Sustainable development of nano-adjuvants for radiotherapy in Mexico

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INTRODUCTION

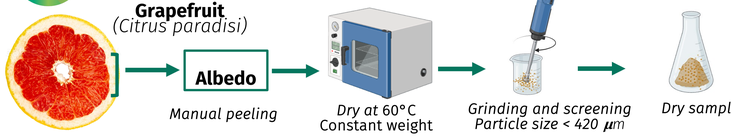
Mexico is the fourth biggest producer of grapefruit in the world. Nowadays, the agricultural industry has been used it for extract their juice, produce food, drinks, drugs and even cosmetics. However, significant amounts of by-products including peels, and seed are usually discarded as waste and often overlooked, despite their rich content of bioactive components, as Naringin, a flavonoid . The valorization of grapefruit by-products represents a compelling opportunity to transform what was once considered waste into valuable resources, through the sustainably material development to different applications.

GENERAL OBJECTIVE

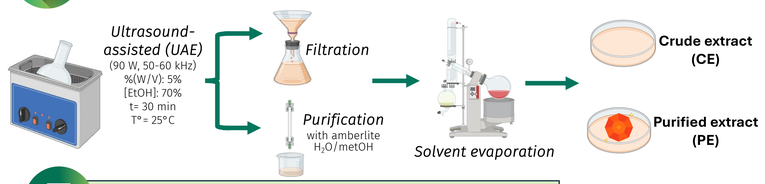
Develop a bismuth-and-natural-extract-based nano-hybrid, follow the principles of green chemistry , obtained from valorization of Mexican citrus waste industry, which we named BiNar.

METODOLOGY

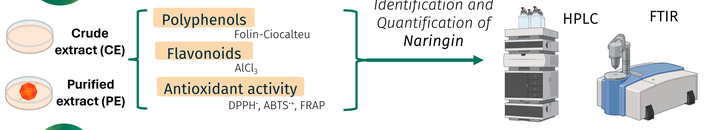
1 Sample preparation



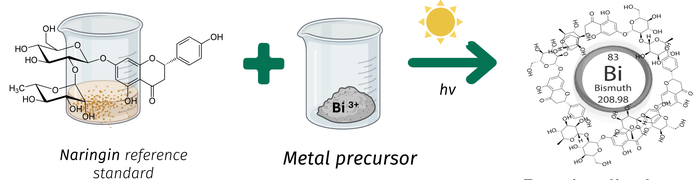
2 Extraction of natural product



3 Analysis of extracts and antioxidant activity



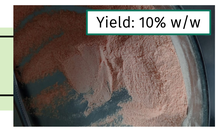
4 Photochemical-assisted green synthesis of BiNar (Pilot test)



PRELIMINARY RESULTS

Dry matter yield

$\frac{200\ g_{Wdry}}{2000\ g_{Wwet}}$



Moisture content

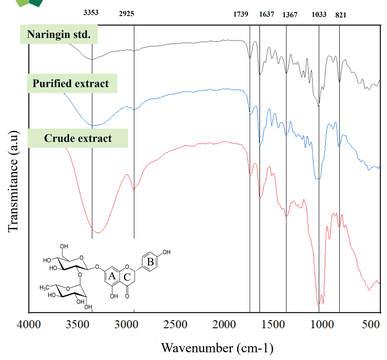
77.6%

Antioxidant activity and total polyphenols and flavonoids content

Determination	CE	PE
	(μmol EQ / g_{Wdry})	
Polyphenol	309.75 (±0.0085)	1006.69 (±0.0185)
Flavonoids	67.32 (±0.0049)	95.75 (±0.0431)
ABTS •+	24.17 (±0.0315)	56.96 (±0.0267)
FRAP	807.21 (±0.0031)	2578.91 ±0.0126)
DPPH	12.52 (±0.0094)	35.54 (±0.0017)

The **purified extract (PE)** has a **higher** concentration of **polyphenols, flavonoids** and better **antioxidant activity** than the crude extract (CE).

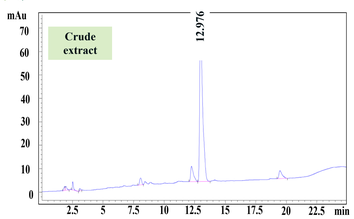
Fourier transform infrared spectroscopy (FTIR)

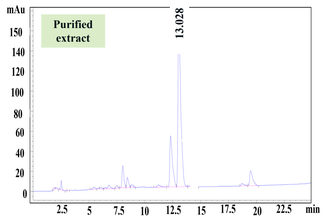


Functional groups- mode of vibration	Wavenumber (cm^{-1})	
	Experimental	Theoretical
Multi-group stretching O-H	3 353	3 500- 3200
Asymmetric stretching C-H (sp^3)	2 925	2 926 ± 10
Conjugate (ketone) C=O with α,β C=C C=C-; C=O	1 637 1739	1 644 -1 617 1700 - 1675
Bending (phenol) C-O-H	1 367	1 440-1 220
Bending (ether) C-O	1 033	1 300 -1 000
Out-of-plane bending para-substituted aromatic ring structure B	821	860 - 790

Using the model molecule (naringin) infrared spectrum as a reference, is observed that EP has best fit than EC, evidencing that the **purification is successful.**

High performance liquid chromatography (HPLC)

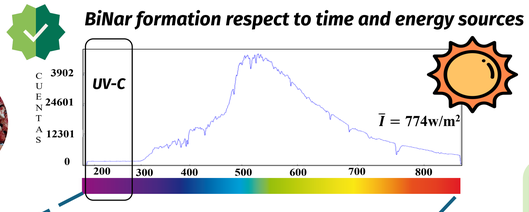


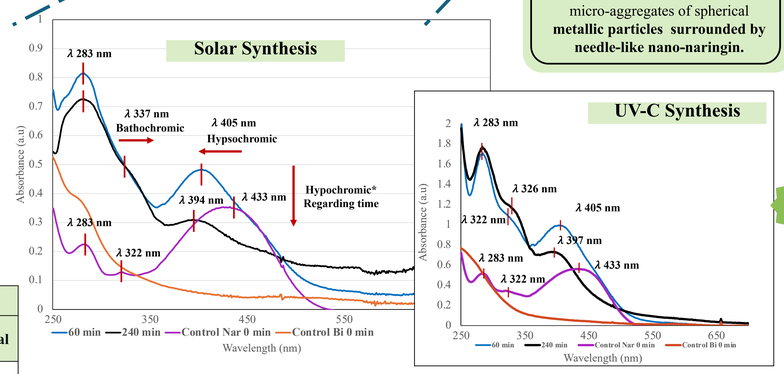


	Retention time (RT)	umol Nar / g_{Wdry}
Naringina std.	13.329	-
Crud extract	12.976	279.00
Purified extract	13.038	553.11

The concentration of **naringin** per gram of dry weight of albedo is almost twice as **high** in the **PE** as in the CE.

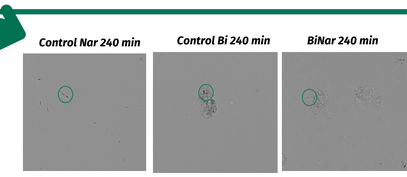
BiNar formation respect to time and energy sources



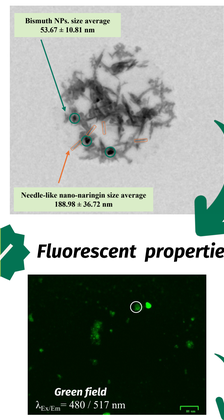


The absorption bands in the UV-Vis during the formation of BiNar with **sunlight and artificial light (UV-C) do not present observable differences** between themselves.

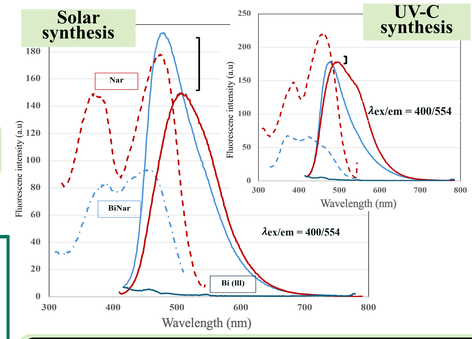
The **metal stabilizes naringin by resonance**, leading the formation of a complex and bathochromic shifts of naringin from λ 322 nm to λ 337 nm.



The **BiNar** obtained using the flavanone standard is formed from micro-aggregates of spherical **metallic particles surrounded by needle-like nano-naringin.**

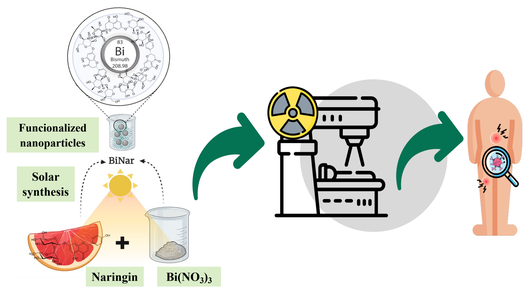


Fluorescent properties



The addition of **bismuth** and **solar** synthesis allow **higher fluorescence** emission with respect to the model flavonoid (naringin) compared to UV-C assisted synthesis.

CONCLUSIONS AND PERSPECTIVES



The **purified extract** (PE) and **sunlight** demonstrate the best qualities for the **green and sustainable synthesis** of BiNar and obtain nanoparticles with biological activity for application in biomedical areas, through the development of **nano-adjuvants** that locally improve the effect of **radiotherapy.**

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[1] J. E. Wong-Paz, J. Contreras-Esquivel, R. Rodríguez-Herrera, M. L. Carrillo-Inungaray, L. I. López-López, G. V. Nevárez-Moorillón, & C. N. Aguilar.Total phenolic content, in vitro antioxidant activity and chemical composition of plant extracts from semiarid Mexican region. *Asian Pacific Journal of Tropical Medicine.* **2015,** 8(2), 104–111.

[2] N. Jara, N. S. Milán, A. Rahman, L. Mouheb., D. C. Boffito, C., Jeffryes & S.A. Dahoumane. Photochemical Synthesis of Gold and Silver Nanoparticles—A Review. *Molecules.* **2021**, 26(15), 4585.

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