Recuperación de compuestos bioactivos de residuos y efluentes del procesado de la alcachofa e higo chumbo

Dra. Esperanza M. García Castelló
Dr. Antonio D. Rodríguez López

19/05/2022

Facsa Fovasa
Cátedra del agua, residuos y economía circular

UNIVERSITAT POLITÈCNICA DE VALÈNCIA

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- Lda. en Ciencias Biológicas, esp. Bioquímica, 1996 (UV).
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INTERESES:

Ind. agroalimentaria
Valorización de residuos sólidos
Tratamiento de aguas residuales
Compuestos bioactivos
Antioxidantes
Colorantes naturales
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Tecnología de membranas
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Procesado alcachofa
Higos chumbos
Aguas residuales de almazaras
Efluentes industria cervecera
Industrias cítricas
Aguacates
Proteínas de soja
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La alcachofa y sus beneficios

Estadísticas de producción

Procesado de la alcachofa. Residuos y efluentes generados

Recuperación de biocomponentes

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La alcachofa y sus beneficios

La alcachofa (*Cynara scolymus*) también se llama alcachofera o alcaucil.

Planta herbácea originaria del Mediterráneo occidental y alcanza una altura de **1.4 - 2.0 m**.

Vuelve a brotar de la cepa todos los años, pasado el invierno, si el frío no la heló.

https://www.planetahuerto.es/revista/cultivo-de-la-alcachofa_00186

https://www.jardinedia.com/cultivo-de-la-alcachofa/

https://www.mapa.gob.es/app/MaterialVegetal/fichaMaterialVegetal.aspx?idFicha=3889

Marzo – Agosto : Siembra
Octubre – Mayo : Cosecha

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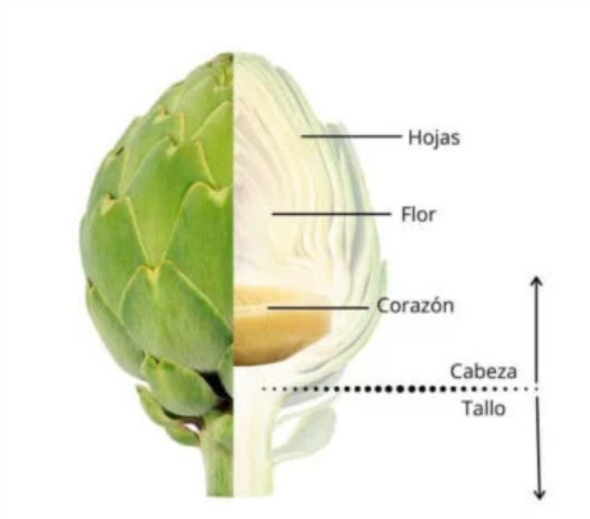
La alcachofa y sus beneficios



https://www.bionella.co/la-alcachofa/

https://www.javirecetas.com/como-pelar-alcachofas-alcauciles/

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La alcachofa y sus beneficios

https://sukaldikas.com/6-beneficios-de-comer-alcachofas/

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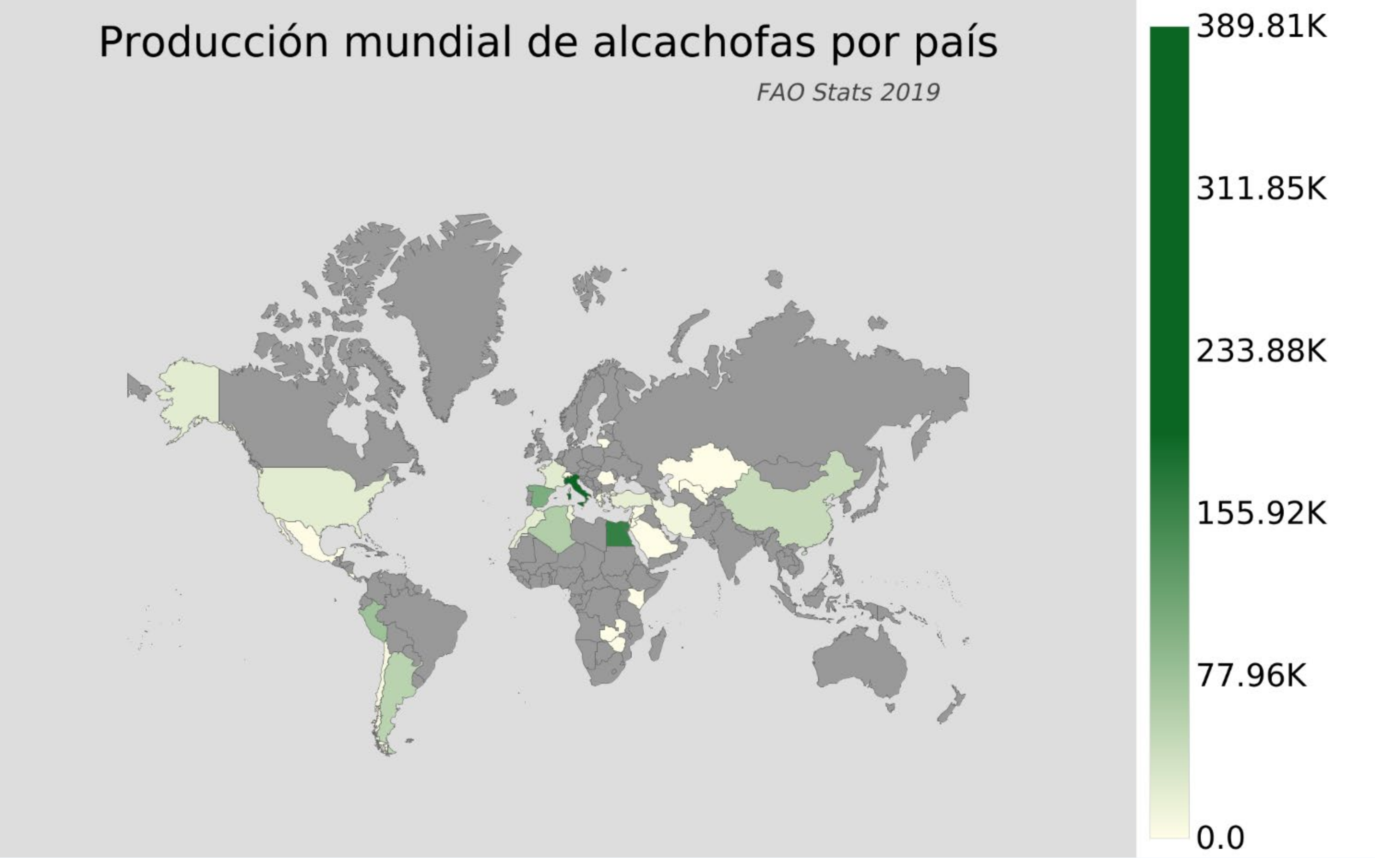
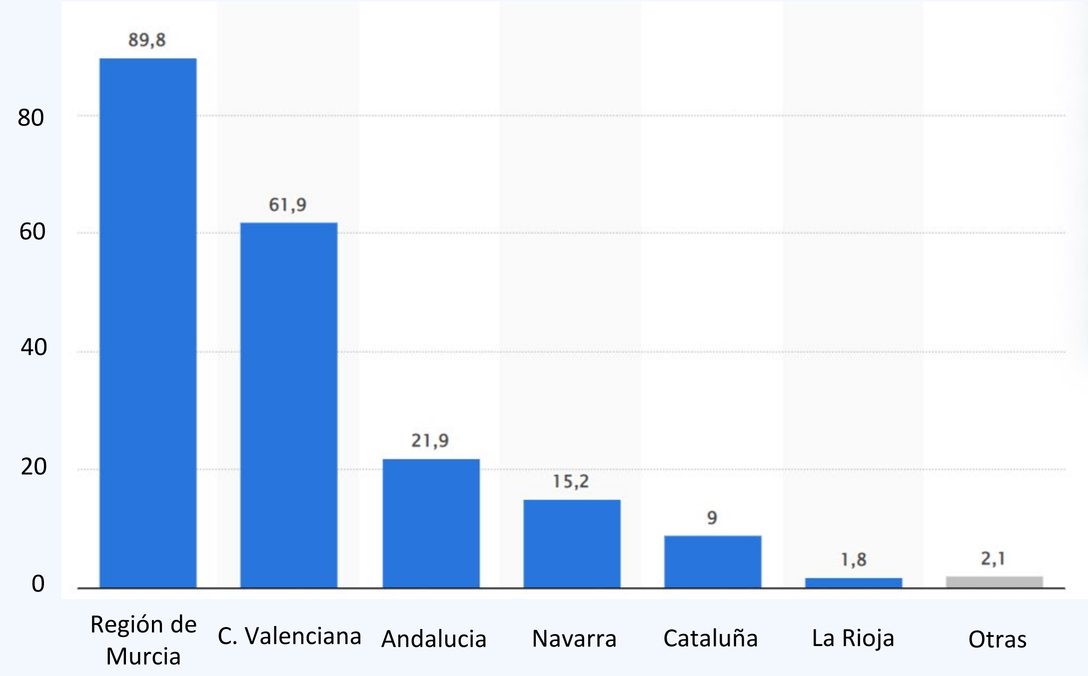
Estadísticas de producción



Fuente: https://www.atlasbig.com/es-es/paises-por-produccion-de-alcachofa

Volumen de alcachofas producidas en España en 2020 , por comunidad autónoma (en miles de toneladas)



https://es.statista.com/estadisticas/510925/produccion-de-alcachofas-en-espana-por-comunidad-autonoma/

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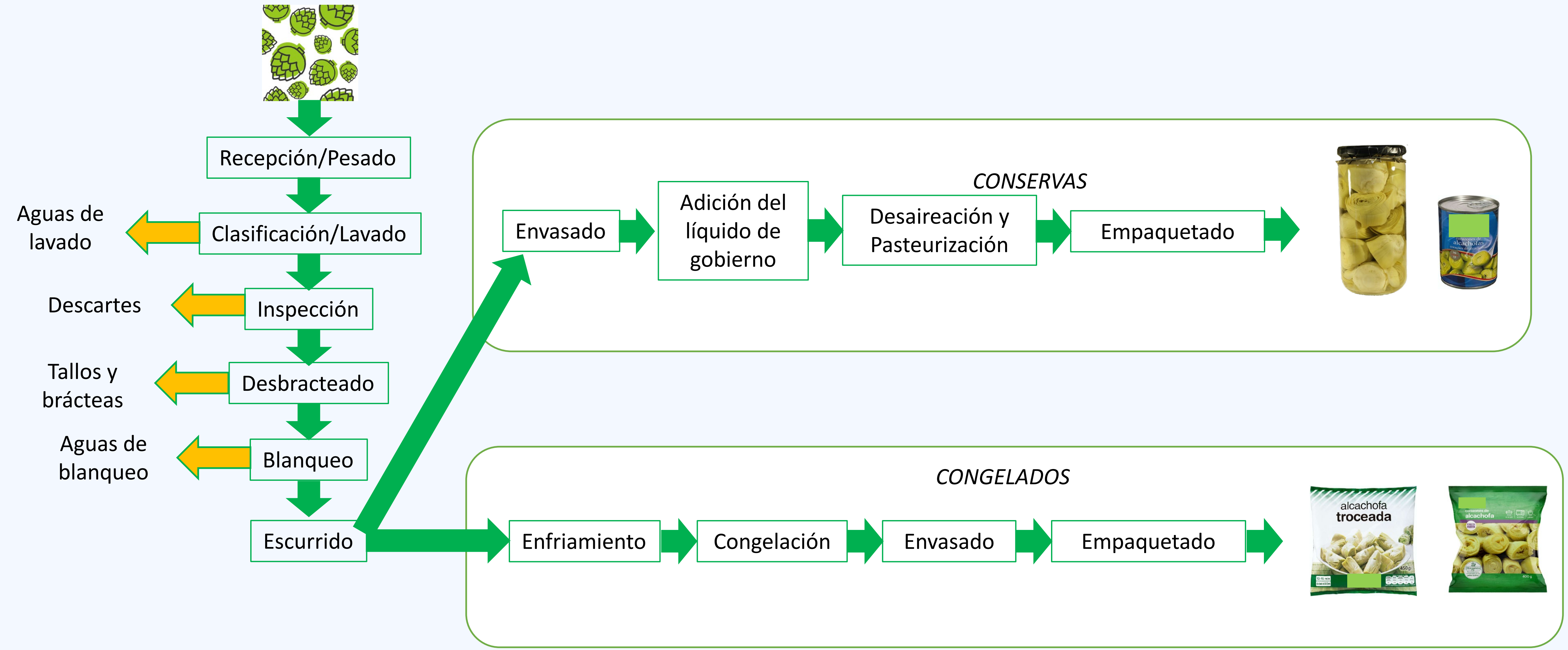
Procesado de alcachofa. Residuos y efluentes generados



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Procesado de alcachofa. Residuos y efluentes generados

RESIDUOS

https://www.interempresas.net/Alimentaria/Articulos/112721-De-subproductos-a-materias-primas-para-la-elaboracion-de-nuevos-alimentos.html

- Suponen entre un 60-65% de la M.P. procesada (https://prtr-es.es/Data/images//Gu%C3%ADa%20MTD%20en%20Espa%C3%B1a%20Transformados%20Vegetales-1F078444C914B509.pdf).
- Compuestos por piezas defectuosas, tallos y brácteas externas.
- Usos tradicionales: producción de compost, metano, bioetanol…

EFLUENTES

- Consumo de agua conservas alcachofa: 6-20 m^3/ton M.P.
- Consumo de agua congelados vegetales: 5-8.5 m^3/ton M.P.
- 70-80% del agua de consumo se vierte como agua residual (https://prtr-es.es/Data/images//Gu%C3%ADa%20MTD%20en%20Espa%C3%B1a%20Transformados%20Vegetales-1F078444C914B509.pdf).
- DQO=600-1000 mg/L y SS=100-500 mg/L (https://www.esamur.com/dmdocuments/agrupal_esamur_depuracion%20aguas.pdf).
- Procede mayoritariamente de aguas de blanque, lavado y sistemas de intercambio de calor.

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Recuperación de biocomponentes

EFLUENTES

WATER RESEARCH 48 (2014) 363–374

Available online at www.sciencedirect.com

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journal homepage: www.elsevier.com/locate/watres

Valorization of artichoke wastewaters by integrated membrane process

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ARTICLE INFO

Article history:
Received 8 August 2013
Received in revised form
23 September 2013
Accepted 26 September 2013
Available online 6 October 2013

Keywords:
Artichoke wastewaters
Phenolic compounds
Sugars
Ultrafiltration (UF)
Nanofiltration (NF)

ABSTRACT

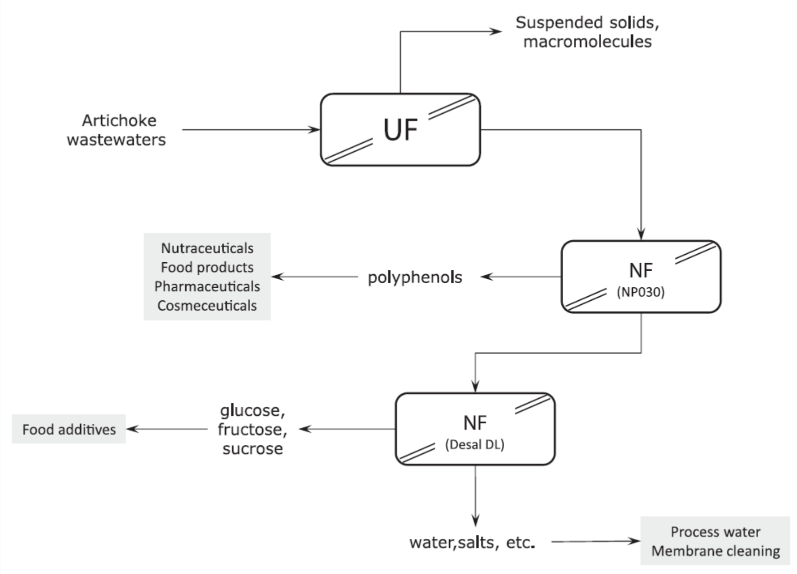
In this work an integrated membrane system was developed on laboratory scale to fractionate artichoke wastewaters. In particular, a preliminary ultrafiltration (UF) step, based on the use of hollow fibre membranes, was investigated to remove suspended solids from an artichoke extract. The clarified solution was then submitted to a nanofiltration (NF) step. Two different 2.5 × 21 in. spiral-wound membranes (Desal DL and NP030) with different properties were investigated. Both membranes showed a high rejection towards the phenolic compounds analysed (chlorogenic acid, cynarin and apigenin-7-O-glucoside) and, consequently, towards the total antioxidant activity (TAA). On the other hand, the Desal DL membrane was characterized by a high rejection towards sugar compounds (glucose, fructose and sucrose) (100%) when compared with the NP030 membrane (4.02%).

The performance of selected membranes in terms of permeate flux, fouling index and water permeability recovery was also evaluated.

On the base of experimental results, an integrated membrane process for the fractionation of artichoke wastewaters was proposed. This conceptual process design permitted to obtain different valuable products: a retentate fraction (from the NP030 membrane) enriched in phenolic compounds suitable for nutraceutical, cosmeceutical or food application; a retentate fraction (from the Desal DL membrane), enriched in sugar compounds, of interest for food applications; a clear permeate (from the Desal DL membrane) which can be reused as process water or for membrane cleaning.

Table 2 – Chemical composition of artichoke wastewaters.

Suspended solids (%)	2.5 ± 0.10
TSS (°Brix)	3.05 ± 0.05
Glucose (mg/L)	960 ± 1
Fructose (mg/L)	837 ± 1.07
Sucrose (mg/L)	1050 ± 0.41
TAA (mM Trolox)	8 ± 0.042
Chlorogenic acid (mg/L)	251 ± 2.64
Cynarin (mg/L)	164.7 ± 1.41
Apigenin-7-O-glucoside (mg/L)	101 ± 2



Conceptual process design for the treatment of artichoke wastewaters based on UF and NF operations.

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Recuperación de biocomponentes

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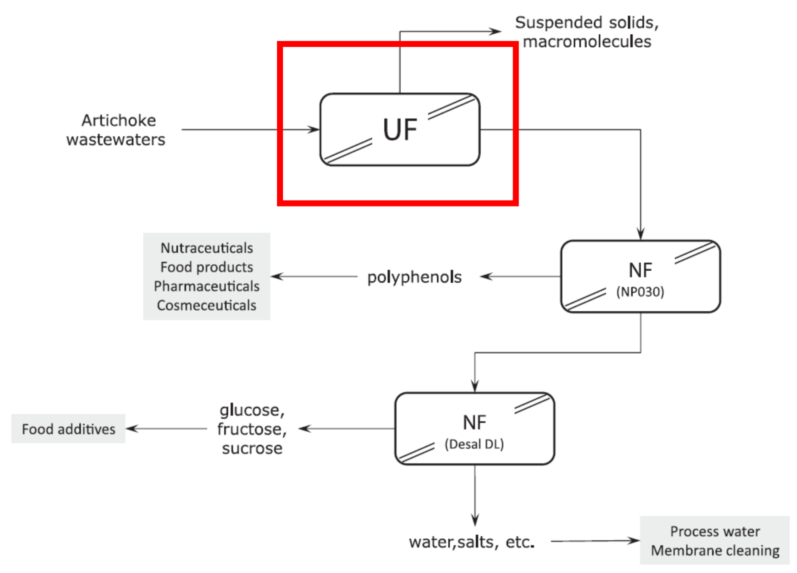

Conceptual process design for the treatment of artichoke wastewaters based on UF and NF operations.

Table 4 – Chemical composition of artichoke wastewaters before and after the clarification with the UF membrane.

Parameters	Feed	Permeate	Retentate
Suspended solids (%)	2.5 ± 0.10	n.d.	2.43 ± 0.10
TSS (°Brix)	3.05 ± 0.05	2.94 ± 0.065	3.11 ± 0.07
Glucose (mg/L)	960 ± 1	958 ± 0.93	966 ± 0.66
Fructose (mg/L)	837 ± 1.07	830 ± 2.5	840 ± 1.70
Sucrose (mg/L)	1050 ± 0.41	1040 ± 0.49	1055 ± 0.6
TAA (mM Trolox)	8 ± 0.042	7.9 ± 0.04	8.2 ± 0.3
Chlorogenic acid (mg/L)	251 ± 2.64	245 ± 4.6	250.6 ± 1.52
Cynarin (mg/L)	164.7 ± 1.41	161 ± 1.1	162.6 ± 1.52
Apigenin-7-O-glucoside (mg/L)	101 ± 2	100 ± 4.5	100.4 ± 2.9

Condiciones del proceso:
- TMP=0.31 bar
- Qf=556 L/h
- T=24ºC
- VRF=5.67

Membrana de UF:
- Fibra hueca
- Polisulfona
- MWCO=50 kDa

Eliminación de los sólidos en suspensión

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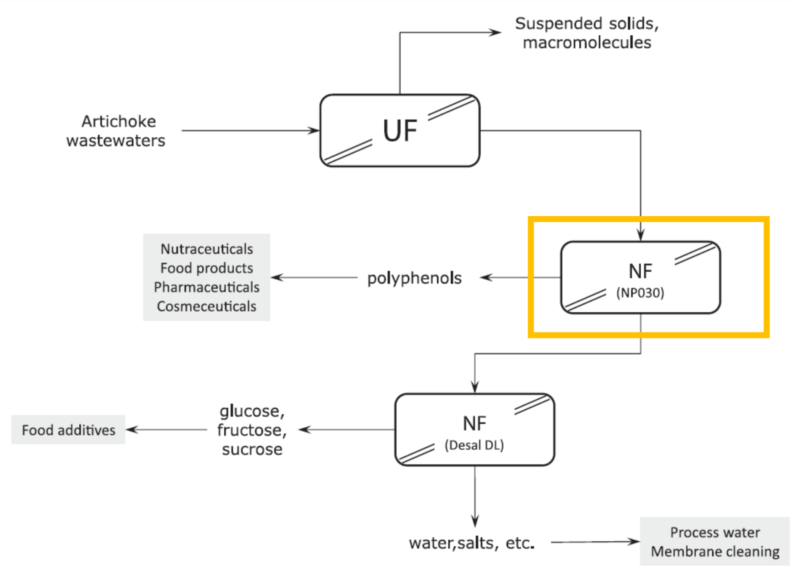
Recuperación de biocomponentes

EFLUENTES



Conceptual process design for the treatment of artichoke wastewaters based on UF and NF operations.

Condiciones del proceso:
- TMP=8 bar
- Qf=300 L/h
- T=25ºC
- VRF=5.0

Membrana de NF:
- Arrollamiento en espiral
- Polietersulfona
- MWCO=400 Da

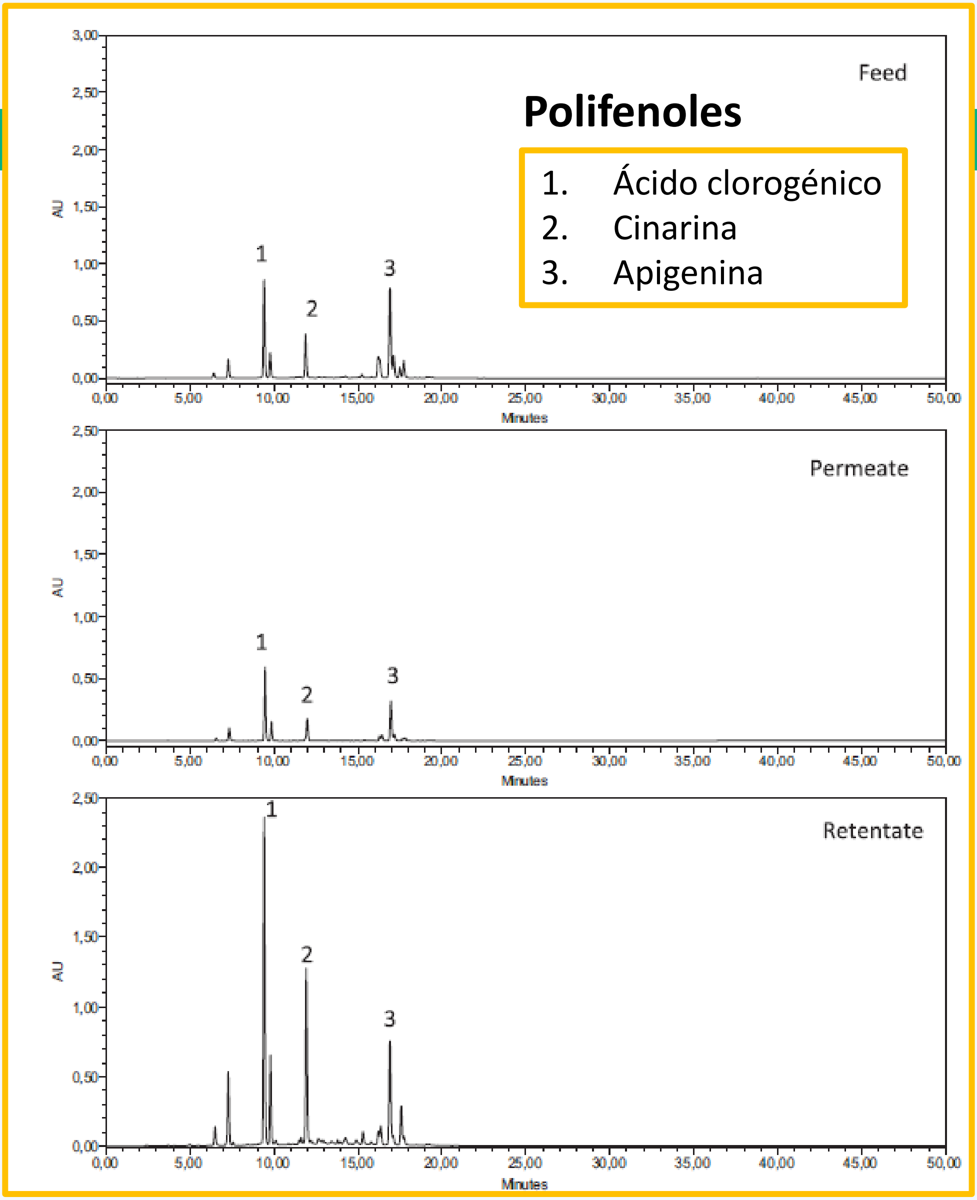


Fig. 3 – HPLC chromatograms of phenolics compounds detected in feed, permeate and retentate samples coming from the NF process with the NP030 membrane (VRF = 5). Peak 1: chlorogenic acid; 2: cynarin; 3: apigenin-7-O-glucoside.

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Recuperación de biocomponentes

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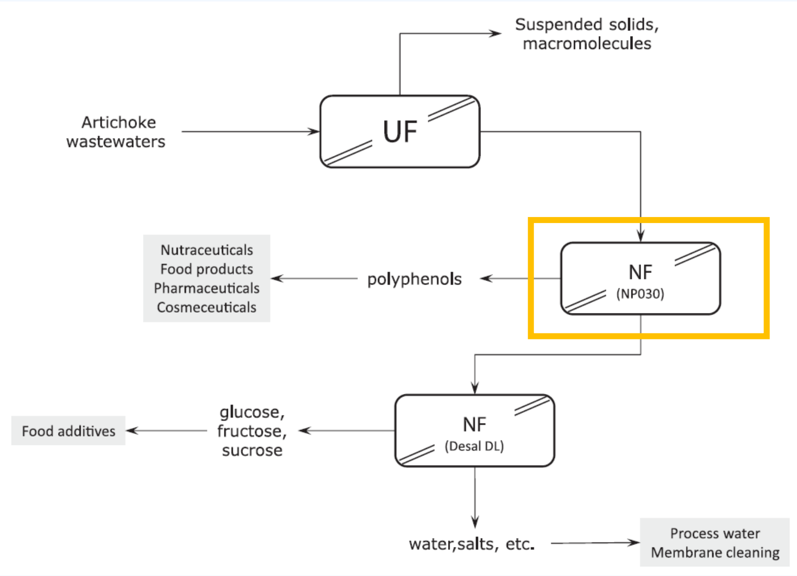

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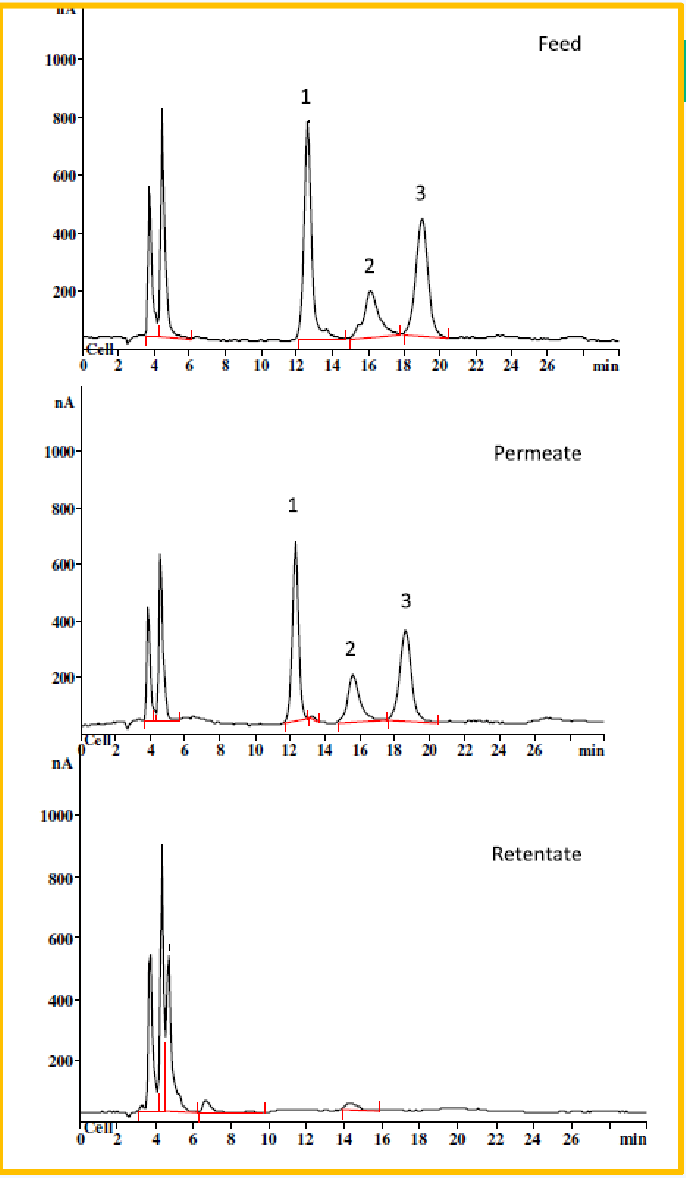

Azúcares

1. Glucosa
2. Fructosa
3. Sacarosa

Fig. 6 – HPAEC chromatograms of sugars detected in feed, permeate and retentate samples coming from the NF process with the NP030 membrane. Peak 1: glucose; 2: fructose; 3: sucrose.

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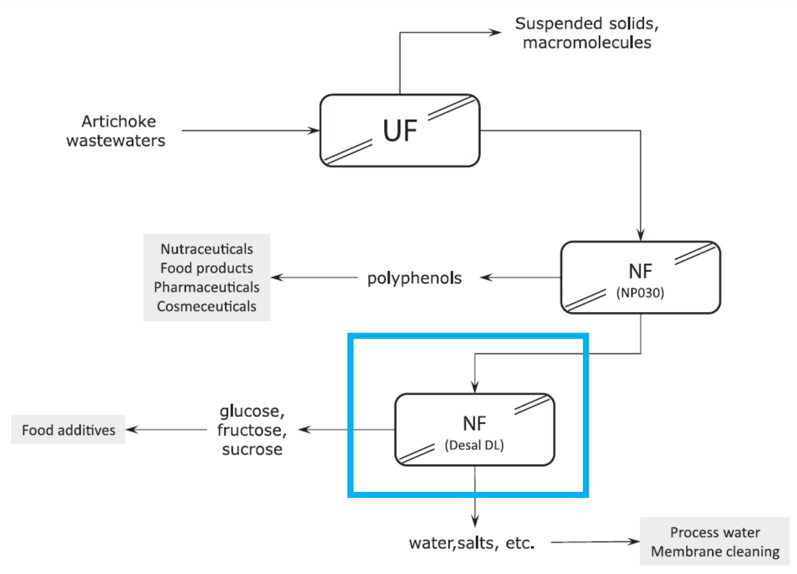
Recuperación de biocomponentes

EFLUENTES



Conceptual process design for the treatment of artichoke wastewaters based on UF and NF operations.

Condiciones del proceso:
- TMP=8 bar
- Qf=400 L/h
- T=25ºC
- VRF=5.0

Membrana de NF:
- Arrollamiento en espiral
- Poliamida aromática
- MWCO=150-300 Da

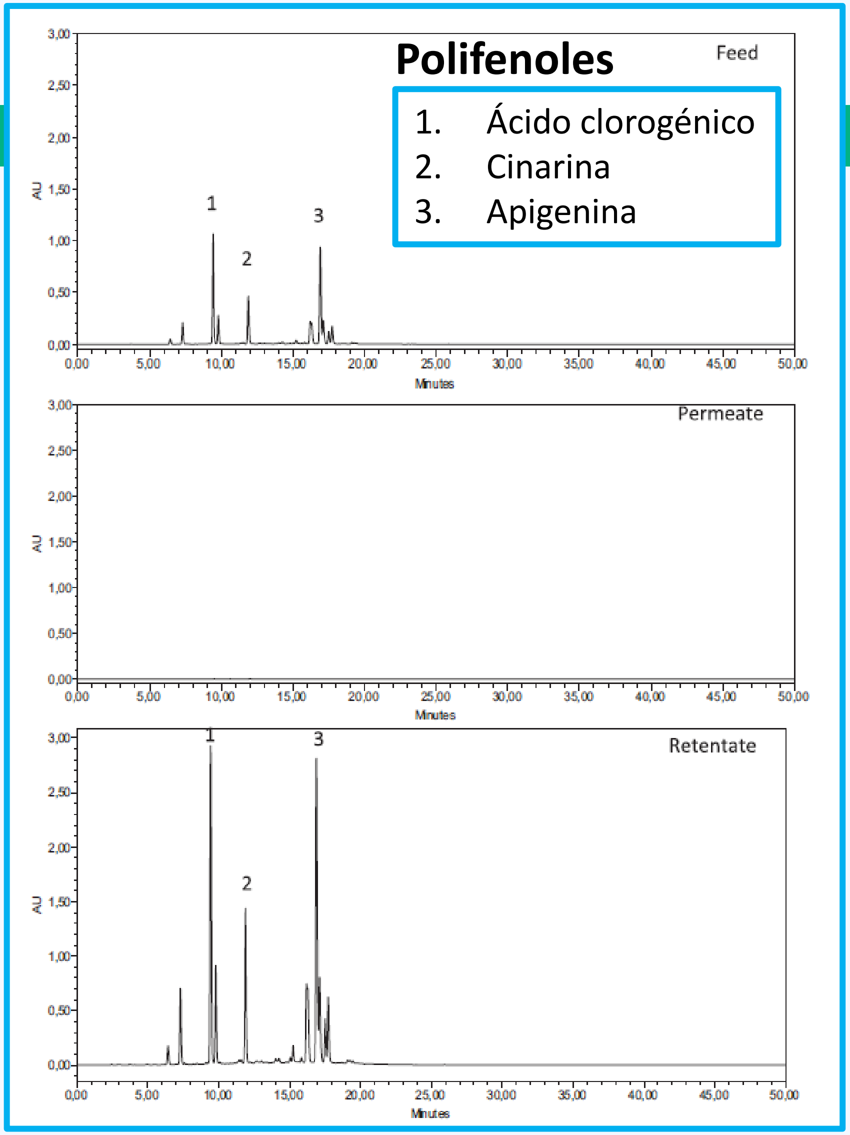


Fig. 4 – HPLC chromatograms of phenolics compounds detected in feed, permeate and retentate samples coming from the NF process with the Desal DL membrane (VRF = 5). Peak 1: chlorogenic acid; 2: cynarin; 3: apigenin-7-O-glucoside.

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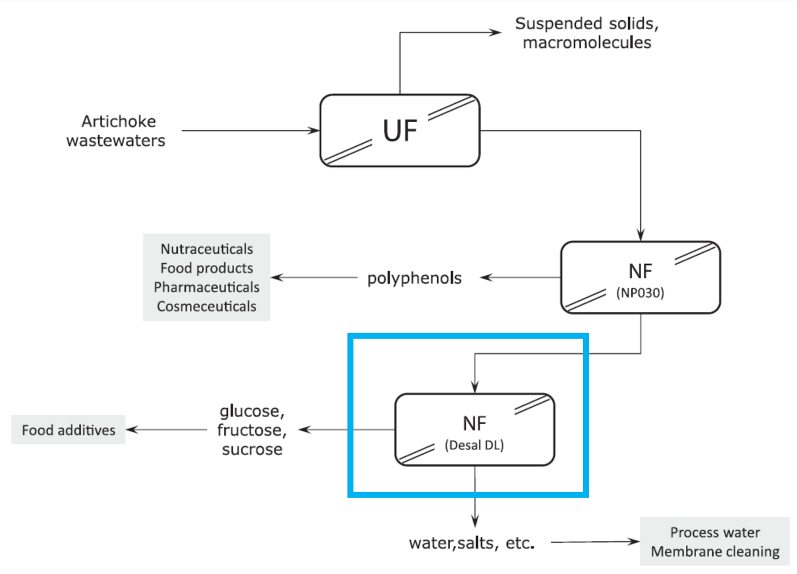

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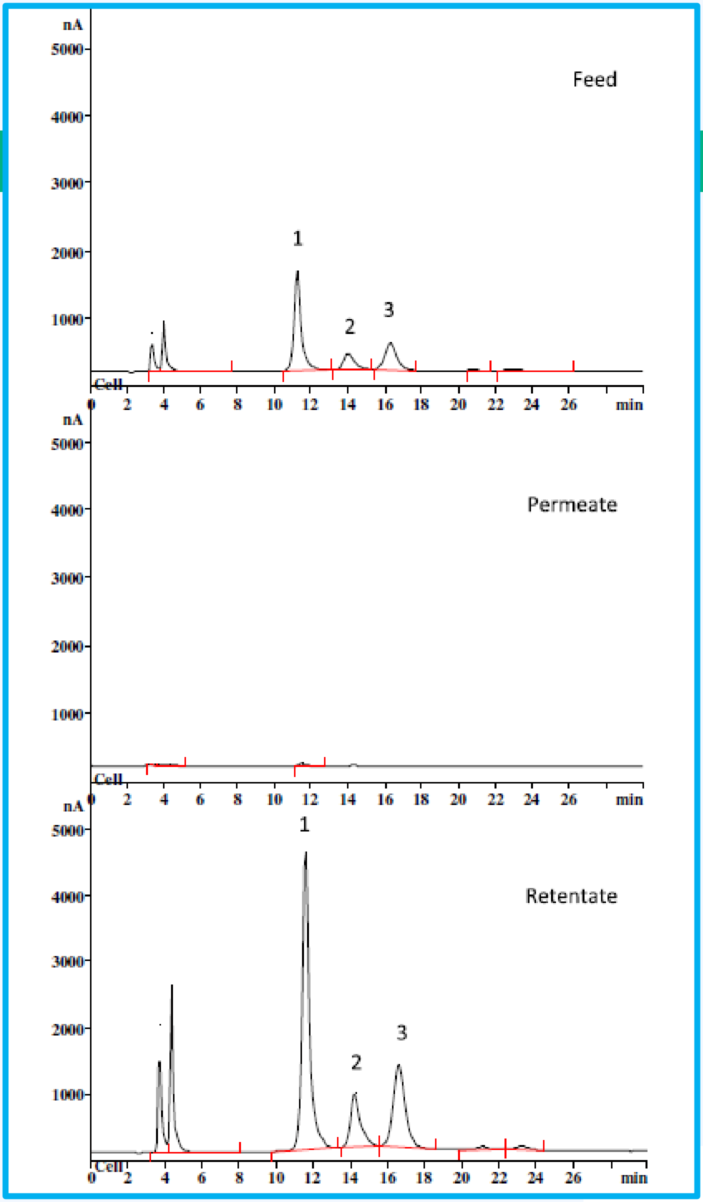

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Recuperación de biocomponentes

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Separation and Purification Technology 144 (2015) 153–161

Contents lists available at ScienceDirect

Separation and Purification Technology

journal homepage: www.elsevier.com/locate/seppur

Purification of artichoke polyphenols by using membrane filtration and polymeric resins

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[b] Department of Chemical and Nuclear Engineering, c/o Universitat Politècnica de València, Camino de Vera, s/n, 46022 Valencia, Spain
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ARTICLE INFO

Article history:
Received 22 December 2014
Received in revised form 17 February 2015
Accepted 18 February 2015
Available online 26 February 2015

Keywords:
Artichoke wastewaters
Ultrafiltration
Nanofiltration
Macroporous resins
Phenolic compounds

ABSTRACT

The present study aimed at evaluating the potential of an integrated process based on the use of membrane technology and adsorbent resins for the recovery, concentration and purification of phenolic compounds from artichoke wastewaters.

In particular, artichoke wastewaters coming from the blanching step were pre-treated by ultrafiltration (UF) in order to remove suspended solids and macromolecular compounds. The UF permeate was submitted to a nanofiltration (NF) process producing a concentrated fraction enriched in phenolic and sugar compounds.

Three different macroporous resins were tested through adsorption/desorption methods to produce purified phenolic fractions with high antioxidant activity. Samples produced in UF, NF and adsorption–desorption tests were assayed for phenolic composition (chlorogenic acid and apigenin 7-glucoside), sugar composition (fructose, glucose and sucrose) and antioxidant activity.

Among the three different tested resins, the S 7968 offered the best performance in terms of adsorption/desorption ratio for chlorogenic acid, with a total adsorption/desorption yield (TADY) of 63.39%; for the apigenin 7-O-glucoside the S 7968 and the S 2328 resins showed a TADY in the range 68.31–78.45%.

Table 1
General composition of artichoke wastewaters

Parameters	Feed
pH	4.18 ± 0.03
TSS (°Brix)	2.3 ± 0.1
Suspended solids (%)	3.08 ± 0.08
TAA (mM Trolox)	13.2 ± 0.2
Chlorogenic acid (ppm)	560.1 ± 1.3
Apigenin-7-O-glucoside (ppm)	80.0 ± 1.3
Glucose (ppm)	1422.0 ± 2.5
Fructose (ppm)	614.0 ± 2.1
Sucrose (ppm)	350.0 ± 2.4

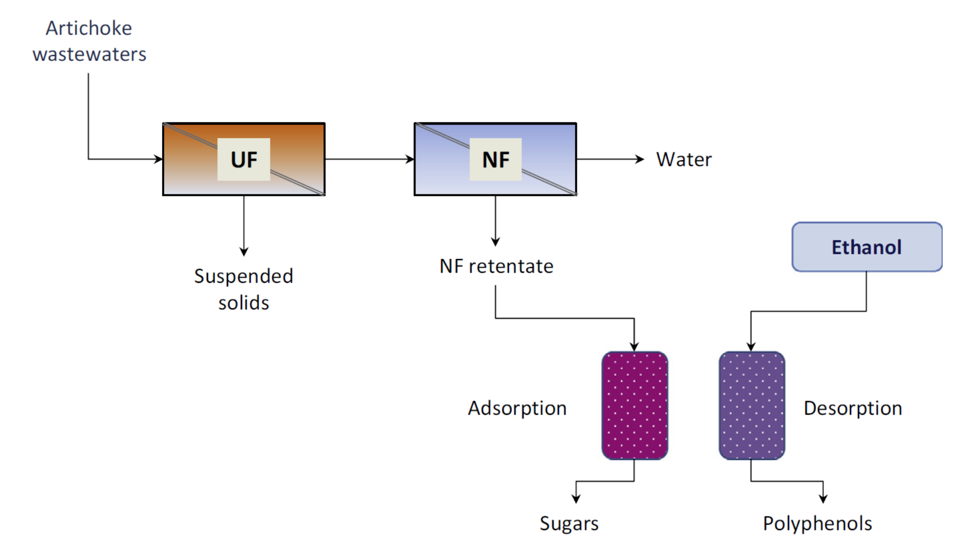

Fig. 1. General scheme of the investigated process.

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Recuperación de biocomponentes

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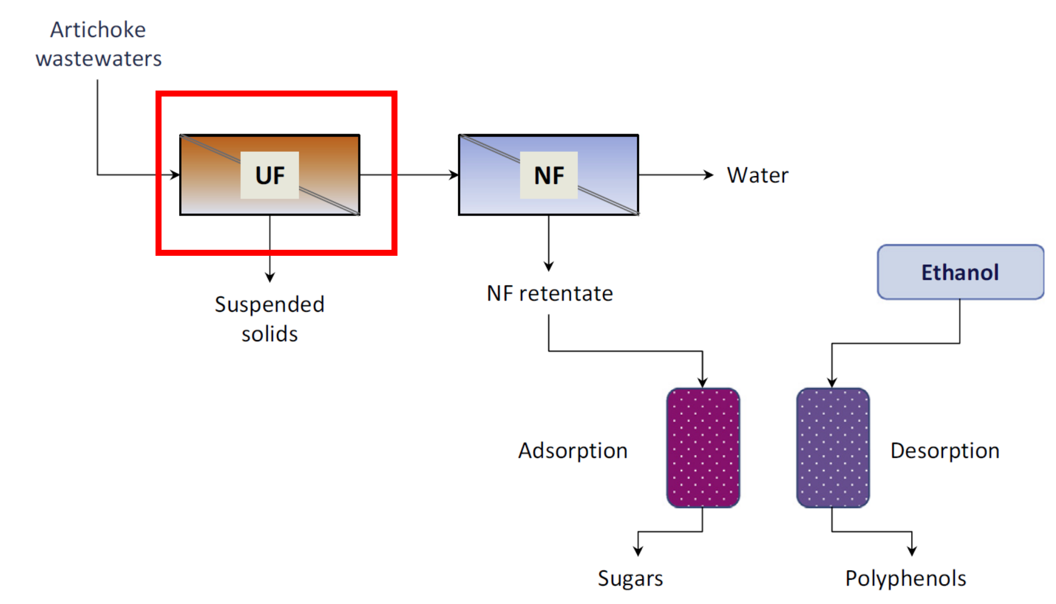

Fig. 1. General scheme of the investigated process.

Table 1
General composition of artichoke wastewaters before and after the UF process.

Parameters	Feed	Permeate	Retentate
pH	4.18 ± 0.03	4.12 ± 0.12	4.16 ± 0.60
TSS (°Brix)	2.3 ± 0.1	2.3 ± 0.1	2.6 ± 0.1
Suspended solids (%)	3.08 ± 0.08	n.d.	3.17 ± 0.07
TAA (mM Trolox)	13.2 ± 0.2	13.0 ± 0.2	13.1 ± 0.1
Chlorogenic acid (ppm)	560.1 ± 1.3	555.4 ± 1.2	556.20 ± 3.0
Apigenin-7-O-glucoside (ppm)	80.0 ± 1.3	75.0 ± 0.2	81.0 ± 2.1
Glucose (ppm)	1422.0 ± 2.5	1400.0 ± 3.2	1450.0 ± 1.7
Fructose (ppm)	614.0 ± 2.1	600.0 ± 2.3	627.0 ± 2.7
Sucrose (ppm)	350.0 ± 2.4	320.0 ± 3.1	365.0 ± 3.7

Eliminación de los sólidos en suspensión

Condiciones del proceso:
- TMP=430 kPa=4.3 bar
- Qf=4 m^3/h
- T=25ºC

Membrana de UF:
- Tubular
- TiO_2
- MWCO=15 kDa

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Recuperación de biocomponentes

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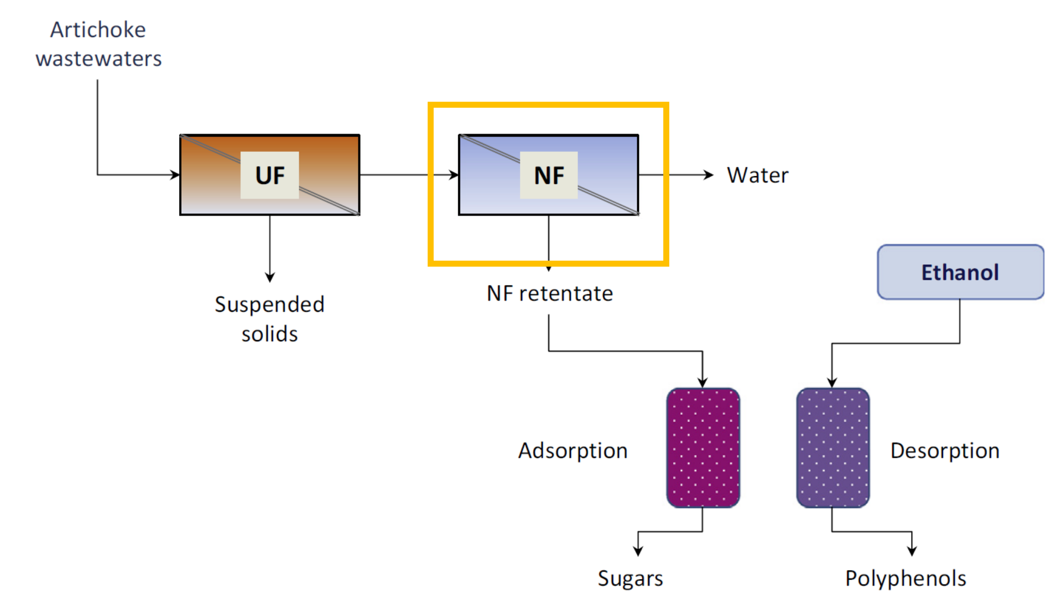
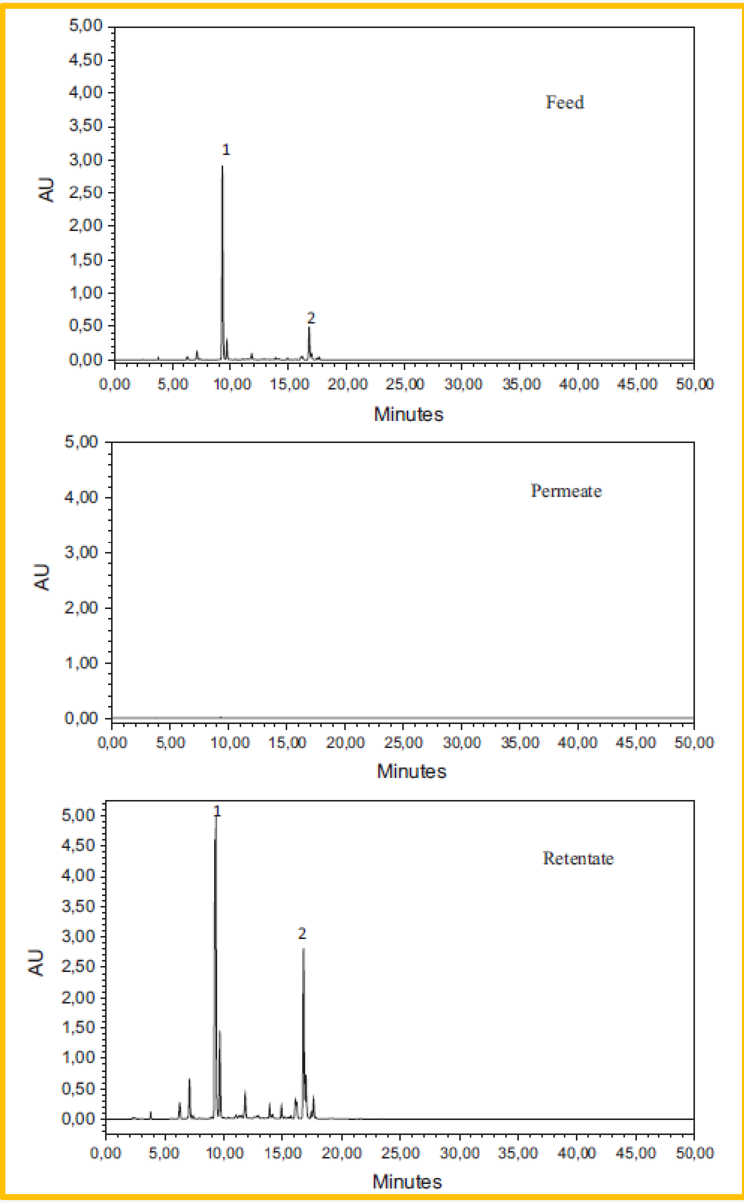


Fig. 1. General scheme of the investigated process.

Condiciones del proceso:
- TMP=800 kPa=8 bar
- Qf=300 L/h
- T=12ºC
- VRF=5.0

Membrana de NF:
- Arrollamiento en espiral
- Poliamida aromática
- MWCO=200-300 Da



Polifenoles

1. Ácido clorogénico
2. Apigenina

Fig. 4. HPLC chromatograms of phenolics compounds detected in feed, permeate and retentate samples coming from the NF process. Peaks: 1, chlorogenic acid (CA); 2, apigenin 7-O-glucoside (AOG).

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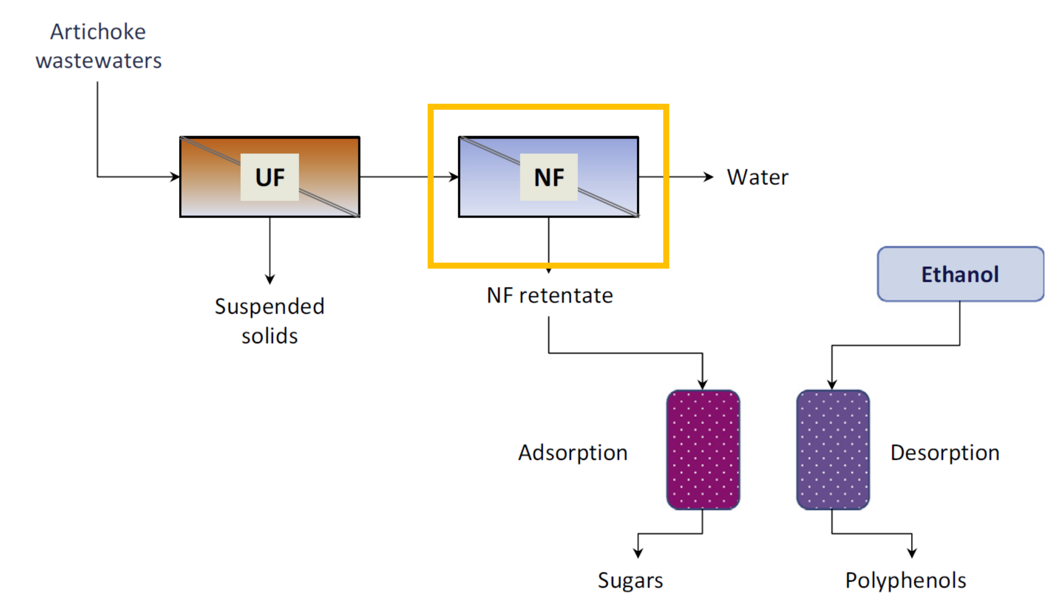
Recuperación de biocomponentes

EFLUENTES



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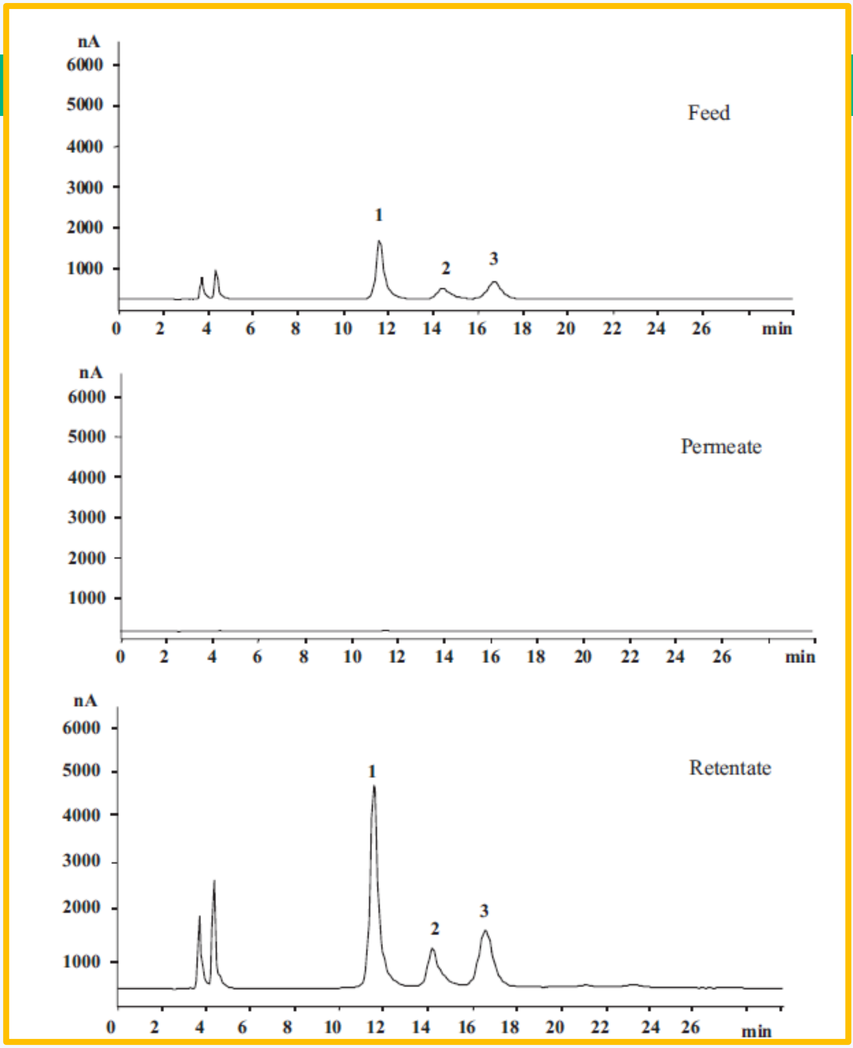

Fig. 5. HPAEC chromatograms of sugars detected in feed, permeate and retentate samples coming from the NF process. Peaks: 1, glucose; 2, fructose; 3, sucrose.

Azúcares

1. Glucosa
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Recuperación de biocomponentes

EFLUENTES

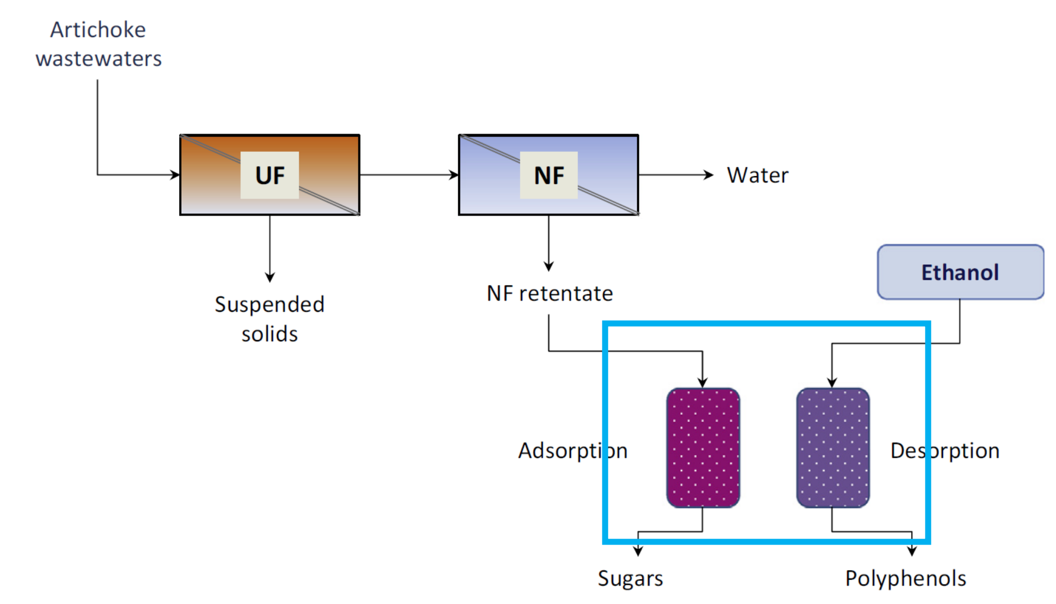


Fig. 1. General scheme of the investigated process.

Table 5
Adsorption and desorption ratios of chlorogenic acid and apigenin-7-O-glucoside for all tested resins

Resin	Adsorption (%)	Desorption (%)
Chlorogenic acid		
Lewatit S 6328A	38.38 ± 1.47	75.74 ± 3.29
Lewatit S 2328	26.65 ± 1.54	72.81 ± 8.10
Lewatit S 7968	81.35 ± 1.91	77.92 ± 1.26
Apigenin 7-O-glucoside		
Lewatit S 6328A	99.88 ± 6.79	20.78 ± 0.91
Lewatit S 2328	85.70 ± 6.42	91.54 ± 4.38
Lewatit S 7968	100 ± 6.23	68.31 ± 1.55

Polifenoles

Table 6
Concentration of glucose, fructose and sucrose in samples before and after the treatment with the tested resins.

Resin	NF retentate (ppm)	After treatment with resin (ppm)
Glucose		
Lewatit S 6328A	5341.0 ± 10.4	5311.0 ± 15.6
Lewatit S 2328	5523.0 ± 6.3	5496.0 ± 11.6
Lewatit S 7968	5638.0 ± 8.4	5622.0 ± 9.2
Fructose		
Lewatit S 6328A	2596.0 ± 6.2	2596.0 ± 5.5
Lewatit S 2328	2662.0 ± 14.6	2625.0 ± 8.8
Lewatit S 7968	2685.0 ± 10.4	2634.0 ± 9.4
Sucrose		
Lewatit S 6328A	1346.0 ± 5.7	1326.0 ± 8.4
Lewatit S 2328	1355.0 ± 9.4	1348.0 ± 10.5
Lewatit S 7968	1388.0 ± 12.5	1375.0 ± 9.7

Azúcares

INDUSTRIA ALCACHOFA

Recuperación de biocomponentes

RESIDUOS SÓLIDOS

Extracción exitosa de **inulina** y **antioxidantes**.

HIGO CHUMBO

Los higos chumbos y sus beneficios

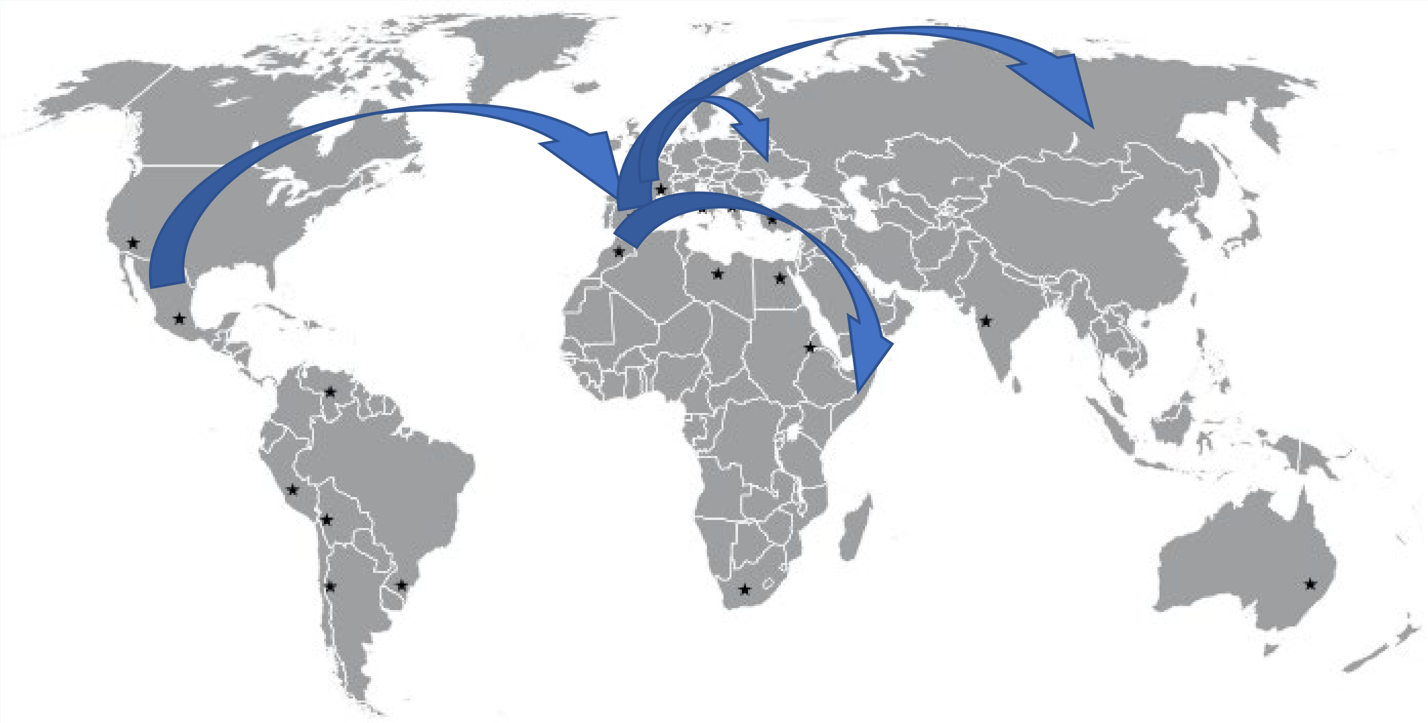
Estadísticas de producción

Caracterización de los higos chumbos

Recuperación de biocomponentes

HIGO CHUMBO

Higos chumbos y sus beneficios



C. Sáenz, H. Berger, J. Corrales García, L. Galletti, V. García de Cortázar, I. Higuera, C. Mondragón, A. Rodrigez-Feliz, E. Sepúlveda and M.T. Varnero. Utilización agroindustrial del nopal. FAO (2006)

HIGO CHUMBO

Higos chumbos y sus beneficios

El género *Opuntia* abarca cerca de 300 plantas de muy diferentes tamaños y características variables.

Sólo 12 de estas especies son utilizadas en la actualidad por el ser humano, ya sea como alimento o forraje para animales.

Especies cultivadas: *Opuntia ficus-indica*, *O. amyclaea*, *O. xoconostle*, *O. megacantha*, *O. streptacantha*.

Opuntia ficus-indica

O. robusta

Especies silvestres: *O. hyptiacantha*, *O. leucotricha*, *O. robusta*.

HIGO CHUMBO

Higos chumbos y sus beneficios

Beneficios medioambientales

En zonas áridas en las que no es posible el crecimiento de otro tipo de especies vegetales, en unos dos años la planta de higo chumbo puede quedar establecida realizando labores de sujeción de suelo y evitando, consecuentemente, la erosión y desertificación del mismo generando ya producción en esos dos años.

M. M. Khalafalla, E. Abdellatef, M. M. Mohameed Ahmed and M. G. Osman, Micropropagation of cactus (*Opuntia ficus-indica*) as strategic tool to combat desertification in arid and semi arid regions, *International Journal of Sustainable Crop Production* 2 (2007) 1-8

A. Rodrigues Santos Costa, G. de Lima Ferreira, E. Buonora de Souza and F. Cartaxo Rolim Neto, Desertification in semi-arid northeast of Brazil, Revista GEAMA *The Journal of environment* 7 (2016) 57-65

V.S. Figuereido, Perspectivas de recuperação de solo para áreas em processo de desertificação no semiárido da Paraíba-Brasil. Scripta Nova 17 (2013).

HIGO CHUMBO

Estadísticas de producción

México 345.000 Ton/año

70.000 ha

Italia 70.000 Ton/año

3.500 ha

Sudáfrica En auge

España 720 Ton/año

- Canarias: 486 Ton/año
- R. Murcia: 137 Ton/año
- C. Valenciana: 53 Ton/año
- Andalucía: 44 Ton/año

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Estadísticas de producción

Table 4
Average commercial quantities and prices, average quantity (in micrograms in a gram of cactus pear dry weight) for the main bio-functional, medicinal, nutraceutical and cosmetic components and value of each g of cactus (dry weight) according to its composition.

Compound	Weight	Average price (€)	Average price (€ μg^{-1})	Average content (μg) in 1 g dw of cactus pear	Value (€) of 1 g dw of cactus pear
Kaempferol (520-18-3)	20 mg	213.68	0.010684	34.04	0.36
Myricetin (529-44-2)	20 mg	238.11	0.011906	65	0.77
Rhamnetin (90-19-7)	10 mg	198.42	0.019842		
Fisetin (528-48-3)	10 mg	195.37	0.019537		
Isorhamnetin (480-19-3)	10 mg	204.53	0.020453	589.87	12.06
Myrcene (123-35-3)	100 mg	134.32	0.0013432		
Galangin (548-83-4)	20 mg	225.89	0.0112945		
Kaempferide (491-54-3)	10 mg	177.05	0.017705		
Luteolin (491-70-3)	10 mg	189.26	0.018926	8.4	0.16
Ferulic acid (537-98-4)	1 g	134.32	0.134320	1050	141.04
Gossypetin (489-35-0)	10 mg	265.58	0.026558		
4-Coumaric acid (501-98-4)	1 g	134.32	0.00013432		
3-Coumaric acid (14755-02-3)	1 g	134.32	0.00013432		
2-Coumaric acid (614-60-8)	1 g	134.32	0.00013432		
(+)- Catechin (154-23-4)	10 mg	186.21	0.018621	50	0.93
Morin (480-16-0)	20 mg	195.37	0.0097685		

Lucía Andreu-Coll, Marina Cano-Lamadrid, Luis Noguera-Artiaga, Leontina Lipan, Angel A. Carbonell-Barrachina, Beatriz Rocamora-Montiel, Pilar Legua, Francisca Hernandez, David Lopez-Lluch (2020) Economic estimation of cactus pear production and its feasibility in Spain. Trends in Food Science & Technology (103), 379-385

HIGO CHUMBO

Caracterización de los higos chumbos

Food Research International 101 (2017) 259–265

Contents lists available at ScienceDirect

Food Research International

journal homepage: www.elsevier.com/locate/foodres

Extensive profiling of three varieties of *Opuntia* spp. fruit for innovative food ingredients

Bruno Melgar[a,b], Eliana Pereira[a], M. Beatriz P.P. Oliveira[c], Esperanza M. Garcia-Castello[b], Antonio D. Rodriguez-Lopez[d], Marina Sokovic[e], Lillian Barros[a], Isabel C.F.R. Ferreira[a,*]

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A R T I C L E I N F O

Keywords:
Opuntia ficus-indica
Opuntia engelmannii
Nutritional properties
Betalains
Antimicrobial activity

A B S T R A C T

Consumer interest in the use of natural ingredients is creating a growing trend in the food industry, leading to research into the development of food products such as colorants, antimicrobials and antioxidant compounds. This work involves an extensive morphological (using physico-chemical assays), chemical (antioxidant activity assays) and microbiological (Gram-positive and negative strains) characterization of prickly peras (*Opuntia ficus-indica* (OFI) var. sanguigna, gialla and *Opuntia engelmannii*) fruits. Through chromatographic assays, these species have shown interesting contents of hydrophilic (sugars, organic acids and betalains) and lipophilic (tocopherols and fatty acids) compounds. While *Opuntia engelmannii* exhibited higher content of betacyanins and mucilage, OFI varieties sanguigna and gialla displayed greater organic acid content. The sanguigna variety also showed the highest α-tocopherol content. All this compounds could be the responsible of enhancing the bioactivity of this variety, which can be observed in its antimicrobial potential, tested in the studied strains too. Results revealed that *Opuntia* spp. could be used as a nutraceutical and/or food additive, maintaining and promoting health and life quality.

***Opuntia Ficus Indica* Var. Gialla**

***Opuntia Ficus Indica* Var. Sanguingna**

Opuntia engelmannii

Nutritional value and hydrophilic compounds of the studied *Opuntia* spp.

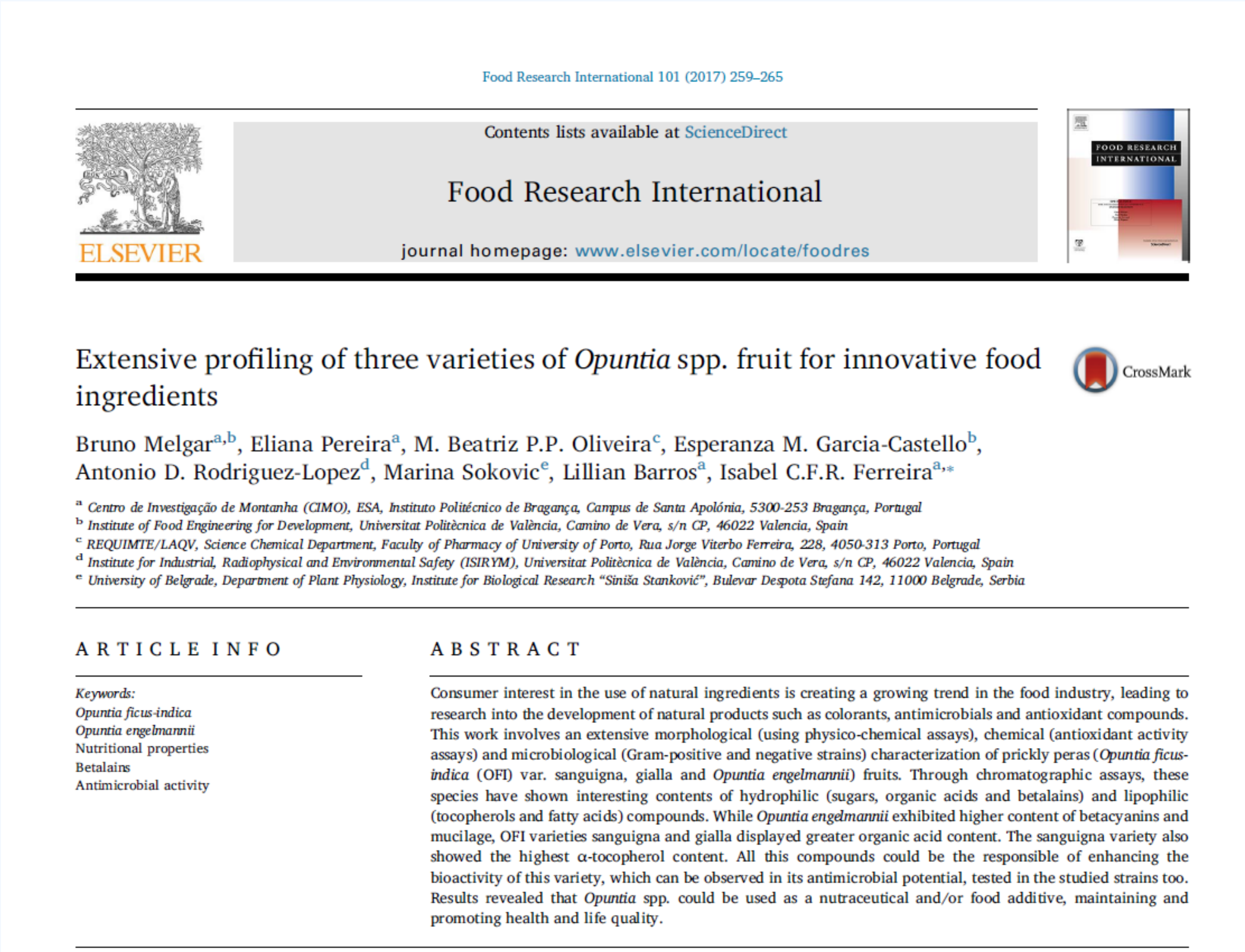
	OG	OS	OE
Moisture (%)	83.38 ± 0.07^{a}	81 ± 2^{a}	65 ± 2^{b}
Fat (g/100 g FW)	0.037 ± 0.001^{b}	0.063 ± 0.004^{b}	0.38 ± 0.03^{a}
Proteins (g/100 g FW)	0.52 ± 0.01^{c}	0.84 ± 0.03^{b}	1.62 ± 0.06^{a}
Ash (g/100 g FW)	0.348 ± 0.004^{c}	0.42 ± 0.02^{b}	0.75 ± 0.02^{a}
Carbohydrates (g/100 g FW)	15.68 ± 0.04^{b}	18 ± 2^{b}	33 ± 2^{a}
Energy (kcal/100 g FW)	65.1 ± 0.1^{b}	77 ± 7^{b}	140 ± 6^{a}
Sugars (g/100 g FW)			
Fructose	4.13 ± 0.02^{b}	4.97 ± 0.07^{a}	0.53 ± 0.01^{c}
Glucose	5.53 ± 0.05^{b}	6.30 ± 0.03^{a}	0.83 ± 0.01^{c}
Sucrose	0.133 ± 0.005^{c}	0.157 ± 0.001^{b}	0.31 ± 0.01^{a}
Sum of free sugars	9.79 ± 0.07b	11.43 ± 0.09^{a}	1.68 ± 0.02^{c}
Organic acids (mg/100 g FW)			
Oxalic	26.7 ± 0.3^{b}	29.5 ± 0.6^{a}	tr
Quinic	28 ± 1*	35.6 ± 0.3*	nd
Malic	tr	tr	tr
Ascorbic	2.3 ± 0.1^{b}	2.0 ± 0.1^{b}	19.7 ± 0.1^{a}
Citric	49.3 ± 0.7^{a}	46.9 ± 0.1^{b}	0.8 ± 0.01^{c}
Succinic	184 ± 1*	131 ± 2*	nd
Fumaric	8.0 ± 0.1*	6.3 ± 0.2*	nd
Sum of organic acids	298.1 ± 0.8^{a}	251 ± 2^{b}	20.5 ± 0.1^{c}

FW, pulp fresh weight; nd, not detected; tr, traces. OG, *Opuntia ficus-indica* var. Gialla; OS, *Opuntia ficus-indica* var. sanguigna; OE, *Opuntia engelmannii*. In each row different letters mean significant differences ($p < 0.05$).

* Statistical differences (< 0.001) were observed when *t*-Student test was applied.

HIGO CHUMBO

Caracterización de los higos chumbos



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Los resultados obtenidos han revelado que las especies de *Opuntia* spp. pueden emplearse como aditivos nutracéuticos y/o alimentarios, manteniendo y favoreciendo la salud y la calidad de vida.

Se ha observado que tienen potencial actividad antimicrobiana.

HIGO CHUMBO

Recuperación de biocomponentes

Industrial Crops & Products 107 (2017) 353–359

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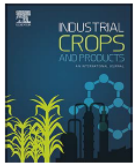

By-product recovery of *Opuntia spp.* peels: Betalainic and phenolic profiles and bioactive properties

CrossMark

Bruno Melgar[a,b], Maria Inês Dias[a], Ana Ciric[b], Marina Sokovic[b], Esperanza M. Garcia-Castello[c], Antonio D. Rodriguez-Lopez[d], Lillian Barros[a], Isabel Ferreira[a,*]

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A B S T R A C T

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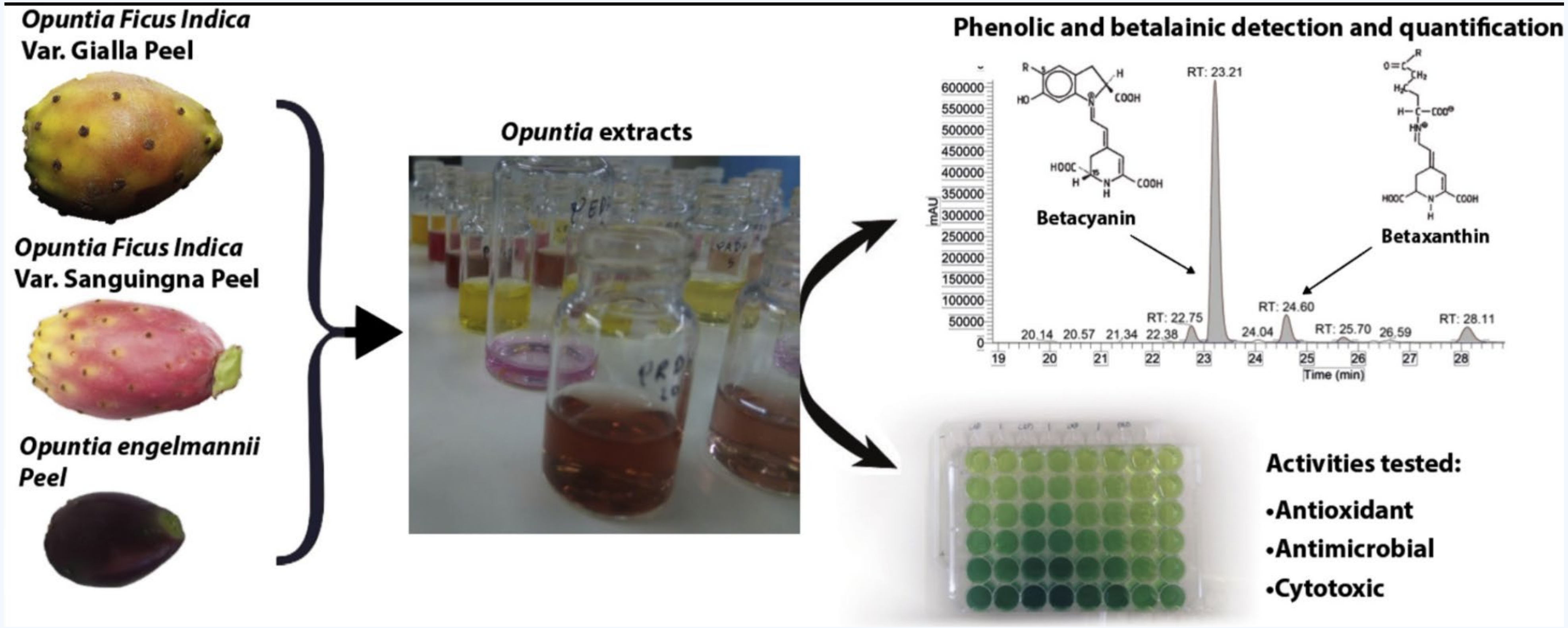
Recuperación de biocomponentes



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Recuperación de biocomponentes

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Se puede sugerir el uso de estos colorantes naturales con actividad antioxidante y antimicrobiana intrínseca, lo que proporcionaría a las industrias la posibilidad de etiquetar sus productos como limpios
y con beneficios funcionales.

HIGO CHUMBO

Recuperación de biocomponentes

molecules

MDPI

Article

Ultrasound and Microwave Assisted Extraction of *Opuntia* Fruit Peels Biocompounds: Optimization and Comparison Using RSM-CCD

Bruno Melgar [1,2], Maria Inês Dias [2], Lillian Barros [2], Isabel C.F.R. Ferreira [2,*], Antonio D. Rodriguez-Lopez [3] and Esperanza M. Garcia-Castello [1,*]

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* Correspondence: iferreira@ipb.pt (I.C.F.R.F.); egarcia1@iqn.upv.es (E.M.G.-C.); Tel.: +351-273303219 (I.C.F.R.F.); +34-9638-7700-0 (ext. 76372) (E.M.G.-C.)

Received: 11 September 2019; Accepted: 2 October 2019; Published: 8 October 2019

check for updates

Abstract: Ultrasound-assisted extraction (UAE) and microwave-assisted extraction (MAE) of bioactive compounds, peels from *Opuntia engelmannii* cultivar (cv.) Valencia were optimized by response surface methodology. Randomized extraction runs were performed for each of the technologies employed in order to build effective models with maximum (bioactive molecules content and yield) and minimum (antioxidant activity) responses. A 5-level, 4-factor central composite design was used to obtain target responses as a function of extraction time (t), solid to liquid ratio (S/L), methanol concentration (*metOH*), and temperature (T). Specific response optimization for each technology was analyzed, discussed, and general optimization from all the responses together was also gather. The optimum values for each factor were: t = 2.5 and 1.4 min, S/L = 5 and 5 g/L, *metOH* = 34.6 and 0% of methanol and T = 30 and 36.6 °C, achieving maximum responses of 201.6 and 132.9 mg of betalains/g, 13.9 and 8.0 mg of phenolic acids/g, 2.4 and 1.5 mg of flavonoids/g, 71.8% and 79.1% of extractable solid and IC_{50} values for the antioxidant activity of 2.9 and 3.6, for UAE and MAE, respectively. The present study suggested UAE as the best extraction system, in order to maximize recovery of bioactive compounds with a high antioxidant activity.

Keywords: *Opuntia*; by-products; phenolic compounds; betalains; extraction optimization; response surface methodology (RSM)

HIGO CHUMBO

Recuperación de biocomponentes

Ultrasonidos

- tiempo = 2,5 min
- Ratio = 5 g/L
- % disolvente = 34,6%
- Temperatura = 30 ºC.

→

- Betalaínas = 201,6 mg/g
- Ácidos fenólicos = 13,9 mg/g
- Flavonoides = 2,4 mg/g

Microondas

- tiempo = 1,4 min
- Ratio = 5 g/L
- % disolvente = 0%
- Temperatura = 36,6ºC.

→

- Betalaínas = 132,9 mg/g
- Ácidos fenólicos = 8,0 mg/g
- Flavonoides = 1,5 mg/g

La extracción asistida por ultrasonidos maximiza la extracción de biocomponentes

Recuperación de compuestos bioactivos de residuos y efluentes del procesado de la alcachofa e higo chumbo

Dra. Esperanza M. García Castelló

Dr. Antonio D. Rodríguez López

19/05/2022

Facsa Fovasa Cátedra del agua, residuos y economía circular

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ESCUELA TÉCNICA SUPERIOR INGENIEROS INDUSTRIALES VALENCIA