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Characterization of creole avocado fruits harvested from both central and northern regions of Guerrero, Mexico

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Abstract

In the State of Guerrero (Mexico) several agro-ecological niches occur, in which native avocados are naturally distributed in backyard gardens and agricultural lands. However, the phenotypical features of their fruits are not known. The aim of this study was to collect and to characterize creole avocado fruits harvested in the northern and center regions of Guerrero, Mexico. Ten physiologically ripe fruits from each genotype were collected. The Avocado Graphic Manual was used in order to characterize them. The following variables were measured: equatorial fruit diameter, polar fruit diameter, equatorial seed diameter, polar seed diameter, as well as fruit, seed, pulp and peel weights. The results indicate that the Jalea-9 and Jalea-8 harvests exhibited a larger fruit diameter. Jalea-11 presented a larger polar diameter and increased weight, Plat-15 possessed higher pulp weight, whereas the fruit peel weight was higher in Plat-16. Fruits from all harvests were classified according to their size as small, medium and large. Some genotypes possessed suitable shape, form and seed weight to undergo germination and to be used as standards for grafting purposes of the HASS and Fuerte varieties. Conversely, there are others that are highly demanded by the regional, national and international market.

Keywords: *Persea americana* Mill, fruit characterization, native avocados.

Introduction

In Mexico, avocado harvest (*Persea americana* Mill.) represents more than 30 percent of the world's production (16). Production expressed in million tons is as follows: Mexico (1.47), followed by Dominican Republic (0.39), Colombia (0.30), Peru (0.29) and Indonesia (0.28) (15). In 2015, Mexico possessed a 187327 ha surface producing 16454225.9 t, having an overall yield of 9.85 t ha^{-1}. The Mexican State in which production was the highest was Michoacán with 1 283 313.3 t grown in 134 942 ha and displaying a 10.5 t ha^{-1} yield. Guerrero State was classified as fifth with 16 522.4 t grown in 4439 ha and a 5.92 t ha^{-11} yield (18).

Avocado possesses valuable dietary properties because its elevated oil (12 – 30%) and protein (3 – 4%) contents, including carbohydrates, vitamins and minerals. These properties enable the possibility of an increased consumption in human diets. During the last years, its industrialization by the food, oil extraction and pharmaceutical industries has been developed (10, 14). The genetic variability arises from the trees growing on the feet of mountains and in backyard gardens. This represents an opportunity to select genotypes that may display an optimal behavior when compared to other vegetable materials that are currently used as rootstock propagated by seeds (11).

Commercial hybrids have been developed from materials obtained from different avocado races that exchange genetic features to establish their formation. Among the most important cultivars in subtropical climates, the "Haas", "Bacon" and "Fuerte" varieties are derived from crossbreeding between the Mexican and Guatemalan races and they possess a distinct hybridization degree (13).

The identification of locations in which several creole and wild-type genotypes occur is important in order to preserve this genetic heritage, and also to elucidate their respective features to exploit them and to improve avocado quality or some other attributes such as resistance or tolerance to pests and diseases as well as environmental and soil features. Thus, the objective of this study was to collect and to characterize creole avocado fruits from both central and norther regions of the Guerrero State (Mexico) to identify those genotypes exhibiting prominent features in order to be considered as good quality consumption fruit and to preserve them in a germplasm bank to subsequently possess available material used for genetic improvement purposes, to use it as rootstock and for consumption fruit.

Materials and Methods

The study was conducted between August 2012 and December 2013 in the following municipalities in the State of Guerrero: Chilapa de Álvarez, Chilpancingo de los Bravo, Iguala de la independencia, Taxco de Alarcón and Tetipác. Sixteen creole avocado genotypes were randomly harvested from trees. Twenty physiologically ripe fruits were collected to perform their respective characterization. From these 20 fruits, 5 groups were formed and their average values were obtained in order to obtain data for each genotype. Trees submitted for sampling were selected based on the opinion of villagers regarding those having the best fruits. They were subsequently referenced by GPS, Garmin Etrex Legend, 2008, to identify their exact location (Table 1).

Table 1. Creole avocado tree location within the State of Guerrero.

HK	Municipality	M	Geographical location	A (m)
Temax-1	Temaxcalapa	TA	N 18° 26' 08.52" W 99° 41' 36.30"	1430
Temax-2	Temaxcalapa	TA	N 18° 26' 10.95" W 99° 42' 05.31"	1349
Temax-3	Temaxcalapa	TA	N 18° 25' 38.0" W 99° 41' 17.1"	1389
Temax-4	Temaxcalapa	TA	N 18° 25' 43.9" W 99° 41' 16.3"	1443
Temax-5	Temaxcalapa	TA	N 18° 25' 40.9" W 99° 41' 16.6"	1415
Mexcal-6	Mexcalcingo	CA	N 17° 23' 01.6" W 99° 00' 56.7"	847
Mexcal-7	Mexcalcingo	CA	N 17° 22' 58.1" W 99° 00' 46.3"	1062
Jalea-8	Jaleaca de Catalán	CB	N 17° 26' 05.6" W 99° 51' 00.3"	902
Jalea-9	Jaleaca de Catalán	CB	N 17° 26' 5.5" W 99° 50' 57.7"	909
Jalea-10	Jaleaca de Catalán	CB	N 17° 26' 5.5" W 99° 50' 59.6"	915
Jalea-11	Jaleaca de Catalán	CB	N 17° 26' 5.8" W 99° 50' 57.4"	906
Sant-12	El Santiago	T	N 18° 38' 7" W 99° 38' 32"	1761
Sant-13	El Santiago	T	N 18° 38' 7" W 99° 38' 32"	1761
Plat-14	Platanillo	II	N 18° 23' 32.3" W 99° 29' 51.4"	1439
Plat-15	Platanillo	II	N 18° 23' 33.9" W 99° 29' 59.9"	1361
Plat-16	Platanillo	II	N 18° 23' 33.9" W 99° 29' 59.9"	1361

HK: Harvest key; M: Municipality; A: Altitude; TA: Taxco de Alarcón; CA: Chilapa de Álvarez; CB: Chilpancingo de los Bravos; T: Tetipác; II: Iguala de la Independencia.

Avocado trees were located in backyard gardens and agricultural lands and they were recorded by using the initial of the municipality's name (Table 1). The measured variables were: fruit length (FL, cm), fruit diameter (FD, cm), fruit length/diameter ratio (FLDR, cm), the fruit's length was divided by its diameter, fruit's weight (FW, g), pulp weight (PW, g), Peel weight (PEW, g), seed weight (SW, g), seed diameter (SD, cm), seed length (SL, cm) and the seed length/diameter ratio (SLDR), as obtained by dividing SL/SD. Fruit characterization was assessed based on the UPOV graphic manual for avocado variety description (3). Data was analyzed by using the Statistical Analysis System software (SAS, Version 9.0) and by a variance analysis (ANOVA), a mean Tukey test (P≤ 0.01) as well as a correlation analysis.

Results

Variance analysis regarding avocado fruit length and diameter

After performing a Tukey test (P ≤ 0.01), highly significant differences were detected among the six quantified and measured variables from all 16 creole avocado genotypes (Table 2). Variance coefficients were within the 6.93 - 12.48 % range thus the results were reliable. Harvests displayed genetic variability regarding fruit features and this enabled their classification as several groups.

Table 2. Mean square values of six measured variables from 16 creole avocado harvests from central and northern regions of the Guerrero State, Mexico

Variables	Rep	Treatment	Error	Mean	CV (%)
FL	0.80	18.30**	0.57	8.39	9.05
FD	0.48	4.35**	0.19	6.34	6.93
FLDR	0.02	0.48**	0.14	1.35	9.12
SD	0.22	3.25**	0.10	4.40	7.47
SL	0.27	4.05**	0.24	4.89	10.22
SLDR	0.02	0.27**	0.01	1.09	12.48
DF	60	15	60		

Rep: Replicate; CV (%): Coefficient of variation percentage; FL: fruit length; FD: fruit diameter; FLDR: fruit length/diameter ratio; SD: seed diameter; SL: seed length; SLDR: seed length/diameter ratio (SLDR); DF: degrees of freedom ****:** highly significant differences (P≤0.01).

Avocado fruit length and diameter

Based on fruit length and diameter, two groups of creole specimens were identified as short and very short. After comparing the mean values from the 16 creole avocado harvests, Jalea-9 was identified as the one displaying larger fruits (13.24 cm). Conversely, Sant-12 was characterized by the smallest length value (6.6 cm). Between these two limit values, a 6.64 cm variation was observed (Table 3).

Regarding fruit diameter, the creole avocado harvests Temax-2 (6.7 cm), Temax-4 (6.8 cm), Jalea-8 (7.4 cm), Jalea-9 (6.9 cm), Jalea-11 (6.9 cm), Plat-14 (6.9 cm), Plat-15 (7.2 cm) and Plat-16 (7.1 cm) significantly surpassed Temax-1 (5.4 cm), Temax-3 (5.1 cm), Mexcal-6 (5.4 cm) and Sant-12 (3.8 cm) (Table 3). Fruit diameter was higher for the Jalea-8 harvest (7.4 cm) when compared to Sant-12. Both values showed a 3.8 cm variation. The highest FLDR values were observed for Temax-3 (2.0) and Jalea-9 (1.9) regarding all other avocado harvests, whereas Temax-2 displayed the lowest fruit length/diameter ratio value (1.0) (Table 3)

Table 3. Mean comparison of length and diameter variables from 16 creole avocado fruits collected in central and northern regions of the Guerrero State

No.	Harvest	FD (cm)	FL (cm)	FLDR (cm)
1	Jalea-9	13.2 a	6.9 a	1.9 a
2	Temax-3	11.1 b	5.1 c	2.0 a
3	Jalea-8	10.8 bc	7.4 a	1.4 bc
4	Jalea-10	9.1 cd	6.4 ab	1.4 bc
5	Plat-16	8.9 cde	7.1 a	1.2 cd
6	Plat-15	8.7 def	7.2 a	1.2 cd
7	Plat-14	8.6 defg	6.7 a	1.2 cd
8	Mexcal-7	7.6 defgh	6.2 abc	1.2 cd
9	Temax-4	7.5 defgh	6.8 a	1.2 cd
10	Mexcal-6	7.1 defgh	5.4 bc	1.4 bc
11	Jalea-11	7.1 efgh	6.9 a	1.0 d
12	Sant-13	7.0 efgh	6.4 ab	1.0 d
13	Temax-1	6.8 fgh	5.4 bc	1.3 bcd
14	Temax-2	6.8 fgh	6.7 a	1.0 d
15	Temax-5	6.6 gh	6.4 ab	1.0 d
16	Sant-12	6.6 h	3.8 d	1.6 b
HSD ($p \leq 0.01$) =		1.98	1.14	0.31
Mean =		8.39	6.33	1.34

FD: fruit diameter; FL: fruit length; FLDR: fruit length/diameter ratio; HSD: honest significant difference.

Avocado seed length and diameter

Upon assessing seed length in 16 harvests, it was observed that Jalea-11 (7 cm), Temax-3 (6.4 cm) and Jalea-9 (5.8 cm) were statistically similar to Jalea-8 (5.4 cm) and Mexcal-7 (5.1 cm). On the other hand, Temax-3 showed statistic similarity to Jalea-9, Jalea-8 and Mexcal-7. These harvests were characterized by higher seed length values when compared to Temax-2, Mexcal-7 and Jalea-8 as they range within 4.6 – 4.8 cm. The latter harvests possessed larger seeds regarding Sant-13, Temax-5, Temax-4, Jalea-10, Temax-1 and Plat-14, with seed length values ranging between 3.7 to 4.3 cm (Table 4). Conversely, when seed diameter values were compared, the Jalea-11 harvest statistically surpassed all other 15 harvests, followed by Jalea-9 (5.6 cm), Plat-16, Jalea-8, Mexcal-7 and Temax-2, that displayed values between 4.4 and 4.5 cm. The latter were larger when compared to Temax-3 and Mexcal-6, as these exhibited values between 3.4 and 3.5 cm. Regarding the seed length/diameter ratio (SLDR), Temax-3 (1.8 cm) was significantly higher by 1 cm when compared to Temax-5 and Sant-13 (0.8 cm), respectively (Table 4).

Table 4. Mean comparison for seed length and diameter from 16 creole avocado harvests collected in central and northern regions of the Guerrero State, Mexico

Harvest	SD (cm)	SL (cm)	SD/SL ratio(cm)
Jalea-9	5.6 b	5.8 abc	1.0b c
Temax-3	3.4 e	6.4 ab	1.8 a
Jalea-8	4.5 c	5.4 bcd	1.1 bc
Jalea-10	4.1 cde	4.2 de	1.0 bc
Plat-16	4.5 c	4.7 cde	0.9 bc
Plat-15	4.2 cde	4.5 cde	1.0 bc
Plat-14	3.8 cde	4.3 de	1.0 bc
Mexcal-7	4.4 c	5.1 bcd	1.1 bc
Temax-4	4.1 cde	4.2 de	0.9 bc
Mexcal-6	3.5 de	4.8 cde	1.3 b
Jalea-11	6.8 a	7.0 a	1.0 bc
Sant-13	4.4 cd	3.7 e	0.8 c
Temax-1	4.0 cde	4.3 de	1.0 bc
Temax-2	4.4 c	4.6 cde	1.0 bc
Temax-5	4.2 cde	3.8 e	0.8 c
Sant-12	3.8 cde	4.9 cde	1.2 b
HSD =	0.85	1.30	0.35
Mean =	4.39	4.88	1.0

SD: seed diameter; SL: seed length; HSD: honest significant difference

Variance analysis for fruit, pulp, peel and seed weights

Highly significant differences were detected (Tukey $p \leq 0.01$) when fruit attributes were quantified for creole avocadoes. This enabled their classification in several groups (Table 5).

Table 5. Mean square values for the measured variables of 16 creole avocado harvests from central and northern regions of the Guerrero State, Mexico

Variables	Rep	Treat	Error	CV (%)
FW	1392.97	24825.85**	1666.76	21.42
PDP	880.61	6847.60**	724.14	27.54
PDC	89.23	588.05**	188.83	51.10
SW	82.88	621.68**	118.12	20.78
DF	60	15	60	

Rep.: Replicate; Treat.: Treatment; CV (%): Coefficient of variation percent; FW: fruit weight; PW: pulp weight; PEW: peel weight; SD: seed weight; DF: degrees of freedom ****:** (Tukey $p \leq 0.01$).

After comparing the fruit's weight of 16 harvests it was observed that Jalea-9 (334.8 g) statistically surpassed Mexcal-7, Jalea-10, Jalea-11 and Plat-14 that weighed between 209 and 289.4 g. In turn, the weight of the latter was above Sant-12, Temax-1 and Mexcal-6 (56 and 162.7 g, respectively) (Table 6). The Plat-15 harvest displayed the highest pulp weight (169.8 g) and it was statistically similar to Jalea-10, Plat-16 and Plat-14 that weighed between 134.2 and 156.8 g, and also the Jalea-11, Temax-5 and Mexcal-17 harvests that exhibited weights ranging from 91.8 to 96.6 g. Furthermore, the pulp weight value of Jalea-10, Plat-16 and Plat-14 significantly surpassed that of Temax-1, Sant-12 and Jalea-9 as these weighed

between 42 and 58.6 g (Table 6). The Plat-16 harvest exhibited the highest fruit peel weight (52.8 g) and it was significantly different from that of Temax-1, Temax-2 and Sant-12, as their values ranged between 10.9 and 16.0 g. Nevertheless, this weight value was statistically similar when compared to all other harvests, having values between 17.3 and 43.8 g (Table 6).

Jalea-11 displayed the highest seed weight (74.2 g) and it was statistically similar when compared to the Temax-4, Jalea-9, Sant-13, Temax-2, Plat-15, Plat-16, Mexcal-7, Jalea-8 and Sant-12 that showed values between 48 and 70.2 g, However, such value was above that observed for the Temax-15, Temax-1, Temax-3 and Jalea-10 harvests, as they weighed between 40.8 and 45.6 g. Furthermore, the Sant-12 harvest statistically surpassed Mexcal-6 and Plat-14 that weighed 38 and 38.4 g, respectively (Table 6).

Table 6. Mean comparison for six variables measured from 16 creole avocado harvests from the central and northern regions of the Guerrero State, Mexico

No.	Harvest	FW (g)	PW (g)	PEW (g)	SW (g)
1	Jalea-9	334.8 a	58.6 d	29.0 ab	48.4 abc
2	Temax-3	149.4 cdef	82.4 cd	22.8 ab	44.8 bc
3	Jalea-8	289.4 ab	75.8 cd	24.6 ab	64.8 a bc
4	Jalea-10	218.8 bcd	134.2 abc	34.8 ab	45.6 bc
5	Plat-16	240.6 abc	141.4 abc	52.8 a	60.4 abc
6	Plat-15	250.4 abc	169.8 a	26.6 ab	53.6 abc
7	Plat-14	218.9 bcd	156.8 ab	21.8 ab	38.4 c
8	Mexcal-7	187.6 bcde	96.6 bcd	30.0 ab	62.0 abc
9	Temax-4	193.6 bcde	04.2 abcd	34.8 ab	48.0 abc
10	Mexcal-6	121.8 def	86.2 cd	27.5 ab	38.0 c
11	Jalea-11	209.0 bcd	91.8 bcd	21.9 ab	74.2 a
12	Sant-13	161.6 cdef	83.0 cd	43.8 ab	51.6 abc
13	Temax-1	98.0 ef	42.0 d	10.9 b	43.2 bc
14	Temax-2	162.7 cde	102.3 abcd	17.3 ab	52.4 abc
15	Temax-5	156.6 cdef	93.4 bcd	15.5 b	40.8 bc
16	Sant-12	56.0 f	44.8 d	16.0 b	70.2 ab
HSD ($p \leq 0.01$) =		106.57	70.243	35.87	28.36

Fruit weight (FW); pulp weight (PW); peel weight (PEW); seed weight (SW); HSD: honest significant difference; *Mean values with the same letter in one column are equivalent (Tukey, $p \leq 0.01$).

Discussion

According to the graphic manual for avocado description (3), the creole avocado fruits harvested were classified as short and they were represented by the Jalea-10, Plat-16, Plat-15, Plat-14, Mexcal-7, Temax-4, Mexcal-6, Jalea-11, Sant-13, Temax-1, Temax-2, Temax-5 and Sant-12 harvests, as their fruit length ranged between 5.6 and 8.2 cm. Furthermore, small fruits were comprised by the Jalea-9, Temax-3 and Jalea-8 harvests (10.7 a 13.2 cm). Acosta *et al*. (2013) reported that in the northern Nuevo León region in Mexico fruit size was larger (3.8 a 10.9 cm) when compared to those creole genotypes from the central and northern regions of the Guerrero State. The harvest Ixtapan-1 harvest collected in the Ixtapan del Oro region (State of Mexico) exhibited an 11.0-cm length (4), whereas the creole avocadoes Cabezón and Verde natural possessed 12.25 and 8.63 cm fruit lengths (8). 114 accessions were evaluated at the Bajío Experimental Field in Celaya (Guanajuato, México) of 35 existing populations of the avocado (*Persea americana* Mill., var. *drymifolia*) germplasm bank. A 9.8-cm fruit length was reported (12).

Jalea-8 displayed the larger fruit diameter (7.4 cm) varying 3.8 cm when compared to Sant-12 as the latter showed the smallest diameter. In this study, the resulting diameter values (3.4 and 7.3 cm) were similar to those observed for creole fruits in the southern region of Nuevo León (Mexico) (2). In another study conducted in Ixtapan del Oro (State of Mexico), the Ixtapan-1 harvest displayed diameter values of 6.4 and 8.6 cm (4), whereas the Cabezón creole avocado showed an 8.7-cm diameter (8). Montes *et al*. (2017), reported an equatorial diameter value ranging from 3.6 to 7.4 cm for creole avocado (*Persea americana* Mill. var. *drymifolia*).

The highest fruit length/diameter ratio values were observed for the Temax-3 and Jalea-9 harvests (2.0 and 1.9 cm), whereas Temax-2 was characterized by the lowest FLDR (1.0 cm). Harvests were classified in four groups: the first one comprised by Temax-3 and Jalea-9 with a mean FLDR of 0.8-1.04 cm and they were classified as very small fruits. The second group consisted of small fruits (1.2 - 1.4 cm) and it was comprised by the Mexcal-6, Jalea-8, Jalea-10 and Sant-12 harvests. The third group consisted of medium-sized fruits (1.6-1.8 cm) and it included the Temax-1, Temax-4, Mexcal-7, Plat-14, Plat-15 and Plat-16 accessions. Finally, the fourth group consisted of large-sized fruits (2.0-2.3 cm) and it is represented by Temax-2, Temax-5, Jalea-11 and Sant-13 (3). In a study that characterized creole avocadoes harvested in State of Mexico, Sánchez (1999) found fruits displaying FLDR values of 1.4 cm, corresponding to the smaller avocadoes identified in this study. Montes *et al*. (2017) reported a 2.0 cm FLDR for creole avocadoes. The Cabezón creole avocado, as found on State of Mexico, exhibited a 2.23 FLDR (8).

Regarding seed diameter and length, the most representative harvest was Jalea-11 (6.8 polar diameter and 7 cm length). The most notable seed length/diameter ratio value (SLDR) was Temax-3 with 1.8 cm. Another study evaluated 114 avocado accessions and the SLDR was 2.0 cm (12). Harvests from State of Mexico exhibited 4.62 cm of seen length for the Verde Natural creole avocado (8). In contrast, the fruits from the creole avocadoes of the Mexican race obtained from the "El Batán" locality (Donato Guerra, State of Mexico) displayed 3-4 cm seeds and they were considered suitable to be included in the garden center because their uniformity and high germination percentage (4). Seed size and weight are considered a marker of physiological quality as it has previously observed that the larger seeds display optimal seedling germination and strength (7). Regarding fruit weight, Jalea-9 was prominent (334.8 g), whereas Sant-12, Temax-1 and Mexcal-6 exhibited lower values (56 and 162.7 g). Similar results were observed by Acosta *et al*. (2013) for the northern region of the Nuevo León State as they reported creole avocado fruits weighing between 28 and 354 g. Other studies indicated that mean weight ranged between 10.53 and 251.4 g, (6), whereas genotypes of the *drymifolia* variety collected along 24 States of the Mexican Republic displayed weights ranging between 23.9 and 285.4 g (17). The fruit weight from the harvests in this study were higher when compared to those observed on the southern region of Nuevo León (Mexico), in which fruits weighed between 63 and 144 g (2). In State of Mexico, the fruit of the Ariete creole avocado weighed 120.5 g (8). The avocado (*Persea americana* Mill. var. *drymifolia*) Germplasm Bank at the experimental field on Celaya (Guanajuato, Mexico), they reported values ranging between 35 and 290 g and mean weight value was 152 g (12).

The Plar-15 and Plat-14 genotypes exhibited a higher pulp amount (169.8 g). A 98.35 g pulp weight value was reported for the southern region of Nuevo León (2) and this value was lower when compared to that obtained in this study, although it was similar to intermediate values. A fruit weight value of 147.85 was reported by other study conducted on creole avocadoes in the northern region in Nuevo León (1) and these results were similar to those obtained in this study. At the Bajío Experimental Field in Celaya, the avocado (*Persea americana* Mill., var. *drymifolia*) Germplasm Bank found a pulp weight value that ranged between 18 and 219 g, showing a mean value of 94 g (12).

The Jalea-11 harvest was prominent regarding seed weight (74.2 g) whereas Plat-14 from the Platanillo locality was the opposite case (38 g). These values (7.08 and 69.76 g) were similar to those observed in Nuevo León (6). Sánchez (1999) reported a 46.5 g mean weight for creole avocadoes from State of Mexico, whereas Acosta *et al*. (2012) reported a seed weight of 44.55 g on the southern region of Nuevo León. These size values were lower regarding those obtained in this study. Montes *et al*. (2017) evaluated avocado harvests and reported values seed weight values ranging from 9 to 91 g and a mean value of 38 g. Regarding peel weight, the Plat-16 harvest from Platanillo municipality (Iguala, Guerrero) was prominent as it showed 52.8 g values. In contrast, peel weight was lower the harvests Temax-1, Temax-5 and Sant-12 (10 g), implying that these possess a thin peel.

Generally, the results indicate that a genetic variability exists among the native avocado specimens within the central and northern region in the Guerrero State. The existing variation among genotypes pose several limitations because fruit represents a feature that enables a distinction between the wild-type and grown forms as trees produce fruits of several sizes (5, 2).

Conclusion

Diversity exists among avocado genotypes. They are variable regarding fruit size, seed weight and pulp amount. Based on the Graphic Manuel for Avocado Variety Description, fruits were classified as very small, small, medium and large. An alternative exists for producers within the central and northern regions in Guerrero (Mexico) that avocado harvests with suitable features may be commercialized as dry fruit, mainly at local and regional markets. Moreover, seed may be used as standard for rootstock production.

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