RGCS REVISTA GREGORIANA DE CIENCIAS DE LA SALUD

ISSN 3028-8940

ORIGINAL ARTICLE

JANUARY-JUNE 2026;3(1):124-135
https://doi.org/10.36097/rgcs.v2i2.3174

Electrospinning encapsulation of a majagua flower (*Talipariti elatum* Sw.) extract in zein for sustained release of bioactive compounds

*Encapsulación por electrohilado de un extracto de flor de majagua (*Taliparitielatum *Sw.) en zeína para liberación sostenida de compuestos bioactivos*

Dairon Iglesias*, José A. Arencibia, Alicia Casariego, Joe Doyharzabal

Pharmacy and Food Institute, University of Havana, Cuba.

**Corresponding author*

Reception: 23-02-2025 *Acceptance:* 28-04-2025 *Publication:* 31-01-2026

ABSTRACT

The majagua flower (*Talipariti elatum* Sw.) is rich in bioactive compounds with antioxidants, neuroprotective, antimicrobial, anticancer, and cardioprotective activity, although they are highly sensitive to degradation during processing and storage. To stabilize them, microcapsules were prepared by electrospinning encapsulation using zein as a protective matrix in three extract concentrations (10, 20, and 30% w/w). FT-IR analysis confirmed zein's ability to encapsulate the extract's bioactive compounds. The morphology of the particles was evaluated by SEM, and the release of compounds was consistent with the Peleg and Korsmeyer-Peppas models. The highest encapsulation efficiency was achieved with 20% w/w (~69%), showing uniform particles and controlled release by diffusion. These results confirm that electrospinning with zein effectively protects the bioactive compounds of the majagua flower, ensuring sustained release and potential biological functionality, with applications in pharmaceutical and nutraceutical formulations.

Keywords: *Talipariti elatum*, bioactive compounds, zein, electrospinning, controlled release, microencapsulation.

RESUMEN

La flor de majagua (*Talipariti elatum* Sw.) es rica en compuestos bioactivos con actividad antioxidante, neuroprotectora, antimicrobiana, anticancerígena y cardioprotectora, aunque son altamente sensibles a degradación durante procesamiento y almacenamiento. Para estabilizarlos, se prepararon microcápsulas mediante encapsulación por electrohilado usando zeína como matriz protectora en tres concentraciones de extracto (10, 20 y 30 % p/p). El análisis FT-IR confirmó la capacidad de la zeína para encapsular los compuestos bioactivos del extracto. La morfología de las partículas se evaluó por SEM y la liberación de compuestos se ajustó a los modelos de Peleg y Korsmeyer-Peppas. La mayor eficiencia de encapsulación se alcanzó con 20 % p/p (~69 %), mostrando partículas uniformes y liberación controlada por difusión. Estos resultados confirman que la electrospinning con zeína protege eficazmente los compuestos bioactivos de la flor de majagua, garantizando liberación sostenida y potencial funcionalidad biológica, con aplicaciones en formulaciones farmacéuticas y nutracéuticas.

Palabras clave: *Talipariti elatum*, compuestos bioactivos, zeína, electrohilado, liberación controlada, microencapsulación.

Cite as: Iglesias, D., Arencibia, J. A., Casariego, A., & Doyharzabal, J. (2026). Electrospinning encapsulation of a majagua flower (*Talipariti elatum* Sw.) extract in zein for sustained release of bioactive compounds. *Revista Gregoriana de Ciencias de la Salud*, *3*(1), 124-135. https://doi.org/10.36097/rgcs.v2i2.3174

INTRODUCTION

The majagua flower (*Taliparitі elatum* Sw.) has proven to be a significant source of phenolic compounds and flavonoids, which possess antioxidant, antimicrobial, neuroprotective, and potential anticancer and cardioprotective effects. These benefits position the majagua flower as a promising raw material for the development of pharmaceutical and nutraceutical products (Fernández-Perez et al., 2020; Bécquer-Viart et al., 2018). However, its use is limited by its instability in the face of various environmental factors, which leads to the degradation of its bioactive components during storage (Fernández-Perez et al., 2020). This limitation highlights the need to develop effective methods to stabilize its compounds and preserve their properties.

In this context, one of the most innovative and effective solutions is the encapsulation of plant extracts using electrospinning, a technique that allows the fabrication of micro- and nanofibers that offer controlled release of bioactive compounds, in addition to improving their morphological stability. This method is particularly suitable for protecting plant extracts from external factors, while also facilitating their application in various health fields, as demonstrated by the growing body of research on their use in medicine and pharmacy (Franco & Jimenez, 2025). Thanks to the fibers' ability to release bioactive compounds gradually, electrospinning contributes to greater efficiency and a longer duration of action for the encapsulated active ingredients.

One of the most promising alternatives for encapsulating plant extracts is the use of zein, a hydrophobic protein derived from corn, which has been noted for its biocompatibility, biodegradability, and affinity for phenolic compounds. These characteristics allow zein to act as a stabilizing agent for the active ingredients, protecting them from the action of external agents such as humidity, light, and oxygen, factors that accelerate their degradation (Franco & Jimenez, 2025). This study evaluated zein's ability to stabilize the bioactive compounds of the majagua flower extract, analyzing its physicochemical and morphological properties and the mechanisms of compound release, in order to explore its potential applications in the Health Sciences.

METHODOLOGY

Majagua flowers (*T. elatum*) were hand-picked and selected for uniformity in size and color, discarding samples with morphological alterations. The petals were separated from the pistil. Majagua flower extract (FFE) was obtained with a 1:2 mass/solvent ratio using a 78%

hydroalcoholic mixture acidified with 1% (w/v) citric acid for 12 h on a sieve at 250 min^{-1} and room temperature. After vacuum filtration, the extract was concentrated in a rotary evaporator (BÜCHI R-114, Switzerland) at 40 °C and 100 min^{-1} until reaching 10–11% total solids.

Subsequently, the EFM was characterized by determining total solids by indirect gravimetry using a thermobalance (Sartorius MA-40, Germany) at 105 °C until constant mass was reached, and by determining pH with a BASIC 20+ pH meter, according to Miranda and Cuéllar (2000). Total polyphenols were quantified by the Folin-Ciocalteu method (Slinkard & Singleton, 1977), measuring absorbance at 765 nm using a Rayleigh UV1601 spectrophotometer, calibrated with gallic acid (100–500 mg/L). The results were expressed as mg of gallic acid (GA) per mL of EFM.

The electrohydrodynamic procedure was performed using 10% w/w zein solutions in 80% (v/v) aqueous ethanol under magnetic stirring (IKA, CMAG HS 4, Germany), following methods by Alehosseini et al. (2019a; 2019b). The EFM was incorporated at 10, 20, and 30% w/w relative to the zein. The solutions were prepared at ~28 °C with magnetic stirring at 200 min^{-1} for 5 min, loaded into 5 mL syringes with an 18-gauge nozzle, and processed in a horizontal electrohydrodynamic instrument with a 0–30 kV power supply (Acopian, USA) and a syringe pump (KD Scientific, USA). Flow rate (0.10–0.15 mL/h), voltage (12, 14, and 16 kV), and tip-collector distance (8–12 cm) were evaluated using a factorial design under ambient conditions (Figure 1).

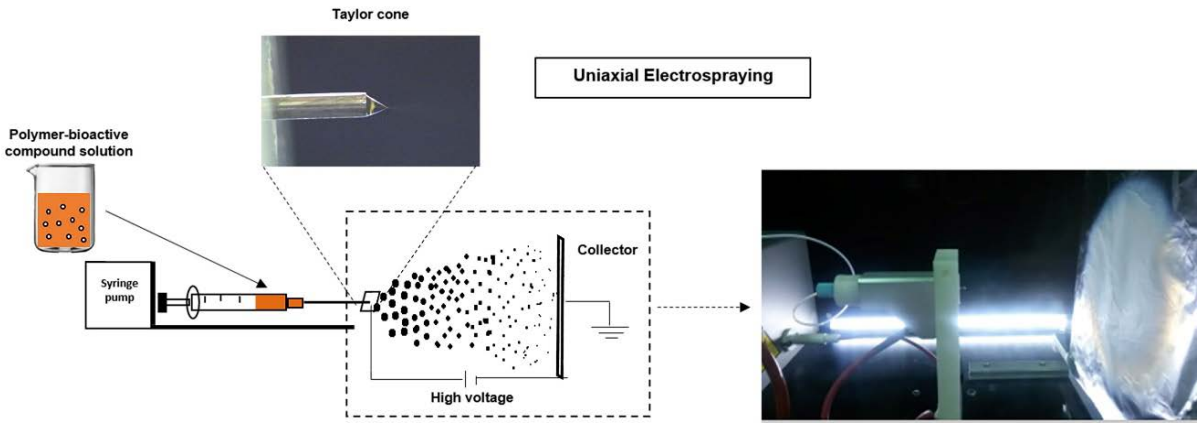

Figure 1. General scheme of the electrohydrodynamic process with horizontal configuration.

The encapsulation efficiency (EE) was determined by dissolving 10 mg of sample in 80% (v/v) ethanol and centrifuging at 12,000 min^{-1} for 10 min. The surface EFM was evaluated after rinsing and filtration (0.2 µm). The antioxidant capacity was measured by ABTS (equations 1 and 2) according to Arnao et al. (2001), modified by Thaipong et al. (2006).

$$\%\ catchment\ ABTS = \frac{Abs_{initial} - Abs_{final}}{Abs_{initial}} * 100 \qquad \text{(Eq. 1)}$$

$$EE\ (\%) = \frac{\%\ ABTS_{total} - \%\ ABTS_{superficial}}{\%\ ABTS_{total}} * 100 \qquad \text{(Eq. 2)}$$

The FT-IR spectra of PE without extract (CZ), with extract (CZE), and of the lyophilized majagua flower extract (EML) were acquired on a Bruker Tensor 37 in ATR mode, 450 to 4000 cm^{-1} range, averaging 15 to 16 scans at 4 cm^{-1} resolution (Gómez-Mascaraque et al., 2017).

Morphology was evaluated using SEM (Hitachi S-4800, Japan). Samples were mounted on stainless steel supports and metallized by Au/Pt sputtering (SC7620, Quorum). The analysis was performed at 20 kV, with a working distance of ~9.5 mm (Gómez-Mascaraque et al., 2017).

The release of phenolic compounds from encapsulated polymers (EPs) was evaluated in a 50% ethanol/water hydroalcoholic medium. The EPs were suspended at 15 mg/mL, and periodic determinations of total phenolic content (TP) were performed in the supernatant according to Slinkard and Singleton (1977). The percentage of TP released was calculated relative to the total encapsulated phenolic content.

The TP release profiles over time were fitted using the empirical Peleg model (equations 3 and 4) and the Korsmeyer–Peppas model (equations 5 and 6), which is widely used to describe the release of active compounds from polymer matrices (Korsmeyer et al., 1983; Peleg, 1988).

$$M_t = \frac{t}{k_1 + k_2 t} \qquad \text{(Eq. 3)}$$

$$\frac{t}{M_t} = k_1 + k_2 t \qquad \text{(Eq. 4)}$$

Where: Mt is the cumulative percentage of PT released at time t, k_1: Peleg rate constant, k_2: Peleg capacity constant, R_0: initial release rate and the inverse of k_1.

$$\frac{M_t}{M_\infty} = kt^n \qquad \text{(Eq. 5)}$$

$$\log \frac{M_t}{M_\infty} = \log k + n \log t \qquad \text{(Eq.6)}$$

Where: Mt is the amount of compound released at time t; M∞ is the amount released at equilibrium or asymptotic release; k: release kinetic constant; n: release exponent.

RESULTS AND DISCUSSION

Table 1 presents the characterization parameters of the EFM. The ST content reflects the non-volatile fraction of the extract; its high concentration was associated with a significant increase in PT, consistent with and exceeding values previously reported for this species (Gutiérrez et al., 2017).

The pH value obtained shows a decrease compared to the unconcentrated extract; however, this decrease is within acceptable ranges according to Reyes & Cisneros-Zevallos (2007), who state that PT in extracts remain stable at pH values below 5.5. Therefore, the results obtained represent a beneficial characteristic in the final product.

Table 1. Characterization of the majagua flower extract

Parameter	Mean (Standard deviation)
Total solids (%)	9,8 (0,48)
pH	2,84 (0,03)
Total polyphenols (mg GA/mL)	10,65 (0,21)

The factorial design allowed for the evaluation of the influence of flow rate, voltage, and tip-to-collector distance on electrospraying stability. At short distances (8 cm), the process was not adequately established, regardless of the flow rate (0.10–0.15 mL/h) and voltage (14–16 kV). At 10 cm, the spray improved with a flow rate of 0.15 mL/h, resulting in a more stable Taylor cone, although small droplets persisted in the collector. At 0.10 mL/h, the flow was too restricted, causing instability. Optimal conditions were achieved at 12 cm, with a flow rate of 0.15 mL/h and a voltage of 16 kV, resulting in homogeneous spraying and a stable Taylor cone. This combination was identified as the most suitable for processing.

Table 2 shows the values for the electrospray stability (ES). The 10% w/w and 20% w/w encapsulation patterns showed high EE values: 70.8 and 68.9%, respectively. Since no significant differences were found between the two patterns, the 20% w/w pattern was selected as having the

highest EE, as it presented a higher EFM content.

Table 2. Encapsulation efficiency (EE) of electropulverized particles

Majagua flower extract in zein solutions (% w/w)	ABTS decolorization (%)		Encapsulation efficiency (%)
	Total	Surface	
10	15,9 (2,18) a	54,7 (1,25) a	70,8 (3,37) a
20	20,3 (1,47) b	65,3 (5,3) b	68,9 (1,84) a
30	37,7 (2,67) c	75,5 (2,2) c	50,0 (4,43) b

Different letters indicate significant differences within the same column.

The comparison of the FT-IR spectra of the lyophilized majagua extract (EML), zein (CZ), and encapsulated structures (CZE) shows zein's ability to incorporate phenolic compounds (Figure 2). The EML shows characteristic flavonoid bands: –OH 3500–3000 cm^{-1} (Cuesta et al., 2015), –CH_2/–CH_3 3000–2850 cm^{-1}, C=O and aromatics 1600–1450 cm^{-1}, including ~1500 cm^{-1}, and C–O–C/C–O ~1022 cm^{-1} (Ortega et al., 2007), corresponding to anthocyanins (Barragán et al., 2018), rutin (Goitia, 2018), and gossypitrin (González et al., 2017). Zein exhibits amide bands A (~3300 cm^{-1}), I (~1650 cm^{-1}), II (~1540 cm^{-1}), and III (~1250 cm^{-1}), indicating a predominance of α helix and structural stability (Aceituno-Medina et al., 2013).

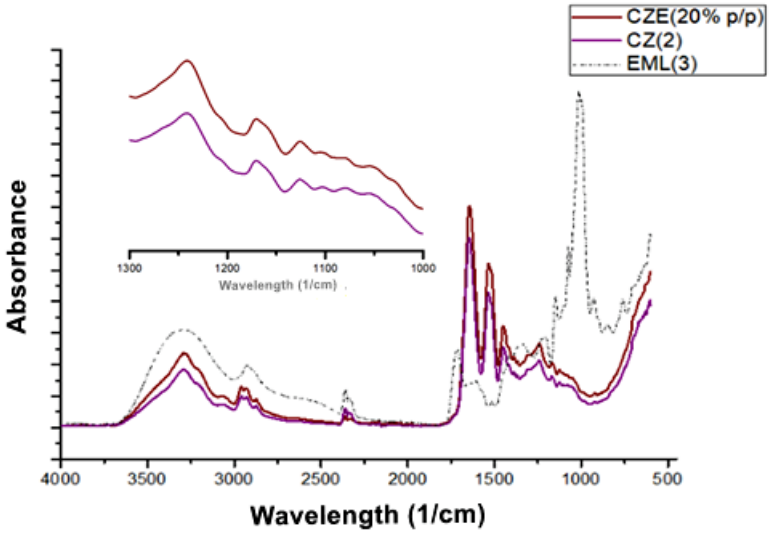

Figure 2. IR spectrum of the lyophilized majagua extract (EML), zein (CZ), and encapsulated structures (CZE).

In CZE, signals from both EML and CZ coexist, confirming the incorporation of phenolics (Figure 2). Several bands in the extract are attenuated or overlap: –OH with amide A and carbonyls at 1700–1640 cm^{-1} with amide I. The 1022 cm^{-1} peak shifts to 1111–1106 cm^{-1}, and bands such as 1227, 1610, 1700, 2898–2937, and 3335 cm^{-1} show changes in intensity, reflecting vibrational constraints and alterations in the chemical environment (Larkin, 2011). The attenuation and displacement of the extract bands, along with the preservation of the amide bands, confirm that the phenolic compounds are effectively encapsulated through non-covalent interactions, without altering the secondary structure of zein.

The morphology of the PEs with 20% w/w EFM (Figure 3) shows, at low magnification (5 µm; Figure 3A), irregular and wrinkled particles, reflecting the reorganization of the zein matrix during solidification. At higher magnification (1 µm; Figure 3B), hollow structures with rough surfaces and an absence of free crystals are observed, indicating efficient integration of the extract. The morphological heterogeneity suggests phenol-protein interactions, while the roughness and internal cavities could favor the controlled release of phenolic compounds.

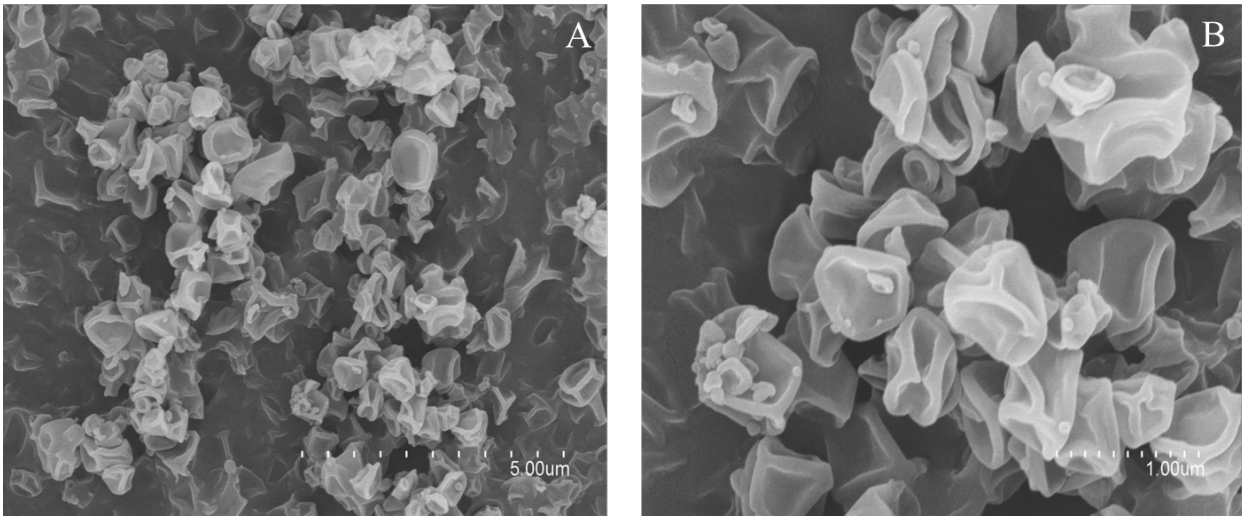

Figure 3. SEM micrographs of zein PE with 20% w/w EFM: (A) 5 µm; (B) 1 µm.

Figure 4A shows the cumulative release of PT from EFM-containing microparticles, revealing a biphasic profile. A rapid initial release is observed during the first 4 h, reaching ~78%, attributed to PT on the surface or in accessible cavities, followed by sustained release up to ~90% at 24 h. The second stage reflects controlled diffusion from the core, indicating good structural

integrity. This behavior, with immediate and prolonged release, is favorable for nutraceutical and pharmacological applications.

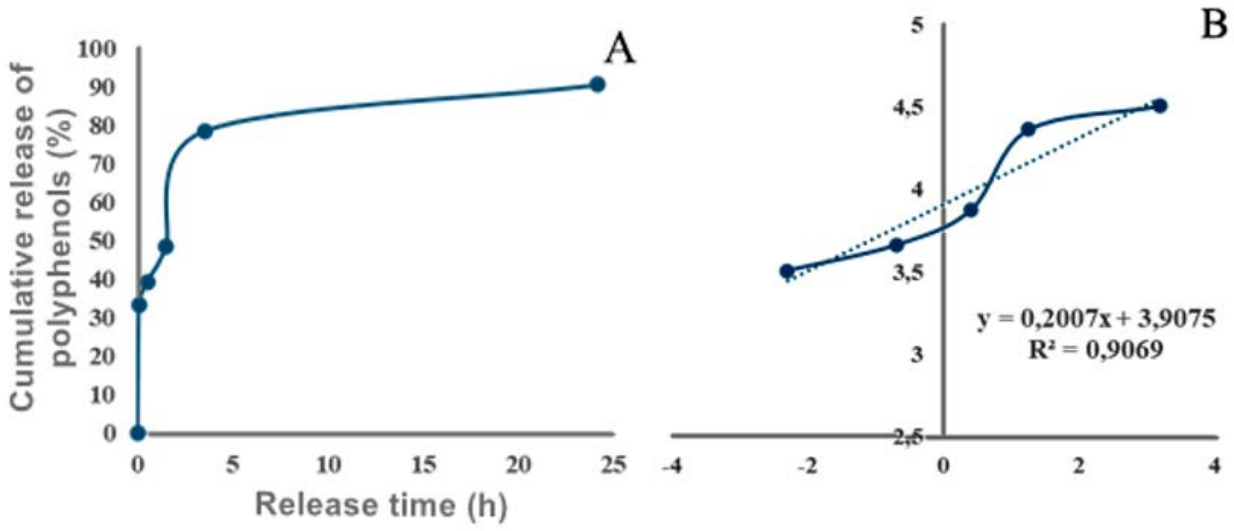

Figure 4. (A) Cumulative PT release profile from PE with EFM. (B) Linear fit of the Korsmeyer–Peppas model applied to the release data.

The fit of the PT release profiles to empirical models showed excellent performance, with R^2 values close to 1 for Korsmeyer–Peppas (0.9069) and Peleg (0.9982), demonstrating reliable modeling. The linearity of the Korsmeyer–Peppas model (Figure 4B) yielded n = 0.2007 and k = 21.9, indicating a release mechanism dominated by Fickian diffusion from the zein matrix (Lee, Choi & Han, 2021). PT release was evaluated in media simulating hydrophilic and lipophilic affinity (European Pharmacopoeia Commission, 2020). Aqueous solutions with 50% ethanol allowed for the characterization of the migration of lipophilic compounds. The results confirm the efficiency of zein capsules for sustained release of bioactives, supporting their pharmacognostic and nutraceutical potential.

CONCLUSIONS

Microcapsules containing 20% w/w majagua flower extract were obtained, with high encapsulation efficiency (69.2%) and no difference compared to 10% w/w. FT-IR confirmed the presence of polyphenolic compounds. Under optimal conditions (flow rate 0.15 mL/h, voltage 16 kV, distance 12 cm), release followed the Korsmeyer-Peppas model, indicating Fickian diffusion,

demonstrating its potential for controlled-release pharmaceutical systems of bioactive compounds.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

AUTHOR CONTRIBUTIONS

Conceptualization: Dairon Iglesias, José A. Arencibia, Alicia Casariego, and Joe Doyharzabal. **Data curation:** Dairon Iglesias and Alicia Casariego. **Formal analysis:** Dairon Iglesias, José A. Arencibia, Alicia Casariego, and Joe Doyharzabal. **Investigation:** Dairon Iglesias, José A. Arencibia, Alicia Casariego, and Joe Doyharzabal. **Methodology:** Dairon Iglesias, José A. Arencibia, Alicia Casariego, and Joe Doyharzabal. **Project administration:** Alicia Casariego. **Resources:** Dairon Iglesias, José A. Arencibia, Alicia Casariego, and Joe Doyharzabal. **Software:** Dairon Iglesias. **Supervision:** Alicia Casariego. **Validation:** Dairon Iglesias and José A. Arencibia. **Visualization:** Dairon Iglesias and José A. Arencibia. **Writing – original draft:** Dairon Iglesias, José A. Arencibia, Alicia Casariego, and Joe Doyharzabal. **Writing – review & editing:** José A. Arencibia.

REFERENCES

Aceituno-Medina, M., Lopez-Rubio, A., Mendoza, S., & Lagaron, J. M. (2013). Development of novel ultrathin structures based in amaranth (Amaranthus hypochondriacus) protein isolate through electrospinning. *Food Hydrocolloids*, *31*(2), 289-298. https://doi.org/10.1016/j.foodhyd.2012.11.009

Alehosseini, A., Gómez-Mascaraque, L. G., Martínez-Sanz, M., & López-Rubio, A. (2019a). Electrospun curcumin-loaded protein nanofiber mats as active/bioactive coatings for food packaging applications. *Food Hydrocolloids*, *87*, 758-771. https://doi.org/10.1016/j.foodhyd.2018.08.056

Alehosseini, A., Sarabi-Jamab, M., Ghorani, B., & Kadkhodaee, R. (2019b). Electro-encapsulation of Lactobacillus casei in high-resistant capsules of whey protein containing transglutaminase enzyme. *LWT-Food Science and Technology*, *102*, 150-158. https://doi.org/10.1016/j.lwt.2018.12.022

Arnao, M. B., Cano, A., & Acosta, M. (2001). The hydrophilic and lipophilic contribution to total antioxidant activity. *Food Chemistry*, *73*(2), 239-244. https://doi.org/10.1016/S0308-8146(00)00324-1

Barragán Condori, M., Aro Aro, J. M., Huamaní Meléndez, V. J., & Cartagena Cutipa, R. (2018). Antocianinas, compuestos fenólicos y capacidad antioxidante del mio mio (*Coriaria ruscifolia* L.). *Revista de Investigaciones Altoandinas*, *20*(4), 419-428. https://doi.org/10.18271/ria.2018.419

Bécquer-Viart, M. A., González-Yaque, J., Fonseca-Fonseca, L. A., Núñez-Figueredo, Y., & Andreu, G. L. P. (2018). Antioxidant and neuroprotective effects of gossypitrin, a flavonoid from *Talipariti elatum*, against chemical hypoxia-induced PC12 cell death. *Journal of Pharmacy & Pharmacognosy Research*, *6*(2), 72-80. https://www.redalyc.org/journal/4960/496055771002

European Directorate for the Quality of Medicines & HealthCare. (2025). European Pharmacopoeia (11th ed., Cap. 2.9.3 Dissolution of solid dosage forms) [Ediciones en línea]. European Pharmacopoeia Online. https://pheur.edqm.eu/home

Fernández-Perez, A., Iglesias-Guevara, D., Cartaya-Quintero, R., & Arencibia-Sánchez, J. A. (2020). Obtención de un extracto rico en antocianinas a partir de flor de majagua (*Talipariti elatum* SW). *Revista CENIC Ciencias Biológicas*, *51*(2), 132-140. https://www.redalyc.org/journal/1812/181272273005

Franco, R. F., & Jimenez, P. C. (2025). Pharmacological applications of electrospun nanofibers loaded with bioactive natural compounds and extracts: A systematic review. *Drugs and Drug Candidates*, *4*(1), 8. https://doi.org/10.3390/ddc4010008

Goitia, H., Ferrer, E., & Williams, P. (2019). Síntesis de complejos vo-flavonoides. Estudio de su actividad citotóxica y capacidad antioxidante. *Investigación Joven*, *6*(Especial), 68-69. https://revistas.unlp.edu.ar/InvJov/article/view/6865

Gómez-Mascaraque, L. G., Hernández-Rojas, M., Tarancón, P., Tenon, M., Feuillère, N., Ruiz, J. F. V., ... & López-Rubio, A. (2017). Impact of microencapsulation within electrosprayed proteins on the formulation of green tea extract-enriched biscuits. *LWT-Food Science and Technology*, *81*, 77-86. https://doi.org/10.1016/j.lwt.2017.03.041

González, J., Cuéllar, A., Nossin, E., & Monan, M. (2017). Iron chelating activity of gossypitrin isolated from the petals of *Taliparitielatum* Sw. (Fryxell) Malvaceae. *Journal of Agricultural Studies*, *5*(1). https://doi.org/10.5296/jas.v5i2.11174

Kokalj Ladan, M., Straus, J., Tavčar Benković, E., & Kreft, S. (2017). FT-IR-based method for rutin, quercetin and quercitrin quantification in different buckwheat (*Fagopyrum*) species. *Scientific Reports*, *7*, Article 7226. https://doi.org/10.1038/s41598-017-07665-z

Korsmeyer, R. W., Gurny, R., Doelker, E., Buri, P., & Peppas, N. A. (1983). Mechanisms of solute release from porous hydrophilic polymers. *International Journal of Pharmaceutics*, *15*(1), 25-35. https://doi.org/10.1016/0378-5173(83)90064-9

Larkin, P. (2011). Infrared and Raman spectroscopy; principles and spectral interpretation. Wiley.

Lee, J. S., Choi, I., & Han, J. (2021). Mathematical modeling of cinnamon (Cinnamomum verum) bark oil release from agar/PVA biocomposite film for antimicrobial food packaging: The effects of temperature and relative humidity. *Food Chemistry*, *363*, 130306. https://doi.org/10.1016/j.foodchem.2021.130306

Leuci, R., Brunetti, L., Poliseno, V., Laghezza, A., Loiodice, F., Tortorella, P., & Piemontese, L. (2020). Natural compounds for the prevention and treatment of cardiovascular and neurodegenerative diseases. *Foods*, *10*(1), 29. https://doi.org/10.3390/foods10010029

Miranda, M., & Cuellar, A. (2000). Manual de prácticas de laboratorio. Farmacognosia y Productos Naturales. La Habana: Editorial Félix Varela, 70-110.

Mohd Sairazi, N. S., & Sirajudeen, K. N. S. (2020). Natural products and their bioactive compounds: neuroprotective potentials against neurodegenerative diseases. *Evidence-Based Complementary and Alternative Medicine*, *2020*(1), 6565396. https://doi.org/10.1155/2020/8852680

Ordoudi, S. A., de los Mozos Pascual, M., & Tsimidou, M. Z. (2014). On the quality control of traded saffron by means of transmission Fourier-transform mid-infrared (FT-MIR) spectroscopy and chemometrics. *Food Chemistry*, *150*, 414-421. https://doi.org/10.1016/j.foodchem.2013.11.014

Ortega, R., Muñoz, A., Talens, P., & Chiralt, A. (2016). Improvement of properties of glycerol plasticized starch films by blending with a low ratio of polycaprolactone and/ or polyethylene glycol. *Food Hydrocolloids*, *56*, 9-19. https://doi.org/10.1016/j.foodhyd.2015.11.029

Peleg, M. (1988). An empirical model for the description of moisture sorption curves. *Journal of Food Science*, *53*(4), 1216-1217. https://doi.org/10.1111/j.1365-2621.1988.tb13565.x

Reyes, L. F., & Cisneros-Zevallos, L. (2007). Degradation kinetics and colour of anthocyanins in aqueous extracts of purple- and red-flesh potatoes (*Solanum tuberosum* L.). *Food Chemistry*, *100*(3), 885-894. https://doi.org/10.1016/j.foodchem.2005.11.051

Slinkard, K., & Singleton, V. L. (1977). Total phenol analysis: automation and comparison with manual methods. *American Journal of Enology and Viticulture*, *28*(1), 49-55. https://doi.org/10.5344/ajev.1977.28.1.49

Thaipong, K., Boonprakob, U., Crosby, K., Cisneros-Zevallos, L., & Byrne, D. H. (2006). Comparison of ABTS, DPPH, FRAP, and ORAC assays for estimating antioxidant activity from guava fruit extracts. *Journal of Food Composition and Analysis*, *19*(6-7), 669-675. https://doi.org/10.1016/j.jfca.2006.01.003