The vitamin C content was rather low (24 mg/100 g). Among the pigments, *all-trans*-lutein (1.6 mg/100 g) was the predominant carotenoid, and chlorophyll a (7.9 mg/100 g) the predominant chlorophyll.

The compositions of Padrón type peppers were compared with the composition data listed for green sweet peppers in two recent compilations of such data (Buss *et al.*, 1987; Feinberg *et al.*, 1991). The major differences found between Padrón type peppers and sweet peppers were: the free sugars content was 45% lower than that reported by Feinberg *et al.* (1991), but the starch content was 80 times higher and the insoluble fibre was twice higher; vitamin C content was, on average, 38% lower than that reported by both authors; and β-carotene content was 20% higher than that reported by Feinberg *et al.* (1991) and five times higher than that reported by Buss *et al.* (1987).

In summary, we report quantitative data for the composition of a variety of (Longum) of *Capsicum annuum, L.*, a species which is extensively cultivated in Galicia (N.W. Spain) and are attracting increasing commercial interest. It should be stressed that the climate of Galicia (mild winters, warm summers and persistent rain) is very different from that of central and southern Spain and thus our results may not generalize the Padrón type peppers grown in these regions or elsewhere.

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