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Review

Bioactive compounds and health benefits of some palm species traditionally used in Africa and the Americas – A review

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ABSTRACT

Ethnopharmacological relevance: According to previous ethno-medicinal reviews, *Cocos nucifera*, *Elaeis guineensis* and *Phoenix dactylifera* are among the main palms which are often used on the American and African continents to treat infections, infestations and disorders in the digestive, respiratory, genito-urinary, dermal, endocrine, cardiovascular, muscular-skeletal, mental and neural systems, as well as neoplasms, dental issues and metabolic and nutritional disorders. In addition, one or more species of the wild genera *Acrocomia*, *Areca*, *Astrocaryum*, *Attalea*, *Bactris*, *Borassus*, *Calamus*, *Chamaedorea*, *Chamaerops*, *Euterpe*, *Hyphaene*, *Mauritia*, *Oenocarpus* and *Syagrus* have a high number of records of these ethno-medicinal uses. The most used parts of the palm tree are the fruits, followed by roots, seeds, leaves and flower sap.

Aim of the study: This review discusses the phytochemical composition and the pharmacological properties of these important ethno-medicinal palms, aiming to provide a contribution to future research prospects.

Materials and methods: Significant information was compiled from an electronic search in widely used international scientific databases (Google Scholar, Science Direct, SciFinder, Web of Science, PubMed, Wiley on line Library, Scielo, ACS Publications), and additional information was obtained from dissertations, theses, books and other relevant websites.

Results: Palms, in general, are rich in oils, terpenoids and phenolic compounds. Fruits of many species are notable for their high content of healthy oils and fat-soluble bioactive compounds, mainly terpenoids, such as pigment carotenoids (and provitamin A), phytosterols, triterpene pentacyclics and tocols (and vitamin E), while other species stood out for their phenolic compounds derived from benzoic and cinnamic acids, along with flavan-3-ol, flavone, flavonol, and stilbene compounds or anthocyanin pigments. In addition to fruits, other parts of the plant such as seeds, leaves, palm heart, flowers and roots are also sources of many bioactive compounds. These compounds are linked to the ethno-medicinal use of many palms that improve human health against infections, infestations and disorders of human systems.

Conclusions: Palms have provided bioactive samples that validate their effectiveness in traditional medicine. However, the intensive study of all palm species related to ethno-medicinal use is needed, along with selection of the most appropriate palm accessions, ripe stage of the fruit and /or part of the plant. Furthermore, the complete profiles of all phytochemicals, their effects on animal models and human subjects, and toxicological and clinical trials are suggested, which, added to the incorporation of improved technological processes, should represent a significant advance for the implementation of new opportunities with wide benefits for human health.

1. Introduction

Palms (Arecaceae/Palmae) have a pantropical distribution and inferred origins in the tropical rain forest (Baker and Couvreur, 2013; Dransfield et al., 2008). Their diversification started during the mid-Cretaceous period of Laurasia, about 100 million years ago (Couvreur et al., 2011), with recent (Miocene) increase in these diversification rates, mainly from a South American source of dispersing lineages (Baker and Couvreur, 2013). Among 760 palm species found in the Americas, the popular and traditional medicinal use of 106 species is known (Macía et al., 2011; Sosnowska and Balslev, 2009), while 23 species belonging to 11 genera were described in African palm ethnomedicine, especially against infections/infestations and digestive system disorders (Gruca et al., 2015).

Palms play a prominent role in the history of food and agriculture, from ancient times to the present. Many of these species are an important source of oils, and the oil palm (*Elaeis guineensis* Jacq.) is a major oil producer (May and Nesaretnam, 2014). As a portable source

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Table 1
Main palm species identified as source of bioactive compounds and pharmacological activities in African and American continents.

Palm species[1] (accepted names)	Synonyms cited in this review	Main common names
Acrocomia aculeata (Jacq.) Lodd. ex Mart.	*Acrocomia lasiospatha* Mart.	Macaúba, bocaiuva[2, 8], grugru; macaw
Areca catechu L.		Areca; betel[2]
Astrocaryum aculeatum G. Mey.		Tucumã, tucumã-do-Amazonas[3]
Astrocaryum vulgare Mart.		Tucumã-do-Pará, awara[2,9]
Attalea maripa (Aubl.) Mart.	*Maximiliana maripa* (Aubl.) Drude	Inajá[12], maripá
Attalea speciosa Mart.	*Orbignya phalerata* Mart.; *Orbignya speciosa* (Mart.) Barb. Rodr.	Babassu, babaçu[2], aguaçu
Attalea phalerata Mart. ex. Spreng.	*Scheelea phalerata* (Mart. ex. Spreng.) Burret	Bacuri[4], urucuri, shapaja
Bactris gasipaes Kunth		Peach palm; pupunha; chonta; persikopalm[2]
Butia sp.		Jelly palm; butiá; coquinho azedo[5]
Cocos nucifera L.		Coco palm, coconut[2]
Elaeis guineensis Jacq.		Oil palm, dendê, African oil palm[2]
Euterpe oleracea Mart.		Açaí; assaí; açaí-do-Pará[2]
Euterpe precatoria Mart.		Açaí-do-Amazonas[10]
Euterpe edulis Mart.		Juçara, jussara, açaí-da-mata atlântica[2,11]
Hyphaene thebaica (L.) Mart.		Doum palm[2], doom palm
Mauritia flexuosa L.f.	*Mauritia vinifera* Mart.	Buriti; aguaje, moriche; muriti, morete[2]
Oenocarpus bacaba Mart.		Bacaba[12], ungurauy, punáma
Oenocarpus distichus Mart.		Bacaba-de-leque[6]
Oenocarpus bataua Mart.		Patawa, patauá, bataua[2]
Phoenix dactylifera L.		Date palm, tamar, tamr[2]
Syagrus oleracea (Mart.) Becc.		Guariroba, gueroba[7]
Syagrus coronata (Mart.) Becc.		Licuri, ouricuri[2]
Syagrus romanzoffiana (Cham.) Glassman	*Arecastrum romanzoffianum* (Cham.) Becc.	Queen palm, jerivá; "chiri va", pindó[2,7, 13]

[1]http://www.palmweb.org; http://www.theplantlist.org/; [2]http://mpns.kew.org/mpns-portal/; [3](Sagrillo et al., 2015) (Jobim et al., 2014); [4](Lima, 2014); [5](Hoffmann et al., 2014); [6](Carvalho et al., 2016); [7](Coimbra and Jorge, 2012); [8](Ramos et al., 2007); [9](Bony et al., 2012a, 2012b); [10](Kang et al., 2012; Peixoto et al., 2016); [11](Cardoso et al., 2015; Cardoso et al., 2015; Schulz et al., 2015); [12](Santos et al., 2013a); Oderinde and Oboh (1988).

of both food and water, *Cocos nucifera* L. (coconut) has played a critical role in the ability of humans to voyage, establish trade routes and colonise lands, while it continues to have hundreds of commercial uses (Gunn et al., 2011). The earliest records of *Phoenix dactylifera* L. (date palm) cultivation date back approximately 7000 years in the lower Mesopotamian basin (Khelil et al., 2016; Terral et al., 2012), along with other long-domesticated perennial plants such as the fig tree, the olive tree and the grapevine (Terral et al., 2012). *P. dactylifera* is widely cultivated in arid and semiarid regions, where high temperature, intense light, ultra-violet radiation, salt and sand erosion provide stress conditions. An extremely xeric environment leads to the development of morphological, physiological and molecular strategies for the survival of these plants (Khelil et al., 2016), which may influence their metabolites and their bioactive composition.

The palms mentioned above, along with those cited in Table 1, have been widely used in traditional medicine on the African and American continents. Among American indigenous and non-indigenous peoples (Paniagua-Zambrana et al., 2015; Sosnowska and Balslev, 2009) and among African peoples (Gruca et al., 2015), the most common traditional uses were against infections/ infestations and digestive system disorders. On the African continent, the treatment of gastrointestinal worms, malaria, and bacterial infections (mainly related to sexually transmitted diseases and gastro-intestinal disturbances), along with genitourinary system disorders and rites/ magic (related with the stigma of infertility and its negative social repercussions, especially for women) have been well documented (Gruca et al., 2015). Among northwestern South American peoples, the importance of the treatment of skin and subcutaneous tissue and the respiratory system have been described (Paniagua-Zambrana et al., 2015), while the preponderance of treatments for pain, injuries, disorders of the skin tissue and muscular-skeletal system among other American indigenous and non-indigenous peoples may be connected to everyday hunting activities, for which palms could provide emergency relief (Sosnowska and Balslev, 2009). Other African and American uses include the treatment of respiratory, endocrine, cardiovascular, mental and neural systems, of neoplasms, and for dental health, along with metabolic and nutritional disorders. The most used parts of the palm tree are the fruits (17–53%), especially their oils (33%), followed by roots (17–40%), seeds (10–16.5%), palm heart (9.5–18%), leaves (5–21%), flowers (3–8.5%) and flower sap (6%) (Agra et al., 2008; Dias, 2012; Gruca et al., 2015; Hoffmann et al., 2014; Macía et al., 2011; Paniagua-Zambrana et al., 2015; Sosnowska and Balslev, 2009).

Palms, in general, are rich in oils, terpenoids and phenolic compounds. The mesocarp and endocarp oils of many palms include a range of volatile compounds and other terpenoids that are mainly beneficial to health, such as phytosterols (Santos et al., 2013a), carotenoids and pro-vitamin A (Rodriguez-Amaya et al., 2008), tocols and vitamin E (Coimbra and Jorge, 2012; May and Nesaretnam, 2014; Siles et al., 2013) and triterpene pentacyclics (Bony et al., 2012a; Galotta and Boaventura, 2005; Goh et al., 1988; Koolen et al., 2012; Peng et al., 2015). Among the phenolic compounds, phenolic acids (Chakraborty et al., 2006), resveratrol and other stilbenes (Rezaire et al., 2014; Schauss et al., 2006b; Schulz et al., 2015), anthocyanins (Bicudo et al., 2014; Schauss et al., 2006b) (Gordon et al., 2012), flavones (Williams et al., 1983), flavonols (Williams et al., 1983), dihydroflavonoids (Chin et al., 2008; Kang et al., 2010), flavan-3-ol (Jaffri et al., 2011b), procyanidins (Williams et al., 1983) and lignans (Chin et al., 2008) have been described in different parts of the palm species, especially in fruit pulps, seeds and leaves.

The objective of the present study is to discuss the fatty and water-soluble bioactive compounds of commercial and wild palms and their related biological properties for human health in Africa and the Americas. The diversity of palm bioactive compounds is described, along with a critical evaluation of pharmacological studies and their relationship to the ethno-medicinal use of palms. The species selected in this review are the main palm trees evaluated so far, regarding the presence of bioactive substances and pharmacological studies, among those palms commonly used in traditional medicine on the African and American continents (noting that *Areca catechu*, for example, is by origin an Asian palm that has been introduced on the African continent, where it is traditionally used). In addition to the species presented in this review, many others are frequently used, but they are still little studied with respect to their phytochemical compounds and pharmacology, and these topics should therefore be the subject of increasing study due to the importance they exert.