

Nota / Note

FRUIT CHARACTERIZATION OF HIGH OIL CONTENT AVOCADO VARIETIES

Vicente Manuel Gómez-López

Instituto de Ciencia y Tecnología de Alimentos, Facultad de Ciencias, Universidad Central de Venezuela, Apartado Postal 47097, Los Chaguaramos, Caracas 1041 A, Venezuela
<vgomez@strix.ciens.ucv.ve>

ABSTRACT: To expand the data bank on avocado (*Persea americana* Mill.) varieties all over the world, and to select good varieties for commercial or improving purposes, a partial fruit characterization of 13 high oil content (11.23-18.80%) was performed. The chosen varieties are growing in a Venezuelan germplasm bank: Fuerte, Peruano, Lula, Ortega, Red Collinson, Alcemio, Araitha 1, Pope, Ettinger, Gripiña 5, Barker, Duke, and Ryan. They were characterized for pulp oil and moisture; weight (whole fruit, seed, pulp and peel); length, width and fruit shape; peel characteristics (roughness, color and hand peeling); and ripeness time. The variety Ryan showed the highest oil content (18.80%) and calorific value (191 Kcal/100 g wet flesh). Avocado varieties grown in Venezuela have generally less oil content and are generally lighter than those from other countries. Most of the varieties had low pulp proportion, and were pyriform, with rough green peel and difficult to hand peel. Red Collinson had an uncommon reddish peel. The ripening time was between 4 and 10 days after harvest.

Key words: avocado, fruit characterization

CARACTERIZAÇÃO DE FRUTOS DE VARIEDADES DE ABACATE COM ALTO TEOR DE ÓLEO

RESUMO: O teor de óleo de abacates (*Persea americana* Mill.) é uma característica importante para seu consumo *in natura* e para a indústria. Treze variedades de abacate de alto teor de óleo (11,23-18,80%) de um pomar venezuelano: Fuerte, Peruano, Lula Ortega, Red Collison, Alcemio, Araitha 1, Pope, Ettinger, Gripiña 5, Barker, Duke e Ryan, foram caracterizados pelo teor de óleo da polpa e umidade; peso (fruto inteiro, semente, polpa e casca); comprimento, largura e forma; características da casca (rugosidade, cor e soltura); e tempo de maturação. A variedade Ryan mostrou os maiores teor de óleo (18,80%) e valor calórico (191 kcal/100 g de peso fresco). As variedades venezuelanas têm, em geral, teor mais baixo de gordura e proporção de polpa, e são em geral mais leves que aquelas de outros países. A maioria das variedades é periforme, com casca verde áspera e difíceis de serem descascadas manualmente. A variedade Red Collison tem uma cor avermelhada incomum. A maturação esteve entre 4 e 10 dias após a colheita.

Palavras-chave: abacate, caracterização de fruto

INTRODUCTION

The avocado (*Persea americana* Mill.) is originated in the western hemisphere, most likely in the region ranging from southern Mexico through Central America to northern South America. At least 9000 years ago people living in Mexico had begun to use and select preferred forms of the fruit (Knight Junior, 1980). This fruit was mentioned for the first time in Venezuela in 1567 (Serpa, 1968).

Several articles have been devoted to the description of the characteristics of avocado varieties such as those by the California Avocado Society (1947), Bleinroth et al. (1976), Figueroa (1982), Colucci et al. (1983) and others cited through this one. Some of them describe the same varieties showing dissimilar results for oil content, weight, etc.; due to geographical differences, others describe unique varieties reflecting the wide diversity of this fruit. Moreover, results obtained for the

same variety from the same orchard change between harvest seasons and in the same season because of differences in climatic conditions and harvest time through the season. For this reason, much of the data from varietal descriptions are only reference points and of limited validity, but they are also the only way to share information among growers and scientist, and to search for good varieties.

In addition, there is a trend to promote avocado consumption to improve human blood lipid profiles due to the high monounsaturated fatty acid content of its oil (Bergh, 1992). However, clinical studies supporting that recommendation have been performed using varieties with high oil levels (Colquhoun et al., 1992). To extrapolate these kind of results to other varieties, the oil content of the avocado variety must be known, together with the monounsaturated fatty acid content, the first type of data is provided in this study for some varieties.

To contribute to the expansion of the data bank on avocado varieties all over the world, and to select good varieties for commercial or improving purposes, a partial fruit characterization of 49 varieties growing in a Venezuelan germplasm bank was performed. The results for 36 varieties have been already published (Gómez-López, 1998, 1999, 2000), the results for the high oil category are reported in this article.

MATERIALS AND METHODS

In 1993, 13 to 27 fruits of each of the following avocado (*Persea americana* Mill.) varieties from trees older than seven years were picked: Fuerte, Peruano, Lula, Ortega, Red Collinson, Alcemio, Araira 1, Pope, Ettinger, Gripiña 5, Barker, Duke, and Ryan. The samples were from the collection of Centro Nacional de Investigaciones Agropecuarias, Maracay, Venezuela. They were carried to Instituto de Ciencia y Tecnología de Alimentos, Universidad Central de Venezuela, Caracas, and kept in ambient conditions until ripe. A single fruit was considered ripe, when its skin was ruptured with a 0.8 cm width cylindrical plunger in an Instron Universal Testing Machine model 1101, using a penetration speed of 1 cm min⁻¹; the plunger penetrated the sample perpendicularly to the equator. Three fruits of each variety were measured in five points located equidistantly (Gómez-López, 1998). When the samples were ripe, five fruits of each variety were randomly selected, and analytical determinations performed.

Pulp moisture and oil contents were determined according to Gómez-López (1998) in a pulp pool of five fruits.

Fruit weight (whole fruit, seed, pulp and peel); length, width at the equator, and shape; and the peel characteristics roughness, hand peeling, and color were determined. Color was determined by a tristimulus colorimeter (Colormet, Metron Instruments Inc., Hamilton, Ontario, Canada) using the Lab Hunter System as was described before (Gómez-López, 2000).

Calorific values were estimated by the expression $C = 9.07 F + 21.2$; where C = calorific value expressed as kcal/100 g and F = % oil in avocado flesh (wet basis) (Pearson, 1975).

Means of table 2 were compared by Kruskal-Wallis test ($p < 0.05$), using the Statgraphics 6.0 program.

RESULTS AND DISCUSSION

The ripeness of the different varieties was characterized by the following values obtained by the penetration test, expressed in kilograms (mean \pm standard deviation); Fuerte, 2.45 \pm 0.93; Peruano, 0.64 \pm 0.00; Lula, 1.36 \pm 0.24; Ortega, 1.71 \pm 0.85; Red Collinson, 1.50 \pm 0.15; Alcemio, 0.79 \pm 0.26; Araira 1, 1.46 \pm 0.31; Pope, 1.62 \pm 0.21; Ettinger, 1.23 \pm 0.17; Gripiña 5, 1.33 \pm 0.14; Barker, 0.95 \pm 0.16; Duke, 0.94 \pm 0.34; and Ryan, 0.96 \pm 0.26.

Ryan stood out for having the highest oil content (Table 1) of the 49 characterized varieties. Contrasting the varieties with the highest oil contents from different regions, Venezuelan avocados seem to have relatively low oil contents in comparison to maximal values reported from Chile (25.8%) (Olaeta et al., 1986); South Africa (40.0%) (Pearson, 1975); Morocco (23.4%) (Vogel, 1958) and Brazil (25.5%) (Tango et al., 1969/70) but close to the data reported from Colombia (15.01%) (Salazar et al., 1971) and Texas (20.1%) (Rouse & Knight Junior, 1991).

Peruano, Ortega, Alcemio, Araira 1 and Pope have been unlikely described before. To avoid confusion, it must be pointed out that the Ortega variety described here seems to be different from that described by Lizana & Luza (1979), since the first one is referred by Avilán & Rodríguez (1995) as Guatemalan x West Indian and collected in Venezuela, and the other one is referred to as Mexican and collected in Chile. In addition, the description given here does not match with of Lizana & Luza (1979).

Table 1 - Race^a, Floral Group^a, and Pulp Oil and Moisture Percentages of 13 Avocado Varieties Harvested in Venezuela in 1993.

Variety	Race ^b	Floral group	% oil ^c	% moisture ^d	oil + moisture
Fuerte	M x G	B	11.23	82.85	94.08
Peruano	G x WI	A	11.24	76.28	87.52
Lula	M x G	A	11.49	78.38	89.87
Ortega	G x WI	A	11.61	77.99	89.60
Red Collinson	G x WI	B	11.74	82.19	93.93
Alcemio	WI	A	11.82	76.52	88.34
Araira 1	G x WI	A	13.08	79.08	92.16
Pope	G x WI	A	13.36	75.83	89.19
Ettinger	M x G	A	14.72	78.54	93.26
Gripiña 5	G x WI	B	15.15	76.43	91.58
Barker	WI	A	17.55	74.24	91.79
Duke	M	B	18.18	74.33	92.51
Ryan	M x G	B	18.80	70.41	89.21

^aAccording to Avilán & Rodríguez (1995). ^bM: Mexican, G: Guatemalan, WI: West Indian.

^cData are averages of two samples of a five avocado pool. ^dData are averages of four samples of a five avocado pool.

The pulp oil contents reported by Rouse & Knight Junior (1991) for Ettinger, by Fersini (1975) for Gripiña 5, and by Lozano et al. (1987) for Lula are close to those obtained in this study. The oil content of the Fuerte variety was lower than the values reported by the California Avocado Society (1946), Vogel (1958), Tango et al. (1969/70), Pearson (1975), Fersini (1975) and Olaeta et al. (1986); but similar to that reported by Lizana & Luza (1979). The sums of oil and moisture values were between 87.52 (Peruano) and 94.08 (Fuerte). The last value is higher than the data for Fuerte reported by Pearson (1975), which were between 89.4 and 92.0.

Regarding the healthy benefits from the monounsaturated fatty acid profile of avocados, Colquhoun et al. (1992) used avocados with average weights of 200-500g, and found about 23 % total oil content of which and 54 % was oleic acid. Fuerte grown in Venezuela had 62 % oleic acid (Sciancalepore & Dorbessan, 1981), a similar weight but half of the oil content, therefore it is likely necessary to consume twice the pulp from Venezuelan Fuerte than that advised in the cited work to achieve the claimed healthy benefits, which means eating the huge amount of 1-3 avocados per day.

The calculated calorific value of the variety with the highest oil content was 191 kcal/100 g wet flesh (8 J kg⁻¹), which is three times more than those calculated for the most popular Venezuelan varieties (Gómez-López, 1998).

The weights reported for Ettinger and Lula by Rouse & Knight Junior (1991) are close to those obtained in this work (Table 2), but for Lula and Gripiña 5 they are lower than the range reported by Fersini (1975). Fuerte weight was lower than the values reported by the California Avocado Society (1946), Lizana & Luza (1979), Rouse & Knight Junior (1991) and Fersini (1975); and higher than that reported by Tango et al. (1969/70); for Ryan, lower than the range reported by Morton (1987), and for Barker and Duke lower than the range reported by the California Avocado Society (1946). Ortega and Pope are the heaviest and Duke the lightest ($p < 0.05$). According to the descriptors developed by Avilán et al. (1994), the Ortega variety is very heavy; Araira 1, Barker and Pope, heavy; Alcemio, Ettinger, Lula, Peruano and Red Collinson, medium; Fuerte, Gripiña 5 and Ryan, light; and Duke, very light.

The pulp proportion (Table 2) of Lula was equal to that grown in Corsica (Lozano et al., 1987). Lula was characterized as an extremely low pulp proportion variety, being the second lowest in this category among the 49 varieties studied in this project and the lowest in this group ($p < 0.05$), because of its very big seed; its seed proportion was the highest among the 13 varieties studied in this work ($p < 0.05$). For Fuerte, the pulp proportion was lower than those reported by Lizana & Luza (1979) and Tango et al. (1969/70). Ettinger, Pope and Ortega have the highest pulp proportion ($p < 0.05$).

According to the descriptors of Avilán et al. (1994) Ettinger, Ortega and Pope had high pulp percentage; Araira 1, Barker and Fuerte had medium pulp percentage; and Alcemio, Duke, Gripiña 5, Lula, Peruano, Red Collinson and Ryan low pulp percentage.

The peel proportion (Table 2) of Lula, Ryan and Red Collinson are the highest, while for Ettinger, Ortega and Duke the lowest. Fuerte peel proportion was higher in this characterization than those by Tango et al. (1969/70) while was lower for Duke.

The size of Lula (Table 3) was smaller than that reported by Lozano et al. (1987), and for Fuerte similar. Araira 1 is the longest, Ryan the shortest, Ortega the widest and Duke the narrowest.

Avocado peel color is generally green due to chlorophyll presence, and some varieties turn purple due to anthocyanin pigments (Prabha et al., 1980) or black. For this reason, the uncommon reddish color of the Red Collinson variety (chromaticity value *a*, Table 4) is interesting. The rest of the cultivars were green except Ryan, which was black.

Regarding other external characteristics of the fruits, four varieties were ovate and 9 pyriform; 3 smooth peeled and 10 rough (Table 4).

Ettinger, Fuerte, Gripiña 5, Pope and Red Collinson were easy to hand peel; the others were difficult due to a very adherent peel (Alcemio, Araira 1, Duke, Peruano and Ortega) or to easy to break the peel for the rest.

Regarding ripening time, a seven category descriptor was developed by Lahav et al. (1995), ranging from 6 to 30 days. However, this classification seems to be unsuitable for Venezuelan varieties which do not require more than 12 days to soften. For this reason, a new descriptor was developed to classify varieties harvested in Venezuela, taking into account data from

Table 2 - Fruit Weight and Pulp, Seed and Peel Proportions^a of 13 Avocado Varieties Harvested in Venezuela in 1993.

Variety	Weight (g)	% pulp	% seed	% peel
Fuerte	192.86 ^c	70.90 ^{de}	17.04 ^{bc}	12.06 ^c
Peruano	285.41 ^e	68.52 ^{cde}	23.66 ^{ef}	7.81 ^{ab}
Lula	336.84 ^{ef}	55.68 ^a	31.77 ^h	12.54 ^{cd}
Ortega	463.00 ^g	77.93 ^f	14.73 ^{ab}	7.33 ^{ab}
Red Collinson	322.87 ^e	67.23 ^c	19.14 ^{cd}	13.63 ^d
Alcemio	317.62 ^e	61.94 ^b	26.95 ^{fg}	11.11 ^{bc}
Araira 1	350.36 ^{ef}	71.61 ^{de}	17.85 ^{bc}	10.54 ^b
Pope	405.09 ^{fg}	76.88 ^f	11.80 ^a	11.33 ^{bc}
Ettinger	267.91 ^{de}	76.49 ^f	17.37 ^{bc}	6.14 ^a
Gripiña 5	215.72 ^{cd}	60.26 ^b	27.51 ^g	12.24 ^c
Barker	364.33 ^f	73.84 ^e	18.10 ^{bc}	8.06 ^b
Duke	108.84 ^a	67.49 ^{cd}	24.52 ^{efg}	7.98 ^{ab}
Ryan	146.46 ^b	64.85 ^{bc}	22.41 ^{de}	12.74 ^{cd}

^aData are means of five avocados. Means within columns followed by the same letter are not significantly different ($p < 0.05$).

Table 3 - Size^a (cm) of 13 Avocado Varieties Harvested in Venezuela in 1993 .

Variety	Length	Width
Fuerte	12.04 ± 0.44	5.86 ± 0.19
Peruano	13.34 ± 1.17	6.62 ± 0.64
Lula	13.16 ± 0.51	7.88 ± 0.52
Ortega	16.32 ± 1.73	8.28 ± 0.71
Red Collinson	9.72 ± 0.23	7.80 ± 0.22
Alcemio	14.32 ± 0.68	7.46 ± 0.57
Araira 1	17.22 ± 1.57	6.98 ± 0.61
Pope	15.95 ± 1.07	7.30 ± 0.39
Ettinger	12.84 ± 1.63	6.80 ± 0.41
Gripiña 5	9.46 ± 0.74	6.62 ± 0.65
Barker	12.20 ± 0.47	7.96 ± 0.77
Duke	9.16 ± 0.39	5.28 ± 0.37
Ryan	8.48 ± 0.66	5.92 ± 0.16

^aData are means of five fruits.

Table 4 - External Characteristics of 13 Avocado Varieties^a Harvested in Venezuela in 1993.

Variety	Shape	Peel texture	L ^b	a ^c	b ^d
Fuerte	Pyriform	Rough	29	-3	19
Peruano	Pyriform	Rough	25	-8	37
Lula	Pyriform	Rough	25	-7	31
Ortega	Pyriform	Smooth	32	-8	35
Red Collinson	Ovate	Smooth	11	13	15
Alcemio	Pyriform	Rough	38	-8	46
Araira 1	Pyriform	Rough	41	-6	38
Pope	Pyriform	Rough	25	-7	30
Ettinger	Pyriform	Smooth	37	-11	37
Gripiña 5	Ovate	Rough	27	-4	22
Barker	Ovate	Rough	45	-9	41
Duke	Ovate	Rough	42	-8	26
Ryan	Pyriform	Rough	15	1	6

^aColor data are means of five readings taken at the equator of 5 avocados. ^bLightness. ^cRed/green chromaticity. ^dYellow/blue chromaticity.

almost 700 samples of 31 varieties from this and other reports related to this project (Gómez-López, 1998, 1999, 2000). Ripening times modes ranged from 4 to 12 days, with an average of 7 days and a standard deviation of 2 days. Dividing this range into three parts, gave fast ripening varieties (< 7 days), medium ripening varieties (7-9 days) and slow ripening varieties (> 9 days), which corresponded to 42%, 42% and 16% of the studied varieties, respectively. According to this criterion, Alcemio, Araira 1, Duke, Gripiña 5, Ortega and Peruano are fast; Ryan and Barker medium; and the rest slow.

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