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Review

Revisiting Amazonian Plants for Skin Care and Disease

Bruno Burlando [1,2] and Laura Cornara [2,3,*]

1 Department of Pharmacy, University of Genova, Viale Benedetto XV, 16132 Genova, Italy; burlando@difar.unige.it
2 Biophysics Institute, National Research Council (CNR), via De Marini 6, 16149 Genova, Italy
3 Department of Earth, Environment and Life Sciences, University of Genova, Corso Europa 26, 16132 Genova, Italy
* Correspondence: cornara@dipteris.unige.it; Tel.: +39-010-2099364

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Abstract: This review concerns five species of trees and palm trees that occur as dominant plants in different rainforest areas of the Amazon region. Due to their abundance, these species can be exploited as sustainable sources of botanical materials and include *Carapa guianensis* Aubl., family Meliaceae; *Eperua falcata* Aubl., family Fabaceae; *Quassia amara* L., family Simaroubaceae; and *Attalea speciosa* Mart. and *Oenocarpus bataua* Mart., family Arecaceae. For each species, the general features, major constituents, overall medicinal properties, detailed dermatological and skin care applications, and possible harmful effects have been considered. The major products include seed oils from *A. speciosa* and *C. guianensis*, fruit oil from *O. bataua*, and active compounds such as limonoids from *C. guianensis*, flavonoids from *E. falcata*, and quassinoids from *Q. amara*. The dermatologic and cosmetic applications of these plants are growing rapidly but are still widely based on empiric knowledge. Applications include skin rehydration and soothing; anti-inflammatory, antiage, and antiparasite effects; hair care; burn and wound healing; and the amelioration of rosacea and psoriasis conditions. Despite a limited knowledge about their constituents and properties, these species appear as promising sources of bioactive compounds for skin care and health applications. An improvement of knowledge about their properties will provide added value to the exploitation of these forest resources.

Keywords: Amazonian tree species; antiage properties; essential fatty acids; flavonoids; hair care; humectant; limonoids; quassinoids; skin soothing; wound healing

1. Introduction

The search for new bioactive principles to be used in pharmaceutical and cosmetic products is to a wide extent directed towards natural sources, mostly botanical entities. The Amazon region holds extraordinarily rich plant diversity, and therefore it is attracting much interest for the discovery of new bioactive principles. Traditional plant remedies are generally a preferential starting point for projects of drug discovery from natural sources. However, unlike Asian traditional medicines, popular remedies from the Amazon have not been recorded for thousands of years in herbal pharmacopoeia. By contrast, indigenous groups have made extensive use of rainforest plant materials to meet their health needs. Only in recent times, the Amazonian ethnobotanical culture has started to be discovered and taken into consideration for the development of new drugs and skin care products.

In this review, we report five species of trees and palm trees that occur as dominant species in different rainforest areas of the Amazon region. Due to their abundant occurrence and the possibility of cultivation, these species can be exploited as sustainable sources of botanical materials. They include *Carapa guianensis* Aubl., a timber tree of the Meliaceae family that can be cultivated and is known as alternative mahogany; *Eperua falcata* Aubl., a timber tree of Fabaceae that is dominant in Guyana

forests; *Quassia amara* L., a small tree belonging to Simaroubaceae that is cultivated on a commercial scale; and two very abundant Arecaceae species, *Attalea speciosa* Mart. and *Oenocarpus bataua* Mart. Each species has been treated by considering its general features, major constituents, overall medicinal properties, detailed dermatological and skin care applications, and any harmful effects. Literature data on the medicinal uses of plants and their constituents have been collected from different online databases, including Scopus, Web of Science, PubMed, Google Scholar, https://clinicaltrials.gov, and the Espacenet patent repository.

2. *Attalea speciosa* Mart.

Family: Arecaceae; synonym: *Orbignya phalerata* Mart.; common name: babassu; parts used: seeds and fruits. INCI (International Nomenclature of Cosmetic Ingredients) names [1]: Attalea Speciosa Mesocarp Extract and Attalea Speciosa Seed Oil.

2.1. Features

This is a palm tree reaching 30 m in height. The stem carries at the apex a crown of large, pinnated leaves; the flowers are assembled in large, axillary, bending inflorescences up to 1.5 m long; and the fruits are oblong nuts of about 6 cm, rusty in color and containing two to six seeds. The species is widespread and economically important, especially in Maranhão, a state in northeastern Brazil. The fruit is exploited as an energy source, food, or medicine, while the seeds obtained by manual breaking of the fruit are transformed into oil [2–4].

2.2. Constituents

The seeds contain about 65% to 68% lipids. The oil is similar to coconut oil and is composed mainly of triglycerides with monounsaturated and saturated fatty acids. The major oil constituents include lauric (about 50%), myristic (20%), palmitic (11%), oleic (10%), stearic (3.5%), and linoleic (1.5%) acids [5]. Due to its high degree of saturation, the oil is semi-solid at 20 °C, while it melts completely at temperatures above 25 °C to 30 °C.

An ethanol extract of the leaves was reported to contain flavonoids, steroids, and/or triterpenoids, and saponins, while gas chromatography analysis showed linolenic acid as a major constituent, followed by the terpene citronellol and the fatty acids linoleic, palmitic, capric, and stearic acid [6].

2.3. Properties

Popularly used remedies in Maranhão, Brazil, are the fruit mesocarp, oil, and a residue of oil production called 'borra'. Mesocarp flour is used for gastritis, inflammation, and leucorrhea; the seed residue is used for wound healing; and the oil is used for wounds and leucorrhea [7]. In addition, the fruit is used for pain and rheumatism, constipation, obesity, leukemia, and circulation, while the oil is also used as an antimicotic and a laxative [8]. Experimental studies in vivo and on tumor cell lines have strengthened the idea that the plant could be useful for venous dysfunctions and as an adjuvant in antitumor treatments [9].

2.4. Dermatologic and Cosmetic Uses

In a study conducted on rats, an aqueous extract of the fruit has induced positive effects on wound healing [10].

The oil has been known as a skin care remedy for centuries because it is emollient and penetrates easily through the skin without leaving a greasy feeling. The oil can be used in cosmetics as an alternative to coconut oil to treat dry skin, itchiness, eczema, and various irritations. The two main oil constituents, namely lauric and myristic acids, have a melting point that is close to body temperature. Consequently the oil melts completely when coming to contact with skin, thus absorbing heat and inducing a cooling effect that corroborates its emollient virtues [11,12]. The oil is also suitable

for dry, dull hair as it confers volume by avoiding oily appearance [13]. Populations inhabiting the Tucuruí Lake Protected Areas in the eastern Amazon use the oil for skin infections, myiasis, and mycosis. In addition, they use it as hair moisturizing agent, and, curiously, the oil from the beetle *Pachymerus nucleorum* larva, which develops inside the seed of the coconut, is also used for the same purpose [4].

2.5. Adverse Effects

An extract in water of the pulverized mesocarp of the fruit, administered to mice at doses of up to 3 g/kg did not induce harmful effects [14]. Moreover, no adverse effects are known in humans due to the use of oil or other products of the plant.

3. *Carapa guianensis* Aubl.

Family Meliaceae; common name: andiroba; parts used: seeds, leaves, and bark. INCI names: Carapa Guaianensis Oil PEG-8 Esters, Carapa Guaianensis Oil Polyglyceryl-6 Esters, Carapa Guaianensis Seed Oil, and Carapa Guaianensis Seed Powder.

3.1. Features

This is a large tree reaching 30 m in height, with a cylindrical trunk and a thick, oval crown. The bark is grey or brown, with a fissurated and scaly appearance. The leaves are paripinnate and alternate, with elliptic-to-lanceolate leaflets, dark green above and opaque below. The flowers are clustered in large, unisexual inflorescences, and the fruit is a dehiscent capsule, dropping at maturity and containing various seeds [15,16].

The species grows both wild and cultivated in equatorial and tropical zones of South America. The wood has commercial value and is known as 'Brazilian mahogany'. The seeds are used to extract a pale yellow oil that is economically important in the Amazon region [17].

3.2. Constituents

The seed oil is rich in essential fatty acids, prevalently saturated ones, and melts at a temperature of about 25 °C. The main components include oleic, palmitic, linoleic, myristic, and stearic fatty acids [18], while other components include squalene, stigmasterol, and cholesterol [19]. The seeds and other plant portions contain limonoids (tetranortriterpenoids) such as methyl-angolensate, gedunin, 7-deacetoxy-7-oxogedunin, deacetylgedunin, 6α-acetoxygedunin, and andirobin. Phragmalin-type and mexicanolide-type limonoids, collectively known as carapanolides, have also been isolated from seeds and oil [20]. Limonoids confer to the plant and the oil a bitter taste [21], from which derives the name 'andiroba' in the Tupi-Guarani language [22]. Other compounds include triterpenes (e.g., ursolic acid), flavonoids (naringenin), coumarins (scopoletin), benzoic acid derivatives (3,4- and 2,6-dihydroxymethylbenzoate), and long-chain fatty acids (tetra-triacontanoic, triacontanoic acids) [23]. Flowers and leaves contain volatile compounds such as the cyclic sesquiterpenes bicyclogermacrene, germacrene B, germacrene D, and α-humulene [24].

3.3. Properties

People in the Amazon region have been using the plant as traditional medicine for centuries. Its reported uses include bark tisanes against intestinal ailments, parasites, and skin problems, and, in addition, an oil-derived soap used for its anti-inflammatory, antimicrobic, antiarthritic effects and as an insect repellent [25]. Guyana Patamona people macerated bark in water and used it for eczema, measles, and chicken pox, an infectious disease causing mild fever and inflamed blisters [26].

The plant anti-inflammatory properties are thought to depend on the presence of limonoids, as testified by studies on murine models of arthritis and allergy [27,28]. Edema formation has been inhibited by the oil in different rodent models via the impairment of signaling pathways

triggered by histamine, bradykinin, and platelet-activating factor [29]. Other studies have shown toxic properties of limonoids on insect larvae [30,31]. More specifically, gedunin and some of its derivatives have been investigated for antimalarial, hepatoprotective, and antitumor properties [32–34]. Anti-inflammatory, analgesic, and antiallergic virtues of the oil have led to the development of pharmaceutical products [35].

3.4. Dermatologic and Cosmetic Uses

In traditional medicine, the oil is applied to wounds or used for massage, as insect repellent, and for skin problems like psoriasis. It is also popularly used to prevent sarcopsyllosis and pediculosis [36].

An emulsion of the oil and the synthetic corticosteroid desonide has been clinically tested for the treatment of burns [37]. In another study, conducted on patients subjected to inguinal hair removal with pulsed light, the oil emulsion has induced analgesic and anti-inflammatory effects comparable to those of desonide alone [38]. The wound healing activities of the ethanolic extracts of leaves and bark have been observed in studies on rats [39,40].

The oil is intensively used in the cosmetic industry for lotions, shampoos, creams, and soaps [41]. Its skin care value is mainly due to the abundant presence of linoleic acid, known to be involved in the maintenance of the epidermal layer. The oil is emollient, hydrating, firming, and rejuvenating and has a lenitive effect on irritated skin due to the presence of limonoids. It can be also used as a tonic balm for hair [42].

In a study focused on the oil mechanism of action, the inhibition of glucose-6-phosphate dehydrogenase, which normally promotes fibroblast conversion to adipocytes, has been interpreted as a potential anti-cellulite effect [43]. The depigmenting and anti-wrinkle properties of the oil have also been described [44].

3.5. Adverse Effects

Studies on the systemic toxicity of the oil have been conducted on mice and rats, revealing no disturbing effects, with the exception of slight increments of liver weight and alanine aminotransferase plasma levels [19,45,46].

4. *Eperua falcata* Aubl.

Family Fabaceae, common name: wallaba, parts used: bark. INCI names: Eperua Falcata Bark Extract.

4.1. Features

This is a fast growing tree that can reach a height of 40 m. The leaves are paripinnate with falcate leaflets. The flowers are clustered in reclining inflorescences, and the fruits are falcate pods, hanging from a long peduncle, recalling the blade of a sword. Due to their typical aspect, the fruits are called ‘eperu’ by natives, meaning ‘saber sword’ in creole language. The fruits undergo explosive dehiscence at ripening, throwing seeds to distances of tens of meters.

The species is native from Guyana and neighbouring regions of Brazil, Venezuela, and Suriname. It grows on sandy, drained grounds poor in nutrients. In Guyana, it is a main arboreal plant, forming so-called ‘wallaba forests’, and being exploited as construction timber [47].

4.2. Constituents

The wood contains resinous substances, from which different compounds have been isolated, including the diterpenes eperuic acid and cativic acid (labd-7-en-15-oic acid) [48]. Other compounds isolated from the wood are the flavonol (-)-dihydrokempferol; the glycosylated 3-hyroxyflavanones engeletin, neoengeletin, and astilbin; the flavan-3-ols catechin, epicatechin, and 3-(4-hydroxybenzoyl)-

epicatechin (wallaba epicatechin); the phenolics p-hydroxybenzoic, gallic, and ellagic acids; and proanthocyanidins [49].

4.3. Properties

The bark and wood resin are traditionally used by indigenous populations for toothache, wounds, and articular pain. The wood resin is also an antimycotic and insect repellent [48].

4.4. Dermatologic and Cosmetic Uses

Traditional uses of the plant have inspired scientific research aimed at exploring its anti-inflammatory effects on the skin. These studies have concerned a bark aqueous extract containing proanthocyanidins and flavonoids such as astilbin and engeletin and have been addressed to mechanisms of neuroinflammation mediated by nociceptive terminals. Observed effects include the prevention of pro-inflammatory peptides and cytokines release through the inhibition of the NF-kB pathway in cutaneous nociceptors and keratinocytes. It has also been found that astilbin and engeletin suppress inflammatory processes induced by UV rays on keratinocytes, suggesting that these compounds could play a main role in the anti-inflammatory effects of the extract [50]. Based on these findings, the bark acqueous extract is used in soothing products aimed at alleviating skin redness, rosacea, and chronic micro-inflammatory processes [51].

4.5. Adverse Effects

No harmful or allergic effects have been reported for the plant principles.

5. *Oenocarpus bataua* Mart.

Family: Arecaceae, common name: patawa, parts used: fruit. INCI names: Oenocarpus Bataua Acid, Oenocarpus Bataua Fruit Oil, and Oenocarpus Bataua Seed Oil.

5.1. Features

This is a tree palm, up to 25 m tall, with 10 to 16 apical leaves, each three to seven meters long and having a blade consisting of about 100 segments on each side. The inflorescence is a panicle of small yellow flowers emerging below the leaf crown. The fruit is a red-purple drupe.

The species grows on sandy, acid grounds in wet environments. It is one of the most abundant arboreal plants of the Amazon region and a main source of materials such as wood and leaves. The fruits are also widely used as food, cosmetics, and medicine. Fat extracted by boiling the fruits and collecting the supernatant is used for preparing a milk-like beverage called 'chicha' in Ecuador, 'vino de seje' in Venezuela, and 'vinho de patauá' elsewhere. This drink is an important source of calories and protein in the indigenous diet [52]. Fruits contain 30% lipids (dry weight) that can be converted by cold pressure into yellow-greenish oil, similar to olive oil, which is used as food and cosmetics. Also, in French Guiana and Peru, small local industries produce ice-cream with the palm mesocarp [53,54].

5.2. Constituents

The most abundant oil constituent is the ω-9 oleic acid, followed by palmitic acid. Other major fatty acids include stearic, linoleic, arachidic, pentadecanoic, and α-linolenic acids. The non-saponifiable fraction comprises various sterols such as β-sitosterol, Δ5-avenasterol, stigmasterol, campesterol, campestanol, and cholesterol and, in addition, carotenoids, mainly β-carotene, and tocopherols, mainly α-tocopherol [55,56].

The leaf and root extracts contain hydroxycinnamic acids such as caffeoylquinic and caffeoylshikimic acids and C-glycosyl flavones [57]. Stilbene and its derivative, piceatannol, have been isolated from a methanolic extract of the fruit pulp [58].

5.3. Properties

The fruit pulp is a traditional, multi-purpose remedy against alopecia, cough, bronchitis, tuberculosis, and malaria [56].

5.4. Dermatologic and Cosmetic Uses

People in the Amazon region use the oil as a hair tonic against dandruff, allegedly owing to its antibacterial and antimycotic properties. Moreover, the oil confers strength and brightness to hair [59].

Following its popularity in the regions of origin, the oil has been introduced in the cosmetic industry. Topical applications induce hydrating, thickening, and elasticizing effects, render the skin smooth and silky, and result in a rapid penetration that avoids a greasy feeling. Overall, the oil is an antiage agent and protects the skin from harmful exterior agents, possibly due to its high contents of ω-9 fatty acids, vitamin E (tocopherols), and vitamin A (retinoids). The oil can be also used as a vehicle for the transdermal delivery of lipophilic active principles such as testosterone [60].

5.5. Adverse Effects

No damaging effects are known following topical application of the oil.

6. *Quassia amara* L.

Family: Simaroubaceae, common name: amargo, parts used: wood and bark. INCI names: Quassia Amara Wood, Quassia Amara Wood Extract, Quassia Amara Wood Powder, and Quassin.

6.1. Features

This is a small, evergreen tree, four to six meters high, with a smooth, grayish bark. The leaves are alternate and imparipinnate, with oblong, acuminate leaflets, having winged rachis and reddish veins. The flowers are borne in racemes and have five reddish, spirally twisted petals. The fruit is an aggregate of five obovate-elliptic drupes, attached to a red, fleshy receptacle and containing a single seed each [26].

The species is native to Guiana and northern Brazil but is also found in Venezuela, Colombia, Argentina, Panama, and Mexico. It grows in wet forests at elevations not exceeding 500 m above sea level.

The plant is used as an herbal remedy for the presence of bitter principles. The species *Picrasma excelsa*, known as Jamaican quassia, has properties similar to those of *Q. amara*. Herbal products from either species are frequently indistinctly commercialized under the name of 'quassia'. In addition to herbal ingredients, *Q. amara* is used for the production of flypaper and methylated spirits.

6.2. Constituents

The plant contains seco-triterpene-δ-lactones known as quassinoids, typical of the family Simaroubaceae. The major quassinoids are quassin, neoquassin, 18-hydroxyquassin, simalikalactone D, picrasin, and quassimarin. Most quassinoids have a C-20 structure, but simalikalactone D has a C-25 structure and quassimarin has a C-27 structure [61,62]. The plant also contains indolic alkaloids of the β-carboline family such as 1-vinyl-4,8-dimethoxy-β-carboline, 1-methoxycarbonyl-β-carboline, and 3-methylcanthine-2,6-dione [63].

6.3. Properties

Quassinoids are responsible for most of the plant's biological properties and its strong bitter taste. In southern America, the plant is used as antimalarial and febrifuge substance, as an alternative to quinine root. It is also used as an appetizer and digestive due to its bitter principles and as an insecticide and an antiparasite substance, and it is reported in the Pharmacopeias of different countries [64].

Antimalarial properties have been investigated on animal models, while in vitro studies have revealed cytotoxic activity of simalikalactone D and E on chloroquine-resistant *Plasmodium falciparum*

strains [65–67]. In addition, various in vitro and in vivo studies have shown antiviral, insecticidal, anti-inflammatory, gastroprotective, antidiabetic, and antifertility activities of quassinoids [68–73].

β-Carboline alkaloids are a wide family of compounds known as DNA intercalating agents and inhibitors of cyclin-dependent kinases, topoisomerases and monoamino-oxydases. These compounds also interact with benzodiazepine and serotonin receptors, inducing sedative and anxiolytic effects [63].

6.4. Dermatologic and Cosmetic Uses

The infusion is used as a topic treatment for skin parasites like scabies and lice, while clinical investigations have shown prophylactic effects rather than insecticide activity [74,75]. These data are in agreement with studies on the mechanism of action of plant extracts, showing the inhibition of chitin production that prevents louse egg adhesion to hairs [76].

Antifungal and anti-inflammatory properties have been exploited against facial seborrheic dermatitis in a randomized, double-blind study on human patients [77]. Wood and bark extracts are generally used in cosmetics as conditioning and invigorating agents, while antioxidant, anti-inflammatory, and anti-aging properties have also been reported [78]. Different wood extracts have been proposed as either skin collagen stimulants or hair tonics [79,80].

6.5. Adverse Effects

Plant derivatives and quassinoids are generally well tolerated by humans and laboratory animals. Negative effects observed on rat fertility are reversible and not accompanied by damage to other body systems [70]. The plant has been approved as a food supplement by the EU and indicated as Generally Recognized as Safe (GRAS) by the US FDA.

7. Conclusions and Perspectives

We have selected a group of arboreal species that are major elements of the Amazon landscape and culture, being intensively utilized in this region and nearby areas. These plants are valuable sources of oil and other products, but their potentials to generate drugs have been investigated to a limited extent. Even less explored is the possibility of finding applications for dermatologic and cosmetic problems. The use of these products on skin is to a large extent inspired by empiric knowledge, mostly derived from the traditional practices of Amazonian people (Table 1).

Table 1. Reported Effects on Skin and Hair of Phytocomplexes and Active Principles from Amazonian Plants.

Species	Phytocomplexes	Phytochemicals	Effects	Ref.
Attalea speciosa	Fruit extract		Wound healing	[10]
	Seed oil,		Soothing, emollient,	[12]
		Lauric acid, myristic acid	Hydrating, hair volumizing	[11]
Carapa guianensis	Seed oil		Wound healing, insect repellent, anti-psoriasis	[36]
	Seed oil		Emollient, hydrating, firming, depigmenting, rejuvenating	[42]
	Seed oil		Glucose-6-phosphate dehydrogenase inhibition	[43]
	Seed oil/desonide emulsion		Burn healing, analgesic, anti-inflammatory	[37,38]
	Leaf ethanolic extract		Wound healing	[39,40]
		Limonoids	Lenitive	[42]

Table 1. *cont.*

Species	Phytocomplexes	Phytochemicals	Effects	Ref.
Eperua falcata	Bark aqueous extract		Prevention of neuroinflammation through NF-κB inhibition	[50]
	Bark aqueous extract		Lenitive, soothing, anti-rosacea	[51]
		Astilbin, engeletin	Suppression of inflammation induced by UV	[50]
Oenocarpus bataua	Fruit oil		Antibacterial, antimycotic, anti-dandruff	[59]
	Fruit oil		Hydrating, thickening, elasticizing	[60]
Quassia amara	Wood infusion		Anti-parasites, scabies, lice	[74,75]
	Wood and bark extract		Inhibition of louse chitin production	[76]
	Wood and bark extract		Anti-seborrheic dermatitis	[77]
	Wood and bark extract		Antioxidant, anti-inflammatory, anti-aging, collagen stimulant, hair tonic	[78–80]

However, a starting point for the achievement of a scientific basis for skin care and health applications can derive from phytochemical knowledge. Various classes of molecules have been isolated that are potentially interesting in this sense such as the limonoids of *C. guianensis*, the diterpenes and flavanonols of *E. falcata*, and the quassinoids of *Q. amara*. In addition, the abundant lipid fractions of *A. speciosa*, *C. guianensis*, and *O. bataua*, have peculiar compositions, especially in the non-saponifiable fraction, that could provide interesting bioactive molecules. A few pieces of literature have highlighted the importance of these compounds for the development of skin care applications, providing examples for phytosterols [81], limonoids [82], astilbin, and engeletin [83,84]. However, such a complex of knowledge is the tip of an iceberg of hitherto undiscovered bioactivities and constituents in the phytocomplexes of these plant species.

In conclusion, the species examined in this survey are promising sources of bioactive compounds for skin care and health applications. Investigations directed to expand the knowledge about their properties and bioactive agents will give added value to the exploitation of forest resources, possibly helping to orient their utilization toward non-destructive production chains. Following ethical principles and eco-sustainable aims, the Amazon's biodiversity could become a platform for technological research and development of new cosmetic ingredients and products.

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