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Review Article

Oilseed Plants of the Semi-arid Region: *Acrocomia aculeata* and *Syagrus cearensis* as Therapeutic Sources

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Abstract

Medicinal plants have been used for centuries as a valuable therapeutic alternative, especially in communities with limited access to conventional medicines. Today, scientific interest in these plants continues to grow, primarily due to the compounds they produce, known as secondary metabolites. These compounds not only help plants defend themselves against threats such as insects and diseases but also offer health benefits, including antioxidants, antimicrobial, and anti-inflammatory properties. In the Chapada do Araripe, a region of the Brazilian semi-arid zone, biodiversity is vast, and several plants with medicinal potential have been identified. Among them, two palm species stand out: *Acrocomia aculeata* and *Syagrus cearensis*. The oil extracted from *A. aculeata* is rich in oleic acid, a type of healthy fat widely used in cosmetics, food, and even biofuel production. Meanwhile, the oil from *S. cearensis*, known as catolé coconut oil, has high nutritional value and antimicrobial and antiviral properties. Additionally, the use of natural products, such as vegetable oils and plant extracts, is increasingly being studied as a promising solution to combat microbial resistance. When combined with traditional medicines, these products can enhance treatment effectiveness, offering new health alternatives.

Keywords: *Medicinal plants; Secondary metabolites; Chapada do Araripe Vegetable oils; Microbial resistance*

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1. Introduction

1.1 Medicinal Plants

The ancient use of medicinal plants demonstrates their integral role in human evolution, serving as the first therapeutic resources for treating diseases, especially in underprivileged communities. Due to the socioeconomic conditions of these communities, access to medications and medical supplies is often limited, leading to the search for plant-based sources for treating various ailments [1]. In this context, plant-based products have become a "living pharmacy," with their therapeutic effects attributed to a rich arsenal of phytochemical compounds, both organic and inorganic, which offer vast potential for human exploration in the production of plant-based products [2].

Many plants continue to be used as complementary therapies alongside established treatments, often influenced by ancestral practices or recommendations from family members and close acquaintances. This traditional knowledge is passed down through generations [3, 4]. According to Silva et al. [5], traditional knowledge should be valued, as it contributes to the conscious and responsible use of medicinal plants.

Certain practices are essential for the safe and effective use of medicinal plants, including correct plant identification, knowledge of which parts to use, preparation methods, modes of administration, and appropriate dosages. These aspects integrate traditional knowledge with scientific evidence [6].

In this context, scientific research on the medicinal potential of natural products has significantly increased in recent years [7]. This growth is particularly evident in academic and industrial fields, where efforts are directed toward studying and exploring medicinal plants to develop new pharmaceutical products [8]. Pharmacological research focuses on secondary metabolites, which are concentrated in extracts, essential oils, and fixed oils, providing various biological activities to plants [9].

Plants produce a vast and diverse array of organic compounds derived from primary metabolism. These compounds do not directly contribute to plant growth and development but instead serve crucial evolutionary functions that enhance environmental adaptation [10, 11]. Secondary metabolites play fundamental roles in plant protection, inhibiting insect and herbivore attacks, shielding against UV radiation, preventing diseases, and aiding in seed dispersal [11].

These metabolites, known as phytochemicals, are synthesized through various secondary metabolic pathways in plants [12, 13]. In summary, the biosynthesis of phytochemical compounds originates from glucose metabolism through two primary intermediates: shikimic acid and acetate-malonate pathways, or even a combination of these biosynthetic routes [14]. These compounds can be found in different plant parts, and numerous chromatographic techniques have been employed to explore and characterize them chemically [15].

1.2 Medicinal Plants of the Chapada do Araripe

Brazil possesses an astonishing wealth and diversity of native flora, accounting for 20% of the world's plant biodiversity [16]. This richness is distributed across distinct biomes, including the Cerrado, which exhibits significant phytophysiognomic heterogeneity [17].

Among forested regions, the Chapada do Araripe stands out nationally. Located in the Brazilian semi-arid region, it spans the northeastern states of Pernambuco, Piauí, and Ceará. It comprises two conservation units: the Araripe-Apodi National Forest (Flona Araripe-Apodi) and the Chapada do Araripe Environmental Protection Area (APA-Araripe), along with a Geopark. The Chapada do Araripe is notable for its archaeological heritage and its rich flora and fauna. This protected area is managed by public environmental agencies and private initiatives [18-20].

The region has a well-preserved plateau with altitudes ranging from 800 to 1,000 meters, featuring diverse phytophysiognomies, including humid forests (seasonally evergreen), Caatinga, Savanna (Cerrado sensu stricto and Cerradão), and Carrasco (steppe savanna), with Cerrado as the dominant vegetation type. The vegetation is classified into Cabeça Molhada, Cabeça Seca, Caatinga, Cerrado, and Cerradão [21, 22].

The soils of the Chapada do Araripe are primarily deep Yellow Latosol and Yellow-Red Latosol [23], highly weathered throughout their profile. These soils are well-drained, strongly leached, and found in flat reliefs. The predominant climate is tropically hot, with an average annual precipitation of approximately 760 mm and an average temperature of 24 to 26° C [23].

Numerous medicinal plants with known therapeutic properties have been identified in this area. Ethnobotanical studies have been instrumental in documenting the medicinal plants of the Chapada do Araripe [17, 24-27]. This local knowledge has been valuable in guiding phytochemical and pharmacological research to discover new pharmaceuticals [17].

Based on studies of the floristic diversity of the Chapada do Araripe [22], a total of 474 species belonging to 275 genera and 79 families were cataloged across different phytophysiognomies. The five richest families in terms of species diversity were Fabaceae, Rubiaceae, Euphorbiaceae, Bignoniaceae, and Asteraceae, along with Arecaceae. Conversely, 27 families were represented by only single species. In terms of growth forms, tree species were predominant, followed by shrubs, herbs, vines, subshrubs, epiphytes, hemiparasites, and aquatic plants [22, 28].

1.3 The Arecaceae Family and the Species *Acrocomia aculeata* and *Syagrus cearensis*

The Arecaceae family plays a crucial ecological role by providing habitat for wildlife, supporting local and regional communities through employment, and serving as a food source for both animals and humans. However, compared to other botanical families, it remains underexplored. Scientifically, this family is attributed to palm trees, also known as *Palmae*, and belongs to the order Arecales, the class Liliopsida, and the division/phylum Magnoliophyta. Currently, approximately 3,000 palm species are recorded worldwide [29-31]. In Brazil, 390 species are documented across the country [29].

Palm trees generally exhibit a stipe growth form, which is usually woody, simple, or occasionally branched (Figure 1). Their leaves are petiolated, simple, alternate, or rarely distichous, with palmate or segmented leaf structures, and most species have spines [32]. Their inflorescences and infructescences belong to the group of Angiosperms, particularly monocotyledons. Most of their fruits are drupes, though some are berries (Figure 2), each typically containing a single seed [32].

Figure 1. *Representatives of species from the Arecaceae family.*

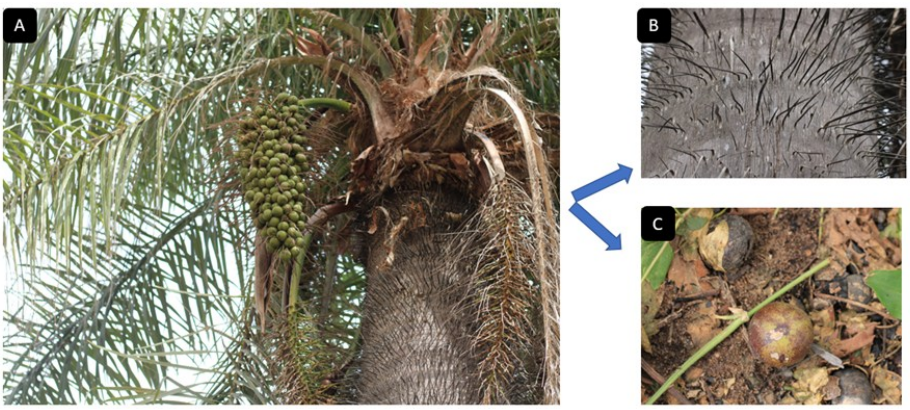

Figure 2. *Characteristics of species from the Arecaceae Family; A: Representation of leaves, inflorescence, and infructescence; B: Spines on the stem; C: Ripe fruit.*

In this family, species primarily propagate through seeds, but germination typically occurs slowly and at low percentages, influenced by various factors such as physical dormancy imposed by the woody endocarp [33, 34].

Scientific research reports a range of biological properties that explain their use in traditional medicine, including antifungal activity [35], antimicrobial activity [36, 37], antitumor activity [38 (Nascimento et al., 2006)], immune system-related activity [39], anti-inflammatory [40], antioxidant [41, 42], and immunomodulatory potential [43]. Due to the medicinal potential of some species in this family, such as babaçu oil (*Attalea speciosa*) and coconut oil (*Cocos nucifera*), they are included in the National List of Medicinal Plants of Interest to the Unified Health System (SUS).

Despite the wide range of products available on the market for treating diseases, medicinal plants are a viable alternative. Generally, they are low-cost and easily accessible, gaining market space with the aim of expanding therapeutic options.

These plants in the industry may or may not undergo preliminary processes to produce products such as extracts (e.g., aqueous and ethanolic) and oils (fixed and essential) [44], which are prepared through methods involving solvents, steam, and supercritical fluids [45]. The plant parts used in these processes can vary (roots, stems, leaves, fruits, and seeds) [44].

Regardless of the extraction method used, it is crucial to chemically characterize the secondary metabolites present in the sample being studied, as their presence indicates potential biological actions [46].

Among the species of particular importance in this family for medicinal use, *Acrocomia aculeata* (Jacq.) Lodd. ex Mart. and *Syagrus cearensis* Noblick stand out.

1.3.1 Acrocomia aculeata Plant Species

Acrocomia aculeata, commonly known as "bocaiuva" or "macaúba," among other common names, is an oilseed plant rich in a good source of medium-chain fatty acids (MCFAs), predominantly mono-unsaturated. These fatty acids make up about 80% of the total composition of the oil from *A. aculeata* nuts, with the major compounds being oleic acid (71.7%) and palmitoleic acid (3%) [47]. These metabolites are responsible for a range of effective pharmacological activities.

Oleic acid exhibits several positive effects, such as potential antioxidant activity and regulation of fatty acid and cholesterol biosynthesis through the positive regulation of AMP-activated protein kinase, which phosphorylates and inactivates both acetyl-CoA carboxylase and 3-hydroxy-3-methyl-glutaryl-CoA reductase [48, 49].

Oleic acid, as well as the products resulting from its subsequent denaturation and elongation, are known as omega-9 fatty acids. This oil is considered one of the healthiest sources of fat in the diet and is commonly used as a substitute for animal fat sources rich in saturated fat [50]. Palmitoleic acid, or delta-9-cis-hexadecenoic acid, is an omega-7 monounsaturated fatty acid. Like oleic acid, it also provides various health benefits through consumption, being considered a "good fat."

This plant is a perennial, fruit-bearing palm, characterized by trunks and leaves covered with spines. It can grow up to 15 meters in height with a diameter between 20 to 30 cm (Figure 3). Native to tropical forests, it extends from the southern region of Mexico to southern Brazil, reaching countries such as Paraguay and Argentina [51-53]. Its fruiting period occurs mainly during the rainy season [54, 55].

The fruit of this plant is globular in shape, consisting of a hard epicarp, a fibrous and mucilaginous mesocarp, and a woody endocarp that is firmly adhered to the mesocarp [33]. These fruits have traditionally been consumed by indigenous and rural communities, and they are currently being widely explored for biodiesel production [56, 57].

The use of its fruits is reported in several sectors, such as the biotechnology, pharmaceutical (for the production of medicines and cosmetics), and food industries [58, 59]. This is due to its organic and inorganic composition, including minerals, dietary fibers, and proteins that are beneficial to the human body [60].

The macaúba nut is highly nutritious, rich in oil and fibers, and contains bioactive compounds such as phenolic compounds and tocopherols, which support the growth of probiotic microorganisms [58]. Therefore, the use of macaúba seeds has great potential for applications in food formulations, which can enhance its nutritional value. The macaúba fruit is mainly obtained through extraction, and its edible parts consist of pulp and kernel [58]. It is important to note that fixed oils with significant medicinal value are extracted from these fruits [58, 59].

Figure 3. *Plant species Acrocomia aculeata.*

1.3.2 Plant Species Syagrus cearensis

Another native Brazilian palm, with fruits of high oleaginous potential, is *Syagrus cearensis* (Figure 4), commonly known as "coco catolé." This stipe-type plant has a solitary stem, reaching heights of 5 to 20 meters and a diameter of approximately 15 to 30 cm. Its fruit yields an oil widely used and appreciated in the regional diet, as well as having potential in industries for the manufacture of cosmetics, therapeutic purposes, and biodiesel production, similar to *Acrocomia aculeata* and *Cocos nucifera* [5, 58, 61].

Figure 4. *Plant species Syagrus cearensis.*

The phytochemical composition of the *Syagrus cearensis* oil shows significant values of saturated fatty acids (SFA - 84.42%), monounsaturated fatty acids (MUFA - 12.72%), and polyunsaturated fatty acids (PUFA - 2.85%), confirming the characteristic profile of oils from Arecaceae species, with a predominance of saturated fatty acids [18]. Other prominent fatty acids in *coco catolé* oil include lauric acid, myristic acid, caprylic acid, palmitic acid, capric acid, and stearic acid [18, 62].

The chemical composition and sensory aspects of *Syagrus cearensis* oil are similar to coconut oil (*Cocos nucifera L.*), confirming the physicochemical and sensory similarities between these two oil-producing species, both referred to as lauric oils [18, 61]. Lauric acid, a medium-chain fatty acid, is known for its high digestibility, antimicrobial, and antiviral activity [63].

Among its bioactive compounds, it is worth highlighting tocopherols and phenolic compounds, which have potent antioxidant and microbiological activity. Salicylic acid, a phenolic compound, stands out as the major component, with concentrations of up to 46.91%]18[. Several reports describe this compound as having therapeutic potential for human health, such as analgesic, antipyretic, and anti-inflammatory properties.

1.4 What are Fixed Oils?

Fixed oil, as the name suggests, is a substance that does not volatilize like essential oils. They have a higher molecular weight and do not evaporate quickly like essential oils, which are volatile and composed of different chemical structures. Examples of fixed vegetable oils are found in the pulp and kernels of fruits from Arecaceae species.

Many studies show that fixed oils are promising in combating diseases, especially in the microbiology field. They are being considered for their potential to replace or enhance first-choice therapies in treating human ailments [35, 64]. The growing interest in evaluating the therapeutic effects of natural products is driven by the fact that numerous people around the world rely on alternative medicine to maintain their health [65].

The high content of bioactive compounds found in these oils gives the studied palms characteristics of a promising food, with high nutritional value for fresh consumption and processing, which is advantageous for some regions of Brazil. When included in diets, these oils reveal significant functional and health-beneficial properties [59].

The topical application of vegetable oils for cosmetic and medicinal purposes has been practiced for a long time, as they provide many positive physiological benefits [66]. Due to the various biological properties associated with vegetable oils, there is a growing trend for their use as natural raw materials in pharmaceutical and cosmetic products. This has generated great interest in oils extracted from plants, leading to rapid and significant expansion in both national and international markets for these oils [67].

1.5 Microbial Resistance

The emergence of bacterial and fungal strains resistant to a wide variety of antibiotics, including different classes of drugs, has become a pandemic problem due to limited therapeutic options. The ability of Gram-positive organisms to acquire resistance to nearly all useful antibiotics has raised concerns among healthcare professionals [41].

In this context, *in vitro* assays used to detect new antifungal and antibacterial agents from natural products are useful tools for evaluating plant derivatives such as oils, extracts, and lectins [41, 68]. Many studies emphasize the importance of interactions between these natural compounds combined with antifungal and antibacterial drugs to enhance the effectiveness of these drugs by inhibiting microbial growth and acquired resistance to first-line drugs [41, 69].

Although antibiotics are effective, their indiscriminate use by the population is the main cause of the development of resistant strains [70], due to the natural exchange of genetic material that occurs intra- or inter-specifically among Gram-negative bacilli [71]. The combination of natural products with first-choice antibiotics can yield excellent results in the direct action against many species of bacteria and fungi, a relationship known as synergy, enhancing the biological activity of the drug [70]. Additionally, the use of plant-based drugs offers advantages, such as easy availability and safety, with fewer side effects [7].

Pathogenic species of fungi from the *Candida* genus and bacteria like *Escherichia coli*, *Pseudomonas aeruginosa*, and *Staphylococcus aureus* are among the microorganisms responsible for infectious diseases with antibiotic resistance profiles [65]. Strategies to address this issue are gaining attention in scientific research, as infectious diseases are one of the main health problems in hospitals and community settings, contributing to increased mortality and/or morbidity.

Conclusion

The use of medicinal plants, particularly in underserved communities, has been an ancient practice that demonstrates the close relationship between nature and human health. Plants, with their vast arsenal of phytochemicals, serve as valuable resources in the search for accessible and effective treatments. The richness of Brazil's flora, particularly in the Chapada do Araripe, highlights the importance of botanical diversity and the traditional knowledge accumulated over generations. Species such as *Acrocomia aculeata* and *Syagrus cearensis* not only illustrate the medicinal potential of palms but also emphasize the need for scientific research to validate their biological properties and contribute to the pharmaceutical and food industries.

The growing interest in these plants, coupled with advances in extraction methodologies and characterization of their bioactive compounds, opens new opportunities for the development of innovative products that can add economic and social value to local communities. Therefore, it is essential to value and integrate traditional knowledge with scientific research to promote the conscious and sustainable use of medicinal plants, ensuring not only the preservation of biodiversity but also the strengthening of community health practices.

Conflict of Interest

The authors declare no conflict of interest.

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