

Phenotypic characterization of the Jica-TH-19 avocado variant for Central Mexico

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Abstract

The variant called JICA-TH-19, located in the Experimental Orchard of the 'Presidente Juárez' Faculty of Agrobiology, was selected in 2021. Avocado trees descended from the original Hass variety from the state of California, USA, established during the 1970s in the INIFAP orchard in Uruapan, were used as reference material (control). Segregating materials were planted in 2016 and characterized between 2018-2022, in an experimental orchard located 4 km from Uruapan, Michoacán and its coordinates are: 19° 23' 54.3" north latitude, 102° 03' 12.9" west longitude, and an altitude of 1 636 m. The objective was to characterize morphologically variant genotypes of original 'Hass' avocado that have the potential to be exploited commercially in the avocado belt of Michoacán. The characterization of the trees and their vegetative and reproductive organs was carried out based on the Manual of descriptors for avocado (CICTAMEX, 1991), published by the Sánchez Colín Foundation with the support of the standard format followed by the International Board for Plant Genetic Resources (IBPGR).

Palabras clave:

Persea americana Mill., development, quality.



Origin

The trees are Hass seed segregators and have been propagated on landrace rootstocks originated from seed. Because the avocado is an open-pollinated species, it contains a great genetic variability that has been the product of the evolution of thousands of years of natural selection and domestication, giving rise to various morphological groups and races adapted to different environments. These resources are a unique source of genes (traits) that can be used for the genetic improvement of germplasm and new varieties (Pliengo *et al.*, 2020). Strictly speaking, the practice of propagating the crop by seed in some countries generates variants that are different from the parent tree (Juma, 2020). In addition, diverse climatic, edaphic, humidity, and topography conditions affect phenotypic quality and variation (Poudel *et al.*, 2018). In the avocado-growing area of Michoacán, new Hass-type materials have emerged, with characteristics similar to Hass but that differ in properties attractive to producers, such as flowering season, earliness and high yield, cases of those called Jiménez, Méndez, and Flor de María, among others.

Although apparently similar, these materials arise from various edaphoclimatic, agronomic, and genetic factors, forming defined groups, they can also cause variation in the content of metabolites in the leaves of the Hass variety (García *et al.*, 2016), so these changes could trigger different phenotypic expressions. Jica-TH-19 is a material that originates in the same conditions as the cultivars mentioned and due to its particular characteristics, it presents itself as an option for high-density orchards, it is of low size, early flowering, early, with high yield, rough fruit, and average weight of 200 to 260 g.

Characteristics of the plant

Tree

The 5-year-old trees of the JICA-TH-19 variant were characterized in 2021. They have an elliptical, dense crown and are of open habit. The branches are irregularly distributed, acute angle of insertion of the main branches ($< 90^\circ$), the surface of the trunk bark is corrugated (Figure 1). The young shoots presented an extensive branching pattern, with an average length of 21.2 cm, diameter of 0.64 cm and internode distance of 2.79 cm. Green and slightly pubescent stem, green lenticels, the surface of the apex is pubescent, brown to light brown. Figure 2 shows the main shoot characteristics of the JICA-TH-19 variant.



Figure 1. JICA-TH-19 variant: characteristics of the tree, tree size, distribution of primary branches and trunk surface.



Figure 2. JICA-TH-19 variant: shoot branching pattern, brown to light brown color, and lenticels.



Leaves

JICA-TH-19 trees have leaves of variable shape, from ovate to oblong-lanceolate; small to large, with an average leaf blade length of 13.73 cm and a leaf blade area of 66.31 cm², they have wavy edges with a faint anise smell and leathery friability. Their mature leaves are dark green and the young ones light green, with ribbed petioles with an average length of 5.95 cm, with an acute angle at their insertion and a slight pubescence of white to yellow, the venation on the upper side is conspicuous in appearance, and its relief from intermediate to elevated on the underside, the angle formed by the secondary veins with respect to the main vein is acute, with a slight pubescence and no twisting of the apex, the shape of the base of the leaf is angular and in the cross-section the leaf is observed as incurved.

The values for the characteristics of leaf blade length, leaf area, and petiole length, depending on the coefficient of variation determined, were 15.34%, 21.87%, and 13.51%, respectively. Regarding the leaf blade area, there was a continuous distribution with asymmetry towards low values from 139.53 to 24.13 cm². The data on the variable of petiole length showed an asymmetrical distribution towards high values from 2.9 to 8.8 cm; however, the leaf blade showed a symmetrical distribution with values from 6.9 to 22.3 cm.

Inflorescences

The JICA-TH-19 variant begins flowering two years after being grafted and generally, the main flowering occurs in September with an intermediate abundance; it also shows a secondary flower flow, both of which last for 75 days. Its flowers are type A, cream-colored with moderate pubescence; the position of the inflorescence is terminal with the presence of green lenticels. The main axis measures 11.41 cm, with 9.23 branches on average and 30.4 flowers on the longest axis. In flowers, the pedicel measures 0.54 cm on average, their petals are 0.49 cm long and 0.3 cm wide and have pubescence with medium density. The sepal measured 0.38 cm long by 0.2 cm wide and had medium pubescence. The style of the flower is crooked and pollen and nectary are present.

Fruit

The first fruiting in JICA-TH-19 variant trees occurs two years after being grafted and planted. The development period of the fruit is 240 days; after reaching physiological maturity, it can be retained on the tree for a period of two to three months. It is usually harvested from August to November. The shape of the fruit varies from ellipsoid to obovate, uniform in size, with an average of 10.29 cm and values from 5.6 to 12.7 cm and 7.45 cm (from 5.5 to 10.4 cm) in length and diameter, respectively, close to the ideal value of 10 cm reported by (Dixon *et al.*, 2007).

The average weight is 230.4 g (fruits from 139 to 341 g). The shape of the base is sunken, flattened or inflated with the apex at level or oblique and slightly sunken or rounded in shape and absent, broken, or entire edges, with the presence of small to large lenticels and a density of few to dense, with a color that varies from yellow to light yellow, corky lenticels are also present.

The peel is flexible with a slight adhesion to the pulp, 0.17 cm thick (0.1 to 0.2 cm), green to dark green or blended in color and its brightness is weak to strong with a rough texture. The pedicel varies in shape, with an average length of 1.41 cm (0.7 to 2.2 cm), cylindrical, conical or rounded, with a base diameter of 0.75 cm (0.4 cm to 1.2 cm) and its apex of 0.79 cm (0.4 to 1.2 cm).

The nail-shaped head of the pedicel is present on some fruits, with a conspicuous distinction at the junction of the pedicel with the peduncle; the peduncle had a length of 14.27 cm (4.7 to 27.1 cm) and a diameter of 0.39 cm in the middle part, (0.2 to 0.7 cm). The position of the pedicel in the fruit is asymmetrical or very asymmetrical, yellow to green in color and smooth surface, this position coincides with what was reported by Quiñones *et al.* (2023) for landrace fruits, the persistence of perianth is strong. The pulp near the peel is green and the pulp near the seed is light yellow. The pulp has a creamy texture with a low anise flavor and no sweet, bitter, or nutty flavor, it had a slight anise smell and showed absence or presence of fibers; the average weight of the pulp was 180.20

g (CV= 18.7%). After 4 hours of cutting the fruit, the darkening of the pulp was low; in general, the flavor of the fruit is good, after being harvested, the fruit had a duration of 18 days in storage under environmental conditions and a shelf life of four to six days.

Seed

The seed of the JICA-TH-19 variant is variable in shape, from ellipsoid to oblong or ovoid with a flattened base and conical apex, small to medium or large in size compared to the fruit; it has an average length of 4.46 cm (2.9 cm to 5.7 cm) and a diameter of 3.71 cm (1.7 cm to 4.8 cm), with an average weight of 36.84 g (20 to 28.5 g) and 13.65 g of percentage in weight in relation to the weight of the fruit.

The surface of the seed is moderately rough and ivory to pink in color; the coat is attached to the seed, but not to the pulp; with no free space in the cavity, which was 4.46 cm (3 to 5.8 cm) and 3.7 cm (1.8 to 4.9 cm) in length and diameter, respectively. The cotyledons are attached, the shape of the seed cross-section is circular, and the position of the embryonic axis is vertical without the presence of germinated seeds in mature fruit. The indicated seed characteristics are shown in Figure 3.

Figure 3. JICA-TH-19 variant: seed shape, embryonic axis with vertical position and seed size, circular shape in cross-section.



In relation to the variables: seed cavity length, cavity diameter, seed length, seed diameter, and seed weight of the two avocado genotypes, there were highly significant differences, except for the trait of percentage of the seed in weight in relation to the fruit since, in the two genotypes, the seeds analyzed showed no significant differences, which resulted in JICA-TH-19 and Hass being statistically equal, as can be seen in Table 1; the aforementioned characteristics can be seen in Figure 3.



Table 1. Coefficients of variation of the traits of length, diameter, and weight of avocado fruits of the JICA-TH-19 selection in contrast to the Hass variety.

Fruit length (cm)			Fruit diameter (cm)			Fruit weight (g)		
Genotype	Mean ^z	Group	Genotype	Mean ^z	Group	Genotype	Mean ^z	Group
JICA-TH-19	10.29	B	JICA-TH-19	7.45	B	JICA-TH-19	230.42	B
Hass	9.68	C	Hass	6.66	C	Hass	290.3	A

The characteristics considered for seed in terms of creamy yellow and reddish color when they are split coincide with those reported by Kusumastuti *et al.* (2023), for the species *Persea americana* Mill., although there was also a slight variation of this coloration to slightly pink or ivory. The two genotypes presented small to medium seeds in relation to the size of the fruit, which is considered within the avocado ideotypes (Dixon *et al.*, 2007).

The 10 variables analyzed in the fruits of the two genotypes studied indicated highly statistically significant differences for most cases, except for the length of the peduncle pedicel and the diameter of the apex of the pedicel, which were statistically the same, Tukey's comparison of means at 0.05 significance. In terms of fruit diameter, both genotypes behaved statistically equal; in diameter, 'Hass' was the smallest (6.66 cm).

The fruit weight was 230.37 g for Hass (Table 1). The length of the fruit peduncle was shown by the JICA-TH-19 variant (14.28 cm), the largest peduncle diameter was observed in JICA-TH-19 (0.39 cm) and Hass (0.34 cm), they were statistically equal; the diameter of the base of the pedicel was smaller in JICA-TH-19 (0.67 cm). As indicated, there was a difference in the size and shape of the fruit, even between the same genotypes, which is understood by the variation that is reported for the species *Persea americana* Mill. (Ranjitha *et al.*, 2021).

Yield

It has an average yield of 80-110 kg tree⁻¹, has a continuous production behavior (there is no alternation) and its size is dwarf, less than 3 m tall.

Conclusions

The JICA-TH-19 avocado genotype presented morphological characteristics in leaves, flower and fruit that place them as variants of the Hass variety, so it is probably the parent of the variant. JICA-TH-19 presented fruit morphological characteristics similar to the Hass variety, rougher and medium-sized, which makes it a candidate to be commercially exploited due to its quality and productivity.

The JICA-TH-19 variant had a good oil content compared to Hass and can be exploited for industrial processing purposes or in Mexican dishes that can enhance its qualities such as high pulp content and fruit weight. What has already been studied in other avocado varieties that have emerged, very similar to Hass but that differ in qualities such as dwarfism, productivity, earliness, and high fruit quality, is repeated.

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