SHORT COMMUNICATION

Studies related to the chemical composition, biological activities and toxicity of methanolic extracts of noni (Morinda citrifolia) fruits and leaves

Daiane Barbosa de Matos Lima¹, Anaí Loreiro dos Santos¹, Claudia Andréa Lima Cardoso¹, Laiza Canielas Krause¹,² and Elina Bastos Caramão¹,²,³

¹Post Graduate Program in Industrial Biotechnology (PBI), Tiradentes University (UNIT), Aracaju, Sergipe, Brazil; ²Institute of Research and Technology (ITP), Tiradentes University (UNIT), Aracaju, Sergipe, Brazil; ³Center for Studies in Natural Resources, State University of Mato Grosso do Sul (UEMS), Dourados, MS, Brazil; ⁴National Institute of Science and Technology in Energy and Environmental (INCT-E&A), Salvador, Bahia, Brazil

ABSTRACT

Morinda citrifolia is a plant that grows in Brazilian northeast and presented a wide range of therapeutic, industrial and technological applications. Based on this, the aim of this work was to study the chemical composition, main biological activities and potential toxicity of its extracts, aiming their industrial application. Important compounds were identified in the methanolic extracts obtained by ultrasonic and Soxhlet extractions from leaves and fruits. GC × GC allowed for the identification of phytosterols, fatty acids and methyl esters, besides others (scopoletin, hydrocarbons, alcohols, terpenes). By HPLC-DAD, compounds like catechin, rutin, quercetin could be also identified and quantified. Their content of polyphenols and flavonoids was considered between the international standards. The extracts showed high antioxidant activities (EC₅₀ ~ 300 µg mL⁻¹, using DPPH assay) compared with those from the literature. The extracts did not show toxicity or mutagenicity, but presented cytotoxicity, which can indicate their use safely in phytotherapeutic or nutritional applications.

ARTICLE HISTORY

Received 4 July 2021
Accepted 9 December 2021

KEYWORDS

Morinda Citrifolia; GC × GC; LC-DAD; antioxidant activity; sonication; polyphenols

CONTACT

Elina Bastos Caramão elina@ufrgs.br

© 2021 Informa UK Limited, trading as Taylor & Francis Group
1. Introduction

_Morinda citrifolia_ Linn (Noni) is a perennial fruitful plant that reaches 6 m in height (Chan-Blanco et al. 2007; Nerurkar et al. 2015) and belongs to the Rubiaceae family, being traditionally used as therapeutic treatment of diseases such as arthritis, tuberculosis, diabetes and hypertension (Ali et al. 2016). Due to its adaptability to edaphoclimatic conditions and its value in the market, the cultivation of noni tends to grow in Brazil, mainly aiming its medicinal use and functional foods production (Vasconcelos et al., 2014). Its juice has antioxidant and anti-inflammatory properties (Motshakeri and Ghazali 2015). Its commercialization is not allowed in Brazil due to the lack of studies proving their action and nontoxicity (Deng et al. 2010). Almeida et al. (2019) carried out an excellent review involving updated and comprehensive information on _M. citrifolia_ (mainly fruits), such as its traditional use, biochemical, herbal and toxicological properties, processes and standardizations of derived products. In view of the wide range of therapeutic, industrial and technological applications of the different components of _M. citrifolia_, this work aims to study the chemical composition and main biological activities of _M. citrifolia_ fruits and leaves extracts from the Northeast region of Brazil (Sergipe) with a view to their industrial, nutritional and pharmacological application.

2. Results and discussion

The extractions by sonication revealed higher yields (fruits 14.7% and leaves 15.95%) if compared to Soxhlet (fruits 5.66% and leaves 5.24%) for both samples. To facilitate the data interpretation, it was used the following codes: Soxhlet extract of fruits (SEF), Soxhlet extract of leaves (SEL), ultrasonic extract of fruits (UEF) and ultrasonic extract do leaves (UEL).

The HPLC analysis of the extracts revealed the presence of nine different polyphenols (Figure S2 and Table S3, supplementary material). Sonication extracts showed higher concentrations for all the nine compounds than Soxhlet extracts; regarding advantages such as lower solvent consumption and shorter extraction time. The sonication technique allowed for the increase the yield of bioactive compounds such as rutin and quercetin by five and six times, reducing the extraction time by 3.2 times. In the fruit extracts, quercetin and catechin were the major constituents (15.6 and 15.0 mg g⁻¹, respectively). These compounds are reported as the main constituents in Noni fruit extracts, however in lower concentration than that obtained in the present study (Huang et al. 2016; Meinhart et al. 2019). The content of rutin in Brazilian Noni was higher than those obtained by other authors.

In the leaf extracts, the concentration of epigallocatechin, gallocatechin and quercetin can be highlighted. The concentration of these compounds was higher than those reported in the literature for Noni leaves extracts obtained by conventional techniques (Hui et al. 2020). Rutin, catechin and quercetin, flavonoids identified in these extracts, exhibit significant biological activities, such as antioxidant, antimicrobial, among others (Prakash et al. 2019; Araújo et al. 2021).

Acute toxicity, evaluated by _A. salina_ assay, did not show mortality in the evaluated concentration (LC₅₀ >1000 µg mL⁻¹) (Nguta et al. 2011).
The results of cytotoxic and mutagenic activities, evaluated by *A. cepa* bioassay, are summarized in Table S3. All extracts showed cytotoxic activity represented by a decrease in germination index (GI) and an increase in mitotic index (MI), when compared to the negative control (*p* < 0.05) (Francisco et al. 2018). These effects increased with the increasing of the concentration (0.1 to 1.0 mg mL⁻¹). No significant differences were observed for mutagenicity index (MTI), thus no mutagenic effects were observed, at any concentration, when compared to the negative control.

Boontha et al. (2018) reported cytotoxic activity against human breast cancer cells for fruit extracts of Noni. Extracts from leaves and some isolated compounds (dammacanthal, rutin, and scopoletin) also showed cytotoxic effect against cancer cell according to Thani et al. (2010) and crude extract showed higher activity than the isolated compounds, indicating synergic effect. Thus, the presence of rutin and scopoletin in the extracts obtained in the present study could explain the cytotoxicity reported.

### 3. Conclusions

The ultrasonic extracts showed higher yields than those obtained by Soxhlet, with the reduction of the extraction time and solvent consumption. GC × GC allowed for the identification of important compounds, with activities recognized in the literature, such as fatty acids, scopoletin, phytosterols and terpenes. HPLC-DAD allowed for the identification of nine different compounds in leaves fruit extracts, noteworthy: catechin, quercetin, gallic acid, gallocatechin and epigallocatechin. The extracts were nontoxic in *A. salina* assay and showed some cytotoxicity, but did not show mutagenicity, in *A. cepa* bioassay. These results indicated the potential use of the extracts from Brazilian *Morinda citrifolia* in anticancer therapies, as the literature already has been reported.

**Disclosure statement**

No potential conflict of interest was reported by the authors.

**Funding**

The authors thank CNPq, CAPES and FAPITEC for the financial support for this study.

**References**

Ali M, Kenganora M, Manjula SN. 2016. Health Benefits of Morinda citrifolia (Noni): A Review. Phcogj. 8(4):321–334.

Almeida ES, De Oliveira D, Hotza D. 2019. Properties and Applications of Morinda citrifolia (Noni): A Review. Compr Rev Food Sci Food Saf. 18(4):883–909.

Araújo FF, Farias DP, Neri-Numa IA, Pastore GM. 2021. Polyphenols and their applications: An approach in food chemistry and innovation potential. Food Chem. 338:127535.

Boontha S, Kaewjaiboon N, Rattanatanyapat P, Nanto W, Taolam S, Buranrat B, Pitaksuteepong T. 2018. Cytotoxicity and cell migration suppression by noni fruit extract on michigan cancer
Foundation-7 human breast cancer cells and development of topical microemulsions. Phcog Mag. 14(59):499.

Chan-Blanco Y, Vaillant F, Pérez AM, Belleville MP, Zúñiga C, Brat P. 2007. The ripening and aging of noni fruits (Morinda citrifolia L.): microbiological flora and antioxidant compounds. J Sci Food Agric. 87(9):1710–1716.

Deng S, West B, Jensen J. 2010. A quantitative comparison of phytochemical components in global noni fruits and their commercial products. C. J. Food Chem. 122(1):267–270.

Fidrianny I, Octaviani GD, Kusmardiyan S. 2018. Study of antioxidant profile and phytochemical content of different organs 51 extracts of Morinda citrifolia L. J. Pharm. Sci. Res. 10: 2102.

Firmansyah A, Winingsih W, Manobi JDY. 2021. Review of Scopeotelin: Isolation, Analysis Process, and Pharmacological Activity. Biointer. Res. Appl. Chem. 11:12006.

Francisco LFV, Crispim BA, Viana LF, et al. 2018. Cytotoxicity, Genotoxicity and Mutagenicity of Aluminum, Manganese and Lead in Meristematic Cells of Root Allium cepa. Orbital: Elect. J. Chem. 10:60.

Huang C, Wei Y-X, Shen M-C, Tu Y-H, Wang C-C, Huang H-C. 2016. Chrysin, abundant in Morinda citrifolia fruit water-EtOAc extracts, combined with apigenin synergistically induced apoptosis and inhibited migration in human breast and liver cancer cells. J Agric Food Chem. 64(21):4235–4245.

Hui CK, Majid NI, Yusof HM, et al. 2020. Catechin profile and hypolipidemic activity of Morinda citrifolia leaf water extract. Heliony. 6:004337.

Islam MT, Ali ES, Uddin SJ, Shaw S, Islam MA, Ahmed MI, Chandra Shill M, Karmakar UK, Yarla NS, Khan IN, et al. 2018. Phytol: A review of biomedical activities. Food Chem Toxicol. 121: 82–94.

Jayaraman SK, Manoharan MS, Illanchezian S. 2008. Antibacterial, antifungal and tumor cell suppression potential of Morinda citrifolia fruit extracts. Int. J. Integr. Biol. 3:44.

Lemarié F, Beauchamp E, Legrand P, Rioux V. 2016. Revisiting the metabolism and physiological functions of caprylic acid (C8:0) with special focus on ghrelin octanoylation. Biochimie. 120: 40–48.

Ly HT, Pham Nguyen MT, Nguyen TKO, Bui TPQ, Ke X, Le VM. 2020. Phytochemical analysis and wound-healing activity of noni (Morinda citrifolia) leaf extract. J Herbs Spices Med Plants. 26(4):379–393.

Meinhart AD, Damim FM, Caldeirão L, de Jesus Filho M, da Silva LC, da Silva Constant L, Filho JT, Wagner R, Godoy HT. 2019. Chlorogenic and caffeic acids in 64 fruits consumed in Brazil. Food Chem. 286:51–63.

Motshakeri M, Ghazali HM. 2015. Nutritional, phytochemical and commercial quality of noni fruit: A multi-beneficial gift from nature. Trends Food Sci. Technol. 45(1):118–129.

Nerurkar PV, Hwang PW, Saksa E. 2015. Anti-diabetic potential of noni: The Yin and the Yang. Molecules. 20(10):17684–17719.

Nguta JM, Mbaria JM, Gakuya DW, et al. 2011. Biological screening of Kenya medicinal plants using A. salina L. (Artemiidae). Pharmacol. Online. 2:458.

Prakash M, Basavaraj BV, Chidambar Murthy KN. 2019. Biological functions of epicatechin: Plant cell to human cell health. J. Funct. Foods. 52:14–24.

Sibi G, Chatly P, Adhikari S, Ravikumar KR. 2012. Phytoconstituents and their influence on antimicrobial properties of Morinda citrifolia L. Res J Med Plant. 6(6):441–448.

Thani W, Vallisuta O, Siripong P, Ruangwises N. 2010. Anti-proliferative and antioxidative activities of Thai noni/Yor (Morinda citrifolia Linn.) leaf extract. Southeast Asian J Trop Med Public Health. 41(2):482–489.

Zhang Z, Zhang Q, Yang H, Liu W, Zhang N, Qin L, Xin H. 2016. Monotropein isolated from the roots of Morinda officinalis increases osteoblastic bone formation and prevents bone loss in ovariectomized mice. Fitoterapia. 110:166–172.