Composition of Italian Kiwi (*Actinidia chinensis*) Puree

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The composition of the Hayward variety of kiwi from Italy was determined including ash, total solids, soluble solids, pectin, organic acids (quinic, citric, malic, D-isocitric), sugars (glucose, fructose, and sucrose), minerals (Na, K, Ca, Mg, and P), amino acids, and total protein. Liquid chromatographic methodology was used for the separation, identification, and quantitation of sugars, organic acids, and amino acids. It was confirmed that the main chemical parameters characterizing this fruit are the quinic acid (mean value 5.38 g/kg), L-ascorbic acid (mean value 1067 mg/kg), potassium (mean value 3000 mg/kg), and arginine (mean value 197 mg/kg). The concentrations of single amino acids and of the total amino acids vary within large limits. Therefore, the determination of fruit content in food products, by means of individual or total amino acid concentration, is very difficult.

INTRODUCTION

Italy is becoming the biggest producer of the kiwi fruit in the world (Cacioppo, 1990). The production of this fruit is, in fact, continuously and rapidly increasing, and it is believed that in 1992 it will reach about 220 000 tons. However, despite this fact, little is known about the analytical features of the fruit produced in Italy, whereas the converse holds for kiwi production of other countries, such as New Zealand, for which it is easy to find much bibliographic information (Harris et al., 1975; Hermann, 1980; Wilson et al., 1983; Luh et al., 1984; Benk, 1985; Balestrieri et al., 1990; Giovane et al., 1990). Therefore, it is rather difficult to qualitatively evaluate the semifinished products of kiwi (puree and juices devoted to ice cream and yogurt production) that are increasingly employed in Italy in these past years.

In this paper we report data on the analytical composition of kiwi purees obtained from the cultivar Hayward (which represents about 95% of the national production) cultivated in various Italian regions.

MATERIALS AND METHODS

Plant Materials. The kiwi fruits used in this study were obtained from different farms in Italy's main growing areas. The kiwi fruit (3 kg) was washed, sliced, and converted into pulp using a mixer. The pulp was passed through a paddle finisher fitted with a 0.4-mm screen to remove skin, seeds, and other coarse materials. The finished pulp was packed into laminated sachets to limit oxidation by diffusion. The samples were blast frozen and stored at −18 °C.

Analytical Determinations. The soluble solids, expressed as degrees Brix, were determined by measurement of refractive index at 20 °C.

The pH was determined by pH meter, Crison Model micro TT 2050.

Titrable acidity (total acids), expressed as citric acid monohydrate, was determined by titrating a 10-g sample to end-point pH 8.1 with 0.1 N NaOH, in accordance with the method reported by the International Federation of Fruit Juice Producers (IFFJP, 1968).

The formol value was determined after 25 g of sample was adjusted to pH 8.1 with 0.25 N NaOH, following the addition of 10 mL of a 35% formalin solution (at pH 8.1); the liberated acidity was determined by titration to pH 8.1 (IFFJP, 1984) and expressed as milliliters of 0.1 N alkali/100 g of juice.

L-Ascorbic acid was determined by the 2,6-dichlorophenolindophenol titration method (IFFJP, 1964).

The ash content was determined according to IFFJP Method 9 (IFFJP, 1989).

The pectic substances was determined according to the procedure of Dietz and Rouse (1953); the pectin substances were differentiated as pectin (water soluble, WS), calcium pectate (sodium exametaphosphate soluble pectin, ES), and protopectin (NaOH soluble, NS). All of the pectic substances were precipitated by ethanol, and the separated precipitate was dissolved in water, in sodium exametaphosphate, and in alkali solution. The pectins were hydrolyzed by the alkali to galacturonic acid, and its concentration was determined in each solution by the reaction with carbazide in the presence of sulfuric acid. The red color produced was measured at 525 nm by spectrophotometer.

The proteins were determined according to the Kjeldahl procedure (IFFJP, 1965).

Sample Preparation for Acid Determination (Quinic, Malic, and Citric). HPLC Analysis. Fruit puree (30 g) was clarified by centrifugation at 12000*g* for 15 min. The clarified extract was filtered through a 0.45-μm Millipore filter; 10 mL was chromatographed through a cation-exchange column [AG-1-X8 ($HCOO^-$) poly-prep Bio-Rad] and washed with water to a total volume of 100 mL. The organic acids were eluted with 6 M formic acid (about 130 mL), collected, and evaporated. The dry samples were recovered with water (10 mL) and filtered through a 0.45-μm Millipore filter before HPLC analysis.

A Merck Lichrosorb RP-18 (10 μm) cartridge was used for HPLC analysis. The eluent consisted of water adjusted to pH 2.4 with H_3PO_4 at a flow rate of 2.0 mL/min. A Waters 410

Table I. Standard Gradient Used for Amino Acid Analysis

time, min	flow, mL/min	% eluent 1	% eluent 2
initial	1	100	0
13.5	1	97	3
24	1	94	6
30	1	91	9
60	1	66	34
62	1	66	34
62.5	1	0	100
66.5	1	0	100
67	1	100	0

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Table II. Free Sugars and Pectin Content of Kiwi Puree

	farm no.	sucrose, g/kg	glucose, g/kg	fructose, g/kg	total,[a] g/kg	Glu/Fru ratio	WS pectin,[b] g/kg	ES pectin,[c] g/kg	NS pectin,[d] g/kg	total pectin, g/kg
sample										
Basilicata	1	8.50 ± 0.30	62.10 ± 2.2	54.00 ± 2.0	114.60 ± 3.8	0.96 ± 0.02	4.52 ± 0.6	1.58 ± 0.2	0.80 ± 0.1	6.90 ± 0.4
Basilicata	2	6.00 ± 0.20	50.10 ± 2.3	53.60 ± 1.9	109.70 ± 3.0	0.93 ± 0.02	2.66 ± 0.3	1.27 ± 0.2	0.45 ± 0.1	4.38 ± 0.5
Calabria	1	trace	38.50 ± 1.6	47.30 ± 1.6	85.80 ± 3.0	0.81 ± 0.03	4.38 ± 0.7	1.56 ± 0.1	0.61 ± 0.2	6.55 ± 0.4
Campania	1	trace	24.70 ± 2.1	35.20 ± 2.0	59.90 ± 3.2	0.70 ± 0.02	2.84 ± 0.6	1.27 ± 0.2	0.49 ± 0.2	4.60 ± 0.7
Campania	2	trace	20.00 ± 1.8	28.20 ± 2.0	48.20 ± 2.3	0.71 ± 0.02	4.66 ± 0.2	1.66 ± 0.3	0.59 ± 0.2	6.91 ± 0.4
Campania	3	4.60 ± 0.30	46.30 ± 3.2	46.50 ± 3.0	97.40 ± 4.0	0.99 ± 0.02	3.13 ± 0.3	1.37 ± 0.3	0.61 ± 0.1	5.11 ± 0.5
Piemonte	1	trace	35.60 ± 2.0	39.10 ± 1.9	74.70 ± 2.8	0.95 ± 0.02	4.90 ± 0.4	1.47 ± 0.2	0.62 ± 0.2	6.99 ± 0.3
Piemonte	2	trace	36.90 ± 2.4	38.60 ± 2.5	75.50 ± 4.0	0.96 ± 0.03	3.35 ± 0.2	1.48 ± 0.2	0.55 ± 0.2	5.38 ± 0.3
Piemonte	3	trace	41.00 ± 1.8	42.30 ± 2.2	83.3 ± 2.9	0.97 ± 0.02	4.01 ± 0.7	1.26 ± 0.2	0.44 ± 0.1	5.71 ± 0.6
Toscana	1	trace	43.20 ± 2.6	47.30 ± 2.4	90.5 ± 1.5	0.91 ± 0.03	4.42 ± 0.3	1.34 ± 0.3	0.47 ± 0.2	6.23 ± 0.6
Toscana	2	trace	38.60 ± 1.8	41.70 ± 2.0	80.3 ± 2.7	0.92 ± 0.05	4.00 ± 0.5	1.33 ± 0.2	0.83 ± 0.1	6.16 ± 0.4
Friuli	1	trace	43.20 ± 2.0	49.40 ± 1.8	92.6 ± 3.1	0.87 ± 0.02	4.40 ± 0.5	1.43 ± 0.1	0.37 ± 0.3	6.20 ± 0.5
Friuli	2	trace	41.20 ± 2.0	42.30 ± 2.0	83.5 ± 1.7	0.97 ± 0.03	4.44 ± 0.2	1.44 ± 0.2	0.96 ± 0.2	6.84 ± 0.3
Lazio	1	trace	52.30 ± 2.1	55.0 ± 1.5	107.3 ± 2.4	0.95 ± 0.02	3.87 ± 0.4	1.35 ± 0.1	0.78 ± 0.1	6.00 ± 0.4
Lazio	2	2.80 ± 0.30	67.00 ± 1.2	61.90 ± 1.5	121.7 ± 3.0	0.92 ± 0.03	3.38 ± 0.3	1.72 ± 0.5	0.88 ± 0.1	5.98 ± 0.5
Lazio	3	trace	50.60 ± 1.4	54.60 ± 2.3	105.2 ± 2.4	0.93 ± 0.03	3.99 ± 0.2	1.50 ± 0.2	0.66 ± 0.2	6.15 ± 0.4
Puglia	1	trace	52.00 ± 2.2	53.10 ± 2.1	105.1 ± 1.5	0.98 ± 0.02	3.78 ± 0.7	1.61 ± 0.1	0.53 ± 0.2	5.92 ± 0.4
Puglia	2	trace	47.70 ± 1.4	49.00 ± 2.0	96.7 ± 3.0	0.97 ± 0.02	4.06 ± 0.5	1.49 ± 0.1	0.88 ± 0.1	6.43 ± 0.6
Veneto	1	trace	24.60 ± 2.8	31.70 ± 2.4	56.3 ± 3.3	0.78 ± 0.02	2.77 ± 0.4	1.33 ± 0.1	0.51 ± 0.1	4.61 ± 0.5
Veneto	2	trace	56.80 ± 1.8	61.88 ± 2.0	118.68 ± 3.0	0.92 ± 0.03	3.21 ± 0.3	1.29 ± 0.2	0.6 ± 0.1	5.10 ± 0.5
statistical parameters										
min		2.80	20.00	28.20	48.20	0.70	2.66	1.26	0.37	4.38
mean			42.62	46.63	90.35	0.91	3.84	1.44	0.63	5.91
max		8.50	57.00	61.90	121.70	0.99	4.90	1.72	0.96	6.99
SD			10.55	9.27	20.67	0.09	0.67	0.14	0.17	0.81

[a] Total sugars, sum of sucrose, glucose, and fructose. [b] Water-soluble pectin. [c] Sodium exametaphosphate soluble pectin. [d] NaOH-soluble pectin.

Table III. Composition of Kiwi Puree (Soluble Solids, pH, Mineral Content, Ash, Formol Number, Total Proteins)

	farm no.	soluble solids, RO %	pH	mineral elements, mg/kg Na	K	Ca	Mg	P	ash, g/kg	formol no.[a]	total protein, g/kg
sample											
Basilicata	1	15.4 ± 0.2	3.43 ± 0.2	34 ± 3	3356 ± 28	244 ± 12	140 ± 11	167 ± 12	6.34 ± 0.06	9.36 ± 0.8	3.53 ± 0.33
Basilicata	2	15.6 ± 0.1	3.34 ± 0.3	24 ± 5	3296 ± 21	242 ± 21	128 ± 21	158 ± 34	6.52 ± 0.08	9.52 ± 1.1	6.37 ± 0.43
Calabria	1	15.4 ± 0.2	3.38 ± 0.3	28 ± 2	3089 ± 88	177 ± 12	96 ± 17	185 ± 22	6.95 ± 0.12	21.41 ± 1.2	7.22 ± 0.48
Campania	1	13.6 ± 0.2	3.38 ± 0.2	47 ± 3	3403 ± 91	188 ± 27	98 ± 7	145 ± 13	5.64 ± 0.10	12.08 ± 0.9	5.48 ± 0.88
Campania	2	14.0 ± 0.2	3.23 ± 0.3	57 ± 12	3082 ± 51	280 ± 12	130 ± 12	189 ± 16	6.28 ± 0.33	10.14 ± 1.3	6.99 ± 0.93
Campania	3	13.2 ± 0.1	3.11 ± 0.3	73 ± 6	2627 ± 103	241 ± 28	140 ± 13	146 ± 13	4.41 ± 0.21	12.12 ± 0.8	7.31 ± 0.67
Piemonte	1	12.6 ± 0.1	3.36 ± 0.2	32 ± 5	2781 ± 54	361 ± 37	158 ± 21	132 ± 21	5.38 ± 0.08	12.16 ± 1.6	7.03 ± 0.44
Piemonte	2	12.8 ± 0.2	3.20 ± 0.3	75 ± 7	2932 ± 12	176 ± 25	101 ± 11	144 ± 11	5.53 ± 0.11	7.53 ± 1.0	5.52 ± 0.70
Piemonte	3	12.2 ± 0.1	3.27 ± 0.3	18 ± 6	2915 ± 123	204 ± 27	89 ± 16	133 ± 12	5.53 ± 0.21	11.39 ± 1.1	6.08 ± 0.12
Toscana	1	13.2 ± 0.1	3.41 ± 0.3	24 ± 2	3078 ± 74	126 ± 28	73 ± 12	145 ± 21	5.65 ± 0.08	17.72 ± 1.9	9.16 ± 0.69
Toscana	2	13.0 ± 0.2	3.47 ± 0.2	29 ± 3	3203 ± 151	167 ± 48	153 ± 11	151 ± 12	5.19 ± 0.12	17.4 ± 2.1	8.80 ± 0.93
Friuli	1	13.0 ± 0.1	3.25 ± 0.1	22 ± 8	2398 ± 68	193 ± 78	106 ± 12	155 ± 16	5.27 ± 0.24	11.84 ± 0.7	3.60 ± 0.90
Friuli	2	13.6 ± 0.1	3.30 ± 0.3	15 ± 3	2390 ± 79	192 ± 49	112 ± 11	161 ± 7	4.64 ± 0.13	11.07 ± 0.9	4.42 ± 0.21
Lazio	1	15.0 ± 0.2	3.43 ± 0.2	30 ± 7	3380 ± 174	169 ± 34	128 ± 16	193 ± 9	7.17 ± 0.14	14.20 ± 0.9	7.92 ± 0.57
Lazio	2	15.8 ± 0.2	3.18 ± 0.3	46 ± 8	2740 ± 66	163 ± 37	151 ± 8	145 ± 12	4.41 ± 0.13	13.08 ± 0.6	5.41 ± 0.20
Lazio	3	14.8 ± 0.2	3.25 ± 0.2	63 ± 11	3135 ± 88	239 ± 45	76 ± 9	120 ± 11	5.68 ± 0.13	7.37 ± 0.7	4.02 ± 0.12
Puglia	1	14.0 ± 0.1	3.36 ± 0.2	31 ± 6	3066 ± 201	137 ± 38	99 ± 11	169 ± 19	4.73 ± 0.11	13.89 ± 1.4	7.08 ± 0.66
Puglia	2	14.0 ± 0.1	3.41 ± 0.3	34 ± 19	3275 ± 24	163 ± 12	119 ± 11	165 ± 38	7.31 ± 0.08	13.36 ± 0.5	7.19 ± 0.99
Veneto	1	15.0 ± 0.2	3.16 ± 0.2	33 ± 16	2949 ± 31	300 ± 27	173 ± 5	136 ± 22	5.35 ± 0.09	7.70 ± 1.1	5.41 ± 0.33
Veneto	2	14.4 ± 0.1	3.25 ± 0.2	23 ± 13	2996 ± 15	320 ± 34	189 ± 9	120 ± 11	5.83 ± 0.10	6.78 ± 0.8	5.18 ± 0.36
statistical parameters											
min		12.2	3.11	15	2390	126	73	120	4.41	6.78	3.53
mean		14.03	3.31	37	3004	214	123	153	5.69	12.01	6.17
max		15.8	3.47	75	3403	361	189	193	7.31	21.41	9.16
SD		1.1	0.10	17.63	297.65	62.89	31.75	20.84	0.85	3.75	1.61

[a] mL of 0.1 M NaOH/100 g.

differential refractometer was used as detector.

D-Isocitric acid was determined by enzymatic method (Boehringer Mannheim, 1980).

Sodium, potassium, calcium, and magnesium were determined by atomic absorption after sample mineralization performed with sulfo–nitric mixture according to the MUACV (1961). The results reported are expressed as milligrams per kilogram of fresh product.

Phosphorus was determined according to the method of Ambanelli et al. (1968).

Sample Preparation for Sugar Determination (Glucose, Fructose, and Sucrose). HPLC Analysis. Fruit puree (30 g) was clarified by centrifugation at 12000*g* for 15 min. The clarified extract was filtered through 0.45-μm Millipore filters. A sample of 20 μL was used for analysis. A Merck Lichrosorb NH2 (10 μm) cartridge was used. The eluent consisted of acetonitrile–water (80:20) which was degassed and filtered through a 0.22-μm Millipore filter. Individual sugars were identified by comparison with reference compounds. A Waters-Millipore 600E liquid chromatograph was employed, and a differential refractometer (Model 410) was utilized as a detector for sugar analysis.

Amino Acid Sample Preparation and HPLC Analysis. Fruit puree (30 g) was clarified by centrifugation at 12000*g* for 20 min. The clarified extract was filtered through 5- and 0.45-μm Millipore filters; 1 mL was applied on a cation-exchange column (100 × 6 mm AG 50X8-H^+ Bio-Rad). After column washing with 50 mL of Milli-Q water, the amino acids were eluted with 3.0 M NH_3 (about 10 mL) and collected. After 5 mL of

Table IV. Organic Acid Composition of Kiwi Puree

	farm no.	total acidity,[a] g/kg	citric acid, g/kg	D-isocitric acid, mg/kg	L-malic acid, g/kg	quinic acid, g/kg	ascorbic acid, mg/kg
sample							
Basilicata	1	14.00 ± 0.84	12.02 ± 0.74	96.72 ± 0.12	1.10 ± 0.12	4.80 ± 0.10	1410.00 ± 128
Basilicata	2	14.60 ± 0.62	14.93 ± 0.78	96.72 ± 0.08	1.52 ± 0.10	4.32 ± 0.12	1990 ± 110
Calabria	1	14.60 ± 0.68	13.92 ± 0.91	81.84 ± 0.24	1.20 ± 0.16	4.28 ± 0.20	1230.00 ± 108
Campania	1	14.40 ± 0.54	11.10 ± 0.38	76.26 ± 0.18	0.92 ± 0.14	4.00 ± 0.20	974.00 ± 88
Campania	2	15.80 ± 0.10	13.28 ± 0.26	89.28 ± 0.64	1.06 ± 0.44	4.63 ± 0.24	778.00 ± 94
Campania	3	17.90 ± 0.12	16.02 ± 0.10	78.12 ± 0.22	1.11 ± 0.10	4.03 ± 0.16	730.00 ± 64
Piemonte	1	12.60 ± 0.84	10.13 ± 0.58	50.92 ± 0.10	2.01 ± 0.34	7.60 ± 0.22	673.90 ± 80
Piemonte	2	17.30 ± 1.22	14.48 ± 0.80	126.48 ± 0.88	1.17 ± 0.15	5.41 ± 0.22	785.50 ± 122
Piemonte	3	12.50 ± 0.16	9.06 ± 0.34	49.05 ± 0.96	1.10 ± 0.20	5.09 ± 0.16	973.80 ± 98
Toscana	1	13.30 ± 0.28	11.72 ± 0.12	66.96 ± 0.14	1.14 ± 0.12	6.27 ± 0.23	1246.00 ± 112
Toscana	2	12.90 ± 0.45	10.82 ± 0.88	70.68 ± 0.12	1.35 ± 0.05	7.10 ± 0.18	998.60 ± 136
Friuli	1	14.70 ± 0.86	11.02 ± 0.16	81.84 ± 1.64	0.99 ± 0.32	5.65 ± 0.18	1415.00 ± 234
Friuli	2	14.00 ± 0.98	9.66 ± 0.82	66.96 ± 0.49	1.24 ± 0.40	6.59 ± 0.46	1120.00 ± 148
Lazio	1	14.00 ± 1.44	12.19 ± 0.48	78.12 ± 2.48	1.16 ± 0.22	6.65 ± 0.38	1546.00 ± 28
Lazio	2	17.10 ± 1.20	13.87 ± 0.80	106.02 ± 20.44	2.70 ± 0.44	4.55 ± 0.28	883.70 ± 98
Lazio	3	16.50 ± 0.22	11.82 ± 0.12	109.74 ± 12.57	3.11 ± 0.12	3.47 ± 0.58	775.90 ± 42
Puglia	1	14.40 ± 0.36	12.84 ± 0.16	89.28 ± 36.90	1.45 ± 0.10	5.51 ± 0.70	991.60 ± 38
Puglia	2	13.80 ± 0.56	11.76 ± 0.20	74.40 ± 12.20	1.77 ± 0.12	6.32 ± 0.20	1063.70 ± 190
Veneto	1	14.80 ± 1.42	10.04 ± 0.26	58.21 ± 10.46	1.04 ± 0.28	5.30 ± 0.15	872.00 ± 186
Veneto	2	15.40 ± 0.22	12.78 ± 0.10	84.07 ± 32.00	1.37 ± 0.66	6.04 ± 0.70	886.00 ± 24
statistical parameters							
mean		12.50	9.06	49.05	0.92	3.47	673.90
mean		14.73	12.17	81.58	1.43	5.38	1067.19
max		17.90	16.02	126.48	3.11	7.60	1990.00
SD		1.53	1.85	19.45	0.58	1.14	326.81

[a] Titrable acidity (pH 8.1) expressed as citric acid monohydrate.

methionine sulfone (0.4 mM) was added, the sample was evaporated, recovered with 0.1 M HCl (10 mL), and filtered through a 0.45 μm filter. A sample of 20 μL was dried by workstation Pico Tag (Waters) (about 60 mTorr) and added with 20 μL of CH_3OH, triethylamine, and an aqueous solution of 1 M sodium acetate in the volume ratio 2:1:2; 20 μL of derivatizing solution (7 CH_3OH:1 phenylisothiocyanate:1 H_2O Milli-Q:1 triethylamine) was added, and the mixture was allowed to stand at room temperature for 20 min. Then it was vacuum dried and recovered with CH_3OH (10 μL), sheared on vortex, and vacuum dried (50–60 mTorr).

A 200-μL aliquot of a "sample diluent" was then added, sheared on vortex until clear, and filtered through a Millipore HVA filter. Samples of 20 μL were used for analysis.

The sample diluent solution was obtained by dissolving 710 mg of Na_2HPO_4/L of water, titrating to pH 7.40 with 10% phosphoric acid, and then adding acetonitrile to 5% v/v.

The analysis was performed on a Pico Tag column eluted with the gradient reported in Table I. Eluent 1 was obtained by dissolving 9.525 g of sodium acetate trihydrate/L of Milli-Q water, adding 100 μL of a EDTA–Na solution (1 g/100 mL of Milli-Q water), and titrating to pH 6.50 with 10% acetic acid. This solution was mixed with acetonitrile 39:1 (v/v).

Eluent 2 was obtained by mixing acetonitrile, methanol, and Milli-Q water in the ratio 3:1:2.67 (v/v/v). This solution was degassed under vacuum for 20 s.

Individual amino acids were identified by comparison with standard (Pierce).

Table V. Content of Free Amino Acids (AA) of Kiwi Puree

	farm no.	amino acids, mg/kg									
		Asp	Glu	Ser	Asn	Gly	Gln	His	Gaba	Thr	Ala
sample											
Basilicata	1	2 ± 0.5	80 ± 0.9	11 ± 1.1	13 ± 0.3	3 ± 0.5	2 ± 0.5	6 ± 0.8	13 ± 0.8	9 ± 1.8	32 ± 0.9
Basilicata	2	46 ± 0.4	122 ± 1.4	16 ± 0.4	9 ± 0.7	7 ± 0.3	2 ± 0.7	6 ± 0.3	15 ± 0.4	15 ± 1.1	31 ± 0.4
Calabria	1	62 ± 0.4	219 ± 2.0	34 ± 0.8	90 ± 0.5	15 ± 0.3	41 ± 0.8	21 ± 0.5	19 ± 0.5	21 ± 0.8	75 ± 0.8
Campania	1	73 ± 0.9	137 ± 0.8	18 ± 1.6	18 ± 0.5	9 ± 0.5	6 ± 0.3	8 ± 1.1	12 ± 0.4	20 ± 0.6	21 ± 0.5
Campania	2	48 ± 0.8	147 ± 0.7	14 ± 0.5	12 ± 1.0	9 ± 0.4	5 ± 0.6	5 ± 0.3	14 ± 1.9	13 ± 3.1	23 ± 0.4
Campania	3	48 ± 0.7	119 ± 0.9	19 ± 0.5	14 ± 1.4	6 ± 0.4	5 ± 0.6	8 ± 0.5	22 ± 1.0	16 ± 0.3	34 ± 0.3
Piemonte	1	33 ± 0.3	209 ± 1.4	40 ± 0.7	111 ± 0.4	9 ± 0.4	23 ± 1.3	20 ± 0.4	45 ± 0.3	31 ± 0.3	121 ± 1.0
Piemonte	2	78 ± 0.5	87 ± 0.4	9 ± 0.8	5 ± 0.5	7 ± 0.4	3 ± 0.9	5 ± 1.0	5 ± 0.3	6 ± 0.4	14 ± 1.4
Piemonte	3	88 ± 0.5	131 ± 0.5	19 ± 0.3	18 ± 0.3	12 ± 0.4	5 ± 0.7	9 ± 0.3	37 ± 0.8	18 ± 0.5	40 ± 0.8
Toscana	1	18 ± 0.3	149 ± 0.8	31 ± 1.1	87 ± 0.5	13 ± 0.4	5 ± 0.3	14 ± 0.3	37 ± 3.8	23 ± 0.6	90 ± 0.9
Toscana	2	17 ± 1.3	153 ± 0.6	26 ± 0.7	69 ± 0.4	26 ± 0.5	23 ± 0.3	11 ± 0.3	27 ± 0.9	18 ± 0.9	101 ± 0.8
Friuli	1	42 ± 0.9	87 ± 0.5	13 ± 0.4	13 ± 1.0	8 ± 0.4	5 ± 0.5	5 ± 0.3	10 ± 2.5	12 ± 0.3	18 ± 0.8
Friuli	2	84 ± 1.4	169 ± 0.6	22 ± 1.9	26 ± 0.4	10 ± 0.4	10 ± 0.3	11 ± 0.3	9 ± 0.3	24 ± 0.7	32 ± 0.5
Lazio	1	12 ± 0.4	150 ± 1.8	18 ± 0.3	50 ± 0.8	8 ± 0.5	21 ± 0.5	13 ± 0.9	14 ± 0.5	17 ± 0.3	41 ± 0.5
Lazio	2	81 ± 1.8	241 ± 2.4	16 ± 0.5	19 ± 0.8	7 ± 0.3	14 ± 1.2	9 ± 1.8	28 ± 0.3	18 ± 1.2	11 ± 0.4
Lazio	3	31 ± 0.7	91 ± 0.7	7 ± 0.8	6 ± 0.8	3 ± 0.5	1 ± 0.3	10 ± 1.8	7 ± 0.5	3 ± 0.3	6 ± 0.6
Puglia	1	81 ± 1.8	192 ± 3.4	20 ± 2.8	49 ± 1.1	11 ± 0.4	12 ± 0.3	10 ± 1.1	27 ± 0.3	18 ± 0.3	44 ± 0.4
Puglia	2	84 ± 0.7	173 ± 0.9	12 ± 0.8	43 ± 0.4	7 ± 0.5	12 ± 0.9	9 ± 0.5	15 ± 0.3	12 ± 0.4	26 ± 0.9
Veneto	1	41 ± 0.8	123 ± 2.1	21 ± 0.5	9 ± 0.3	10 ± 0.3	11 ± 0.5	12 ± 0.4	22 ± 0.3	13 ± 0.5	100 ± 2.6
Veneto	2	45 ± 0.4	137 ± 0.4	24 ± 0.5	9 ± 0.7	10 ± 0.9	14 ± 1.2	18 ± 1.1	23 ± 0.3	7 ± 0.5	38 ± 1.6
statistical parameters											
min		2	80	7	5	3	1	5	5	3	6
mean		51	146	20	34	10	11	10	20	16	197
max		88	241	40	111	26	41	21	45	31	121
SD		27	45	8	32	5	10	5	11	7	34

RESULTS AND DISCUSSION

In the following analysis, 60 samples from 20 different farms in Italy's main growing areas have been analyzed. Each farm of a specific region is indicated with a number in the tables. The values reported in Tables II–VI are means of triplicate analyses on samples obtained as indicated under Materials and Methods from 30 fruits at full ripening stage.

The most represented carbohydrates in the kiwi puree were fructose and glucose. Sucrose is present in much lower quantity and in some samples as trace level; this could be due to the presence in the fruit of an invertase that hydrolyzed the sucrose during the mincing and screening of the fruit (Reyes et al., 1982). As occurs with other fruits, fructose is more abundant than glucose; the molar ratio is between 0.70 and 0.99.

The total pectin content is similar to that of other fruits such as apricot and peach (Vidal-Valverde et al., 1982).

We confirmed that kiwi fruit has a high content of mineral salts, particularly potassium (Table III). The kiwi purees show sodium concentration of about 40 ± 18 mg/kg. Therefore, higher values (mean value + 2SD > 80 mg/kg) can be indicative of inappropriate processing or illegal treatments.

As far as the ratio potassium/magnesium is concerned we found that it never exceeds the value of 42. This value can be useful to detect addition of potassium compounds. On the other hand, low magnesium levels are indicative of sample dilution.

The phosphorus content ranged between 120 and 193 mg/kg with a mean value of 152 mg/kg (Table III).

The calcium content was higher than that reported by Scholten (1983) but substantially agrees with that reported by Herrmann (1980) and Dassler et al. (1975), with values between 200 and 600 mg/kg.

The titrable acidity (see Table IV) ranged between 12.50 and 17.90 g/kg and was mostly due to citric acid (mean value 12.17 g/kg), quinic acid (mean value 5.38 g/kg), and malic acid (mean value 1.44 g/kg). The high concentration of quinic acid can be very useful to evaluate the percent of kiwi content in a food product.

The Brix/acid ratio is a way to evaluate objectively the optimum harvesting time for several fruits (Ough and Alley, 1970). It is calculated by dividing the sugar content of the fruit, expressed as degrees Brix, by its percentage of acid. The Brix/acid ratio for kiwi fruit is reported in Table VI. This value ranged between 7.36 and 11.

For the content of D-isocitric acid and the ratio citric acid/isocitric acid, we found that the values varied in a wide range: 49–126 mg/kg and 107–205, respectively. The ratio citric acid/malic acid ranged between 8 and 15. We found that the samples where this ratio was lower than 8 often showed high acidity and/or high quinic content.

Finally we confirmed the high content of L-ascorbic acid in kiwi fruit with values ranging between 674 and 1990 mg/kg.

Amino acid compositions are given in Table V. In all of the samples there are identical patterns of amino acid content; 21 amino acids were detected. The data show that arginine and glutamic acid were the major amino acids (about 50% of total amino acids) and that the relative proportions of aspartic acid, glutamine, asparagine, alanine, and arginine show very large variation with standard deviations between 26.9 (aspartic acid) and 187 (arginine). The remaining amino acids were found in smaller amounts. The total content of amino acid ranges very widely (246–1557 mg/kg); the same behavior is shown by formol number (6.78–21.41 mL of 0.1 N NaOH/100 g of juice) and total proteins (3.53–9.16 g/kg). In Table VI we have shown some ratios of specific components of kiwi puree. The ratio formol number/(arginine + glutamic acid) seems to be a very interesting parameter. It ranges between 16.4 and 76.9, with a standard deviation of 15.33. This value is lower than that found for the ratio formol number/glutamic acid (SD 23.52) and for formol number/arginine (SD 79.56). Finally, it can be noted that only 5% of samples presented values of the ratio formol number/(Arg + Glu) greater than 70 and only 8% of samples presented values lower than 20. Therefore, this parameter may be used as a quality index.

CONCLUSIONS

As expected the analytical composition of the kiwi produced in Italy is very similar to that found for the

Table V (Continued)

amino acids, mg/kg											total AA, mg/kg
Arg	Pro	Tyr	Val	Met	Cys	Ile	Leu	Phe	OrN	Lys	
86 ± 0.4	5 ± 1.1	3 ± 0.8	4 ± 0.8	1 ± 0.3	7 ± 0.5	2 ± 1.1	9 ± 0.6	9 ± 0.4	1 ± 0.3	9 ± 0.3	307 ± 8.7
74 ± 0.4	4 ± 0.5	2 ± 0.5	10 ± 0.4	7 ± 0.4	2 ± 0.5	4 ± 1.0	22 ± 0.9	5 ± 0.3	3 ± 0.6	3 ± 0.4	405 ± 8.9
793 ± 1.4	7 ± 0.5	18 ± 0.4	18 ± 0.4	10 ± 0.4	5 ± 0.4	13 ± 0.3	55 ± 0.6	39 ± 0.5	4 ± 0.7	3 ± 0.5	1557 ± 11.6
107 ± 1.5	5 ± 0.3	5 ± 0.3	2 ± 0.9	5 ± 0.4	2 ± 0.4	6 ± 0.5	35 ± 0.8	15 ± 0.5	3 ± 1.1	5 ± 0.5	513 ± 7.8
65 ± 1.1	5 ± 1.0	8 ± 0.6	19 ± 0.3	8 ± 0.3	1 ± 0.3	8 ± 0.5	29 ± 0.8	18 ± 0.7	2 ± 0.5	19 ± 0.4	473 ± 9.5
121 ± 1.2	5 ± 0.3	2 ± 0.4	6 ± 0.5	2 ± 0.6	4 ± 0.5	8 ± 0.5	23 ± 0.6	17 ± 0.6	1 ± 0.5	16 ± 0.3	497 ± 10.6
247 ± 0.5	10 ± 0.4	11 ± 0.7	23 ± 0.8	4 ± 0.3	2 ± 0.3	7 ± 0.3	22 ± 0.7	10 ± 0.5	4 ± 0.5	22 ± 0.7	1004 ± 7.6
31 ± 0.8	4 ± 0.3	11 ± 0.5	8 ± 0.4	3 ± 0.5	1 ± 0.5	4 ± 0.3	23 ± 0.4	23 ± 0.3	1 ± 0.3	4 ± 0.7	332 ± 10.5
102 ± 0.4	8 ± 0.3	25 ± 0.5	1 ± 0.5	7 ± 0.6	4 ± 0.6	9 ± 0.4	31 ± 0.9	6 ± 0.4	3 ± 0.3	26 ± 0.5	601 ± 6.9
430 ± 7.2	8 ± 0.3	22 ± 0.8	15 ± 0.3	9 ± 1.4	6 ± 0.7	6 ± 0.5	31 ± 1.7	30 ± 0.7	3 ± 0.3	25 ± 0.5	1053 ± 11.6
429 ± 1.6	6 ± 0.3	14 ± 0.3	10 ± 0.4	2 ± 1.0	6 ± 1.9	8 ± 0.3	29 ± 0.5	22 ± 1.2	3 ± 0.3	18 ± 0.3	1017 ± 8.8
67 ± 0.8	3 ± 0.6	12 ± 0.4	7 ± 0.8	4 ± 0.8	4 ± 0.8	5 ± 0.5	14 ± 1.1	15 ± 1.1	2 ± 0.3	13 ± 0.3	359 ± 7.2
160 ± 0.8	6 ± 0.5	31 ± 0.8	20 ± 1.2	9 ± 0.5	4 ± 1.5	3 ± 0.3	28 ± 1.5	22 ± 1.9	3 ± 0.3	21 ± 0.8	707 ± 9.9
295 ± 5.3	4 ± 0.5	12 ± 0.6	9 ± 0.3	4 ± 0.5	1 ± 0.4	2 ± 0.4	17 ± 1.3	17 ± 1.0	2 ± 1.0	18 ± 0.5	724 ± 5.8
96 ± 0.5	12 ± 0.5	13 ± 0.3	12 ± 0.5	9 ± 0.3	6 ± 1.5	16 ± 0.7	38 ± 0.7	25 ± 0.8	4 ± 0.7	21 ± 0.6	694 ± 13.1
21 ± 0.8	2 ± 0.5	6 ± 0.7	2 ± 0.3	2 ± 0.5	8 ± 1.1	3 ± 0.5	16 ± 1.1	11 ± 0.6	2 ± 0.3	10 ± 0.5	246 ± 4.3
207 ± 1.5	6 ± 0.8	14 ± 0.9	7 ± 0.3	8 ± 0.4	4 ± 1.4	7 ± 0.6	33 ± 1.2	24 ± 0.8	2 ± 0.3	28 ± 0.9	804 ± 8.9
183 ± 0.7	5 ± 0.5	11 ± 1.6	9 ± 0.6	7 ± 0.5	7 ± 0.5	6 ± 0.3	25 ± 1.4	16 ± 1.1	2 ± 1.1	18 ± 0.3	682 ± 8.2
345 ± 2.1	6 ± 0.3	11 ± 0.6	9 ± 0.5	5 ± 0.5	7 ± 0.3	4 ± 0.5	17 ± 1.1	12 ± 0.5	3 ± 0.3	27 ± 0.3	807 ± 7.4
76 ± 0.5	6 ± 0.3	20 ± 0.3	10 ± 1.0	6 ± 0.3	4 ± 0.7	6 ± 0.5	22 ± 0.7	18 ± 0.5	4 ± 0.3	19 ± 0.4	513 ± 4.9
21	2	2	1	1	1	2	9	5	1	3	246
197	6	13	10	5	4	6	26	18	3	16	665
793	12	31	23	10	8	16	51	39	4	28	1557
187	2	8	6	3	2	3	10	8	1	8	318

Table VI. Ratios of Specific Components of Kiwi Puree

ratios	$\bar{x}^a$	s^b	$x \pm 2s$	range (min-max)
°Brix/acid (ratio)	9.59	0.97	7.65–11.53	7.37–11
glucose/fructose	0.91	0.09	0.73–1.07	0.70–0.99
citric acid/isocitric acid	158.5	35.47	88–230	107–248
citric acid/malic acid	9.4	2.77	3.86–14.95	3.80–14.43
total acid, pH 8.1/ citric acid monohydrate	1.22	0.13	0.96–1.48	0.98–1.47
formol number/argine, g/L	107.8	79.56	trace–267	22.3–351
formol number/glutamic acid, g/L	85.47	23.52	38.43–133	49.5–136
formol number/(Arg ± Glu)	43.26	15.33	12.60–74	16.4–76.9
potassium/magnesium	26.12	7.68	10.80–41.50	15.8–42
magnesium/calcium	0.6	0.15	0.30–0.90	0.32–0.92

[a] Arithmetic mean. [b] Standard deviation.

product coming from other countries; it has been confirmed that the main chemical parameters that characterized this fruit are quinic acid, L-ascorbic acid, potassium, and arginine. However, the values of the various analytical indices show in most cases a high variability that makes difficult their utilization as a measure of kiwi fruit content in a certain product.

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Registry No. Asp, 56-84-8; Glu, 56-86-0; Ser, 56-45-1; Asn, 70-47-3; Gly, 56-40-6; Gln, 56-85-9; His, 71-00-1; Gaba, 56-12-2; Thr, 72-19-5; Ala, 56-41-7; Arg, 74-79-3; Pro, 147-85-3; Tyr, 60-18-4; Val, 72-18-4; Met, 63-68-3; Cys, 52-90-4; Ile, 73-32-5; Leu, 61-90-5; Phe, 63-91-2; Orn, 70-26-8; Lys, 56-87-1; Na, 7440-23-5; K, 7440-09-7; Ca, 7440-70-2; Mg, 7439-95-4; P, 7723-14-0; sucrose, 57-50-1; glucose, 50-99-7; fructose, 57-48-7; pectin, 9000-69-5; citric acid, 77-92-9; isocitric acid, 6061-97-8; malic acid, 97-67-6; quinic acid, 77-95-2; ascorbic acid, 50-81-7.