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Characterization and proposal for the post-harvest management of *Byrsonima crassifolia L.* fruits, yellow and red phenotypes

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Abstract

Nanche is a native fruit with high nutritional and functional value; however, its commercialization is hindered by its short post-harvest shelf life. This study evaluated the physical traits, chemical composition, bioactive compounds, and postharvest management of mature yellow and red nanche fruits collected in Chiapas, Mexico. Standard AOAC methods were employed to evaluate physicochemical parameters, while antioxidant capacity, total polyphenols, flavonoids, and chlorogenic acid were quantified using spectrophotometric assays. To enhance preservation, methyl jasmonate (MeJA) was applied under varying temperature conditions. Both phenotypes showed comparable nutritional potential; however, the red nanche exhibited a lower moisture content, higher levels of antioxidant compounds, and better postharvest performance following MeJA treatment. The combination of MeJA and refrigeration effectively extended shelf life and improved fruit quality, offering a viable strategy to strengthen the nanche value chain and promote its market integration as a functional bioresource.

Keywords: bioresource, methyl jasmonate, nanche, nance

Introduction

Despite scientific and technological advances, few plant species are used as commercial crops, and Nanche (*Byrsonima crassifolia* L.) is a bioresource to Mexico and Central America that neglected plant species but in recent years it has been of interest to the scientific community (Baldermann et al. 2016; Agredano-De la Garza et al. 2021; San-Martín-Hernández et al. 2023) The highest producers states in Mexico are Guerrero (4,027.88 t), Michoacan (3,455.75 t), Nayarit (1,152.64 t), Veracruz (798.74 t), Morelos (257.81 t), Campeche (194.91 t), Yucatan (153.50 t), and Chiapas (143.70 t) (SIAP, 2023). Nanche has generated significant interest among researchers due to its antioxidant, antimicrobial, anti-inflammatory, and antiproliferative properties (Agredano-De la Garza et al. 2021). Also, trees have adapted to drought conditions and soil roughness. The fruits are globose drupes that are climacteric, exhibit heterogeneous shape, color, flavor, and size, and have a short shelf life (Hernández-Cuello et al. 2022). Nanche fruit is sweet and sour due to its high vitamin C content, boasting a pleasant taste and a distinctive aroma. Consumers' fruit consumption encompasses raw fruit, as well as fruit incorporated into soft drinks, jelly, syrup, or preserves. Commercial production gives the species relative economic importance (Avilés-Peraza, 2015). Nanche is important not only for the quality of the fruits it produces but also for its antioxidant capacity (Maldonado et al. 2020). Various studies have shown the functional advantages of using nanche as a fresh fruit, as well as the development and value of food formulations based on it. However, unlike other crops, it has not yet established a sustainable value chain. One reason is the short shelf life of the fruit, resulting in the loss of sensory attributes that are acceptable to the consumer.

Methyl Jasmonate (MeJA) is a chemical that

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induces the synthesis of defensive compounds may be used against pathogens, salt stress, drought stress, low temperature, heavy metal stress and toxicities of other elements, demonstrating to decrease the detrimental impacts of storage, for this reason, MeJA can be an alternative for improving the quality of fresh fruits (Reyes-Díaz et al. 2016; Yu et al. 2018). However, in nanche, the evaluation and development of methods for handling post-harvest are growing. The aim of this study was to determine the physical characteristics, chemical composition, beneficial compounds, and post-harvest handling of Methyl 3-oxo-2-(2-pentenyl)cyclopentane acetate in the yellow and red fruits of nanche as an alternative post-harvest conservation method.

Materials and methods

Local collectors harvested mature nanche fruits of yellow and red phenotypes in Ejido Ulapa, Acapetahua municipality, Chiapas (15.3848, -92.7933). The healthy fruits were transported to the Food Analysis Laboratory of the University of Science and Arts of Chiapas, where they were disinfected with a chlorine solution (100 ppm) for 3 min and dried at room temperature.

Physical characteristics of fruits

The physical characteristics of fresh and healthy nanche fruits of the yellow and red phenotypes were determined. For this, 100 fruits of each phenotype were randomly selected, and the total fruit weight, polar diameter, equatorial diameter, thickness, firmness, pulp and peel weight, seed weight, and shape index were determined. The measurements were carried out using an OHAUS PIONEER analytical balance Item PA214, a 300 mm Stainless Hardened digital caliper, and an FT fruit tester FORCE DIAL FD20 Wagner; the shape index was obtained by dividing the polar diameter by the equatorial diameter of the fruits. The color of the epicarp and mesocarp was determined in 20 repetitions using a Minolta CR-400 colorimeter (Minolta, Ltd. Co., Ltd., Japan), where the parameters L (lightness), a* (green-red intensity), and b* (blue-yellow intensity) were evaluated.

Composition proximal

The chemical composition considered pH (AOAC 981.12), total soluble solids (TSS) (AOAC 932.12), titratable acidity (TA) (AOAC 942.15), and flavor index. The flavor index was calculated by dividing the TSS and TA values (Maldonado Peralta et al. 2020). The proximal determination considered moisture AOAC (930.15), total ash AOAC (942.05), lipids AOAC (920.039), crude fiber Zumbado (2002), and proteins AOAC (984.13).

Phenolics and antioxidant capacity

All samples were prepared at 5% in water, ethanol (EtOH) at 80%, and methanol (MeOH) at 70%. Each sample was processed separately and was previously weighed in 50 mL Falcon tubes. Each reagent was added, and the mixture was stirred in an Eppendorf ThermoMix at 1000 rpm, 25°C for 60 minutes, protected from light. Afterwards, the samples were centrifuged for 20 minutes at 5000 rpm, and the supernatant was transferred to amber glass tubes and stored frozen until use.

Determination of total polyphenolic compounds

The supernatant samples were quantified for total polyphenolic compounds using the Folin-Ciocalteu method. Which consisted of mixing 200 µL of each extract with 200 µL of 0.01 M sodium carbonate and letting it react for 5 minutes, then adding 200 µL of Folin-Ciocalteu reagent (1:1) and letting it rest for another 5 minutes, followed by the addition of 1250 µL of distilled water, and finally letting it react for 30 minutes and measuring the absorbance in a VELAB UV-VIS spectrophotometer at a wavelength of 790 nm. For the expression of polyphenolic compound content, a calibration curve with gallic acid was prepared, ranging from 0 to 400 ppm, to be expressed in gallic acid equivalents (GAE).

Antioxidant capacity

The antioxidant capacity was determined using the DPPH (2,2-diphenyl-1-picrylhydrazyl) and ABTS (2,2'-azino-bis (3-ethylbenzothiazoline-6-sulfonic acid) techniques. The DPPH radical was prepared at a concentration of 100 µM (3.9 mL) dissolved in absolute methanol. Then, 0.1 mL of the sample was added, mixed, and incubated in the dark for 30 minutes. Finally, the absorbance was measured at a wavelength of 517 nm.

The antioxidant activity evaluated was expressed as a capture percentage and was carried out using the following equation:

$$\text{Antioxidant activity (\%)} = \frac{\text{Abs of radical} - \text{Abs of sample}}{\text{Abs of radical}} * 100$$

Total flavonoid content

The total flavonoid content (TFC) was determined by the method proposed by Barros et al. [12], based on the formation of a flavonoid-aluminum complex. Volumes of 0.5 mL of extracts were added to 2 mL of distilled water, and 0.15 mL of a 5% NaNO2 (Sigma Aldrich) solution was added. The mixture was stirred and left to stand for 6 min. Then, 0.15 mL of 10% AlCl3 was added, stirred, and left to stand for 6 min. Next, 2 mL of 4% NaOH was added to the mixture, and the volume was topped up with water to obtain a final volume of 5 mL. The absorbance of the reaction was measured at 510 nm with an Evolution 220

UV-Vis spectrophotometer. Total flavonoid content was calculated with a standard curve constructed using catechin (Sigma-Aldrich) as a standard. Results were reported as catechin equivalents (CE) in grams per kilogram of dry extract (Guzmán Ceferino et al. 2022).

Chlorogenic acid

The colorimetric assay for the determination of chlorogenic acid consisted of mixing 400 µl of extract with 400 µl of 0.17 mol·l-1 urea and 400 µl of 0.1 m·l-1 acetic acid (both Sigma Aldrich), This was shaken for 15 s, 400 µl of 0.14 mol·l-1 $NaNO_2$ was added and incubated for 2 min at 25 °C, in the absence of light. Finally, 400 µL of 0.5 mol · L^{-1} NaOH was added and centrifuged at 5,000 × g at 25 °C for 10 min. To quantify the concentration, a calibration curve was prepared using chlorogenic acid (Sigma Aldrich) concentrations ranging from 0 µg mL^{-1} to 250 µg mL^{-1}, and absorbance was measured at 510 nm with an Evolution 220 UV-Vis spectrophotometer. Content of chlorogenic acid was expressed as chlorogenic acid equivalents (CAE) in grams per kilogram of dry extract (Díaz-Orduño et al. 2018; Ceferino et al. 2022).

Post-harvest handling

Methyl Jasmonate (MeJA) (Methyl 3-oxo-2-(2-pentenyl) cyclopentane acetate) used in this work was purchased from Sigma-Aldrich Chemical with 99% purity, a molecular weight of 224.30 g mol^{-1}, and a density of 1.03 g mL^{-1}.

To evaluate the effectiveness of MeJA in the post-harvest handling of *B. crassifolia* L. fruits, twelve chambers were arranged, evenly distributed between the yellow and red phenotypes. In each chamber, 300 g of disinfected and dried fruits were deposited. Subsequently, a filter paper disc impregnated with 100 µL of MeJA was introduced into T1 and T2. The chambers were sealed for three hours to allow for the volatilization of the hormone. After this period, the discs were removed and the treatments were arranged under the following conditions: T1) MeJA at room temperature, 2) MeJA refrigerated at 5 °C, 3) Without MeJA at room temperature, and 4) Without MeJA refrigerated at 5 °C. The weight loss evaluation was conducted every 24 hours using an OHAUS PIONEER Item PA214 analytical balance, and visual observation was also performed to identify damaged fruits.

Statistical analysis

The analysts performed descriptive statistical analysis to determine the mean and standard deviation. An independent samples t-test was used to analyze physical characteristics, proximate chemical composition, and bioactive compounds. One-way ANOVA, followed by Tukey's test, was used to evaluate the effects of post-harvest handling on nanche fruits of both yellow and red phenotypes. The statistical software used was JMP® 7.0 (SAS Institute Inc.). The color of the fruits was described qualitatively.

Results and discussion

Table 1 shows the results of physical characteristics and compares the yellow and red phenotypes of nanche. The analysis revealed statistically significant differences for the fruit's various variables, except for total fruit weight. The weight of this characteristic is important in the fruits. Our results showed weight similarity to the phenotypes of the samples studied by Rojas-García et al. (2021), but differed from those evaluated in some previous studies. In another study, the weights ranged from 6 to 6.8 g for the yellow phenotype (Rivas-Castro et al. 2019), which is greater than our results (**Table 1**). In diameters of fruit, our results are slightly lower (Table 1) than those reported by Hernández-Cuello et al. (2022) for polar diameter (1.61 cm), equatorial diameter (1.72 cm) in red phenotype, and polar diameter (1.69 cm), equatorial diameter (2.03 cm) in yellow phenotype. These differences are consequences of the phenotype and other factors, including environmental conditions of production without agronomic management (Rojas-García et al. 2021).

Table 1. Physical characteristics of the fruits of nanche (*B. crassifolia* L), yellow and red phenotypes.

Parameters	Unit	*Nanche phenotype*	
		Yellow	Red
Total fruit weight	g	4.061±0.5564 a	3.565±0.5147 a
Polar diameter	cm	1.663±0.1383 a	1.4469±0.1900 b
Equatorial diameter	cm	1.7472±0.1185 a	1.6836±0.1853 b
Thickness	cm	0.4762±0.0662 b	0.5469±0.0706 a
Firmness	kg.f	1.468±0.5268 b	3.8581±1.8685 a
Pulp and peel weight	g	3.1623±0.5898 a	2.3579±0.4179 b
Seed weight	g	0.8988±0.2647 a	1.2074±0.3809 b
Shape index	-	0.957±0.0774 a	0.865±0.1146 b

Mean and standard deviation (*n*=100). Lowercase letters are group statistical (t-test) in row.

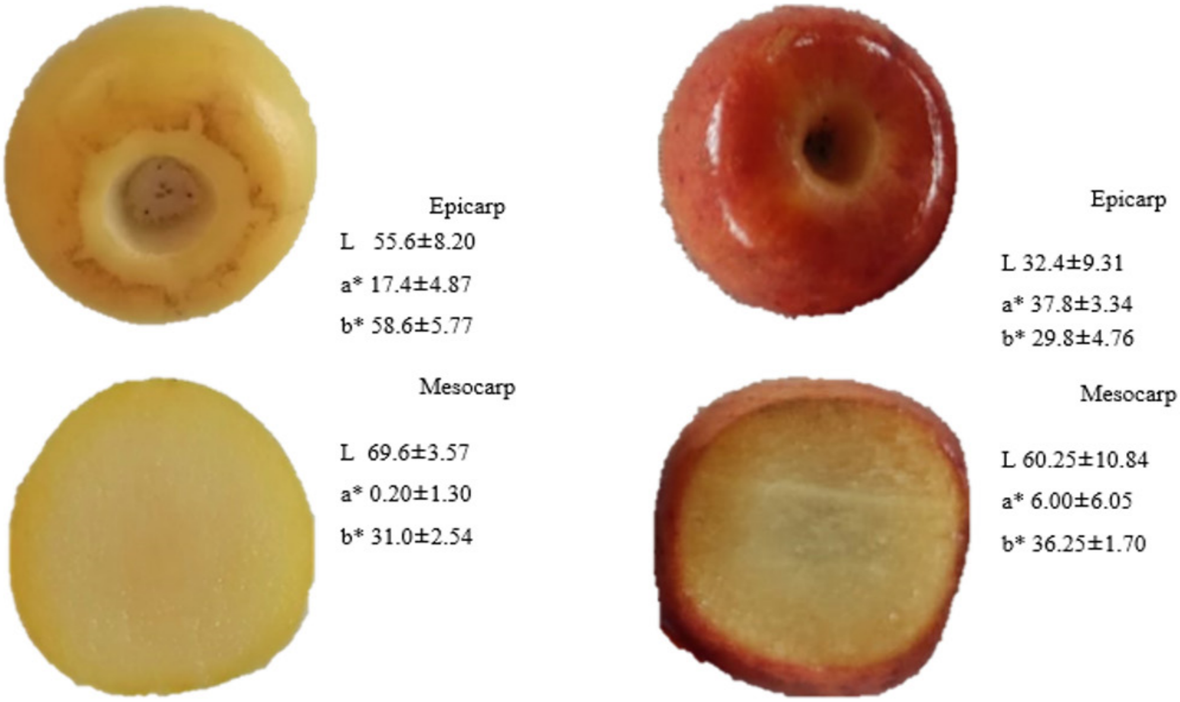

Figure 1. Values of L, a*, and b* color of the fruits of nanche (*B. crassifolia L.*) yellow and red phenotypes.

Figure 1 presents the color (L*a*b*) of epicarp and mesocarp for two phenotypes. The yellow phenotype has epicarp warm-toned color with medium lightness, characterized by a strong yellow (L* 55.6, a* 17.4, b* 58.6) and mesocarp light-toned color with a moderate yellow component and negligible chromatic bias along the red-green axis (L* 69.6, a* 0.20, b* 31.0). Red phenotype has epicarp dark warm-toned color with a strong red component and a noticeable yellow hue (L* 32.4, a* 37.8, b* 29.8) and mesocarp warm-toned color with medium-high lightness, characterized by a moderate yellow component and a slight reddish bias (L* 60.25, a* 6.00, b* 36.25). This result is evidence that the red phenotype may have consumption advantages over the yellow one when marketed as fresh fruit. Research on color preferences in food selection has shown that consumers tend to prefer red-colored items, while yellow is among the least favored, partly because red is associated with sweetness (Kan et al. 2021; Muñiz et al. 2023).

Table 2 presents a summary of the results of chemical and proximal composition analysis for the nanche phenotypes. Only two variables showed a significant difference: pH and moisture

These results, physical characteristics, and proximal and chemical composition demonstrated that both nanche phenotypes have the same potential for consumers as fresh fruit, and in their use in food products. Some products made with nanche include dried fruit, ice cream, fermented beverages, tamales, desserts, candies, atoles, and fresh drinks, among others (San-Martín-Hernandez et al., 2023).

The percentage of protein, etereo extract, and fiber; both phenotypes are within the reported ranges for this fruit (Santana et al., 2023). The composition of lipids (oleic, palmitic, linoleic acid) and fiber (20%) ensures that even at low concentrations in the fruit, they exhibit bioactivity because of their molecules (Santana et al. 2023). An advantage of the yellow phenotype is its lower moisture content (Table 2), which increases shelf life because it contains less water available for the growth of microorganisms. However, the red phenotype is more resistant to handling post-harvest due to its higher

Table 2 Proximal and chemical composition of nanche (*B. crassifolia L.*)

Parameters	Nanche phenotype	
	Yellow	Red
pH	5.64 ± 0.20^{a}	4.84 ± 0.03^{b}
Total soluble solids (%)	11.92 ± 0.38^{a}	11.17 ± 0.90^{a}
Titratable acidity	0.75 ± 0.23^{a}	0.67 ± 0.18^{a}
Flavor index	16.93 ± 5.28^{a}	17.35 ± 3.83^{a}
Moisture (%)	78.88 ± 0.51^{b}	81.38 ± 1.00^{a}
Ash (%)	3.49 ± 0.01^{a}	3.35 ± 0.11^{a}
Etereo extract (%)	6.89 ± 0.11^{a}	6.86 ± 0.11^{a}
Crude fiber (%)	15.06 ± 0.62^{a}	12.52 ± 1.90^{a}
Protein (%)	0.65 ± 0.22^{a}	0.96 ± 0.09^{a}
Polyphenols ($g.kg^{-1}$)	0.725 ± 0.035^{b}	1.075 ± 0.072^{a}
Flavonoids ($g\ kg^{-1}$)	1.097 ± 0.018^{b}	2.68 ± 0.027^{a}
Acid chlorogenic ($g.kg^{-1}$)	0.547 ± 0.024^{b}	1.160 ± 0.081^{a}
Antioxidant activity DPPH (%)	94.956 ± 1.36^{a}	95.356 ± 1.168^{a}

Average of three replicates and standard deviation. Capital letters show statistical groups in the column (P≤0.05).

mesocarp content, which facilitates processing into products such as dehydrated goods. While the yellow red has greater potential for the development of fermented beverages and fresh drinks, the difference in moisture content is minimal between the two phenotypes of nanche.

The polyphenol, flavonoid, and chlorogenic acid content was higher in the red phenotype; however, there were no significant differences in DPPH radical scavenging between the two nanche phenotypes (**Table 2**). The high percentage of antioxidant activity indicates the functional potential of the nanche fruit; further studies on bioavailability and biodigestibility are necessary to fully evaluate its potential.

Table 3 shows an increase in the shelf life of consumer-grade fruit nanche with the use of methyl-oxo-2-(2-pentenyl), and **Figure 2** shows the appearance of the fruits at the end of the consumer-grade shelf life (see **Table 3**).

The combination of MeJA and temperature increases the shelf life by two days compared to the control at room temperature. Additionally, only MeJA and a temperature of 20°C increased for some days, but the appearance of the fruit was better with the combination of MeJA and refrigeration. This treatment recommends increasing shelf life with MeJA at -5°C. However, the study was limited to one specific MeJA concentration. Currently, the nanche shelf life is one factor that has hindered the development of a value chain. The development of post-harvest technologies, such as the application of MeJA, is a process that will contribute to the commercialization of fruit.

Conclusions

The red and yellow nanche phenotypes exhibit nutritional and functional characteristics suitable for consumption as fresh fruit, enabling them to compete with other established fruits in the market. Using MeJA is a promising way to extend the shelf life of nanche and contribute to the development of a value chain.

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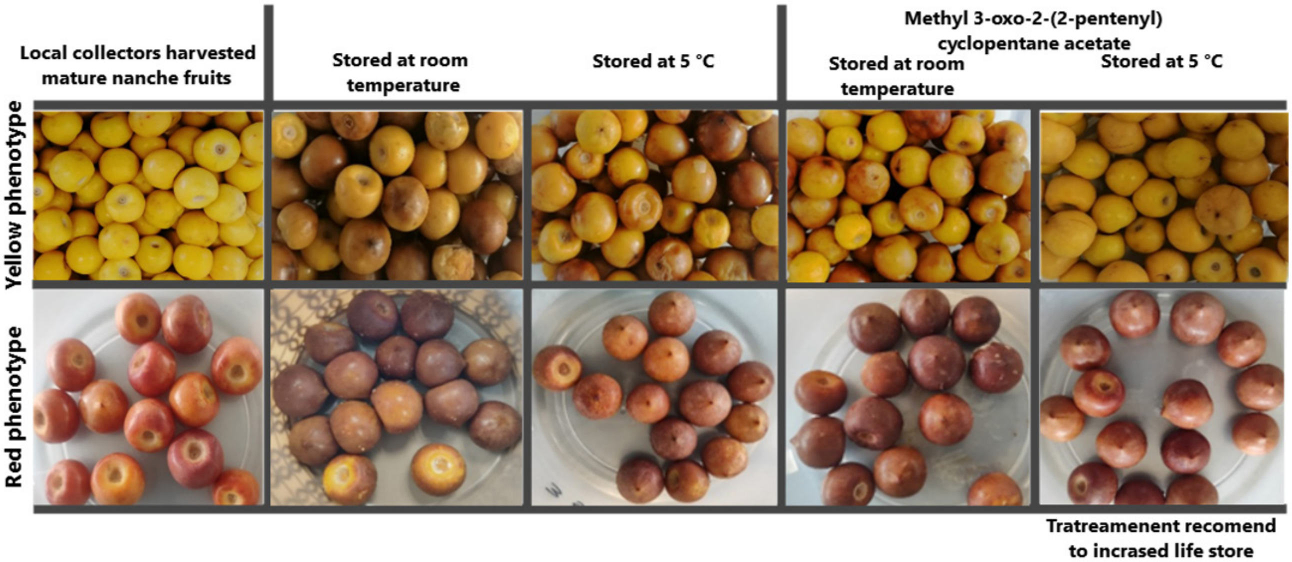

Figure 2. Nanche fruit consumer-grade shelf-life treatments alongside a control group using temperature and methyl jasmonate**.**

Table 3. Post-harvest handling of B. crassifolia L. fruit lots (yellow and red phenotypes) with methyl jasmonate (MeJA) and refrigerated to 5 °C.

Phenotype	Treatments	Weight initial(g)	Weight final(g)	Weight loss(g)	Days of consumer-grade shelf-life
Yellow	MeJA / 25 °C	300 ± 0.00	240^{c}	60^{a}	9^{ab}
	MeJA / 5 °C		264^{b}	36^{b}	**12^{a}**
	25°C		266^{b}	34^{b}	6^{b}
	5°C		281^{a}	19^{c}	6^{b}
Red	MeJA / 25 °C		297^{a}	3.63^{b}	5^{bc}
	MeJA / 5 °C		294^{a}	5.73^{b}	**10^{a}**
	25°C		295^{a}	5.63^{b}	4^{c}
	5°C		277^{b}	23.23^{a}	8^{ab}

Conflict of interest

None of the authors has a conflict of interest to disclose.

References

Agredano-De la Garza, C.S., Balois-Morales, R., Berumen-Varela, G., León-Fernández, A.L., Bautista-Rosales, P.U., López-Gúzman. G.G., Pérez-Ramírez, I.F., 2021. Physicochemical characterization and dietary fiber of 15 nance (*Byrsonima crassifolia* L.) fruits selections from Nayarit. *Scientia Horticulturae* 289: 1-7.

Avilés-Peraza, G.C., 2015. Rico y popular: Importancia y usos tradicionales del nance (*Byrsonima crassifolia* (L.) Kunth). *Desde El Herbario CICY* 7: 157–160.

Baldermann, S., Blagojević, L., Frede, K., Klopsch, R., Neugart, S., Neumann, A., Ngwene, B., Norkeweit, J., Schöter, D., Schöter, A., Schweigert, F. J., Wiesner, M., and Schreiner, M., 2016. Are neglected plants the food for the future? *Critical Reviews in Plant Sciences* 35: 106–119.

Ceferino, J.G., Ovando, M.AM., Ordo, Y.M., Ancona, D.V., Lanestosa, A.C., 2022. *In vitro* antioxidant and a-amylase inhibitory activity of extracts from peel and pulp of in *Chrysophyllum caito* cultivated in the Mexican southeast. *Journal of Food and Nutrition Research* 61: 16–26.

Díaz-Orduño, G.R., Madera-Santana, T.J., Meléndez-Amavizca, R., Felician-Vega, A., Sánchez-Torreblanca, J.N., Sánchez-Escalante, A., Torrescano-Urrutia, G.R., 2018. Composición y actividad antioxidante de extractos de cáscara de papa esterilizados con autoclave e irradiación. *Biotecnia* 20: 51-58.

Hernández-Cuello, G., Ramos-Carbajal, E., González-Mejías, O., Pérez-Petitón, J., Monzón-Monrabal, L.L., 2022. Evaluación de propiedades químico-físicas en nanche (*Byrsonima crassifloria* L.). *Revista Ciencias Técnicas Agropecuarias* 31:1-6.

Kang, S.R., Faber, C., Ladjahasan, N., Quam, A. 2021. Color and flavor perception. In International Conference on Applied Human Factors and Ergonomics. Springer International Publishing, Cham, Switzerland. p. 226–232.

Maldonado, P.M., Sánchez, S.P., Rojas, G.A., Valenzuela, L.J.L., Bottini, L.M., Gutiérrez, L.A., 2020. Characterization and evaluation of fruits of 'nanche' (*Byrsonima crassifolia* L.). *Revista Mexicana de Ciencias Agrícolas* 11: 151–160.

Muniz, V. R. G. D. F., Ribeiro, I. S., Beckmam, K. R. L., Godoy, R.C.B.D., 2023. The impact of color on food choice. *Brazilian Journal of Food Technology* 26: e2022088.

Reyes-Díaz, M., Lobos, T., Cardemil, L., Nunes-Nesi, A., Retamales, J., Jaakola, L., Alberdi, M., Ribera-Fonseca, A., 2016. Methyl jasmonate: An alternative for improving the quality and health properties of fresh fruits. *Molecules* 21: 567.

Rivas-Castro, S.F., Martínez-Moreno, E., Alia-Tejacal, I., Pérez-López, A., 2019. Physical and physiological changes in phenotypes of nance [*Byrsonima crassifolia* (L.) H.B.K.] with different harvest maturity, *Scientia Horticulturae*, 265: 108620.

Rojas-García, A.R, Maldonado-Peralta R., Salinas-Vargas, D., Wilson-García, C.Y., Sabino-López, J.E., Maldonado-Peralta, M.A., 2021. Variación morfológica en frutos de nanche (*Byrsonima crassifolia*) en el trópico seco. *Ecosistemas y Recursos Agropecuarios* 8: e2883.

San-Martín-Hernández, C., Martínez-Téllez, M.A., Valenzuela-Amavizca, O.N., Aispuro-Hernández, E., Sánchez-Sánchez, M., Hernández-Camarillo, E., López-Martínez L.X., Quintana-Obregón, E.A., 2023. *Byrsonima crassifolia* L. Kunth a bio-resource with potential: Overview and opportunities. *Folia Horticulturae* 35: 61-75.

Santana, M.G., Martinez, R.M., Teodoro, A.J., 2023. Biological effects of muri (Byrsonima spp.). In: Mérillon, JM., Ramawat, K.G. (eds) Plant Specialized Metabolites. Reference Series in Phytochemistry. Springer, Cham. p. 123-134.

SIAP, 2023. Statistical Yearbook of Agricultural Production. Secretariat of Agriculture and Rural Development. Mexico. Accessed on February 15, 2024. https://nube.siap.gob.mx/cierreagricola

Yu, X., Zhang, W., Zhang, Y., Zhang, X., Lang, D., Zhang, X., 2018. The roles of methyl jasmonate to stress in plants. *Functional Plant Biology* 46: 197-212.

Conflict of Interest Statement: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.