Eco-friendly extraction of bioactive metabolites from Ecuadorian quinoa (Chenopodium quinoa Willd.) by natural deep eutectic solvents (NADES)

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Introduction

Natural deep eutectic solvents (NADES), prepared with abundant and low-cost primary metabolites, are eco-friendly, non-toxic, biodegradable, easy to prepare and possess a remarkable solubilizing potential. Quinoa is an Andean pseudocereal whose production and consumption have increased worldwide as it was reported to contain bioactive compounds with beneficial effects on health. As other parts of the plant could yield to interesting and health-promoting new by-products, different types of NADES (viscous and less viscous) solvents were investigated, using simple and rapid HPTLC-bioautographic methods, for their capacity to extract antioxidant compounds from quinoa leaves. The most abundant sapogenins were identified in the husk of bitter quinoa seeds and in bitter quinoa seeds by LC-MS.

Natural Deep Eutectic Solvents

Preparation: Heating method

Weigh each component of the mixture according to the mole ratio

Heat in water bath at 50°C with magnetic stirring at 350 rpm

Obtaining a clear and transparent liquid

Vortex 5 min at 40°C, 60 min

Ultrafiltrate RT, 30 min

Centrifuge 25°C, 40 min, 4000 g

NADES extracts

Extraction

Water was added to improve the extraction process by reducing the viscosity of NADES: N1 = 17.5% w/w H2O, N2 = 20% w/w H2O, N3 = 10% w/w H2O and N4 = 10% w/w H2O. The thermogrames do not present melting points, characterising these diluted NADES as eutectic solvents.

Phenolic compounds extracted with eight different NADES (N1 to N8): (1) HPTLC CHEMICAL PROFILING AND (2) HPTLC-BIOAUTOGRAPHY

Methodology and results

HPTLC conditions:

Mobile phase: formic acid - water = methyl ethyl ketone - ethyl acetate (10:10:30:50 v/v)

Derivatization

a) 10 g/L solution of diphenylboric acid methyl ester in MeOH
b) 50 g/L solution of PEG400 in MeOH

Fig. 1 High performance thin-layer chromatograms of standard solutions: Rutin (1), Kaempferol (2), Samples: quinoa seed methanolic extract (3) and quinoa leaf extract in water (4), methanol (5) methanol +20% H2O (6), quinoa leaf NADES N1 (7), N2 (8), N3 (9), N10 (10), N11 (11), N12 (12), N13 (13) and N14 (14) extracts

HPTLC conditions:

Mobile phase: formic acid - water = methyl ethyl ketone - ethyl acetate (10:10:30:50 v/v)

Derivatization

0.5 mg/ml solution of 2,2-diphenyl-1-picrylhydrazyl in MeOH. Leave the plate in dark for 60 min

Fig. 2 DPPH assay of standard solution of Rutin (1). Samples: quinoa seed methanolic extract (2) and quinoa leaf extract in water (3), methanol (4) methanol + 20% H2O (5), quinoa leaf NADES N1 (6), N2 (7), N3 (8), N4 (9), N10 (10), N11 (11), N12 (12) and N13 (13) extracts

Conclusions and perspectives

Extraction of quinoa leaves bioactive compounds is possible using NADES; given their non-toxicity, these solvents allow direct addition of extracts to food formulations and pharmaceutical products. NADES quinoa leaves extracts are antioxidants, qualifies for possible new functional ingredients. Regardless the sample or extraction method, the major detected sapogenins were hederagenin and phytolaccagenic acid. Interestingly, the extracts of quinoa metabolites in NADES show high stability (they retain initial organoleptic characteristics) in storage at 5°C for several weeks, which represents an advantage for the industry avoiding separation and purification processes. The elaboration of products based on quinoa NADES-extracts such as edible film coating or multifunctional wound dressing hydrogel is in process.

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