SHORT COMMUNICATION

Antioedematogenic activity, acetylcholinesterase inhibition and antimicrobial properties of Jacaranda oxyphylla

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ABSTRACT

Jacaranda oxyphylla Cham. (Bignoniaceae) is a shrub found in the Brazilian cerrado and used in folk medicine to treat microbial infections. The aim of this study was to carry out a phytochemical screening and evaluate antioedematogenic, antimicrobial and antiacetylcholinesterase properties of \textit{J. oxyphylla} crude extracts. All extracts analysed showed presence of terpenoids, which are potentially active chemical substances. A high AChE inhibitory activity for hexane extract from leaves and for the extracts from twigs was found. Ethanol extract from leaves of \textit{J. oxyphylla} showed activity against Gram-positive (\textit{Staphylococcus aureus} and \textit{Bacillus cereus}) and Gram-negative (\textit{Escherichia coli}) bacteria. This extract was also effective in inhibiting the stages of inflammation evaluated. Biological investigation and phytochemical screening of \textit{J. oxyphylla} extracts provided additional evidence of its traditional medicinal value.

ARTICLE HISTORY

Received 29 January 2015
Accepted 7 August 2015

KEYWORDS

Bignoniaceae; \textit{Jacaranda oxyphylla}; anti-inflammatory; AChE inhibition; antibacterial activity

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Supplemental data for this article can be accessed at http://dx.doi.org/10.1080/14786419.2015.1095744.

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1. Introduction

Bignoniaceae is a family constituted by approximately 800 species of woody trees and shrubs. *Jacaranda* is one of the most important genera, due to the larger number of studies, the wide use to restore degraded areas and the medicinal uses (Martins et al. 2008; Castillo & Rossini 2010). The genus *Jacaranda* is classified within the tribe Tecomeae, which is a member of the Bignoniaceae family that occurs in almost all continents, Asia, Africa, Europe and the Americas (Heywood et al. 2007; Gachet & Schühly 2009). *Jacaranda oxyphylla* Cham. is a small tree popularly known as ‘caroba-de-São-Paulo’ and used in folk medicine as antimicrobial agent (Scudeller 2004; Fenner et al. 2006).

Previous chemical investigations of *Jacaranda* species have revealed the presence of sterols, triterpenes and various polyphenols (Gachet & Schühly 2009). New phenylethanoid and phenylpropanoids glucosides were isolated from the aerial parts of *Jacaranda mimosifolia* and the antioxidant activity of the phenylethanoid compound was described (Zaghloul et al. 2011; Rana et al. 2013). Pentacyclic triterpenes oleanolic and ursolic acids were isolated from *Jacaranda caroba*, the latter being obtained as being 1–2% of the crude extract (Valadares 2009). Therapeutic properties have been attributed to these triterpenes, such as antitumour (Laszczyk 2009), anti-inflammatory (Checker et al. 2012) and antimicrobial activities (Wolska et al. 2010).

Biological potential of extracts from different species of *Jacaranda* have proved to be highly promising. For example, the alcoholic extract from *J. caroba* showed digestive properties (Botton et al. 2005) and polar extracts from *Jacaranda cuspidifolia* and *J. mimosifolia* showed activity against various Gram-positive and Gram-negative micro-organisms, revealing that some species of this genus are potential sources for obtaining new antimicrobial agents (Rojas et al. 2006; Arruda et al. 2011). Recent study from *Bergenia ligulata* extracts showed that phenolic and flavonoid contents are important for antimicrobial and antioxidant activities, but other metabolites can probably contribute to these biological actions (Agnihotri et al. 2015).

Anti-inflammatory activity was reported for the methanol extract of *J. cuspidifolia* (Arruda 2009) and hydroalcoholic extract of *Jacaranda decurrens* (Santos et al. 2012), and these species are popularly used to treat rheumatism and inflammation (Gachet & Schühly 2009). New bioassay-guided investigation was carried out in *Carissa carandas* extracts and showed that terpenoids, such as sterols and terpenes, are potential anti-inflammatory agents (Galipalli et al. 2015).

There are a few studies on Bignoniaceae species with activity on neurodegenerative disorders such as Alzheimer’s disease. For example, acetylcholinesterase inhibitory action was observed for hexane extract from the aerial parts of *J. cuspidifolia* (Arruda 2009). Recent phytochemical analyses from *Agrimonia* extracts showed that the inhibition of cholinesterases can be related especially to flavonoid glycosides (Kubínová et al. 2015). Keeping this in mind, phytochemical screening and antioedematogenic, antiacetylcholinesterase and antimicrobial activities from leaves and twigs of *J. oxyphylla* were investigated, aiming to contribute to the understanding of chemical and biological properties of this species.

2. Results and discussion

2.1. Phytochemical screening

This screening pointed to the presence of terpenoids as the major phytochemical constituents detected in all extracts from leaves (HL, CL and EL) and twigs (HT, CT and ET) of
It is reported that sterols and triterpenes isolated from *Jacaranda* species presented biological activities (Gachet & Schühly 2009). Ethanol extracts from *J. oxyphylla* (EL and ET) revealed the presence of other classes of chemical compounds such as saponins, flavonoids and tannins, and the results are summarised in Table S1.

### 2.2. Antioedematogenic assay

Carrageenan is a polysaccharide that progressively induces oedema reaching its maximum after about 4 h. Local inflammation process is measurable and the paw oedema model represents the most used method adopted for the evaluation of drugs (Winyard & Willoughby 2003). In the first hour of the test, after carrageenan injection, increased permeability occurs mediated by histamine and serotonin. In the second hour, the presence of kinins increases altering blood vessels’ permeability. After three hours occurs a further increase in the permeability of the vessels by the action of prostaglandins (Di Rosa et al. 1971; Loram et al. 2007). Based on this information, the antioedematogenic assay was carried out during 4 h. The results are present as volume of oedema (Figures S1–S3) and antioedematogenic activity as per cent inhibition of oedema.

A positive activity at different stages of inflammation was observed for *J. oxyphylla* extracts. The extracts HL and HT significantly inhibited carrageenan-induced mice paw oedema at the third hour (Figure S1). The values for volume of oedema followed by the percent inhibition of oedema in parenthesis induced by HL at 3 h post-carragenin administration were 0.038 mL (46%), 0.032 mL (57%) and 0.048 mL (35%) for 30, 100 and 300 mg kg⁻¹, respectively (p < 0.0003, Newman-Keuls), and by HT were 0.026 mL (65%), 0.037 mL (49%) and 0.042 mL (41%) for 30, 100 and 100 mg kg⁻¹, respectively (p < 0.002, Newman-Keuls). These results were quite similar to those observed for the group treated with indomethacin (10 mg kg⁻¹), in which the volume of oedema was 0.023 mL (69% of inhibition).

Regarding the chloroform extracts from leaves (CL) and twigs (CT), significant results were found for CL, whereas CT showed no significant differences (Figure S2). The CL extract induced inhibition in all inflammation phases evaluated. All the doses of CL (30–300 mg kg⁻¹) presented antioedematogenic effect with volume and percent inhibition of oedema values of 0.028 mL (65%), 0.051 mL (36%) and 0.048 mL (39%) at the second hour and 0.024 mL (74%), 0.045 mL (52%) and 0.060 mL (36%) at the third hour compared to the negative control group. Indomethacin (positive control) inhibited inflammation in 46, 56, 70 and 50% (p < 0.05), with oedema volume of 0.038, 0.033, 0.028 and 0.035 mL, at the first, second, third and fourth hours, respectively, after treatment.

Ethanol extracts from leaves (EL) and twigs (ET) also inhibited carrageenan-induced mice paw oedema (Figure S3). At the first hour, the doses of 30 and 100 mg kg⁻¹ inhibited the inflammatory process in 43 and 53% (oedema volume of 0.035 and 0.028 mL, respectively) and at the second hour, in 40 and 50% (oedema volume of 0.048 and 0.040 mL, respectively). At the third hour, the oedema volume was 0.065, 0.033 and 0.062 mL (31, 65 and 34% inhibition of oedema in the doses of 30, 100 and 300 mg kg⁻¹, respectively). Indomethacin inhibited 70% of the inflammatory process in the third hour (p < 0.05) and showed values next to 50% in other times analyzed. All the doses tested of ET extract inhibited the inflammatory process at the first, second and third hours. Highest inhibition was observed at the third hour, with volume and percent inhibition of oedema values of 0.042 mL (55%), 0.041 mL (56%) and 0.021 mL (78%) in the doses of 30, 100 and 300 mg kg⁻¹, respectively, compared to the
negative control group. Indomethacin induced inhibition of the inflammation process in 59, 56, 70 and 50% ($p < 0.05$) in the first, second, third and fourth hours.

From these results, it was possible to conclude that the extracts inhibited the effect of histamine, serotonin and prostaglandins mediators during the inflammatory process evaluated. These chemical mediators are associated to the enhancement of vascular permeability that occurs during inflammation, therefore showing the antiedematogenic activity of *J. oxyphylla* extracts.

### 2.3. Acetylcholinesterase inhibition assay

Extracts form leaves (HL, CL and EL) and twigs (HT, CT and ET) of *J. oxyphylla* presented a pronounced *in vitro* inhibition activity against acetylcholinesterase (AChE), as shown in Table S2. The inhibition of ACHE induced by HL, HT and ET of *J. oxyphylla* presented promising activities (71.5–84.1%) compared with inhibitory effects of the standard eserine (97.2%). Moreover, twig extracts showed higher potential to inhibit AChE, compared to leaf extracts. These findings revealed the potential neuroprotective effect of *J. oxyphylla*.

### 2.4. Antimicrobial screening

Results from the antimicrobial assay performed using extracts from leaves (HL, CL and EL) and twigs (HT, CT and ET) of *J. oxyphylla* are listed in Table S2. The activity against Gram-positive bacteria (*Bacillus cereus* and *Staphylococcus aureus*) was high for EL (96.9 and 96.6%), and the growth inhibition of *B. cereus* was also observed for CL (61.6%). In relation to Gram-negative bacteria, *J. oxyphylla* extracts were more active against *Escherichia coli*, and the CT extract presented high activity against this bacterium (96.8%). The extracts from leaves HL and CL also showed promising results against *E. coli* (77.4% and 68.1%, respectively). These results indicated that there is a wide spectrum of antimicrobial action in EL extract from *J. oxyphylla* and a selective activity for *E. coli* in the CT extract.

### 3. Conclusion

In this study, different crude extracts from leaves and twigs of *J. oxyphylla* rich in terpenoids showed anti-inflammatory, antiacetylcholinesterase and antibacterial activities. Regarding antimicrobial activity, a relevant action against Gram-positive bacteria (*S. aureus* and *B. cereus*) was found for EL extract from *J. oxyphylla*. For Gram-negative bacteria, the extracts were mostly active against *E. coli*. A high activity of HL extract and different extracts from twigs to inhibit AChE was observed. In the anti-inflammatory assay, CL and EL extracts were effective in inhibiting different stages of inflammation evaluated. Biological assays and phytochemical investigation of *J. oxyphylla* extracts provide important information to confirm its medicinal value.

### Supplementary material

Experimental details relating to this paper are available online, alongside Tables S1-S2 and Figures S1-S3.
Acknowledgements

The authors are grateful to Brazilian agencies CNPq, CAPES and FAPEMIG for the financial support.

Disclosure statement

No potential conflict of interest was reported by the authors.

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