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Research note

Influence of crop age on the production and physicochemical composition of Ataulfo mango

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Abstract

For the producers of Acapetahua, it is essential to know the age at which the crops will produce the highest quantity of quality mangoes due to the profits obtained from their sale. To this end, in 2021, the quantitative and experimental methodology was applied in three cultivars (7, 12, and 22 years old) to evaluate the production behavior through a linear regression analysis and the Anova of the physical characteristics of the fruits: total fresh mass of the fruit (TFMF), fruit length (FL), fruit diameter (FD), peel weight (PW), seed weight (SW), and pulp weight (PW), as well as color angles L, a^* and b^* (peel and pulp) and proximate chemical composition (moisture, total ash, lipid, crude fiber, crude protein, and total soluble solids) by Tukey's test at 5%. The production of first-quality mangoes showed a favorable trend over time as the harvested crates increased at an older age of the crop. The best physical characteristics were found in first-quality fruits from the 22-year-old crop: TFMF (320.2 g), length (11.58 cm), diameter (6.62 cm), PW (69.8 g), SW (33.5 g), and PW (209.3 g); on the other hand, color attributes (L, a^*, and b^*) were observed outstanding in first-quality fruits from the seven-year-old crop both in the peel and in the pulp. It was concluded that the 22-year-old crop has a higher production of high-quality fruits, and the quality decreases as the crop age decreases.

Keywords:

Mangifera indica L., harvested crates, pulp, quality classification.

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Mango (*Mangifera indica* L.) is found in tropical and subtropical agroecosystems; the tree reaches 40 m in height (Hernández-Guerrero *et al*., 2015). It is a perennial cultivar with an area of 77 993 ha harvested and a production of 510 700 t in Mexico (SIAP, 2019). Mendoza-Hernández *et al*. (2020) point out that Chiapas ranked fourth nationally, generating 237 530 t year^{-1}. Mazariegos-Sánchez *et al*. (2017) mention that Acapetahua has a planting area of 1 506.5 ha and production of 10 828.5 t.

The Ataulfo mango is appreciated for its sensory properties: succulent, fleshy, oval shape, thin seed, and abundant pulp; it contains vitamins A and C and is rich in minerals, fibers, and antioxidants; its calorie, fat, and sodium contents are low (Wall-Medrano *et al*., 2015). The management of these orchards includes pruning, fertigation, postharvest management and pest and disease control (Cruz-Barrón *et al*., 2014).

The objective of identifying the influence of the age of the crop on the production and physicochemical composition of the mango harvested in Acapetahua arose due to the curiosity of producers to know at what age their crop produces better quality mangoes, which is reflected in higher profits. The study was conducted in Acapetahua, Chiapas, Mexico, in orchards aged 7, 12, and 22 years in May 2021. The orchards are located at 15° 17' 09.8" north latitude, 92° 41' 39.0" west longitude, 15° 16' 26.7" north latitude, 92° 44' 17.8" west longitude and 15° 16' 18.6" north latitude, 92° 41' 19.4" west longitude with 29, 25, and 33 masl.

The municipality's climate is warm sub-humid with rains in summer, and warm humid with abundant rains in summer, with temperatures between 26 and 30 °C and rainfall of 1 500 to 3 500 mm (Galán, 1999). The management consisted of cultural practices, flower induction with phosphonitrate 33-03-00, biological control with Bankit® and Cypermethrin®, and Bioforte® to improve yield.

A total of 60 healthy fruits were collected at physiological maturity according to their quality and classified according to the (NMX-FF-038-SCFI, 2016). The fruits were transported to UNICACH, disinfected, and ripened for 5 ±1 days under environmental conditions of 31 ±2 °C. The production of 15 trees was evaluated, and the number of crates was counted, which had an average weight of 30 kg. Production was measured at physiological maturity. TFMF, PW, PW, and SW were determined with an OHAUS® Scout-Pro balance. A PRETUL® vernier was used to calculate FL and FD.

The color of the pulp and peel was evaluated through individual images. A 16 Mpx camera was used, without zoom, 0° angle, 15 cm distance, natural lighting, in automatic mode, without flash, and JPEG format of 3456 x 4608 px, and the images were analyzed with the Adobe Capture software (Figure 1).

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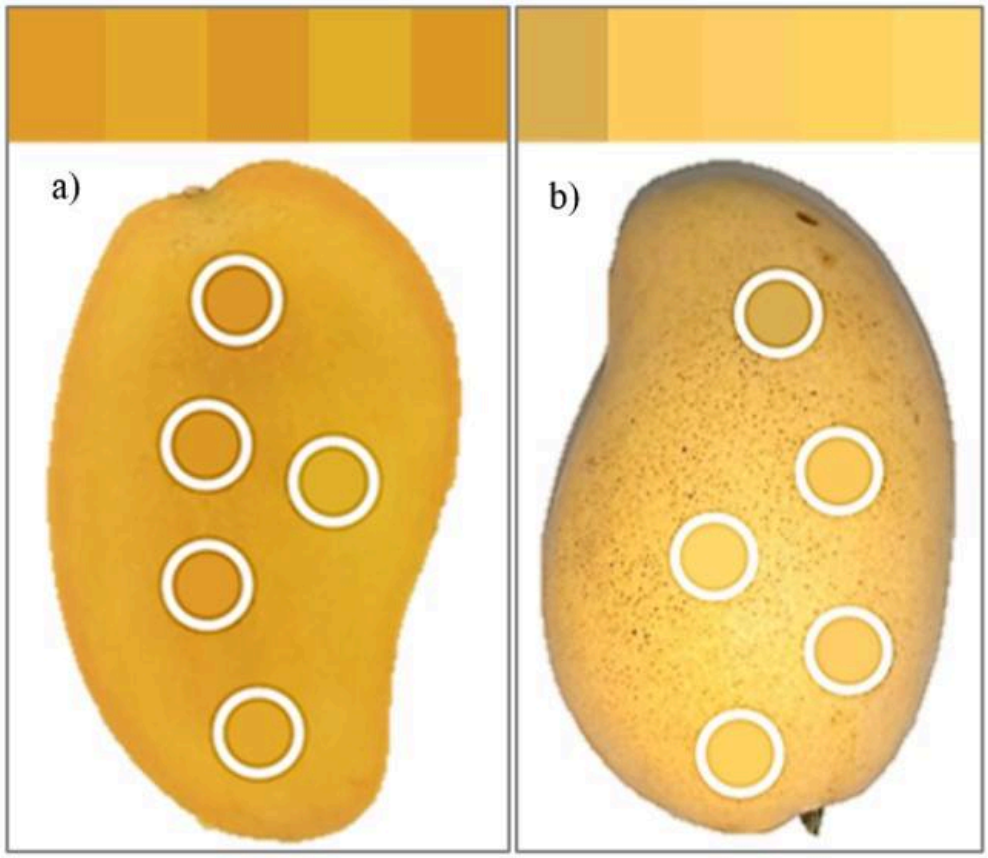
Figure 1. Parameters evaluated L, a^*, and b^* in: a) pulp; and b) peel.



In the proximate chemical analysis of the pulp, the methodology proposed by Zumbado (2002) was used. Samples were independent for each analysis, with 300 g per quality level. To determine the optimal age of quality mango production, a linear regression analysis was performed, correlating production according to its quality and the age of the crop with a significance level of 95%.

The physical characteristics of the fruits, as well as the proximate chemical composition of the pulp, were statistically compared using a one-way analysis of variance (Anova), Tukey's test $p \leq 0.05$; the data were analyzed in the JMP program version 7.0. The production of first-quality Ataulfo mango increased with the age of the crop; this behavior showed a relationship between the production and the age of the crop with an R^2 of 0.9995, but not for the production of second and third-quality fruits (Figure 2).

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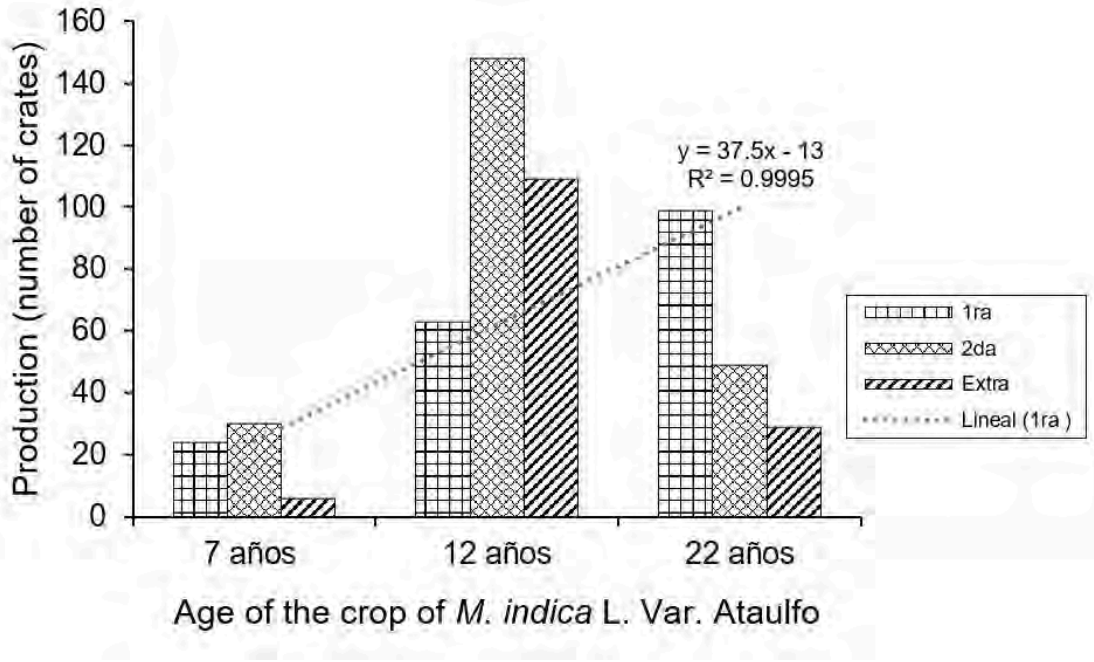
Figure 2. Production of Ataulfo mango according to the age of the crop, classified by its quality.



Studies such as that of Ureña-Bogantes *et al*. (2007) indicate that the harvest begins in the third or fourth year of planting, and from this year onwards, the production increases until reaching its maximum yields in the eighth year. Fallas *et al*. (2009) indicate that in commercial plantations, the highest yields are usually obtained when the tree is between 8 and 15 years old. Thirty-eight point four six percent of the variables studied in the first-quality fruits did not show statistically significant differences. The best traits were observed in fruits from the 22-year-old cultivar (Table 1).

Table 1. Physical characteristics of Ataulfo mango fruits.

Quality	AC	TFMF	Length	Diameter	PW (g)	SW (g)	PW (g)	Peel color			Pulp color		
								L	a*	b*	L	a*	b*
First	7	277.12 b	11.48 a	6.34 a	58.12 b	29.25 a	185.87 b	70.25 a	16.25 a	55.62 a	62.62 a	20.62 a	57.37 a
	12	303.41 a	11.5 a	6.39 a	51.75 b	32.5 a	212.25 a	69.1 a	10.7 b	47.7 b	59 b	18.6 a	51.4 b
	22	320.2 a	11.58 a	6.62 a	69.8 a	33.5 a	209.3 a	65.8 a	13 ab	49 b	56.7 c	16 a	53.5 b
Second	7	207.1 b	10.52 a	5.74 a	38.3 b	25.5 a	138.8 b	63 a	15.1 a	49.1 a	61.7 a	25.2 a	58.1 a
	12	244.91 a	10.58 a	5.97 a	45.33 a	23.91 a	169.16 a	68.3 a	10.4 b	46.6 a	59.6 a	18.2 b	48 c
	22	204.3 b	9.97 b	5.78 a	47.2 a	21.9 a	130.7 b	60.1 a	17.4 a	50.8 a	56.5 b	19.6 b	55 b
Third extra	7	161.5 a	9.3 a	5.29 a	37.71 a	16.5 a	103.21 b	68 a	15 a	55.6 a	61.9 a	20.7 a	59.1 a
	12	186.3 a	9.16 a	5.76 a	34.6 a	20.6 a	126.2 a	58 b	13.3 a	44.2 b	59.3 a	15.6 b	46.7 c
	22	156 a	8.69 a	5.36 a	30.1 a	17.7 a	102.7 b	56.1 b	16.8 a	51.9 a	55.6 b	22.2 a	56.7 b

AC= age of the crop in years; TFMF= total fresh mass of the fruit; PW= peel weight; SW= seed weight; and PW= pulp weight.

The TFMF of the first-quality fruit is classified according to the caliber code established in the (NMX-FF-058, 1999) as fruits of codes 14 and 16, where the 12 and 22-year-old cultivars were the ones with the best characteristics. The difference observed in TFMF can be attributed to climate, nutrition,

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irrigation, cultural practices and plant age (Aular and Rodríguez, 2003). The first-quality FL is similar to what was reported by Maldonado-Astudillo *et al*. (2016) but not for the diameter, which was 20%smaller.

The first-quality fruits corresponding to the 7, 12, and 22-year-old crops had 68, 72, and 67% pulp, respectively; these results coincide with what was published by Guzmán *et al*. (2013) for Tommy Atkins mango. The proportion of SW with respect to TFMF was homogeneous over the years, and an average of 10.80% was reported. The composition of SW and PW was among the values published by Hemawathy *et al*. (1988).

The proportion of these components can vary (Guzmán *et al*., 2013). Peel and stone can be considered waste with important bioactive compounds (Sumaya-Martinez *et al*., 2012). The highest values of L, a^*, and b^* were identified in the fruits of the seven-year-old cultivar in both peel and pulp, according to the methodology of Almanza-Mosqueda *et al*. (2016).

The association of yellowness with the content of β-carotenes present in the fruit and its desirable appearance was corroborated. The proximate chemical composition of the first, second, and extra mango pulp showed statistically significant differences according to Tukey's test $p \leq 0.05$.

The pulp of the extra-quality Ataulfo mango obtained from the seven-year-old cultivar showed greater homogeneity in its composition. The variables of moisture, lipid, and crude fiber of the pulp extracted from first-quality fruits of the 12-year-old and 22-year-old cultivars were similar; on average, the following values were reported: 74.55, 1.11, and 10.61%, respectively; in the same sense, the highest composition of protein (0.95%), and TSS (21.20 °Bx) (Table 2).

Table 2.Proximate chemical composition of the Ataulfo mango pulp (mean ± S, n= 3).

Analysis	1st quality					2nd quality					Extra				
	7	12	22	Average	R^2	7	12	22	Average	R^2	7	12	22	Average	R^2
Moisture (%)	75.94a	74.47a	74.64a	75.01±0.8	0.4658	78.5a	78.36ab	74.7b	77.18±2.15	0.7776	77.09a	78.35a	76.81a	77.41±0.82	0.0291
Total ash (%)	2.71a	2.5b	2.44b	2.55±0.14	0.9067	3.17a	2.35b	2.43b	2.65±0.45	0.6698	3.05a	2.3b	2.24c	2.53±0.45	0.8052
Lipid (%)	0.81b	1.11a	1.12a	1.01±0.17	0.7742	0.79c	1.08a	0.95b	0.94±0.14	0.3033	0.84a	0.8a	0.57b	0.73±0.14	0.8583
Crude fiber (%)	10.25a	11.03a	10.2a	10.49±0.46	0.0029	7.53c	9.64b	17.04a	11.4±4.99	0.9065	7.32c	9.32b	18.58a	11.74±6	0.8783
Crude protein (%)	0.68b	0.95a	0.72b	0.78±0.14	0.0188	1.06a	0.86b	0.74c	0.88±0.16	0.9796	0.97ab	1a	0.91b	0.96±0.04	0.4286
TSS (°Bx)	18.75b	18.91b	21.2a	19.63±1.36	0.7988	17.14b	18.42ab	19.86a	18.47±1.36	0.9988	19.43a	18.87a	19.89a	19.39±0.51	0.2027

The average values of the proximate chemical composition of the fruits are similar to those published by Rivas-Robles *et al*. (2020). The fiber content was greater than 2%, so they were classified as fruits with high fiber content. As the quality of the fruits decreases and the age of the cultivar increases, the fiber content in the pulp increases. Kader (2008) indicates that fiber content is part of the fruit quality index.

Conclusions

The production of first-quality fruits increases with the age of the crop since the 22-year-old mango cultivar presented the highest production of first-quality fruits, and due to their characteristics, these fruits are destined for the primary sector. The best physical characteristics were found in the first-

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quality fruits in the 22-year-old cultivar; this behavior declines as the age and quality of the crop decrease.

The proximate chemical composition of the pulp of the Ataulfo mango fruits showed greater homogeneity, while the crude fiber content increased as the quality declined and the age of the cultivar increased; for their composition, second- and extra-quality fruits have the potential for the secondary sector.

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