Journal of Ethnopharmacology 191 (2016) 216–244

Contents lists available at ScienceDirect

Journal of Ethnopharmacology

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

Review

Recent trends in phytochemistry, ethnobotany and pharmacological significance of *Alchornea cordifolia* (Schumach. & Thonn.) Muell. Arg.

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ARTICLE INFO

Article history:
Received 1 March 2016
Received in revised form
6 June 2016
Accepted 6 June 2016
Available online 11 June 2016

Keywords:
Alchornea cordifolia
Medicinal plant
Traditional use
Biological activity
Phytochemistry
Toxicity

Chemical compounds studied in this article:
Alchorneine (PubChem CID: 217611)
Anthranilic acid (PubChem CID: 227)
Daucosterol (PubChem CID: 45358119)
Ellagic acid (PubChem CID: 5281855)
Gallic acid (PubChem CID: 370)
Gentisic acid (PubChem CID: 3469)
Protocatechuic acid (PubChem CID: 72)
β-sitosterol (PubChem CID: 222284)
Stigmasterol (PubChem CID: 5280794)
Yohombine (PubChem CID: 8969)

ABSTRACT

Ethnopharmacological relevance: *Alchornea cordifolia* (Schumach. & Thonn.) Muell. Arg. (Euphorbiaceae) (*A. cordifolia*) is widely distributed throughout tropical Africa, where it is used extensively in traditional medicine. Conditions for which the plant has enjoyed wide use are: coughs, gonorrhoea, infertility, prostatitis, bacterial infections, diarrhoea, ulcers, pain, inflammation, fever and bronchial troubles. This review summarizes the achievements of the investigations in traditional uses, ethnobotany, phytochemistry, biological activities and toxicological profile of *A. cordifolia*; this review also describes the shortcomings of studies on this herbal drug and thus serves as the basis of further scientific research and development of this traditional herbal drug.

Materials and methods: *A. cordifolia*-related information was collected from various resources including published articles in peer-reviewed journals, unpublished materials, textbooks, government survey reports and scientific databases such as Scifinder®, Pubmed, Science Direct, Wiley, Springer, ACS, Scielo, Web of Science and other web search instruments (Google, Yahoo), published on the subject from 1950 to 2016. 'The Plant List' (www.theplantlist.org) and 'Kew Royal Botanic Gardens' (mpns.kew.org) were used to validate the scientific name of the plant.

Results: The literature revealed several reports on traditional uses, biological activities, chemical constituents and toxicological evaluation of *A. cordifolia*. The phytochemical information indicates identification of 95 compounds including fatty acids, terpenoids, flavonoids, phenolic acids, alkaloids, which exhibited various pharmacological activities such as wound healing, anti-inflammation, anticancer, antioxidant, immunomodulation, antidiarrhoeal, antimicrobial, antidepressant, hepatoprotective, antiplasmodial and anxiolytic. However, there are still significant gaps in the completeness of our understanding of *A. cordifolia* bioactivity, therapeutic value, and roles played by each of the numerous phytoconstituents.

Conclusions: The present review indicated that *A. cordifolia* is a valuable medicinal plant with multiple pharmacological effects. However, further research on the pharmacological mechanism of action of this plant is recommended in order to unravel the pharmacokinetics, pharmacodynamics, clinical relevance and toxicity of its extracts as well as constituents.

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Contents

Abbreviations: ALP, Alkaline Phosphatase; AST, Aspartate aminotransferase; ALT, Alanine aminotransferase; CFA, Complete Freud's Adjuvant; DPPH, 1,1-diphenyl-2-picrylhydrazyl; EAI, Egg-Albumen-Induced; FC, Folin Ciocalteu; FeSO4, Iron (II) Sulphate; FRAP, Ferric Reducing Antioxidant Power; GC-MS, Gas Chromatography-Mass Spectrometry; GLG, 1-O-galloyl-6-O-luteoyl-β-D-glucopyranoside; HIV, Human Immunodeficiency Virus; MLGA, Myricentin-3-O-β-D-galactopyranoside; MGP, Myricentin-3-O-β-D-glucopyranoside; MIC, Minimum Inhibitory Concentration; MRP, Myricentin-3-O-α-L-rhamnopyranoside; MRSA, Methicillin resistant *Staphylococcus aureus*; NOAEL, No Observed Adverse Effect Level; QGP, Quercetin-3-O-β-D-glucopyranoside; RBC, Red Blood Cells; SD, Sprague Dawley; WBC, White Blood Cells

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http://dx.doi.org/10.1016/j.jep.2016.06.021
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1. Introduction

The attempt by mankind to use plants and their products to cure diseases and relieve physical suffering is as old as civilization (Giday et al., 2003). Aboriginal peoples in all ages had some knowledge of plants and through random approach or systematic trial, applied them to various uses. Indeed, most tribes believed that diseases were due to the presence of evil spirits in the body and could be driven out only by the use of poisonous or unlikable substances calculated to make the body unpleasant place in which to remain (Giday et al., 2003). However, this primitive era was followed by the period of the herbalists which disseminated the doctrine of plant as a means to cure illnesses (Idu and Ndukwu, 2006).

In fact, *A. codifolia* (Schumach. and Thonn.) Müll. Arg is such plant which is widely distributed in tropical and subtropical regions of Africa. This plant has a broad-spectrum of traditional applications, including pain and inflammatory disorders, hormonal-related gynecological disorders, infertility, urinary, respiratory and intestinal problems as well as malaria like fevers (Noumi and Yomi, 2001; Banzouzi et al., 2002; Osadebe and Okoye, 2003; Nia et al., 2005; Mavar-Manga et al., 2007; Ajibesin et al., 2011; Ajibade and Olayemi, 2015; Chinsembu, 2015; Siwe Noundou et al., 2016). The effectiveness of *A. cordifolia* has also been highlighted through its traditional use in the treatment of convulsions, prostatitis, leprosy, jaundice, conjunctivitis and nervous troubles (Adjanohoun and Ake, 1979; Kapnang, 1997; Mustofa et al., 2000; Agbor et al., 2004; Noumi, 2010; Adeneye et al., 2014).

The use of *A. cordifolia* in traditional medicine has prompted many researchers to carry out various investigations in conjunction with its chemical composition. Hence, different research teams analysed the chemical constituents of *A. cordifolia* and could identify the following compounds: tannins, phenolic acids such as gallic acid, ellagic acid, protocatechuic acid (Lamikanra et al., 1990; Ogungbamila and Samuelsson, 1990; Banzouzi et al., 2002), flavonoids including quercetin, hyperin and guaijaverin (Lamikanra et al., 1990; Ogungbamila and Samuelsson, 1990; Ajali, 2000), some imidazopyrimidine alkaloids named as alchorneine, alchornidine and several guanidine alkaloids (Mavar-Manga et al., 2004). In addition, Siwe Noundou et al. (2016) have recently reported the isolation of six terpenoids notably stigmasterol, stigmasta-4,22-dien-3-one, friedelin, friedelane-3-one-28-al, 3-O-acetyl-erythrodiol and 3-O-acetyl-aleuritolic acid as well as a phenolic acid called methyl-3,4,5-trihydroxybenzoate from the stem bark of *A. cordifolia*.

The varied popular uses of different plant parts of *A. cordifolia* have led to many modern pharmacological investigations including antibacterial (Ogunlana and Ramstad, 1975; Kambu et al., 1990; Lamikanra et al., 1990; Muanza et al., 1994; Okeke et al., 1999; Ajali, 2000; Ebi, 2001; George et al., 2010; Adeshina et al., 2011; Siwe Noundou et al., 2016), antifungal (Muanza et al., 1994), antiplasmodial (Tona et al., 1999; Banzouzi et al., 2002; Tona et al., 2007), spasmolytic (Ogungbamila and Samuelsson, 1990; Tona et al., 2000), hepatoprotective (Osadebe et al., 2012) and reproductive activities (Ajibade and Olayemi, 2015). Moreover, Boampong (1992) reported the bronchoconstrictive effect of *A. cordifolia* while Ayisi and Nyadedzor (2003) highlighted its antiviral activity across the literature. Acute (Ansah et al., 2009; Donatien et al., 2010; Effo et al., 2013; Ishola et al., 2014; Ajibade and Olayemi, 2015) and sub-acute (Emenalom et al., 2009; Ansah et al.,

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