Artículo de Investigación. Revista Ciencia e Ingeniería. Vol. 47, No. 3 pp.369-378, agosto-noviembre, 2026.
ISSN 1316-7081. ISSN Elect. 2244-8780 Universidad de los Andes (ULA)

Phytochemical and antioxidant characterization of extracts of *Mangifera indica L.* and *Passiflora edulis*

Caracterización fitoquímica y antioxidante de extractos de *Mangifera indica L.* y *Passiflora edulis*

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Abstract

Secondary metabolites are bioactive compounds synthesized by plants, fungi, and microorganisms; more than 25% of drugs are derived from plant sources. Currently, agro-industrial waste such as passion fruit seeds and mango leaves represent residues that can be used as multifaceted raw materials. The purpose of this research was to compare the physicochemical characteristics of two natural extracts used as antioxidants and anti-inflammatories in biomedical applications. Yield, solubility, refractive indices, and phytochemical profile were determined by qualitative screening and Fourier transform infrared spectroscopy (FTIR). The results revealed the superiority of the mango leaf extract over passion fruit seeds in both polyphenol content and antioxidant capacity. The phytochemical screening confirmed that Mangifera indica L. possesses a wide diversity of secondary metabolites, including tannins, anthocyanins, and phytosterols, while in the Passiflora edulis triterpenes, however, coincided with the phenolic compounds and alkaloids. Both extracts showed insolubility in water and high affinity for short-chain alcohols. It is concluded that, although Passiflora edulis it is industrially more viable due to its high performance, the Mangifera indica L. it presents a superior bioactive profile; however, both can be used in the development of pharmaceutical, cosmetic, and food formulations; confirming that waste can be transformed into high value-added raw materials, promoting alternatives that reduce environmental impact and offer therapeutic alternatives.

Keywords: Mangifera indica, Passiflora edulis, antioxidant capacity, total polyphenols, phytochemical profile.

Resumen

Los metabolitos secundarios son compuestos bioactivos sintetizados por plantas, hongos y microorganismos; más del 25 % de los fármacos derivan de fuentes vegetales. Actualmente, los desechos agroindustriales como las semillas de parchita y hojas de mango, representan residuos que pueden ser aprovechados como materia prima multifacética. La finalidad de esta investigación fue comparar las características fisicoquímicas de dos extractos naturales empleados como antioxidantes y antinflamatorios en aplicaciones biomédicas. Se determinó el rendimiento, solubilidad, índices de refracción y perfil fitoquímico mediante tamizaje cualitativo y espectrofotometría de infrarrojos con transformada de Fourrier (FTIR). Los resultados revelaron la superioridad del extracto de hojas de mango sobre las semillas de parchitas tanto en el contenido de polifenoles como en capacidad antioxidante. El tamizaje fitoquímico confirmó que Mangifera indica L. posee una amplia diversidad de metabolitos secundarios, que incluyen taninos, antocianinas y fitoesteroles, mientras en la Passiflora edulis Triterpenos, sin embargo, coincidiendo los compuestos fenólicos y alcaloides. Ambos extractos mostraron insolubilidad en agua y alta afinidad por alcoholes de cadena corta. Se concluye que, si bien Passiflora edulis es industrialmente más viable por su alto rendimiento, la Mangifera indica L. presenta un perfil bioactivo superior, no obstante, ambas puedes ser empleadas en el desarrollo de formulaciones farmacéuticas, cosméticas y alimentos; confirmando que los desechos pueden ser transformados en materias primas de alto valor agregado, promoviendo alternativas que reducen el impacto ambiental y ofrecen alternativas terapéuticas.

Keywords: Mangifera indica, Passiflora edulis, antioxidant capacity, total polyphenols, phytochemical profile.

1 Introduction

In a plant, carbohydrates, amino acids, and proteins are the main metabolites that are primarily active during the development and maturation phases of plant tissues. Secondary metabolites, on the other hand, form the biological system and are produced throughout the developmental cycle to help plants survive and overcome natural obstacles (Azmir *et al*., 2013).

In recent years, research on medicinal plants has increased worldwide due to their applications in phytopharmacology. Among these molecules are phenolic acids, tannins, and flavonoids, which possess important biological properties such as activities antimicrobials, anti-inflammatory, anticancer and antioxidant (Allaguiet al., 2023). Plants and their plant extracts are a relevant source of bioactive compounds widely used in functional foods, as well as for therapeutic purposes.

It is important to highlight the properties of plants used in traditional medicine worldwide, which leverages phytochemistry to determine their applicability. The efficacy of an extract is associated with the synergistic interactions of multiple bioactive compounds present in it; these interactions may not be detectable when the individual compounds are evaluated in isolation (Wink, 2015).

Mangifera indica L., commonly known as mango, belongs to the Anacardiaceae family, its leaves contain a variety of bioactive compounds, including polyphenols, flavonoids, tannins, alkaloids, glycosides, steroids, triterpenoids, saponins, mangiferin, and anthocyanins. These compounds exhibit antioxidant, anti-inflammatory, and antimicrobial properties (Kaur.et al., 2025). Mangiferin, extracted mainly from the leaves and bark, has been studied for its antioxidant and anti-inflammatory properties, showing potential in the treatment of chronic diseases such as diabetes and cardiovascular diseases, among others. (Minniti,et al., 2023; Kumar, et al., 2021).

Mango leaves are considered waste, mainly generated by pruning the plant, but in reality they are of great importance, as they contain a huge variety of phytoactives, including phenolic compounds, crude proteins, essential oils, dietary fiber, vitamins and minerals (Mehmood et al., 2024).

It is worth noting that the main secondary metabolite present in Mangifera indica L. is Mangiferin, whose chemical structure is $C_{19}H_{18}O_{11}$ (1,3,6,7 tetrahydroxyxanthone-C2-β-D-glucoside), a phenolic compound, specifically a xanthone, which is a carbonyl compound consisting of a xanthene heterocycle oxidized at position 9. Mangiferin can be found in the leaves, bark, seeds, flower, fruit, and pulp of the mango, and has high pharmaceutical and nutraceutical value. (Forero and Pulido, 2016).

On the other hand, Passiflora edulis, commonly known as passion fruit, belongs to the Passifloraceae family. It possesses bioactive compounds such as alkaloids, flavonoids like vitexin, isovitexin, orientin, and isoorientin, and also contains anthocyanins, with antioxidant properties that help protect cells from oxidative damage, phenolic acids such as chlorogenic acid and caffeic acid, carotenoids, saponins, and phytosterols such as β-sitosterol. (Villada, et al., 2023. Patel, et al., 2011). However, the main component is piceatannol, which is a stilbenoid and a phenolic compound with the chemical structure $((HO)_2C_6H_3)_2CH)_2$ (4-[(*E*)-2-(3,5-Dihydroxyphenyl)ethene-1-yl]benzene-1,2-diol).
Stilbenoids, which are hydroxylated derivatives of stilbene, belong to the phenylpropanoid family, which is why piceatannol is also considered a phenolic compound. This compound is found primarily in the fruit seeds (Zomer et al., 2022).

Increasing attention has been paid to bioactive food compounds that may provide additional health benefits beyond basic nutritional needs. Among these identified bioactive constituents, polyphenols are the most studied, with growing evidence of their potential role in the prevention of chronic human diseases. They possess numerous biological and pharmacological properties, including neuroprotection, anti-inflammatory, antioxidant, antimicrobial, antihyperglycemic, antiallergic, and chemopreventive activity against cancer. Among these functions, anti-inflammatory activity is the fundamental principle behind many of these activities, as common causal factors in these diseases include inflammation, which leads to increased levels of inflammatory mediators such as pro-inflammatory cytokines, chemokines, and oxidative enzymes in immune cells (Wang et al., 2021).

The purpose of this research was to compare the physicochemical, photochemical and antioxidant characteristics of two natural extracts obtained from mango leaves and passion fruit seeds.

2 Experimental Procedure

2.1 Extraction of bioactive compounds

The leaves of Mangifera indica L. and the seeds of Passiflora edulis were dried in an oven (VWR Scientific, model 1305U) at (100 ± 5) °C for 3 hours, until a constant weight was achieved (AOAC 925.10, 2012). Once dry, they were ground to reduce the sample size.
The extraction of bioactive compounds from both the *Mangifera indica* L. leaves and the Passiflora edulis seeds was performed using the Soxhlet method according to the methodology proposed by Ahmad et al. (2020), with some modifications. The extraction was carried out at 78 °C for 6 hours, using 96% ethanol as the solvent. After the extraction process, the solvent was removed by distillation using a rotary evaporator.

2.2. Phytochemical screening

Phytochemical screening was performed using colorimetric tests, following the methodologies and evaluation criteria proposed by Verde-Star et al. (2016), Shaikh and Patil (2020), and García-Granados et al. (2019), with some modifications, in order to identify the presence of phytoconstituents in the extracts. The tests performed were Dragendroff (Alkaloids), Salkowski (Phenolic Compounds), Ferric Chloride (Phenolic Compounds - Tannins), Shinoda (Flavonoids, Flavones, and Flavonols), Shibata (Flavonols and Flavones), Liebermann-Burchard (Phytosterols - Triterpenes), and Hydrochloric Acid Test (Anthocyanins).

2.3 Caracterización de los extractos de hoja de mango y semillas de parchitas

The refractive index (Covenin 702:2001), total polyphenol content (Jeszka-Skowron et al., 2016), and antioxidant capacity (Pacheco-Coello et al., 2020) were determined for the extracts obtained. The solubility of the extract was also assessed using the methodology proposed by Scotti et al. (2020), based on linear alcohols of different polarities. Fourier transform infrared spectrophotometry was also performed.

3 Results and discussion

3.1 Extraction of bioactive compounds

The extraction yield obtained from mango leaves (Mangifera indica L.) was 8.49%, a value that falls within the range reported by Kassi et al. (2019), who indicate that it ranges from 7.04% to 10.61%. More recent research, such as that by Zahoor et al. (2023), indicates that the yield can range from 6.33% to 9.88% depending on the variety. The extract was a greenish-brown color, very viscous in appearance, and had a characteristic odor.

The processing yield of passion fruit seeds was 34.13%, although other studies, such as Pantoja-Chamorro et al. (2017), reported values between 16.7% and 33.5%, noting that it depends on the technique, solvent, and geographic origin. Scotti et al. (2020), on the other hand, obtained a yield of 19.65%. The extract was an ochre-yellow color, viscous in appearance, and had a characteristic passion fruit odor.

In general, the extraction conditions play a determining role in the performance of the process, since parameters such as the type of solvent, temperature and extraction time, directly influence the diffusion and solubilization of the bioactive compounds (Hernández-Carranza et al., 2015), as well as the variety of the plant.

3.2 *Phytochemical screening*

Table 1 shows the metabolites determined for each extract, where the phytochemical behavior differed in some tests. Both extracts contained alkaloids. In the case of mango leaf, Ali et al. (2020) reported their presence and quantified them, obtaining a value of (0.300±0.141)%, while for passion fruit seed, Chaichit et al. (2026) reported the presence of beta-carbonyl alkaloids such as harmaline, harmine, harman, and harmol, while Yuan et al. (2017) reported the presence of cis- and trans-ferulothyramine.

Alkaloids are notable for their therapeutic properties for humans, such as: antimicrobial, analgesic, antimalarial, antiparasitic (Delovino and Carlos, 2026; Alshammaa, 2016), and sedative, acting as anxiolytics and antidepressants because they play an important role as modulators of stress and anxiety (Campos-Rodríguez et al., 2023).

Table 1. Phytochemical screening of the extracts

Metabolite	Tests	*Mangifera indica* L.	*Passiflora edulis*
Alkaloids	Dragendorff	+++	+++
Phenolic Compounds	Salkowski	+++	+++
	Ferric chloride	+++	-
Flavonoids. Flavones, Isoflavones and Flavonols	Shinoda	+++	++
Flavonols and Flavones	Shibata	+++	-
Tannins	Ferric chloride	+++	-
Phytosterols	Liebermann-Burchard	+++	-
Triterpenes	Liebermann-Burchard	-	+++
Anthocyanins	Hydrochloric acid	+++	-

+ Positive - Negative

Regarding phenolic compounds, the results indicate a notable difference between the species. In the mango leaf extract, the presence of phenolic compounds such as flavonoids was confirmed, specifically flavones, isoflavones, and anthocyanins, as well as tannins, terpenes, terpenoids, and phytosterols. In the passion fruit seed extract, phenolic compounds such as flavonoids and flavones were found. This variability in phenol synthesis can be explained by the findings of García-Granados et al. (2019), who state that the absence of certain phenols and tannins in passionflower seeds, in contrast to their abundance in mango leaves, could be linked to the differential biosynthesis, distribution, and mobilization of their metabolites among the plant's structures.

Phenolic compounds have been proposed in numerous studies to be used as: antioxidants, anti-inflammatories, antimicrobials (gram-positive bacteria, gram-negative bacteria and yeasts), immunomodulators, antiallergics, antifungals, antiparasitics, antipyretics, hepatoprotectants, antidiabetics, antidiarrheals, antiplatelet agents, antivirals and antitumor agents (Amrita et al., 2009; Morais et al., 2016; Kumar et al., 2021; Mirza et al., 2021).

Regarding phytosterols, despite the test being negative in passion fruit extract, research has reported that they are minor components, and compounds such as campesterol, stigmasterol, β-sitosterol and lanosterol have been identified by gas chromatography coupled to mass spectrometry (Pantojas-Chamorro et al., 2017).

On the other hand, the Libermann-Burchardt test was negative for terpenes in mango leaf, however, research such as Kumar et al., (2021) reported monoterpenes, sesquiterpenes, smaller amounts of their analogues and traces of non-terpenoid hydrocarbons and oxygenated hydrocarbons.

3.3. Characterization of the extracts

3.3.1 Total polyphenols and antioxidant capacity

Table 2 shows the parameters measured for each extract. In the case of the refractive index, commonly used as a reference for impurities in oil extracts, it was found that for the *Mangifera indica* L. leaf extract, it falls within the range reported by Zahoor et al. (2023), whose results ranged from 1.443 to 1.457. On the other hand, Nadeem and Imran (2016) mentioned a refractive index value of 1.457. Similarly, Kassi et al. (2019) reported values between 1.458 ± 0.001 and 1.480 ± 0.002. Regarding the seed extract of *Passiflora edulis*, the value found is similar to that reported by Scotti et al., (2020). When compared with other investigations such as Guzman et al., (2021) reported an index of 1.465 ± 0.005, while Cuong et al., (2019) obtained a refractive index of 1.472, slightly lower; the difference may be due to the plant's growing conditions.

Table 2. Características fisicoquímicas de los extractos

Parameter	*Mangifera indica* L.	*Passiflora edulis*
Refractive index	1.442	1.467
Total polyphenols (mg/L)	6190.15 ± 0,92	64.45 ± 0,01
Antioxidant capacity (%)	77.43 ± 0.98	26.27 ± 0.01

The total polyphenol content, as well as the antioxidant capacity of the extracts, shows a behavior that differentiates them in terms of their phytochemical composition (Table 2). Mango leaf extract is rich in polyphenols. Carranza-Ortiz et al. (2025) reported polyphenols ranging from 1036.531 to 5028.293 mg GAE/100 g, results similar to those reported by Wu et al. (2020), who obtained phenolic compounds from mango leaves using 70% ethanol as a solvent and reported a range of 1602 to 3229 mg GAE/100 g. According to Medina-Saavedra et al. (2020), this quantitative variability is due to the fact that these leaves are a significant source of bioactive compounds such as phenols, flavonoids, triterpenes, phytosterols, and polyphenols, among which mangiferin stands out. Domínguez-Ruvalcaba et al. (2025) complements this characterization by identifying other metabolites such as chlorogenic, hydroxybenzoic, caffeic and coumaric acids using HPLC-UV/VIS.

Meanwhile, the seed extract of *Passiflora edulis* revealed a lower concentration of total polyphenols than mango leaf. Noguera-Machado et al. (2019) reported an average total phenol content of 68.72 ± 0.69 mg GAE/g of extract, a value similar to that found in this study. Santana et al. (2017) highlight that the main polyphenol in passion fruit seeds is piceatannol, a stilbenoid with important biological activities such as antioxidant, anti-inflammatory, analgesic, and anticarcinogenic properties..

While mango leaf extracts register exceptional concentrations, passion fruit seeds typically average values between 16 mg GAE/g and 65 mg GAE/g depending on the extraction method.

The phenolic compounds present in the extracts can influence their antioxidant capacity (Table 2). Kulkarni and Rathod (2018) indicate that the high activity in mango leaves is mainly due to mangiferin and other constituents in the crude extract, which possess numerous hydroxyl groups that facilitate electron donation and the termination of free radical chain reactions. Meanwhile, Medina-Saavedra et al. (2021) evaluated the antioxidant activity of aqueous mango leaf extracts using the ABTS assay, obtaining a value of 59.13 mg trolox eq/100 g.

In the case of passion fruit seed extract, Malacrida and Jorge (2012) reported a value of 25.61%, indicating a moderate antioxidant capacity, which is intrinsically linked to its tocopherol composition, especially δ and γ tocopherols, which have superior biological activity compared to the α and β forms. Furthermore, phenolic compounds act synergistically with tocopherols to scavenge free radicals (Silva et al., 2023), while lipid fractions such as squalene and sterols act as protective agents against oxidation (Pantoja-Chamorro et al., 2017; Silva et al., 2023). The polyphenols in P. edulis seeds contain a high amount of piceatannol, which has been reported to have antioxidant activity; therefore, it is considered responsible for the antioxidant activity of the seed extracts.

3.3.2 *Solubility of the extracts*

The solubility of ethanolic extracts of *Mangifera indica* L. leaves and Passiflora *edulis* seeds reflects physicochemical differences based on the nature of their predominant metabolites (Table 3). In the case of mango leaves, solubility is governed by mangiferin, a xanthone that constitutes approximately 41% of the extract content, with an intermediate polarity (Acosta et al., 2016). In contrast, the passion fruit seed extract has a dominant lipid fraction of approximately 81.7%, composed of unsaturated fatty acids and stilbenes such as piceatannol, which gives it a markedly lipophilic character (Krambeck et al., 2020; Santos et al., 2020).

Diaz et al. (2023) indicate that the solvent's dielectric constant is adjusted for polyphenols, while Peron et al. (2025) mention the solubility of the plant material's flavonoids. Both extracts were soluble in intermediate-chain alcohols (propanol, butanol, and pentanol). This behavior is based on the fact that these solvents offer a balance between the ability to form hydrogen bonds and dispersion interactions, a determining factor for dissolving complex molecules (Rajakumar et al., 2014). Following the principle that like dissolves like, the decrease in polarity of these alcohols compared to water allows for efficient intermolecular interaction with both the aromatic nuclei of mangiferin and the hydrocarbon chains of the fatty acids in passionflower (Chaves et al., 2020).

Finally, both extracts are insoluble in water, confirming a shared hydrophobic repulsion. For *Mangifera indica* L., this insolubility is reinforced by lignocellulosic components such as lignin and cellulose present in the leaf structure (Kaur et al., 2025; Kumar et al., 2023). In the case of *Passiflora edulis*, the insolubility derives from repulsive forces towards water molecules, which prefer to form hydrogen bonds with each other rather than interact with the lipid chains of the extract (Díaz et al. 2023).

Tabla 3. Solubility of the extracts

Solvent	*Mangifera indica L.*	*Passiflora edulis*
Water	---	---
Ethanol	++++	++
Propanol	++++	++++
Butanol	++++	++++
Pentanol	++++	++++
Hexanol	++	++++
Heptanol	++	++++

++++ Soluble   --- Insoluble   ++ partially soluble

3.3.3 *Fourier transform infrared spectrophotometry (FTIR).*

The spectrum of the mango leaf extract (Fig. 1) shows a band at 1380.34 cm^{-1} associated with the symmetric bending of the methyl groups (−CH3), which is similar to that reported by Rajakumar et al. (2014) who obtained a band at 1383 cm^{-1} in the dried mango leaf powder, as an indicator of the presence of foliar lipids and terpenes, similar to Barnabas et al. (2022), who showed these groups in the band 1368.71 cm^{-1}.

The band of greatest intensity was located at 1044.42 cm^{-1}, with a strong intensity (35.45% transmittance). This is characteristic of the C-O vibration associated with lignin, hemicellulose, and polyphenolic compounds such as mangiferin. Kaur et al. (2025) highlight the region between 1030 and 1050 cm^{-1}, where the greatest absorption is concentrated due to the carbohydrate nature of the leaf matrix. The spectral region between 1200 and 1300 cm^{-1} represents the C-O stretching signal of aromatic esters.

The band at 879.20 cm^{-1} is associated with the presence of aromatic hydrocarbons and the carbon skeleton structure of terpenoids. Peron et al. (2025) reported a similarity in their study, reporting a band at 880.11 cm^{-1}.

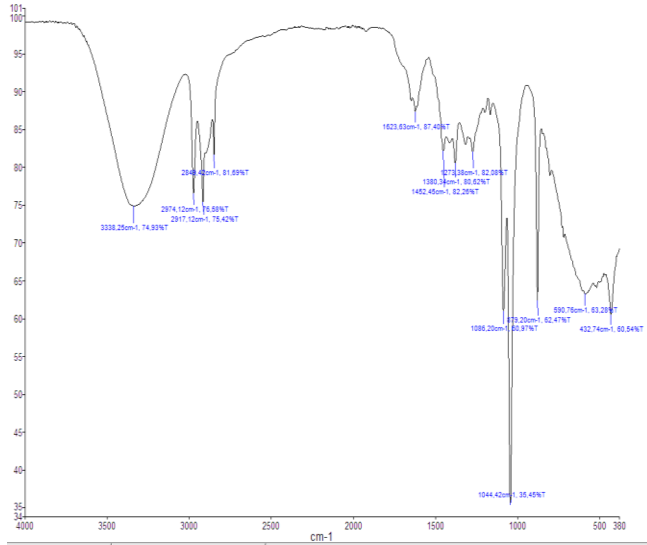

Figure 1. FTIR spectrum of crude extract of *Mangifera indica* L. leaves

On the other hand, the spectrum of the passion fruit seed extract (Fig. 2) showed a band at 3342.98 cm^{-1}, associated with the presence of hydroxyl groups (-OH). Rizwana et al. (2019) state that in the crude extract, a stretch appears at 3370.86 cm^{-1}, indicating the presence of an O–H bond, which could be an alcohol or phenol. At 2854.46 cm^{-1}, a –CH stretch shoulder is identified, confirming the unsaturation of the fatty acids, a region associated with the seed's lipid matrix (Santos et al., 2020). The bands located at 2924.01 and 2854.46 cm^{-1} correspond to the asymmetric and symmetric methylene stretches, respectively.

The band at 1744.13 cm^{-1} is associated with the carbonyl group (C=O), which has been reported in the literature at 1743.82 cm^{-1} and is associated with esters linked to triglycerides (Rizwana et al., 2019). A prominent band was also identified at 1604 cm^{-1}, which is attributed to the C=C bond stretching vibrations characteristic of the aromatic rings present in the polyphenol structure. Rosário et al. (2022) observed a similar frequency at 1637 cm^{-1}, linked to carbonyl groups (C=O) and the elongation of amide groups (N-H). This shift suggests that the components of the extract are not in a free state but participate in specific molecular interactions.

Regarding the 1140 to 710 cm^{-1} region, it shows significant structural complexity, formed by the 1160.19 - 1088.54 and 1046.54 cm^{-1} bands; associated with C-O bond stretching in alcohols and phenolic compounds; and carbohydrate structures, specifically in D-glucose units and polysaccharides such as pectin, as reported by Rizwana et al. (2019). The 721.99 cm^{-1} band is characteristic of long methylene chains in lipids.

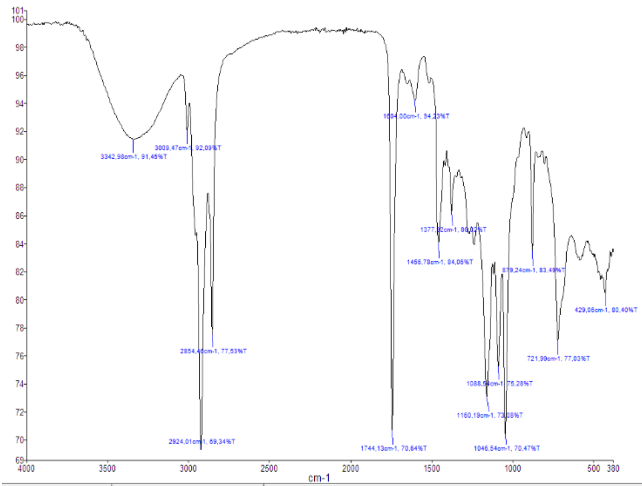

Figure. 2. FTIR spectrum of crude extract of *Passiflora edulis* seeds

4 Conclusion

The extracts possess distinct phytochemical characteristics, as well as different total phenol content and antioxidant capacity, giving each extract distinct antimicrobial and anti-inflammatory properties. The total polyphenol content in *Mangifera indica* L. significantly exceeds that of *Passiflora edulis*, which affects its antioxidant capacity, confirming the correlation between phenolic content and free radical scavenging ability. Phytochemical screening highlights the abundant bioactive components in both species, and FTIR analysis confirmed the diversity of their functional groups. It can be deduced that the nature of the compounds affects their solubility in solvents of different polarities, an important parameter for their inclusion in cosmetic and pharmaceutical formulations. It is concluded that, while *Passiflora edulis* is more industrially viable due to its high yield, *Mangifera indica* L. presents a superior bioactive profile; however, both can be used in the development of new products.

Acknowledgements

To Fonacit for funding this research, project **Nº** 2025000029 CDCH-UC Call 2024.

References

Acosta, J., Sevilla, I., Salomón, S., Nuevas, L., Romero, A., & Amaro, D. (2016). Determination of mangiferin solubility in solvents used in the biopharmaceutical industry. Journal of Pharmacy & Pharmacognosy Research, 4(2), 49-53. ISSN 0719-4250

Ahmad, A. (2020). Total Phenolic, Total Flavonoids Content and Antioxidant Activity of Mangifera sp. Leaf Extracts. Journal of agrobiotechnology, 11(1S), 69-78. https://doi.org /10.37231/jab.2020.11.1S.236

Ali B..Alfa A., Tijani K., Idris E., Unoyisa U., Junaidu Y. (2020). Nutritional Health Benefits and Bioactive Compounds of Mangifera indica L (Mango) Leaves Methanolic Extracts. Asian Plant Research Journal 6(2): 41-51. ISSN: 2581-9992.

Allagui, I.; Horchani, M.; Zammel, N.; Jalouli, M.; Elfeki, A.; Kallel, C.; Mansour, L.; Alwasel, S.; Harrath, A.; Jannet, H., Allagui, M. and Hcini, K (2023). Phytochemical Characterization, Antioxidant and Anti-Inflammatory Effects of Cleome arabica L. Fruits Extract against Formalin Induced Chronic Inflammation in Female Wistar Rat: Biochemical, Histological, and In Silico Studies. Molecules, 28(1), 2-18. https://doi.org /10.3390/molecules28010026

Alshammaa, D. (2016). Preliminary screening and phytochemical profile of Mangifera indica leave's extracts, cultivated in Iraq. International Journal of Current Microbiology and Applied Sciences, 5(9), 163-173. https://doi.org/10.20546/ijcmas.2016.509.01812

Amrita, B., Liakot, A., Masfida, A., y Begum, R. (2009). Studies on theantidiabe-tic effects of Mangifera indica stem-barks andleaves on nondiabetic, type 1 and type 2 diabetic modelrats. Bangladesh Journal of Pharmacology. 4(2), 110-114. https://doi.org /10.3329/bjp.v4i2.2488

Azmir, J.; Zaidul, I.S.M.; Rahman, M.M.; Sharif, K.M.; Mohamed, A.; Sahena, F.; Jahurul, M.H.A.; Ghafoor, K.; Norulaini, N.A.N.; Omar, A.K.M. . (2013). Techniques for extraction of bioactive compounds from plant materials: A review. Journal of Food Engineering, 117(4), 426-*436*. https://doi.org /10.1016/j.jfoodeng.2013.01.014

Barnabas, H. L., Aliyu, B. A., Gidigbi, J. A., Abubakar, A. B., & Markus, A. (2022). Comparative analysis of stable aqueous dispersion of silver nanoparticle synthesized from *Mangifera Indica* and Azadirachta Indica leaf extract. NanoNEXT, 3(4), 1-10. https://doi.org/10.54392/nnxt2241

Campos-Rodriguez, J., Acosta-Coral, K., Moreno-Rojo, C., & Paucar-Menacho, L. (2023). Maracuyá (Passiflora edulis): Composición nutricional, compuestos bioactivos, aprovechamiento de subproductos, biocontrol y fertilización orgánica en el cultivo. Scientia Agropecuaria, 14(4), 479-497. https://doi.org/10.17268/sci.agropecu.2023.040

Carranza-Ortiz D., Ambrosio-Gómez M., Chávez-Portillo M.,Carreón-Hidalgo J. y Martínez-Ramos T. (2025). Extracción e Identificación de Compuestos Fenólicos de hojas de mango (Mangifera indica L.) Revista Politécnica de Aguascalientes, 6 (4) ISSN: 2954-5102

Chaichit, S., Nitthikan, N., Kiattisin, K., y Jiranusornkul, S. (2026). Composición química y potencial antienvejecimiento de fracciones de subproductos *de Passiflora edulis*: un estudio comparativo que integra perfilado metabolómico y acoplamiento molecular. *Compuestos 6(*2), 32. https://doi.org /10.3390/compounds6020032

Chaves, J., de Souza, M., da Silva, L., Lachos-Perez, D., Torres-Mayanga, P., Machado, A., Forster-Carneiro, T., Vázquez-Espinosa, M., González-de-Peredo, A., Barbero, G., & Rostagno, M. (2020). Extraction of Flavonoids From Natural Sources Using Modern Techniques. Frontiers in chemistry, 8(507887), 1-25. https://doi.org /10.3389/fchem.2020.507887

Cuong, T., Phuong, D., Anh, N., Khanh, P., Huong, T., & Cuong, N. (2019). Chemical compositions of Passiflora edulis seed oil cultivated in Viet Nam. Vietnam Journal of Science and Technology, 57(5), 551-558. https://doi.org /10.15625/2525-2518/57/5/13801

Delovino, R., & Carlos, R. (2026). Phytochemical analysis of mango leaves (Mangifera indica L.). International Journal for Multidisciplinary Research, 8(1), 1-8.13. https://doi.org /10.36948/ijfmr.2026.v08i02.71487

Díaz-Villagómez, D., Hernández-Ramírez, R., Cruz-Cruz, D., & Villegas-Gómez, C. (2023). Análisis fitoquímico: Una visión integral de los métodos de extracción de productos naturales. Naturaleza y Tecnología, 10(1) 22-35.

Domínguez-Ruvalcaba, J., Calderón-Santoyo, M., González-Gutiérrez, K., & Ragazzo-Sánchez, J. (2025). Extracto polifenólico de hojas de mango (Mangifera indica L.): Caracterización y actividad antifúngica in vitro. Revista Internacional de Investigación e Innovación Tecnológica, 13(75), 22-38.

García-Granados, R., Cruz-Sosa, F., Alarcón-Aguilar, F., Nieto-Trujillo, A., & Gallegos-Martínez, M. (2019). Análisis fitoquímico cualitativo de los extractos acuosos de Thalassia testudinum Banks ex Köning et Sims de la localidad de Champotón, Campeche, México, durante el ciclo anual 2016-2017. Polibotánica, (48), 151-168. https://doi.org /10.18387/polibotanica.48.12

Guzmán, C., Rojas, M. A., & Aragón, M. (2021). Optimization of ultrasound-assisted emulsification of emollient nanoemulsions of seed oil of Passiflora edulis var. edulis. Cosmetics, 8(1), 1-22. https://doi.org /10.3390/cosmetics8010001

Hernández-Carranza, P., Ávila-Sosa, R., Guerrero-Beltrán, J. Á., Navarro Cruz, A. R., Corona-Jiménez, E., & Ochoa-Velasco, C. E. (2015). Optimization of Antioxidant Compounds Extraction from Fruit By Products: Apple Pomace, Orange and Banana Peel. Journal of Food Processing and Preservation, 40, 103-115. https://doi.org /10.1111/jfpp.12588

Jeszka-Skowron, M., Sentkowska, A., Pyrzyńska, K., & De Peña, M. (2016). Chlorogenic acids, caffeine content and antioxidant properties of green coffee extracts: influence of green coffee bean preparation. European Food Research and Technology, 242(9), 1403-1409. doi.org /10.1007/s00217-016-2643-y

Jorge, N., Malacrida, C., Angelo, P., Andreo, D. (2009). Composição centesimal e atividade Antioxidante do extrato de sementes de maracujá (passiflora edulis) em óleo de soja. Pesquisa Agropecuária Tropical, 39(4), 380-385.

Kassi, A., Soro, Y., Koffi, E., & Sorho, S. (2019). Physicochemical study of kernel oils from ten varieties of Mangifera indica (Anacardiaceae) cultivated in Cote d'Ivoire. African Journal of Food Science, 13(7), 135-142. https://doi.org /10.5897/AJFS2019.1827

Kaur, J., Kaushik, D., Kumar, M., Babagil, G., Amarowicz, R., Proestos, C., Oz, E., Oz, F., Esatbeyoglu, T., & Bordiga, M. (2025). Comprehensive Analysis and Characterization of Mangifera indica L. Leaf Powder. Food science & nutrition, 13(6). 1-13. https://doi.org/10.1002/fsn3.70083

Krambeck, K., Oliveira, A., Santos, D., Pintado, M. M., Silva, J. B., Sousa Lobo, J. M., & Amaral, M. (2020). Identification and quantification of stilbenes (piceatannol and resveratrol) in Passiflora edulis by-products. Pharmaceuticals, 13(4), 1-9. https://doi.org/10.3390/ph13040073

Kulkarni, V., & Rathod, V. (2018). Exploring the potential of Mangifera indica leaves extract versus mangiferin for therapeutic application. Agriculture and Natural Resources, 52(2), 155-161. doi.org /10.1016/j.anres.2018.07.001

Kumar, A., Kumar, J., Tomer, V., Oz, E., Proestos, C., Zeng, M., Elobeid, T., & Oz, F. (2023). Major Phytochemicals: Recent Advances in Health Benefits and Extraction Method. Molecules, 28(2), 1-41. https://doi.org /10.3390/molecules28020887

Kumar, M., Saurabh, V., Tomar, M., Hasan, M., Changan, S., Sasi, M., Maheshwari, C., Prajapati, U., Singh, S., Prajapat, R. K., Dhumal, S., Punia, S., Amarowicz, R., & Mekhemar, M. (2021). Mango (Mangifera indica L.) Leaves: Nutritional Composition, Phytochemical Profile, and Health-Promoting Bioactivities. Antioxidants (Basel, Switzerland), 10(2), 1-23. https://doi.org /10.3390/antiox10020299

Malacrida, C., & Jorge, N. (2012). Yellow passion fruit seed oil (Passiflora edulis f. flavicarpa): Physical and chemical characteristics. Brazilian Archives of Biology and Technology, 55(1), 127-134. https://doi.org /10.1590/S1516-9132012000100016

Medina-Saavedra, G., Ramírez-Rivera, E., Herrera-Corredor, J., Sánchez-Valera, O., & Ramón-Canul, L. (2020). Evaluación de diversas actividades biológicas in vitro en las hojas de Mangifera indica L. Journal CIM, 8(1), 1421-1428.

Medina-Saavedra, G. Y., Herrera-Corredor, J. A., Vargas-Rivera, Y., Sánchez-Valera, O. V., Cabal-Prieto, A., Prinyawiwatkul, W. & Ramón Canul, L. G. (2021). Mango (Mangifera indica L.) leaf extracts as ingredient for the formulation of functional beverages with biological activity. International Journal of Food Science & Technology, 56(7), 3322-3332. https://doi.org /10.1111/ijfs.14910.

Mehmood, H., Mehmood, J., & Zulfiqar, N. (2024). Exploring the phytochemistry and pharmacology of Mangifera indica L. (Mango) leaves: A review. International Journal of Plant Based Pharmaceuticals, 4(1), 9-18, https://doi.org /10.29228/ijpbp.38.

Mirza, B., Croley, R., Ahmad, M., Pumarol, J., Das, N., Sethi, G., y Bishayee, A. (2021). Mango (Mangifera indica L.): a magnificent plant with cancer preventive and anticancer thera-peutic potential. Critical Reviews in Food Science and Nutrition. 61(13), 2125–2151. https://doi.org /10.1080/10408398.2020.1771678

Minniti, G., Laurindo, L. F., Machado, N. M., Duarte, L. G., Guiguer, E. L., Araujo, A. C., Dias, J. A., Lamas, C. B., Nunes, Y. C., Bechara, M. D., Baldi Júnior, E., Gimenes, F. B., & Barbalho, S. M. (2023). Mangifera indica L., By-Products, and Mangiferin on Cardio-Metabolic and Other Health Conditions: A Systematic Review. Life, 13(12), 1-18. https://doi.org /10.3390/life13122270

Morais, C. A., de Rosso, V. V., Estadella, D., & Pisani, L. P. (2016). Anthocyanins as inflammatory modulators and the role of the gut microbiota. *Journal of Nutritional Biochemistry*, *33*, 1-7. h https://doi.org /10.1016/j.jnutbio.2015.11.008

Nadeem, M., & Imran, M. (2016). Promising features of mango (Mangifera indica L.) kernel oil: a review. Journal of Food Science and Technology, 53(5), 2185-2195. https://doi.org/10.1007/s13197-015-2166-8

Noguera-Machado, N., Ojeda, L., Jiménez, M., Kremisisky, M., Velásquez, I., & Pacheco, F. (2019). Evaluación del extracto hidroalcohólico de las semillas de Passiflora edulis y su efecto sobre el crecimiento de Escherichia coli (ATCC 25922). Saber, 31, 248-255.

Pacheco-Coello, F., Peraza-Matrero, M., Orosco-Vargas, C., Ramirez-Azuaje, D., & Pinto-Catari, I. (2020). Determination of total phenolic compounds and evaluation of the antioxidant activity of commercial and artisanal green tea traded in Maracay, Venezuela. Revista Boliviana de Química, 37(1), 28-33. doi: 10.34098/2078-3949.37.1.4

Pantoja-Chamorro, A., Hurtado-Benavides, A., & Martinez-Correa, H. (2017). Caracterización de aceite de semillas de maracuyá (Passiflora edulis Sims.) procedentes de residuos agroindustriales obtenido con CO2 supercrítico. Acta Agronómica, 66(2), 178-85. https://doi.org/10.15446/acag.v66n2.57786

Patel, S., Soni, H., Mishra, K., & Singhai , A. (2011). Recent updates on the genus Passiflora: A review. International Journal of Research in Phytochemistry and Pharmacology, 1(1), 1-16.

Peron, R., Abu, A., Zainudin, M., Abdul, A., Nik, N., Md Sarip, M., & Mohd, N. (2025). Optimization of Harumanis mango leaves extract for enhanced pharmacognostic profile using response surface methodology approaches. Pertanika Journal of Tropical Agricultural Science, 48(5), 1419-1439.

Rajakumar, G., Rahuman, A., Roopan, S., Chung, I.-M., Anbarasan, K., & Karthikeyan, V. (2014). Efficacy of larvicidal activity of green synthesized titanium dioxide nanoparticles using Mangifera indica extract against blood-feeding parasites. Parasitology Research, 114, 571-581. https://doi.org/10.1007/s00436-014-4232-1

Rizwana, H., Al Otibi, F., & Al-malki, N. (2019). Chemical composition, FTIR studies and antibacterial activity of Passiflora edulis f. edulis (Fruit). Journal of Pure and Applied Microbiology, 13(4), 2489-2498. https://doi.org/10.22207/JPAM.13.4.64

Rosário, R., Soares, S., Martins, M., Nascimento, F., Silva, J., Teixeira-Costa, B., Figueira, M., & Santos, O. (2022). Bioactive, technological-functional potential and morphological structures of passion fruit albedo (Passiflora edulis). Food Science and Technology, 42, 1-10.

Santana, F., Torres, L., Shinagawa, F., Silva, A., Yoshime, L., Melo, I., Marcellini, P., & Mancini-Filho, J. (2017). Optimization of the antioxidant polyphenolic compounds extraction of yellow passion fruit seeds (Passiflora edulis Sims) by response surface methodology. Journal of Food Science and Technology, 54(11), 3552-3561. https://doi.org/10.1007/s13197-017-2813-3

Santos, O., Vieira, E., Soares, S., Conceição, L., Nascimento, F., & Teixeira-Costa, B. E. (2020). Utilization of agroindustrial residue from passion fruit (Passiflora edulis) seeds as a source of fatty acids and bioactive substances. Food Science and Technology, 41(Suppl. 1), 218-225. https://doi.org/10.1590/fst.16220

Scotti, E., Velásquez, I., Ojeda, L., Pacheco, F. y Noguera-Machado, N. (2020). Caracterización e incorporación de un extracto de semillas de parchita (Passiflora edulis) en un hidrogel. Revista Ingeniería UC, 27(3), 273-281.

Shaikh, J., & Patil, M. (2020). Qualitative tests for preliminary phytochemical screening: An overview. International Journal of Chemical Studies, 8(2), 603-608. https://doi.org/10.22271/chemi.2020.v8.i2i.8834

Silva, J., Maciel, P., Silva, E., Macedo, R., Santiago, A., Pereira, D., Lima, M., & Ferreira, M. (2023). Extração, caracterização e avaliação do potencial antioxidante do óleo fixo de semente de maracujá amarelo (Passiflora edulis f. flavicarpa). Research, Society and Development, 12(3), 1-19. http://dx.doi.org/10.33448/rsd-v12i3.40606.

Verde-Star, M., García-González, S., & Rivas-Morales, C. (2016). Metodología científica para el estudio de plantas medicinales. En Rivas-Morales, C., Oranday-Cárdenas, M. & Verde-Star, M. (Eds.), Investigación en plantas de importancia médica, OmniaScience, 1-40. http://dx.doi.org/10.3926/oms.313

Villada, J., Aguillón, J., Restrepo, B., Loango, N., & Maldonado, M. (2023). Identification of potential bioactive compounds of Passiflora edulis leaf extract against colon adenocarcinoma cells. Biochemistry and biophysics reports, 34,(101453). 1-7. https://doi.org/10.1016/j.bbrep.2023.101453

Wang, X., Cao Y.,Chen S., Lin J.,Huang D. (2021). Anti-Inflammation Activity of Flavones and Their Structure−Activity Relationship. J.Agric. Food Chem.69,7285−7302. doi.org/10.1021/acs.jafc.1c02015

Wink, M. (2015). Modes of Action of Herbal Medicines and Plant Secondary Metabolites. Medicines. 2(3), 251-286. https://doi.org/10.3390/medicines2030251

Wu, L., Wu, W., Cai, Y., Li, C., & Wang, L. (2020). HPLC fingerprinting based multivariate analysis of phenolic compounds in mango leaves varieties: Correlation to their antioxidant activity and in silico α glucoidase inhibitory ability. Journal of pharmaceutical and biomedical analysis, 191, 113616. https://doi.org/10.1016/j.jpba.2020.113616.

Yuan T. Z., Kao C. L., Li W. J., Li H. T., Chen C. Y. (2017). Constituyentes químicos de las hojas de *Passiflora edulis*. Química Nacional. Compd. 53, 1165–1166. https://doi.org/10.1007/s10600-017-2227-5

Zomer, A., Rodrigues, C., & Maldaner, L. (2022). Piceatannol: a natural stilbene with a broad spectrum of biological activities. Research, Society and Development, 11(9), 1-10. https://doi.org/10.33448/rsd-v11i9.32221

Zahoor, S., Anwar, F., Qadir, R., Soufan, W., & Sakran, M. (2023). Physicochemical attributes and antioxidant potential of kernel oils from selected mango varieties. ACS Omega, 8(25), 22613-22622. https://doi.org/10.1021/acsomega.3c01155

Received: *April 07,2026*

Accepted: *July 05,2026*

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