Investigation note

Texture profile analysis of mango parthenocarpic fruits cv. ‘Ataulfo’

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Abstract

Seedless fruits are called parthenocarpic, in the mango they have a size two to three times smaller than normal fruits and a high content of sugars. They are called ‘mango niño’, have a low economic value because they do not meet the standards of the national and international market. The objective of this study was to characterize parthenocarpic fruits of mango cv. ‘Ataulfo’; through, a texture profile analysis (TPA), weight loss and soluble solids content (TSS). The parthenocarpic fruits (PF) showed a decrease in the textural characteristics until reaching maturity. However, in non-parthenocarpic fruits (NPF) the decrease was less pronounced. The PF showed a softer texture and the most significant parameters were hardness and chewiness. Weight loss and TSS content were higher during storage in PF, indicating pulp with greater sweetness at the end of storage. The results provide important information about the potential uses of the child mango. It is suggested that soft and sweet pulp can be used in applications such as the preparation of syrups to prepare beverages or mango concentrates.

Keywords: mango, parthenocarpic fruit, texture profile analysis.

Reception date: July 2019
Acceptance date: August 2019

The texture is defined as the sensory manifestation of the structure of the food and the way in which the applied forces act, represents the conjunction of mechanical, geometric and superficial attributes of a product registered through mechanical, tactile, visual and auditory sensors. (Szczesniak, 1963; Torres-González *et al*., 2015). However, the texture can be related to the deformation, disintegration and flow of food when a force is applied (Bourne, 2002).

Texture is a critical sensory attribute that can dominate product quality like fruits. From the consumer's point of view, the texture is generally referred to as an indicator of the edible quality and freshness of the fruits, as well as the main factor that determines the acceptance of the product (Valente *et al*., 2011). The loss of texture is one of the main problems of fruits such as mango (Sirijariyawat *et al*., 2012). Currently the commercialization of minimally processed fruits is an attractive commercial option; however, softening and loss of texture is a problem in sliced fruits and vegetables.

The mango (*Mangifera indica* L.) is one of the most popular tropical fruits in the world (Mitcham, 1992). Its pulp (mesocarp) quickly loses consistency during ripening, so it must be consumed before it reaches full maturity and develops undesirable characteristics for the consumer (Maldonado-Astudillo, 2016).

So far, there are few reports on the texture of parthenocarpic fruits (Banjongsinsiri *et al*., 2004; Valente, 2011; Sirijariyawat *et al*., 2012; Ellong *et al*., 2015; Alvis-Bermudez *et al*., 2016). These fruits do not have seed and have a size two to three times smaller than normal fruits, as well as a high content of soluble solids. These fruits have a low price in the market because they do not meet the attributes of national and international standards. Therefore, its commercialization is limited to the national market and its production is partially exploited (Pérez-Barraza, 2007).

In Mexico, parthenocarpy has been reported in the main mango producing areas of the states of Nayarit, Guerrero and Chiapas and an increase in this phenomenon has been observed (Leyva-Mayo *et al*., 2016). The absence of seed in the mango fruits considerably affects the size, reaching three times less than the fruits with seed. The size of the fruits affects their acceptance and commercialization, which generates economic losses in the production of mango cv. 'Ataulfo'. The objective of this study was to characterize parthenocarpic fruits of mango cv. 'Ataulfo'; through, analysis of texture profile, weight loss and content of soluble solids and generate information that allows proposing potential applications for these fruits.

Biological material

Mango fruits cv. 'Ataulfo' in the same state of maturity (physiological maturity) were harvested from a garden of Atoyac de Álvarez (Costa Grande, Guerrero) and taken to the laboratory. Later they were selected, washed and dried to be used in the study. 100 experimental units (50 parthenocarpic fruits (PF) and 50 non-parthenocarpic fruits (NPF) were stored at 24 ±1 °C in a low temperature incubator for five days, the tests were carried out every 24 h during storage.

Physical analysis

A non-destructive sampling with 10 fruits was used as an experimental unit to evaluate the weight, which was determined with a digital scale (Ohaus®, USA) with a sensitivity of 0.1 g. The texture profile study (TPA) was performed with a texture analyzer (TA.XT plus Texture Technologies Corp, Scarsdale, NY). The fruits were compressed twice with a compression probe of 75 mm in diameter with a load cell of 25 kg at a speed of 2 mm s^{-1}, until 20% compression of the transversal diameter of the fruit was achieved, with an interval between compressions of 10 s.

From the results of the two compressions, the following parameters were calculated: hardness (N), necessary force to generate a deformation of the sample; fracturability (N), force necessary to fracture the sample, adhesiveness (N s^{-1}), work necessary to overcome the forces of attraction between the surface of the food and the surface of the probe, elasticity (N s^{-1}), rate at which a deformed material returns to its initial condition after the deformation force is removed, cohesiveness (N), is the degree to which a material can deform before breaking, chewiness (N), energy required to disintegrate a solid food ready for chew; and resilience (N), recovery capacity of a material to return to its original state after the first compression (Szczesniak, 2002).

Chemical analysis

A destructive sampling with 10 fruits was applied as an experimental unit for Total Soluble Solids (TSS, °Brix). The TSS were measured in accordance with NMX-F-103-1982 using an ATAGO® digital refractometer previously calibrated with distilled water, in which a drop of juice was placed from each sample. The measurements were made in triplicate and the results were expressed in °Brix.

Statistical analysis

The results are reported as the mean ±standard deviation (n= 10). An Anova test and a Tukey HSD test were performed to determine statistically significant differences ($p < 0.05$) of fruit characteristics using the SPSS statistical package ver. 22 (IBM Inc., USA).

Discussion

Texture changes

Figure 1a, b shows the texture profile analysis of parthenocarpic (PF) and non-parthenocarpic (NPF) mango cv. ‘Ataulfo’ during 5 days of storage at 24 °C. Significant differences ($p \leq 0.05$) in hardness and chewiness were observed, being the PF presented lower hardness and chewiness. The elasticity, cohesiveness and resilience did not show significant differences ($p \leq 0.05$). However, both types of fruit showed the same tendency to decrease their textural parameters during storage. The textural changes are mainly due to the maturation process, during which the hydrolysis of starch and other structural components such as pectins is carried out, which has an important impact on the texture of the fruits (Huber, 1983).

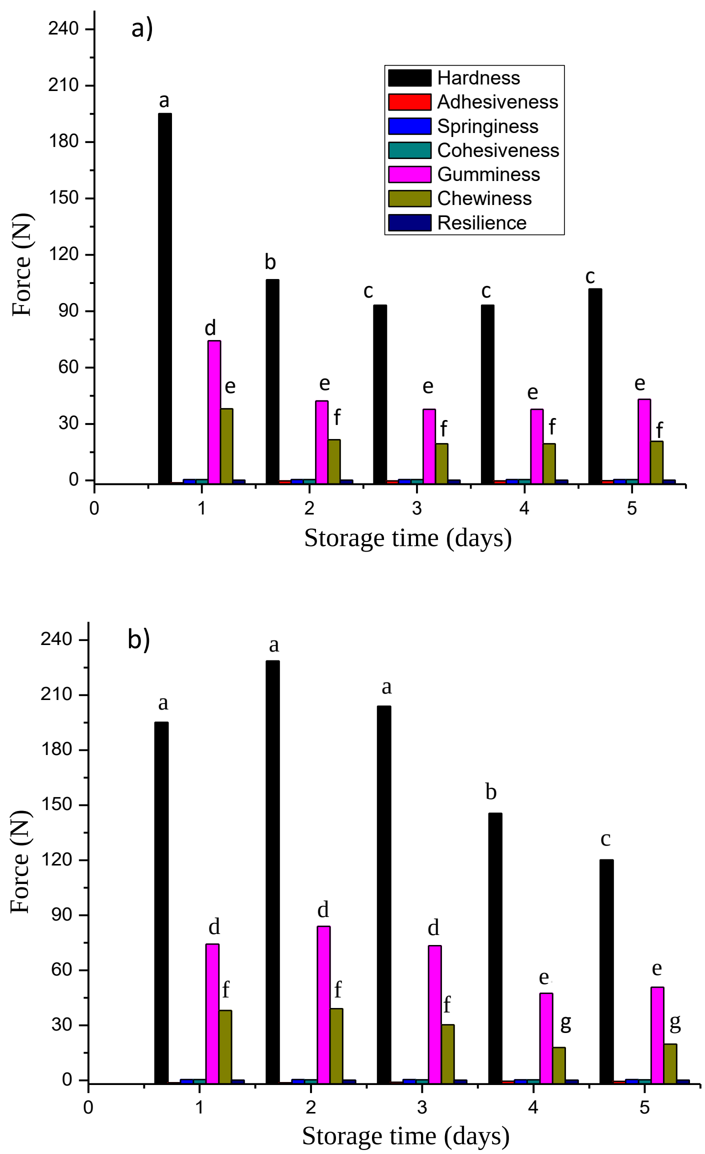

Figure 1. Texture profile analysis in parthenocarpal (a) and non parthenocarpal fruits (b) of mango cv. 'Ataulfo' during 5 days of storage at 24 °C.

According to Szczesniak (1995), it is recommended that reference be made to chewiness for solid products. In this study, the textural parameters of the most significant mango fruits were hardness and chewiness.

The highest hardness observed in NPF is partially due to the fact that the fruits have three fractions (epicarp, mesocarp and endocarp), while PF only have two (epicarp and mesocarp) (Figure 2). The endocarp is empty. This condition negatively affects the hardness of the fruits during compression.

According to previous studies, the mango parthenocarpic fruits have a high content of soluble sugars and lower starch content than the non-parthenocarpic fruits. The increase of TSS is related to the softening of the pulp (Leyva-Mayo, 2016).

Figure 2. a) parthenocarpic fruits of mango cv. 'Ataulfo'; b) fractions of the fruits: 1 endocarp (seed); 2 exocarp (skin); 3 mesocarp (pulp); c) mango parthenocarpic fruits at physiological maturity; d) endocarp without seeds.

Physical and chemical changes

An increase in the weight loss and in the TSS content during storage was observed in both fruits (Table 1), with the PF that observed the highest values of TSS and NPF that had the highest weight loss.

Table 1. Loss of weight and content of soluble solids in mango fruits cv. 'Ataulfo' stored at 24 °C for 5 days.

Storage time (days)	Partenocarpal fruits		Non-parthenocarpal fruits	
	TSS (°Brix)	Weight loss (%)	TSS (°Brix)	Weight loss (%)
1	25.6 ±0.5 d	0 ±0.8 e	17.86 ±0.6 f	0 ±0.5 e
2	26.2 ±0.5 d	4.5 ±0.2 d	19.3 ±0.4 f	5 ±0.2 c
3	28.8 ±0.5 c	6.7 ±0.5 c	20.8 ±0.3 f	7.2 ±0.7 b
4	31 ±0.5 b	8.3 ±0.7 b	22.3 ±0.7 e	9.4 ±0.4 b
5	33.5 ±0.5 a	9.1 ±0.2 b	25.3 ±0.2 d	10.6 ±0.3 a

Average of 10 repetitions ±standard deviation. The letters indicate significant differences between the parthenocarpal and nonparthenocarpal fruits.

Conclusions

The results obtained in this study show that the parthenocarpic fruits had lower hardness and chewiness and higher sugar content than the non-parthenocarpic fruits during the storage conditions, which shows that the child mango has a softer and sweeter pulp than the normal fruits. These results provide important information to propose potential uses as an ingredient to make beverages or syrups.

Acknowledgments

The authors thank the financing of the Autonomous University of Guerrero: seed research project 2014.

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