Characterization of Avocado (*Persea americana* Mill.) Varieties of Very Low Oil Content

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

Twelve avocado varieties of very low oil content (3−6.70%) from Venezuela (Choquette, Linda, Marcus, Nelan, Pollock, Simmonds, Booth 8, Darwin VII Aperado, Palomino, River, Russell and Secundino) were characterized for pulp oil and moisture contents; weight (whole fruit, seed, pulp, and peel); length, width, and fruit shape; peel characteristics (roughness, color, and hand peeling); and ripeness time. The variety Nelan showed the lowest oil content (3.05%); Russell was the largest (19.50 cm); Marcus was the heaviest (776 g); and Marcus and Russell presented the highest pulp proportion (79%). Choquette has the highest potential yield among the first five varieties cited, with 54 492 kg of fruit/ha, 40 324 kg of pulp/ha, and 2 036 kg of oil/ha. Most of the varieties were ovate, with smooth green peel and easily hand peeled. Weight and oil content of these varieties were lower than the same ones studied in other countries. The ripeness time was between 5 and 9 days after harvest.

Keywords: *Avocado; fruit characterization; tropical fruits; Venezuelan fruits; Venezuelan avocados*

INTRODUCTION

Avocado (*Persea americana* Mill.) is an American fruit consumed by pre-Colombian Indians long before the arrival of Spanish conquerors (Vélez and Valery, 1990). It is an oily fruit with an oil content of up to 40% of its pulp weight (Pearson, 1975), its principal component being monounsaturated fatty acids (Swisher, 1988), which have healthy properties (Smith et al., 1983; Wills et al., 1986; Colquhoun et al., 1992), but its levels of nutrients strongly depend on the variety (Hall et al., 1955). Characterization of fruit varieties is fundamental to know the particularities of food that consumers eat or must eat. Although some papers advocate that certain varieties are useful and others not, description of all of them is a valuable tool because it enables selection of some varieties according to grower possibilities and preferences and helps researchers to look for unconventional food sources or applications. Moreover, publishing data of useless varieties avoids time and resources wasted doing additional work.

Fersini (1975) reported the identification of 800 varieties, not all suitable for marketing. Although the avocado fruit is native in the area between southern Mexico and northern South America (Knight, 1980), available bibliography from these countries is scarce. In Venezuela, the introduction and selection of avocado varieties to improve quality and yield dates back to 1937, after the creation of the Estación Experimental de Agricultura y Zootecnia, in Caracas (Avilán et al., 1994). Nowadays, the Centro Nacional de Investigaciones Agropecuarias keeps an avocado collection of 99 varieties (Avilán et al., 1994), the description of which is still in progress.

Variety selection must be oriented toward traditional consumption as well as for product and subproduct processing. For fresh consumption, preferences of different markets must be considered; for example, Venezuelan consumers prefer varieties qualified as very big, while in the rest of the world usually smaller varieties are favored, due to the fact that Fuerte and Hass varieties dominate the international market (Storey et al., 1973/74). Also, the potential use of avocado as a raw material for processed products (Lime, 1969a,b; Gomez and Bates, 1970; Cortés et al., 1971; Lladser and Piñanga, 1975; Scudomore-Smith, 1984) or as an oil source for food and cosmetic purposes (Swisher, 1988) must be considered.

The avocado oil content has always been a key feature in research, and for decades its importance as a quality factor has been discussed (Harding, 1954; Lewis, 1978; Morris and O'Brien, 1980; Lee, 1981; Lee et al., 1983; Brown, 1984; Ministerio de Agricultura Pesca y Alimención, 1989; Plumbey et al., 1989). For this reason, in this work the pulp oil amount was selected as an assortment criterion.

Until now, 49 Venezuelan varieties have been characterized; the goal of this study is to characterize the lowest oil content varieties from this total, with the purpose of increasing the available information about avocado varieties to help people choose specific varieties according to their objectives.

MATERIALS AND METHODS

Samples belong to the collection of the Centro Nacional de Investigaciones Agropecuarias, which is located in Maracay, in the central-north area of Venezuela (latitude 10° 17′ N, longitude 67° 37″ W), in the region of dry premountain forest, to 450 m above the sea level, characterized by an average yearly precipitation of between 900 and 1000 mm and an average temperature of 24−26 °C; its soil belongs to the Entisol order (Avilán et al., 1994). In 1993, between 23 and 27 fruits of each of the following avocado (*Persea americana* Mill.) varieties were picked: Booth 8, Choquette, Darwin VII Aperado, Linda, Marcus, Nelan, Palomino, Pollock, River, Russell, Secundino, and Simmonds. The samples were brought to the

† Fax 58.2.753.3871; e-mail Gomezv@buho.ciens.ucv.ve

S0021-8561(97)00689-4 CCC: $15.00
Published on Web 08/11/1998

Table 1. Pulp Oil and Moisture Percentages of 12 Avocado Varieties

variety	% oil[a]	% moisture[b]
Nelan	3.05	87.41
Simmonds	4.10	86.35
Pollock	4.42	86.28
Marcus	4.94	88.91
Choquette	5.05	87.40
Russell	5.20	86.92
River	5.76	86.68
Palomino	5.84	86.38
Darwin VII Aperado	6.06	84.66
Secundino	6.13	84.42
Linda	6.63	85.71
Booth 8	6.70	84.24

[a] Data are means of two samples of a five avocado pool. [b] Data are means of four samples of a five avocado pool.

Instituto de Ciencia y Tecnología de Alimentos, Universidad Central de Venezuela, Caracas, and kept in environmental conditions until ripeness. According to previous experiences, a single fruit was considered ripened when its skin was ruptured with a 0.8 cm width cylindrical plunger in an Instrom Universal Testing Machine model 1101, using a penetration speed of 1 cm/min; the plunger penetrated the sample perpendicularly to its widest point. Three fruits of each variety were measured in five points located equidistantly. When samples were ripened, 5−9 days postharvest, five fruits of each variety were randomly selected, and some analytical determinations were performed.

Pulp moisture and oil contents were measured in a pulp pool from five fruits. Moisture was determined by taking four samples of 25 g of pulp and drying at 100 °C until constant weight. Oil was measured by extracting each of 3 g of dried pulp with *n*-hexane during 4 h in a Soxhlet extractor and finally drying in a desiccator until constant weight.

Fruit weight (whole fruit, seed, pulp, and peel); length, width at the widest point, and shape; and peel characteristics (roughness, hand peeling, and color by Colormet tristimulus colorimeter measured by the Lab Hunter system) were determined.

Statistical analyses were performed with Statgraphics 6.0. Data in Table 3 were analyzed by Kruskal−Wallis test and data in Table 4 by one-way Anova and least statistical difference tests. Selection of the test type, parametric or nonparametric, was decided by testing homoscedasticity (Bartlett test) and normality (chi-square test); all of the samples were independent. Tests were performed at $p \leq 0.05$.

RESULTS AND DISCUSSION

The ripeness indicator chosen was the softening of the fruit, because it is the most obvious change in avocado fruit associated with this event (Biale and Young, 1971). Ripeness of the samples studied in this work was characterized for the following values in kilograms (mean ± standard deviation); Secundino, 0.83 ± 0.16; River, 1.00 ± 0.24; Russell, 1.05 ± 0.24; Darwin VII Aperado, 1.16 ± 0.10; Linda 1.19 ± 0.18; Simmonds, 1.27 ± 0.25; Booth 8, 1.32 ± 0.08; Pollock, 1.39 ± 0.24; Marcus, 1.40 ± 0.15; Palomino, 1.79 ± 0.58; Nelan, 1.80 ± 0.20; and Choquette, 3.93 ± 0.46.

According to results shown in Table 1, Nelan stood out for having the lowest oil content of the 49 varieties characterized and of all varieties reported previously from different countries (Vogel, 1958; Haendler, 1965; Tango et al., 1969/70; Salazar et al., 1971; Lizana and Luza, 1979; Lozano et al., 1987; Rouse and Knight, 1991). The most common varieties in the Venezuelan market, Choquette and Pollock (Avilán et al., 1994), had very low oil contents; therefore, the amount of calories Venezuelan consumers can get from the most popular varieties is relatively low, so it could be advised to cultivate other varieties with higher oil content to help to solve caloric deficiencies in Venezuela. According to the formula to calculate the caloric value in avocados as a function of oil percentage published by Pearson (1975), Choquette should provide 67 kcal/100 g of pulp and Pollock, 61 kcal/100 g of pulp.

Table 2. Fruit Weight and Pulp, Seed, and Peel Proportions[a] of 12 Avocado Varieties

variety	wt (g)	% pulp	% seed	% peel
Nelan	400 ± 63^{cd}	78 ± 1^{fg}	14 ± 1^{b}	8 ± 1^{a}
Simmonds	327 ± 23^{bc}	76 ± 3^{defg}	15 ± 3^{bc}	9 ± 1^{abc}
Pollock	504 ± 15^{e}	74 ± 8^{bcdef}	14 ± 1^{b}	12 ± 6^{de}
Marcus	726 ± 63^{f}	79 ± 1^{g}	13 ± 1^{b}	8 ± 0^{a}
Choquette	531 ± 85^{e}	74 ± 2^{cdef}	15 ± 2^{bc}	11 ± 1^{d}
Russell	302 ± 37^{b}	79 ± 3^{g}	10 ± 1^{a}	11 ± 2^{d}
River	224 ± 18^{a}	66 ± 2^{a}	21 ± 1^{e}	13 ± 2^{e}
Palomino	360 ± 37^{c}	73 ± 5^{bcde}	17 ± 5^{bcd}	10 ± 2^{bcd}
Darwin VII Aperado	333 ± 38^{bc}	72 ± 2^{bc}	20 ± 2^{de}	8 ± 1^{ab}
Secundino	464 ± 28^{d}	68 ± 4^{ab}	22 ± 4^{e}	10 ± 2^{cd}
Linda	591 ± 67^{e}	77 ± 2^{efg}	10 ± 2^{a}	13 ± 1^{e}
Booth 8	187 ± 40^{a}	73 ± 2^{bcd}	16 ± 3^{bc}	12 ± 3^{de}

[a] Data are means of five avocados. Means within columns followed by the same letter are not significantly different ($p \leq 0.05$).

The oil and moisture contents of some of the varieties studied in this work were lower and higher than values reported in other studies (Table 1). The oil and moisture contents of Simmonds reported by Mazliak (1971) are 6.63 and 83.88% respectively, and by Tango et al. (1969/70), 8.3 and 79.4%. Values for Pollock were close to the reported ones: between 4.31% for oil content (Salazar et al., 1971) and 6.1% (Fersini, 1975). The value reported by Tango et al. (1969/70) was too high (10.5%). Choquette showed an oil content lower than that reported by Haendler (1965), which was 8.94%, and the moisture was higher, 84.85%. The oil content of Booth 8 is in agreement with the values of the California Avocado Society (1946), but the fruit weight (Table 2) is lower than that reported by the Society and Camacho and Ríos (1972). The oil content of the Linda variety is lower than the values reported by the California Avocado Society (1946) and Tango et al. (1969/70). It must be considered that there are some factors affecting these characteristics; the main one might be related to the chronological age of the fruit, because the later is the harvesting date in the season, the higher are the fruit weight and oil content. Also, these differences could be explained by soil and climatic conditions that could cause a lower oil synthesis in comparison with the ones grown in other countries (El-Zeftawi, 1978; Lee et al., 1983; Brown, 1984; Olaeta et al., 1986; Hatton and Reeder, 1987).

As previously stated, the oil content of avocado pulp has been used as a quality indicator for years. Some authors have found that the addition of oil content and moisture values gives a constant, which is near 91 (Pearson, 1975; El-Zeftawi, 1978). This value was between 90.45 and 93.85 in the varieties studied. This kind of information enables one to estimate the oil content of avocado pulp by a moisture determination (Morris and O'Brien, 1980), which is simpler, quicker, and cheaper than an oil determination; a simple algebraic operation is then enough to find the desired value.

The Marcus variety showed the highest weight ($p \leq 0.05$) (Table 2). Also, it was the heaviest of the 49 varieties characterized; its weight could be too high for

Table 3. Size[a] of 12 Avocado Varieties

variety	length (cm)	width (cm)
Nelan	12.00 ± 0.54^{cde}	8.04 ± 0.74^{bc}
Simmonds	11.32 ± 0.68^{bcd}	7.72 ± 0.34^{b}
Pollock	13.96 ± 0.68^{f}	8.48 ± 0.63^{cd}
Marcus	12.00 ± 0.58^{cde}	10.36 ± 0.38^{f}
Choquette	12.30 ± 1.08^{de}	8.94 ± 0.66^{de}
Russell	19.50 ± 2.14^{h}	6.40 ± 0.21^{a}
River	10.28 ± 0.71^{ab}	6.23 ± 0.10^{a}
Palomino	12.70 ± 0.89^{e}	8.02 ± 0.47^{bc}
Darwin VII Aperado	10.88 ± 0.76^{bc}	7.82 ± 0.38^{b}
Secundino	15.74 ± 0.50^{g}	7.68 ± 0.33^{b}
Linda	14.06 ± 1.36^{f}	9.48 ± 0.56^{e}
Booth 8	9.34 ± 0.55^{a}	6.04 ± 0.17^{a}

[a] Data are means of five avocados. Means within columns followed by the same letter are not significantly different ($p \leq 0.05$).

home consumption, but not for industrial purposes. The weights and sizes of Choquette, Pollock, and Simmonds were lower than the values previously reported by others authors (California Avocaco Society, 1946; Tango et al., 1969/70; Salazar et al., 1971; Bleinroth et al., 1976). According to the descriptors developed by Avilán et al. (1994), Linda, Marcus, Choquette, Secundino, and Pollock varieties were very heavy; Nelan and Palomino were heavy; Darwin VII Aperado, Simmonds, and Russell were medium; and Booth 8 and River were light.

Length and width values for the variety Linda (Table 3) were just a little lower than the reported ones by Bleinroth et al. (1976), and its weight was lower than the values reported by Bleinroth et al. (1976) and Tango et al. (1969/70) for Brazilian fruits but higher than the values reported by Camacho and Ríos (1972) for Colombia fruits and in the range published by the Califonria Avocado Society (1946). The Marcus variety was the widest of the 12 varieties ($p \leq 0.05$).

Marcus and Russell varieties had the highest pulp ratio (Table 2) ($p \leq 0.05$). This characteristic is desirable because it allows a better economic yield for buyers or industries as pounds of pulp purchased per unit of money paid. The variety River had the lowest pulp proportion, due to its high seed and peel weights. The pulp yields reported for Simmonds grown in Brazil vary: 81% (Tango et al., 1969/70), 66% (Bleinroth et al., 1976), and the value obtained in this work (76%). According to the descriptors developed by Avilán et al. (1994), varieties Linda, Marcus, Russell, Nelan, and Simmonds had a high pulp percentage; Booth 8, Darwin VII Aperado, Choquette, Palomino, and Pollock had a medium pulp percentage; and Secundino and River had a low pulp percentage. This classification could be used as a reference to establish product prices, but other quality factors must be considered. In addition, varieties Linda and Russell had the lowest seed proportion ($p \leq 0.05$), and Marcus and Nelan the lowest peel proportion ($p \leq 0.05$).

Russell was the only 1 of the 12 varieties with a large neck (Table 3), which is a negative property because it is prone to fracture during transportation and handling (Camacho and Ríos, 1972). However, there could be some relationship between this kind of shape and a very high pulp proportion. This variety was the largest ($p \leq 0.05$) of the 12 reported in this paper and the largest of the 49 varieties studied until now.

The importance of skin appearance depends on the consumer's criteria. Of the 12 varieties studied, Booth 8, Choquette, Linda, and River had rough peels, and the others had smooth peels (Table 4).

Table 4. External Characteristics of 12 Avocado Varieties

variety	shape	peel texture	color		
			L^a	a^b	b^c
Nelan	ovate	smooth	30	−13	45
Simmonds	ovate	smooth	31	−10	36
Pollock	ovate	smooth	31	−9	43
Marcus	round	smooth	27	−10	34
Choquette	ovate	rough	30	−10	46
Russell	cucumber	smooth	27	−10	49
River	piriform	rough	35	−10	31
Palomino	ovate	smooth	33	−12	48
Darwin VII Aperado	ovate	smooth	43	−10	49
Secundino	piriform	smooth	6	16	11
Linda	ovate	rough	12	5	13
Booth 8	ovate	rough	25	−3	23

[a] Luminosity. [b] Red/green chromaticity. [c] Yellow/blue chromaticity.

Table 5. Average Potential Yield of Some Avocado Varieties

variety	kg of fruit/ha	kg of pulp/ha[a]	kg of oil/ha[b]
Choquette	54492[c]	40324	2036
Linda	38134[d]	29363	1947
Marcus	50844[c]	40167	1984
Nelan	48564[c]	37880	1155
Pollock	36024[c]	26658	1173
Simmonds	27132[c]	20620	845

[a] (kg of fruit/ha) × (% pulp). [b] (kg of pulp/ha) × (% oil). [c] From Avilán et al. (1994). [d] Estimated from Figueroa (1982).

Only Linda and Secundino varieties had a dark purple skin, which can be seen in the low luminosity values and the positive values of the chromaticity parameter *a* (Table 4). However, this color is unusual in Venezuelan varieties, but it is common in Chilean ones (Lizana and Luza, 1979), and it has been attributed to anthocyanins (Prabha et al., 1980). The usefulness of marketing varieties of high pulp yields but with purple peel might be confined by consumer trends; for example, Venezuelan consumers are used to purchasing green peel varieties, the only ones available in the market, but the opposite is true in other countries, where the most consumed variety is the dark Hass.

The avocado varieties for direct consumption are peeled by hand, so the easiness of hand peeling is an important characterization factor that is seldom described. All of the varieties studied in this work were easy to hand peel, excluding Simmonds, which had a very adherent peel.

Avocado tree yield, reported as kilograms of fruit per hectare, is an important parameter for choosing a variety for direct consumptiorn. Moreover, yield expressed as kilograms of pulp per hectare is meaningful if the fruits are grown to be used in prepared foods; yield reported as kilograms of oil per hectare is useful for oil extraction purposes, such as food or cosmetic uses (Werman and Neeman, 1986, 1987; Southwell et al., 1990) which could increase in the future. Avilán et al. (1994) estimated avocado orchard yields as kilograms of fruit per hectare for the varieties Choquette, Marcus, Nelan, Pollock, and Simmonds, and Figueroa (1982) determined the kilograms of fruit per hectare for the Linda variety. It can be observed (Table 5) that Choquette had the highest yield in all of the considered parameters. However, the potential yields expresed as kilograms of fruit per hectare, of all the varieties listed, are higher than yields considered as suitable for an avocado orchard, 16−20 ton/ha (Avilán et al., 1994).

Ripeness time, the number of days required for a fruit to ripen after harvest, for Booth 8, Choquette, Linda, Marcus, River, Russell, and Secundino was between 4 and 10 days, with peaks between the days 6 and 9; in almost all cases the ripeness peak was displaced toward the last days. These values agree with those reported by Hatton and Campbell (1959) for six varieties. In addition, it must be kept in mind that the longer is the softening period, the higher will be the loss of weight. To compare data of sample weight, it must be pointed out that in this work data were measured when each fruit softened, so the weight changes during ripeness were not controlled.

ACKNOWLEDGMENT

I thank Luís Avilán of the Centro Nacional de Investigaciones Agropecuarias, Venezuela, for providing all of the plant materials and for advice on various aspects of this study.

LITERATURE CITED

Avilán, L.; Rodríguez, M.; Carreño, R.; Dorantes, I. Selección de variedades de aguacate (Selection of avocado varieties). *Agron.omía Trop.* **1994**, *44*, 593−618.

Biale, J. B.; Young, R. E. The Avocado Pear. In *The Biochemistry of Fruits and their Products*; Hulme, A. C., Ed.; Academic Press: London, 1971.

Bleinroth, E. W.; Zuchini, A. G. R.; Pompeo, R. M. Determinaçâo das características físicas e mecânicas de variedades de abacate e a su conservaçâo pelo frio (The physical and mechanical characteristics of avocado and its low temperature preservation). *Colet. Inst. Tecnol. Aliment.* **1976**, *7*, 29−81.

Brown, B. I. Market maturity indices and sensory properties of avocados grown in Queensland. *Food Technol. Aust.* **1984**, *36*, 474−476.

California Avocado Society. Check list of avocado varieties. *Yearb. Calif. Avocado Soc.* **1946**, *30*, 29−53.

Camacho, S.; Ríos, D. Factores de calidad de algunas frutas cultivadas en Colombia (Quality factors of some fruits cultivated in Colombia). *Rev. Inst. Colomb. Agropecu.* **1972**, *7*, 11−32.

Colquhoun, D. M.; Moores, D.; Somerset, S.; Humphries, J. A. Comparison of the effects on lipoproteins and apolipoproteins of a diet high in monounsaturated fatty acids, enriched with avocado, and a high-carbohydrate diet. *Am. J. Clin. Nutr.* **1992**, *56*, 671−677.

Cortés, R.; González, S.; Pennacchiotti, I.; Parraguirre, V. Estudio de las condiciones químicas y tecnológicas para una posible industrialización de la palta (aguacate) (Study of the chemical and technological conditions to a possible industrialization of the avocado). *Rev. Agroquim. Tecnol. Aliment.* **1971**, *11*, 295−300.

El-Zeftawi, B. M. Physical and chemical changes in fruit of seven avocado cultivars at Mildura. *Aust. J. Agric. Res.* **1978**, *29*, 81−88.

Fersini, A. *El Cultivo del Aguacate* (Avocado production); Editorial Diana: México City, 1975.

Figueroa, M. Cultive aguacates (Grow avocados). *Fonaiap Divulga* **1982**, *1*, 21−24.

Gomez, R. F.; Bates, R. P. Storage deterioration of freeze-dried avocado puree and guacamole. *J. Food Sci.* **1970**, *35*, 472−475.

Haendler, L. L'huile d'avocat et les produits dérivés du fruit (Avocado oil and the products derived from the fruit). *Fruits* **1965**, *20*, 625−633.

Hall, A. P.; Moore, J. G.; Morgan, A. F. B vitamin content of California-grown avocados. *J. Agric. Food Chem.* **1955**, *3*, 250−252.

Harding, P. L. The relation of maturity to quality in Florida avocados. *Proc. Fla. State Hortic. Soc.* **1954**, *67*, 276−280.

Hatton, T. T., Jr.; Campbell, C. W. Evaluation of indices for Florida avocado maturity. *Proc. Fla. State Hortic. Soc.* **1959**, *72*, 349−353.

Hatton, T. T., Jr.; Reeder, W. F. Relationship of bloom date to the size and oil content of Booth 8 avocados. *Citrus Ind.* **1972**, *53* (4), 20−21.

Knight, R. Origin and World Importance of Tropical and Subtropical Fruits. In *Tropical and Subtropical Fruits*; Nagy, S., Shaw, Ph. E., Eds.; AVI Publishing: Westport, CT, 1980.

Lee, S. K. Methods for percent oil analysis of avocado fruit. *Yearb. Calif. Avocado Soc.* **1981**, *65*, 133−141.

Lee, S. K.; Young, P. M.; Schiffman, P. M.; Coggins, C. W., Jr. Maturity studies of avocado fruit based on picking dates and dry weight. *J. Am. Soc. Hortic. Sci.* **1983**, *108*, 390−394.

Lewis, C. E. The maturity of avocados-a general review. *J. Sci. Food Agric.* **1978**, *29*, 857−866.

Lime, B. J. Preparation and storage studies of freeze-dried avocado salad. *Food Technol.* **1969a**, *23*, 317−320.

Lime, B. J. Autoxidation of fatty acid lipids and carotene of freeze-dried avocado salad. *Food Technol.* **1969b**, *23*, 569−572.

Lizana, L. A.; Luza, J. G. Caracterización de la fruta de paltos (*Persea americana* MILL) de la raza mexicana cultivados en Chile (Fruit characterization of the Mexican race avocados grown in Chile). *Proc. Am. Soc. Hortic. Sci., Trop. Reg.* **1979**, *23*, 113−118.

Lladser, M.; Piñaga, F. Criodeshidratación de aguacates. I. Estudio sobre el comportamiento eutéctico e higroscópico del aguacate liofilizado y ensayo de almacenamiento acelerado del mismo (Eutectic and hygroscopic behavior of freeze-dried avocado and assay of its accelerated storage). *Rev. Agroquim. Tecnol. Aliment.* ***1975***, *15*, 547−559.

Lozano, Y. F.; Ratovohery, J. V.; Gaydou, E. M. Etude de caractéristiques pomologiques et physico-chimiques de divers cultivars d'avocats produits en Corse (Study of the pomologic and physicochemical characteristics of several avocado cultivars grown in Corse). *Fruits* **1987**, *42*, 305−315.

Mazliak, P. Constitution lipidique de l'avocat (Lipid constituents of avocado). *Fruits* **1971**, *26*, 615−623.

Ministerio de Agricultura, Pesca y Alimentación. *Norma de Calidad para Aguacates* (Avocado quality regulation); Secretaría General Técnica: Madrid, 1989.

Morris, R.; O'Brien, K. Testing avocados for maturity. *Yearb. Calif. Avocado Soc.* **1980**, *64*, 67−70.

Olaeta, J. A.; Gardizabal, F.; Martínez, O. Variación estacional en el contenido de aceite y su relación con la palatabilidad, en frutos de palto (*Persea americana* Mill.) (Seasonal variation in oil content and its relationship with flavor in avocado fruits). *Agric. Tecn. (Chile)* **1986**, *46*, 365−367.

Pearson, D. Seasonal english market variations in the composition of South African and Israeli avocados. *J. Sci. Food Agric.* **1975**, *26*, 207−213.

Plumbey, R. A.; Jeger, M. J.; Carbon, W. Optimal picking date of avocado in Dominica, W. Indies, in relation to flowering, fruit-growth and chilling. *Trop. Agric. (Trinidad)* **1989**, *66*, 129−134.

Prabha, T. N.; Ravindranath, B.; Patwardhan, M. V. Anthocyanins of avocado (*Persea americana* Mill.) peel. *J. Food Technol.* **1980**, *17*, 241−242.

Rouse, R. E.; Knight, R. J. Jr. Evaluation and observations of avocado cultivars for subtropical climates. *Proc. Fla. State Hortic. Soc.* **1991**, *104*, 24−27.

Salazar, R.; Ríos, D.; Torres, R. Selección de variedades de aguacate (*Persea americana* Mill.) en Colombia (Avocado varietal selection in Colombia). *Rev. Inst. Colomb. Agropecu.* **1971**, *6*, 357−377.

Scudomore-Smith, P. D. The utilization of avocado as frozen savoury spread. *Food Technol. Aust.* **1984**, *36*, 375−378.

Smith, J.; Goldweber, S.; Lamberts, M.; Tyson, R.; Reynolds, J. S. Utilization potential for semi-tropical and tropical fruits and vegetables in therapeutic and family diets. *Proc. Fla. State Hortic. Soc.* **1983**, *96*, 241−244.

Southwell, K. H., Harris, R. V.; Swetman, A. A. Extraction and refining of oil obtained from dried avocado fruit using a small expeller. *Trop. Sci.* **1990**, *30*, 121−131.

Storey, W. B.; Bergh, B. O.; Whitsell, R. H. Factors affecting the marketability of avocado fruit. *Yearb. Calif. Avocado Soc.* **1973/74**, *57*, 33−39.

Swisher, H. E. Avocado oil from food use to skin care. *J. Am. Oil Chem. Soc.* **1988**, *65*, 1704−1706.

Tango, J. S.; da Costa, S. I.; Antunes, A. J.; Figueiredo, I. B. Composiçâo do fruto e do óleo de diferentes variedades de abacate cultivadas no estado de Sâo Paulo (Fruit and oil composition of avocado varieties grown in Sao Paolo State). *Colet. Inst. Tecnol. Aliment.* **1969/70**, *3*, 283−292.

Vélez, F.; Valery, G. *Plantas Alimenticias de Venezuela* (Venezuelan plants for food); Fundación Bigott-Soc. de Ciencias Naturales La Salle: Caracas, Venezuela, 1990.

Vogel, R. Caractéristiques de quelques variétés d'avocatiers cultivés au Maroc (Characteristics of avocado varieties grown in Morocco). *Fruits* **1958**, *13*, 507−509.

Werman, M. J.; Neeman, I. Effectiveness of antioxidants in refined, bleached avocado oil. *J. Am. Oil Chem. Soc.* **1986**, *63*, 352−360.

Werman, M. J.; Neeman, I. Avocado oil production and chemical characteristics. *J. Am. Oil Chem. Soc.* **1987**, *64*, 229−232.

Wills, R. B. H.; Lim, J. S. K.; Greenfield, H. Composition of australian foods. 31. Tropical and sub-tropical fruit. *Food Technol. Aust.* **1986**, *38*, 118−120, 122−123.

Received for review August 11, 1997. Revised manuscript received January 27, 1998. Accepted March 19, 1998.

JF9706890