

Review Article

Jatropha gossypifolia L. (Euphorbiaceae): A Review of Traditional Uses, Phytochemistry, Pharmacology, and Toxicology of This Medicinal Plant

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Jatropha gossypifolia L. (Euphorbiaceae), widely known as “bellyache bush,” is a medicinal plant largely used throughout Africa and America. Several human and veterinary uses in traditional medicine are described for different parts and preparations based on this plant. However, critical reviews discussing emphatically its medicinal value are missing. This review aims to provide an up-to-date overview of the traditional uses, as well as the phytochemistry, pharmacology, and toxicity data of *J. gossypifolia* species, in view of discussing its medicinal value and potential application in complementary and alternative medicine. Pharmacological studies have demonstrated significant action of different extracts and/or isolated compounds as antimicrobial, anti-inflammatory, antidiarrheal, antihypertensive, and anticancer agents, among others, supporting some of its popular uses. No clinical trial has been detected to date. Further studies are necessary to assay important folk uses, as well as to find new bioactive molecules with pharmacological relevance based on the popular claims. Toxicological studies associated with phytochemical analysis are important to understand the eventual toxic effects that could reduce its medicinal value. The present review provides insights for future research aiming for both ethnopharmacological validation of its popular use and its exploration as a new source of herbal drugs and/or bioactive natural products.

1. Introduction

The Euphorbiaceae family, which is considered one of the largest families of Angiosperms, covers about 7,800 species distributed in approximately 300 genera and 5 subfamilies worldwide. These species occur preferentially in tropical and subtropical environments [1, 2].

Among the main genera belonging to this family, there is *Jatropha* L., which belongs to the subfamily Crotonoideae, Jatrophaeae tribe and is represented by about 200 species. This genus is widely distributed in tropical and subtropical regions of Africa and the Americas [1]. The name “*Jatropha*”

is derived from the Greek words “*jatros*,” which means “doctor” and “*trophe*,” meaning “food,” which is associated with its medicinal uses [3]. The *Jatropha* genus is divided into two subgenera, *Jatropha* and *curcas*, from which the subgenus *Jatropha* has the widest distribution, with species found in Africa, India, South America, West Indies, Central America, and the Caribbean [4]. *Jatropha* species are used in traditional medicine to cure various ailments in Africa, Asia, and Latin America or as ornamental plants and energy crops [3]. Several known species from genus *Jatropha* have been reported for their medicinal uses, chemical constituents, and biological activities such as *Jatropha curcas*, *Jatropha elliptica*,

Jatropha gossypifolia, and *Jatropha mollissima*, among others [3].

From these species, *Jatropha gossypifolia* L. (Figure 1) is discussed here. It is a vegetal species widely known as “bellyache bush” and is a multipurpose medicinal plant largely used in folk medicine for the treatment of various diseases [3, 5, 6]. It is widely distributed in countries of tropical, subtropical, and dry tropical weather and tropical semiarid regions of Africa and the Americas [7]. In Brazil, it predominates in the Amazon, Caatinga, and Atlantic Forest and is distributed throughout the country in the North, Northeast, Midwest, South, and Southeast regions [8].

Several human and veterinary uses in traditional medicine are described for different parts (leaves, stems, roots, seeds, and latex) and preparations (infusion, decoction, and maceration, among others) based on this plant, by different routes (oral or topical). The most frequent reports concern its antihypertensive, anti-inflammatory, antiophidian, analgesic, antipyretic, antimicrobial, healing, antianemic, antidiabetic, and antihemorrhagic activities, among many other examples [3, 5, 7, 9]. Other uses are also related to this plant, such as biodiesel production, pesticide, insecticide, vermifuge, ornamentation, and even its use in religious rituals [3, 6, 10–13].

An important feature of *J. gossypifolia* species is that, due to its important potential medicinal applications, in Brazil, it is included in the National List of Medicinal Plants of Interest to the Brazilian Public Health System (*Relação Nacional de Plantas Mediciniais de Interesse ao Sistema Único de Saúde Brasileiro—RENISUS*), which is a report published by the Brazilian Health Ministry in February 2009 that includes 71 species of medicinal plants that have the potential to generate pharmaceutical products of interest to public health of Brazil [14].

Regarding its phytochemical constitution, alkaloids, coumarins, flavonoids, lignoids, phenols, saponins, steroids, tannins, and terpenoids were already detected in different extracts from different parts of this plant [15].

Among the main activities already studied for this species (including various types of extracts from different parts of the plant), the antihypertensive, antimicrobial, anti-inflammatory, antioxidant, and antineoplastic activities mainly stand out, supporting some of its popular uses [3, 16].

Some toxicity studies have shown that despite the known toxicity of *Jatropha* species, *J. gossypifolia* presented low toxicity in some *in vitro* and *in vivo* experiments. However, some studies have indicated that ethanolic extract from the leaves, in acute oral use, is safe for rats, but with chronic use, it could be toxic [17–19].

So, in view of the potential applications of this plant, this review aims to provide an up-to-date overview of the traditional uses, phytochemistry, pharmacology, and toxicity data of different parts from *J. gossypifolia*, which could be significant in providing insights for present and future research aimed at both ethnopharmacological validation of its popular use, as well as its exploration as a new source of herbal drugs and/or bioactive natural products. The medicinal value and pharmacological and/or biotechnological potential of this species are also discussed in this paper.

2. Methodology

An extensive review of the literature was undertaken in different national and international scientific sources, such as Centre for Reviews and Dissemination (<http://www.crd.york.ac.uk/CRDWeb/>), The Cochrane Library (<http://www.thecochranelibrary.com>), PubMed (<http://www.ncbi.nlm.nih.gov/pubmed/>), Science Direct (<http://www.science-direct.com/>), Scopus (<http://www.scopus.com/>), Lilacs (<http://lilacs.bvsalud.org/>), Scielo (<http://www.scielo.org/php/index.php>), Web of Knowledge (<http://apps.webof-knowledge.com>), and the Brazilian database of thesis and dissertations “Domínio Público” (<http://www.dominiopublico.gov.br/pesquisa/PesquisaPeriodicoForm.jsp>). The study database included original articles, theses, books, and other reports that preferentially had been judged for academic quality (peer-reviewed), covering several aspects of the vegetal species (botany, phytochemistry, traditional uses, pharmacology, or toxicology), dating from 1967 (first scientific report) to November 2013, without language restriction. The search strategy was constructed based on the scientific name, synonyms, and main popular names of the species identified by the botanical databases “Flora do Brasil” (<http://floradobrasil.jbrj.gov.br>), Tropicos (<http://www.tropicos.org>), The Plant List (<http://www.theplantlist.org>), and NCBI Taxonomy Browser (<http://www.ncbi.nlm.nih.gov/taxonomy>). The search strategy contained the combination of the following terms: “*Jatropha gossypifolia*” OR “*Jatropha gossypifolia*” OR “*Jatropha gossypifolia*” OR “*Manihot gossypifolia*” OR “*Adenoropium gossypifolium*” OR “*Adenoropium elegans*” OR “*Jatropha elegans*” OR “*Jatropha staphysagrifolia*” OR “*pinhão roxo*” OR “*pinhão-roxo*” OR “*pião roxo*” OR “*pião-roxo*” OR “*peão-roxo*” OR “*peão roxo*” OR “*batata-de-teu*” OR “*bata de teu*” OR “*erva-purgante*” OR “*erva purgante*” OR “*jalapão*” OR “*mamoninha*” OR “*raiz-de-teiú*” OR “*raiz de teiú*” OR “*peão-curador*” OR “*peão curador*” OR “*peão-pajé*” OR “*peão pajé*” OR “*pião-caboclo*” OR “*pião caboclo*” OR “*black physicnut*” OR “*bellyache bush*”. The Endnote X.3.0.1 reference manager was used. The software ACD/ChemSketch Freeware Version 12.01 was used to draw the chemical structures.

3. Botanic Information

Jatropha gossypifolia Linneus is a Euphorbiaceae plant popularly known worldwide as “bellyache bush” or “black physicnut”. It is a pantropical species originating from South America that is cultivated in tropical countries throughout the world [20–22].

In Brazil, it is known by various popular names and the most common are “*pinhão-roxo*,” “*pião-roxo*,” “*peão-roxo*,” “*batata-de-teu*,” “*erva-purgante*,” “*jalapão*,” “*mamoninha*,” “*raiz-de-teiú*,” “*peão-curador*,” “*peão-pajé*,” “*pião-caboclo*,” and “*pião-preto*,” among others [5, 8, 23]. There are also the following vernacular names for *J. gossypifolia*: “*frailecillo*,” “*frailejón*,” “*purga de fraile*” (Colômbia); “*frailecillo*” (Costa Rica); “*frailecillo*,” “*San Juan Del Cabre*,” “*túatúa*,” “*tuba tuba*” (Cuba); “*baga*” (Malinké et Dioula); “*higuereta cimarrona*,” “*túatúa*” (Puerto Rico); “*túatúa*” (Santo

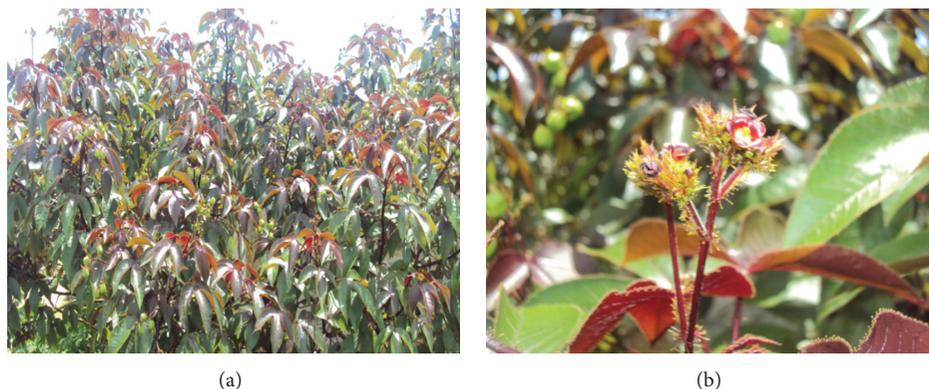


FIGURE 1: *Jatropha gossypifolia* L. (a) aerial parts of plant. (b) flowers detail. Photography by Juliana Félix-Silva.

Domingo); “frailecillo,” “sibidigua,” “tuatúa” (Venezuela); “pignut,” “fignut,” “lapalapa,” “binidasugu,” “oluluidi,” “botuje red,” “botuge pupa” (Nigeria); “athalai,” “lal bherenda” (India); “parrot grass” (Nicaragua); “babatidjin” (Africa); “piñón,” “piñón-colorado,” “piñón negro,” “piñón-rojo,” “purga de huane” (Spanish); “herbe à mal de ventre,” “médiciner cathartique,” “médiciner sauvage” (French); “bellyachebuhs,” “bellyache bush,” “bellyache nettlespurge,” “black physicnut,” “purge nut,” “red fig-nut flower,” “wild cassada” (English); “babatidjin,” “balautandoiong,” “cassava marble,” “cotton-leaf physicnut,” “figus nut,” “kishka,” “lansi-lansinaan,” “médiciner bâtard,” “médiciner noir,” “médiciner rouge,” “quelite de fraile,” “sosori,” “tagumbau-analabaga,” “tatua,” “tauataua,” “tautuba,” “tuatúa blanca,” “tuatúa morada,” “tubang morado,” “tuba sa buaia,” “tuba-tuba” (Achanti); “satamân” (Bambara) [22, 24–31].

The complete taxonomy of the species is Eukaryota; Viridiplantae; Streptophyta; Streptophytina; Embryophyta; Tracheophyta; Euphyllophyta; Spermatophyta; Magnoliophyta; eudicotyledons; core eudicotyledons; rosids; fabids; Malpighiales; Euphorbiaceae; Crotonoideae; Jatrophaeae; *Jatropha*; and *Jatropha gossypifolia* [32]. *Adenoropium gossypifolium* (L.) Pohl, *Manihot gossypifolia* (L.) Crantz, *Adenoropium elegans* Pohl, *Jatropha elegans* Kl., *Jatropha staphysagriifolia* Mill., *Jatropha gossypifolia*, and *Jatropha gossypifolia* are botanical synonymous of *J. gossypifolia* species [8, 32–34].

J. gossypifolia is a small shrub with dark green or more frequently purplish-red dark leaves, with 16–19 cm of length per 10–12.9 cm of width; they are alternate, palmate, and pubescent, with an acuminate apex, cordate base, and serrated margin. The flowers are unisexual, purple, and in cymose summits, with the calyx having five petals, which in male flowers may form a petaloid tube. The fruit is capsular, with three furrows, containing a dark seed with black spots [5, 35, 36]. Regarding the microscopic aspect of the plant leaves, some studies have shown key and important features for botanical identification of this species among other *Jatropha* species [21, 35–37].

4. Chemical Constituents

Various chemical constituents have been detected in extracts from different parts of *J. gossypifolia*, the literature having

reported, in general, the presence of fatty acids, sugars, alkaloids, amino acids, coumarins, steroids, flavonoids, lignans, proteins, saponins, tannins, and terpenoids, as can be seen in Table 1.

Accordingly reviewed by Zhang et al. [15], the main compounds isolated from *Jatropha* genus are the terpenoids. In fact, many of them were isolated from different parts of *J. gossypifolia*. Another very important class from *J. gossypifolia* is the lignoids, since a good number of them was already isolated and identified.

However, it is important to note that most of the phytochemical studies found in literature are not about isolation of compounds, but only about the phytochemical screening of the major classes through chemical qualitative reactions or more sensitive and specific methods such as thin layer chromatography (TLC). Relative to other *Jatropha* species, few studies have isolated chemical compounds from *J. gossypifolia* (Table 2). In addition, up till now it is not clear which are the major bioactive compounds in the plant, since only a few studies were conducted by bioassay-guided isolation.

Additionally, to the best of our knowledge, there are no phytochemical studies regarding the use of water as solvent for the extraction of *J. gossypifolia* constituents. This is important to note since popular use occurs more frequently with infusions or decoctions, and little is known about the constitution of this type of extract. In this context, it is important to conduct studies to evaluate the phytochemical constitution of these extracts. More commonly, the studies use solvents or mixtures of solvents with nonpolar characteristics, which could contribute to further characterization of nonpolar compounds, such as terpenoids and lignoids. Polar compounds such as flavonoids, tannins, and sugars are poorly described in the species so far, probably due to this fact.

5. Traditional Uses

Various medicinal properties for the species *J. gossypifolia* are reported by traditional medicine, as shown in Table 3. Some properties related to *J. gossypifolia* are also common to other species of the *Jatropha* genus [3, 9, 25], where human and veterinary uses are described. Different parts of this plant, such as leaves, stems, roots, seeds, and latex, are used

TABLE 1: Chemical constituents of *Jatropha gossypifolia* L. described in the literature.

Plant part	Classification	Compound	Extract type and/or preparation	Reference	
Whole plant	Coumarin-lignoids	Propacin	Isolated from dichloromethane : methanol (1 : 1, v/v) extract after successive column chromatography on silica gel	[38]	
		Venkatasin	Not specified*	[39]	
	Diterpenes	Citralitrione	Isolated from dichloromethane : methanol (1 : 1, v/v) extract after successive column chromatography on silica gel	[40]	
		Jatrophenone	Isolated from dichloromethane : methanol (1 : 1, v/v) extract after successive column chromatography on silica gel	[41]	
Stem, roots, and seeds	Coumarin-lignoids	Arylnaphthalene lignan	Isolated from petrol ether extract after successive column chromatography on silica gel	[42]	
		Gadain	Isolated from petrol ether extract after successive column chromatography on silica gel	[43]	
Aerial parts	Flavonoids	Jatrophan	Isolated from petrol ether extract	[44]	
		—	Detected by phytochemical screening reactions of ethanol extract	[19, 45]	
	Lignans	Gossypifan	Isolated from petrol ether extract after successive column chromatography on silica gel	[46]	
		Gossypiline	Isolated from dichloromethane : methanol (1 : 1, v/v) extract after successive column chromatography on silica gel	[47]	
	Phenols	—	Quantitative analysis showed that the petrol ether, chloroform, ethyl acetate, and <i>n</i> -butanol extracts presented, respectively, 45.0 ± 1.0 , 106.0 ± 2.3 , 296.0 ± 3.5 , and 128.5 ± 1.1 mg of gallic acid equivalents/g of crude extract	[48]	
	Steroids	—	Detected by phytochemical screening reactions of ethanol extract	[19, 45]	
	Tannins	—	Detected by phytochemical screening reactions of ethanol extract	[23, 45]	
	Triterpenoids	—	Detected by phytochemical screening reactions of ethanol extract	[45]	
	Leaves	Flavonoids	Ricinine	Compound isolated from ethyl acetate extract from senescent leaves	[49]
			—	Detected by phytochemical screening reactions of chloroform and methanol extracts	[50]
—			Quantitative analysis showed 2.81% on leaves	[51]	
—			Not specified	[30]	
—			Identified on leaves by qualitative phytochemical screening reactions	[52]	
—			Identified in ether fraction from ethanol extract	[53]	
—			Identified in ethyl acetate and methyl ethyl ketone fractions from ethanol extract	[53]	
—			Isomers identified in different types of extracts from leaves	[54]	
—			Isomers identified in different types of extracts from leaves	[54]	
—			Identified in ethyl acetate fraction from ethanol extract	[53]	
Leaves	Flavonoids	Vitexin	Isomers identified in different types of extracts from leaves	[54]	
		Vitexin/isovitexin	Identified on leaves by qualitative phytochemical screening reactions	[52]	
		—	Quantitative analysis showed 7.4% on leaves	[55]	
		—	Quantitative analysis showed 2.41% on leaves	[51]	
		—	Quantitative analysis showed 8.6% on leaves	[55]	
		—	Quantitative analysis showed 0.26% on leaves	[51]	
		—	Detected by phytochemical screening reactions of chloroform and methanol extracts	[50]	
		—	Identified on leaves by qualitative phytochemical screening reactions	[52]	
		—	Leaves obtained by micropropagation were macerated in liquid nitrogen and extracted at 4 °C for 6 h with 0.1 M NaCl. The material was centrifuged and the limpud supernatant was dialyzed against water at low temperature in a cellulose membrane to remove nonprotein compound with molecular mass below 3.5 kDa	[56]	
		—	Proteins		

TABLE 1: Continued.

Plant part	Classification	Compound	Extract type and/or preparation	Reference
	Reducing sugars	—	Identified on leaves by qualitative phytochemical screening reactions	[52]
	Saponins	—	Identified on leaves by qualitative phytochemical screening reactions	[52]
	Steroids	—	Quantitative analysis showed 4.15% on leaves	[51]
	Tannins	—	Identified on leaves by qualitative phytochemical screening reactions	[52]
	Terpenoids	—	Detected by phytochemical screening reactions of methanol extract	[50]
	Triterpenes	—	Detected on leaves by qualitative phytochemical screening reactions	[52]
		—	Quantitative analysis showed 5.14% on leaves	[51]
		—	Detected on leaves by qualitative phytochemical screening reactions	[52]
		(2 α , 13 α , 14 β , 20S)-2,24,25-	Isolated from the ethanol extract after successive partitions procedures and column chromatography on silica gel and preparative TLC	[57]
		Trihydroxylanost-7-en-3-one	Isolated from the ethanol extract after successive partition procedures and column chromatography on silica gel and preparative TLC	[57]
		(13 α , 14 β , 20S)-2,24,25-		
		Trihydroxylanosta-1,7-dien-3-one		
	Alkaloids	—	Quantitative analysis showed 2.16% of alkaloid on stems	[51]
		4'-O-Demethyl retrochinensin	Not specified	[58]
		Cleomiscosin A	Compound isolated from ethyl acetate fraction stems after successive column chromatography on silica gel	[59]
	Coumarin-lignoids	Gossypidien	Compound isolated from hexane extract from dried stems after successive column chromatography on silica gel	[60]
		Isogadain	Not specified*	[61]
		Jatrodien	Compound isolated from petrol ether extract after successive column chromatography on silica gel	[62]
		Prasanthaline	Not specified*	[63]
	Flavonoids	—	Quantitative analysis showed 1.2% on stems	[51]
	Phenols	—	Quantitative analysis showed 0.13% on stems	[51]
	Saponins	—	Quantitative analysis showed 2.18% on stems	[51]
	Tannins	—	Quantitative analysis showed 1.36% on stems	[51]
	Alkaloids	—	Quantitative analysis showed 1.6% on roots	[51]
		2 α -Hydroxyjatrophone	Isolated from petrol ether extract after successive column chromatography on silica gel	[64]
		2 β -Hydroxy-5,6-isojatrophone	Isolated from petrol ether extract after successive column chromatography on silica gel	[64]
		2 β -Hydroxyjatrophone	Isolated from petrol ether extract after successive column chromatography on silica gel	[64]
	Diterpenes	Citlaltirione	Isolated from petrol ether fraction from the methanol extract after successive column chromatography on silica gel	[13]
		Falodone	Isolated from petrol ether fraction from the methanol extract after successive column chromatography on silica gel	[13]
		Jatropholone A	Not specified*	[65]
		Jatropholone B	Not specified*	[65]
		Jatrophone	Isolated from ethanol extract	[66]
	Flavonoids	—	Quantitative analysis showed 1.75% on roots	[51]
	Phenols	—	Quantitative analysis showed 0.24% on roots	[51]
	Saponins	—	Quantitative analysis showed 2.83% on roots	[51]
	Tannins	—	Quantitative analysis showed 2.73% on roots	[51]

TABLE 1: Continued.

Plant part	Classification	Compound	Extract type and/or preparation	Reference
	Alkaloids	—	Quantitative analysis showed 2.36% on seeds	[51]
	Amino acids	—	Not specified*	[67]
	Carbohydrates	—	Quantitative analysis showed 30.32% on seeds	[68]
		—	Not specified*	[67]
	Esters	12-Deoxy-16-hydroxyphorbol	Isolated from hydrophilic fraction from the ether extract, by countercurrent chromatography	[69]
		Arachidic acid	Identified in petrol ether extract	[68, 70]
		Caprylic acid	Identified in petrol ether extract	[68, 70]
		Lauric acid	Identified in petrol ether extract	[68, 70]
		Lignoceric acid	Identified in petrol ether extract	[68, 70]
		Linoleic acid	Identified in petrol ether extract	[68, 70]
		Myristic acid	Identified in petrol ether extract	[68, 70]
	Fatty acids	Oleic acid	Identified in petrol ether extract	[68, 70]
		Palmitic acid	Identified in petrol ether extract	[68, 70]
		Palmitoleic acid	Identified in petrol ether extract	[68, 70]
		Ricinoleic acid	Identified in petrol ether extract	[68, 70]
		Stearic acid	Identified in petrol ether extract	[68, 70]
		Vernolic acid	Identified in petrol ether extract	[68, 70]
	Fibers	—	Quantitative analysis showed 9.25% on seeds	[68]
	Flavonoids	—	Quantitative analysis showed 2.26% on seeds	[51]
	Phenols	—	Quantitative analysis showed 0.18% on seeds	[51]
	Proteins	—	Quantitative analysis showed 13.40% on seeds	[68]
	Saponins	—	Quantitative analysis showed 2.37 on seeds	[51]
	Tannins	—	Quantitative analysis showed 6 g/kg on seeds	[68]
		—	Quantitative analysis showed 3.52% on seeds	[51]
Latex	Proteins	Cyclogossine A	Not specified	[71]
		Cyclogossine B	Isolated from ethyl acetate extract by gel filtration column chromatography	[20]
Not specified	Alkaloids	Imidazole alkaloid	Isolated from the plant exudates*	[72]
		Piperidine	Isolated from the plant exudates*	[72]
	Diterpenoids	Abiodone	Not specified*	[73]

*The complete version of the paper was not accessible, so the information was obtained from its abstract.

TABLE 2: Main isolated compounds from *Jatropha gossypifolia* L., described in the literature.

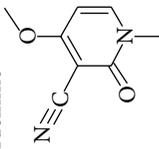
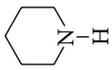
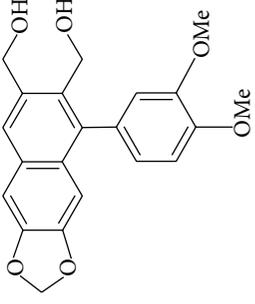
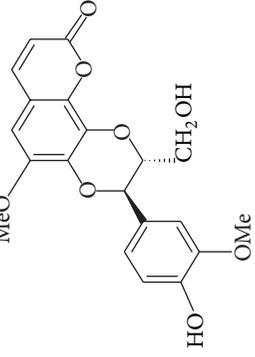
Classification	Compound	Plant part	Biological activity	Reference
	Ricinine 	Leaves	Insecticide <i>in vitro</i>	[49]
Alkaloids	Imidazole alkaloid Piperidine 	Not specified	—	[72]
	4'-O-demethyl retrochinensin Arylnaphthalene lignan 	Stems	—	[58]
	Cleomiscosin A 	Stems, roots, and seeds	—	[42]
		Stems	—	[59]

TABLE 2: Continued.

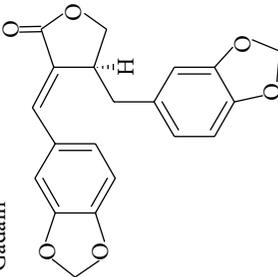
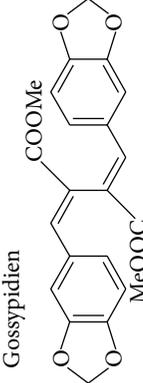
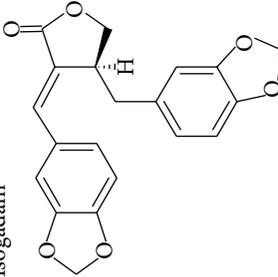
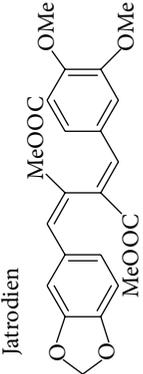
Classification	Compound	Plant part	Biological activity	Reference
	<p>Gadain</p> 	Stems, roots, and seeds	—	[43]
	<p>Gossypidien</p> 	Stems	—	[60]
Coumarin-lignoids	<p>Isogadain</p> 	Stems	—	[61]
	<p>Jatrodien</p> 	Stems	—	[62]

TABLE 2: Continued.

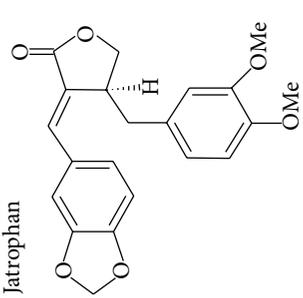
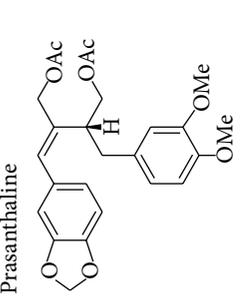
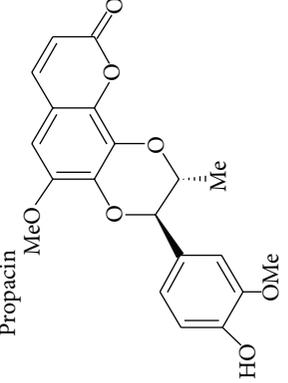
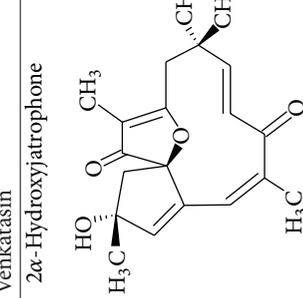
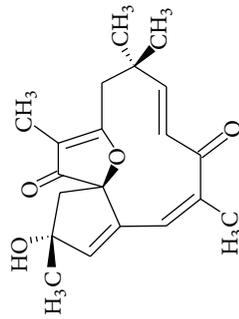
Classification	Compound	Plant part	Biological activity	Reference
	<p>Jatrophan</p> 	Stems, roots, and seeds	—	[44]
	<p>Prasanthaline</p> 	Stems	—	[63]
	<p>Propacin</p> 	Whole plant	—	[38]
	<p>Venkatasin</p> 	Whole plant	—	[39]
	<p>2α-Hydroxyjatrophone</p> 	Roots	Antileukemic <i>in vitro</i> and <i>in vivo</i>	[64]

TABLE 2: Continued.

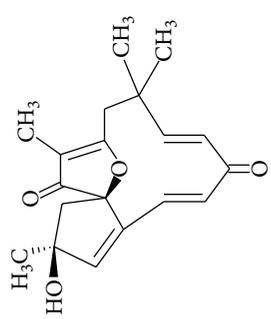
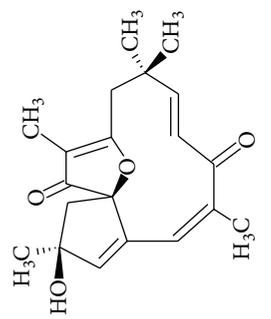
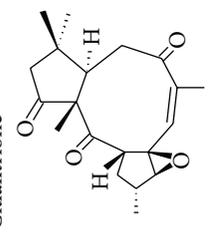
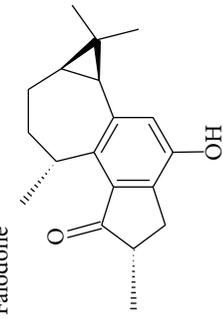
Classification	Compound	Plant part	Biological activity	Reference
	<p>2β-Hydroxy-5, 6-isojatrophone</p> 	Roots	Antileukemic <i>in vitro</i> and <i>in vivo</i>	[64]
	<p>2β-Hydroxyjatrophone</p> 	Roots	Antileukemic <i>in vitro</i> and <i>in vivo</i>	[64]
Diterpenes	<p>Abiodone Citralitriene</p> 	Not specified	Anticancer <i>in vitro</i>	[73]
	<p>Falodone</p> 	Roots	—	[13]
		Whole plant	—	[40]
		Roots	Anticancer <i>in vitro</i>	[13]

TABLE 2: Continued.

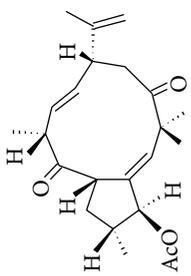
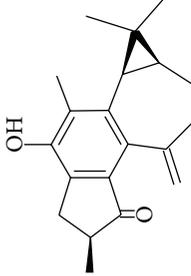
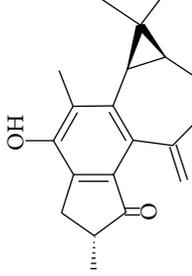
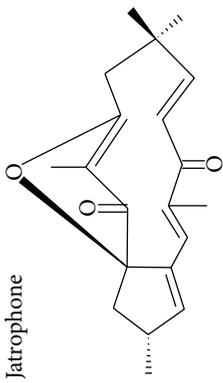
Classification	Compound	Plant part	Biological activity	Reference
	<p>Jatrophonone</p> 	Whole plant	Antibacterial <i>in vitro</i>	[41]
	<p>Jatropholone A</p> 	Roots	—	[65]
	<p>Jatropholone B</p> 	Roots	—	[65]
	<p>Jatrophone</p> 	Roots	Anticancer <i>in vitro</i> and <i>in vivo</i>	[66]

TABLE 2: Continued.

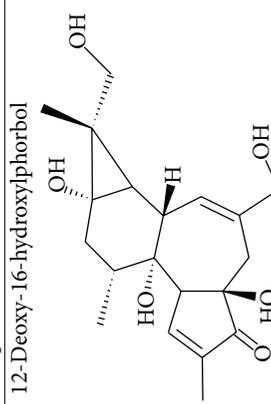
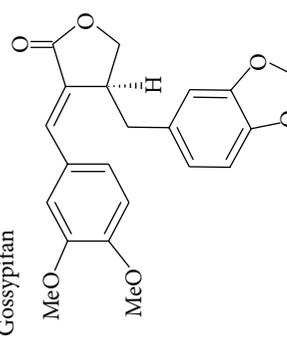
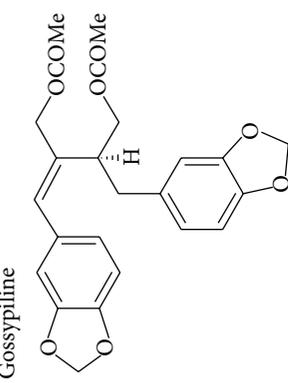
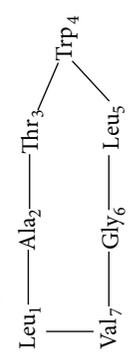
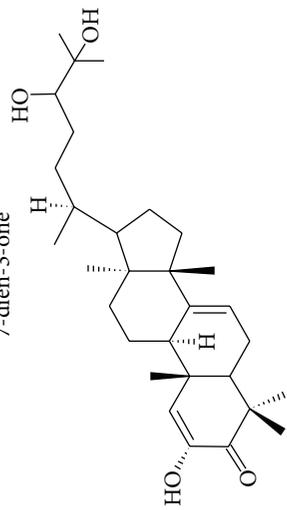
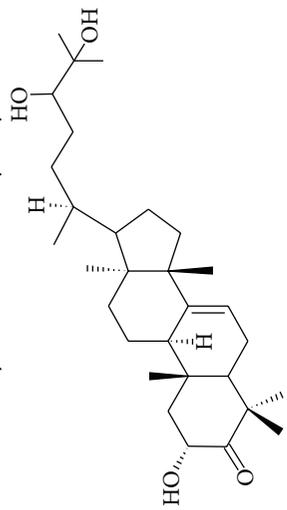
Classification	Compound	Plant part	Biological activity	Reference
Esters	12-Deoxy-16-hydroxyphorbol 	Seeds	Irritant to mouse ear	[69]
	Gossypifan 	Aerial parts	—	[46]
Lignans	Gossypiline 	Aerial parts	—	[47]
	Cyclogossine A 	Latex	—	[15, 71]
Proteins				

TABLE 2: Continued.

Classification	Compound	Plant part	Biological activity	Reference
	<p>Cyclogossinone B</p> <p>Gly₁—Leu₂—Trp₃—Leu₄</p> <p>Leu₈—Ile₇—Ala₆—Ala₅</p>	Latex	—	[15, 20]
	<p>(13α, 14β, 20S)-2,24,25-Trihydroxylanosta-1,7-dien-3-one</p> 	Leaves	—	[57]
Triterpenes	<p>(2α, 13α, 14β, 20S)-2,24,25-Trihydroxylanost-7-en-3-one</p> 	Leaves	—	[57]

in different forms of preparation (infusion, decoction, and maceration, among others), by different routes and forms (oral, topical, baths, etc.). The most frequent reports refer to its anti-inflammatory, antidiarrheal, antiophidian, analgesic, antipyretic, antimicrobial, healing, antianemic, antidiabetic, and antihemorrhagic activities, among many other examples [3, 5, 7, 9].

Some properties are attributed to specific parts of the plant, while others are assigned to different parts. Interestingly, in some cases certain uses may appear contradictory, such as antidiarrheal and laxative or its use as anticoagulant and antihemorrhagic. One hypothesis is that this difference may be related with the dose used, since, for example, the laxative effect is an effect commonly related with toxic events with this plant.

6. Pharmacological Activities

Despite the grand variety of popular uses and the data from *Jatropha* species, *J. gossypifolia* has been scarcely studied regarding biological activities (Table 4). Studies showing the biological potential of aqueous extract are rare so far, which is important to be mentioned since the most popular use of this plant is as a tea (decoction or infusion). Among the main activities that have been studied the antihypertensive, anticancer, antimicrobial, healing, anti-inflammatory, and analgesic activities stand out.

6.1. Antihypertensive Action. Based on popular use of teas from *J. gossypifolia* roots and aerial parts, the hypotensive and vasorelaxant effects of the ethanolic extract of aerial parts of the plant were tested by Abreu et al. [45]. The study revealed that the extract (125 and 250 mg/kg/day, over 4 weeks, by oral route in rats), in a dose-dependent manner, produced a reduction of systolic blood pressure in conscious normotensive animals. This hypotensive effect could be attributed to its vasorelaxant action, since it produced concentration-dependent relaxant effect in rat isolated endothelium-deprived mesenteric artery precontracted with norepinephrine or calcium. Moreover, it inhibited, in a concentration-dependent and noncompetitive manner, the contractile response induced by norepinephrine or CaCl_2 in the same preparation [45].

6.2. Antimicrobial Action. The antibiotic activity of different extracts from *J. gossypifolia* is frequently reported, as observed in Table 4. In general, some extent of antibacterial, antifungal, antiparasitic, and antiviral activity was observed. The only report of *J. gossypifolia* isolated compound with antimicrobial activity is of the macrocyclic diterpene jatrophenone, which presented significant *in vitro* antibacterial activity against *Staphylococcus aureus* [41].

6.3. Anti-Inflammatory and/or Analgesic Action. Many important popular uses of *J. gossypifolia* are related to inflammatory process. Bhagat et al. [28] showed that the methanolic extract of leaves of this species has significant systemic acute and chronic anti-inflammatory activity. The extract,

at 500 and 1000 mg/kg oral doses, was able to inhibit the acute carrageenan-induced paw edema in rats and at 50 and 100 mg/kg oral doses inhibited the chronic cotton pellet-induced granuloma formation in rats. Additionally, the *J. gossypifolia* leaf paste (0.5 and 1 mg/ear) showed significant reduction in TPA-induced local inflammatory changes in mouse ear edema model [28].

In another study, the anti-inflammatory and analgesic properties of the methanol and petrol ether extracts of aerial parts of *J. gossypifolia* were demonstrated in mice [92]. At 100 and 200 mg/kg/day, during 7 days, by oral route, only the methanol extract presented significant analgesic activity in Eddy's hot plate and tail-flick models and anti-inflammatory activity in carrageenan-induced paw edema [92]. The anti-inflammatory activity of the bark from *J. gossypifolia* (methanol and petrol ether extracts) was also demonstrated in carrageenan-induced paw edema in rats [115].

In a recent study, using the *in vitro* human red blood cell membrane stabilization method, Nagaharika et al. [118] suggested that ethanol and water extracts from *J. gossypifolia* leaves have anti-inflammatory activity. According to the authors, since human red blood cell membranes are similar to the lysosomal membrane components, the prevention of hypotonicity-induced membrane lysis of these cells could be taken as a measure in estimating the anti-inflammatory property of compounds [118].

The analgesic activity of the methanol extract from the leaves of *J. gossypifolia* was evaluated in acetic acid-induced writhing test in mice, where highly significant inhibition was seen of 67.56 and 65.14% at 200 and 400 mg/kg oral doses, respectively [111]. Similar results were observed in the methanolic extract from fruits [110].

6.4. Healing Action. The healing action of the ethanol crude extract of *J. gossypifolia* (plant part not specified) was evaluated in suture healing of ventral abdominal wall of rats, through tensiometric measurement and macro- and microscopic aspect of postoperative period. The extract, which was administered by an intraperitoneal instillation of 100 mg/kg single dose in the peritoneal cavity, presented more intense adhesion on macroscopic examination and greater strain evaluation and vascular neoformation. However, a greater inflammatory process was also observed, and other histological parameters were similar to the control group, indicating that, in general, the extract presented poor wound healing properties in the used model [124].

Another study evaluated the healing action of the hydroethanolic crude extract from leaves of *J. gossypifolia* in the healing process of sutures performed on the bladder of rats, and similar results were presented, although some improvement might have been observed in some parameters. In general, the authors concluded that no favorable healing effect was observed with the administration of single intraperitoneal dose of *J. gossypifolia* L. [108]. In another study analyzing the morphological aspects of the healing process occurring in open skin lesions in rats under topical administration of raw extract from *J. gossypifolia* (details

TABLE 3: Popular medicinal uses of *Jatropha gossypifolia* L. described in the literature.

Plant part	Popular use	Preparation and/or mode of use	Reference	
Whole plant	Analgasic (headache)	Leaves anointed with "Sebo de Hoianda" (mutton tallow) and heated in the fire are used as compress for headaches	[5]	
	Analgasic (toothache)	Not specified	[3]	
	Antimicrobial	Not specified	[3]	
	Antipyretic	Decoction	[20]	
	Dyscrasia	Not specified	[3]	
	Dysphonia	Not specified	[3]	
	Wound healing	Not specified	[74, 75]	
	Aerial parts	Antianemic (malaria treatment)	Decoction, used by oral route	[76]
	Aerial parts	Abscess	Bath	[77]
Alopecia		Ash leaves	[25]	
Analgasic (eye pain)		Not specified	[78]	
Analgasic (headache)		Not specified	[78]	
Analgasic (headache and otitis)		Not specified	[79]	
Analgasic (pain in general)		Decoction or infusion	[80]	
Analgasic (toothache)		Decoction or infusion	[80]	
Antianemic		Decoction	[81]	
		Decoction by oral route	[82]	
		Ash of leaves	[25]	
Anticancer		Decoction of the association of leaves of <i>J. gossypifolia</i> with leaves of <i>Petiveria alliacea</i> and aerial parts of <i>Stachytarpheta jamaicensis</i> , by oral route	[29]	
		Not specified	[3]	
Anticonvulsivant		Not specified	[83]	
		Decoction	[84, 85]	
Antidiabetic		Decoction by oral route	[30]	
		Decoction by oral route	[30]	
Antidiarrheal		Not specified	[3]	
Antihemorrhagic		Decoction by oral route	[30]	
		Fresh crushed leaves are used in cases of cutaneous and nasal bleeding	[86]	
Anti-infective		Decoction by oral route	[30]	
		Not specified	[87, 88]	
Anti-inflammatory		Not specified	[78]	
		Decoction	[81]	
Antipyretic	"Tea"	[5]		
	Not specified	[88]		
Antiseptic	Bath prepared from the leaves	[5]		
Antithrombotic	Decoction or infusion	[80]		
Antitumorogenic	Decoction by oral route	[30]		
	Leaf juice	[89]		
Boils	Application of the pounded leaves	[90]		

TABLE 3: Continued.

Plant part	Popular use	Preparation and/or mode of use	Reference
	Burns	Ash of leaves	[25]
	Contraceptive and oxiotoxic	Used in association with seeds of <i>Gossypium arboreum</i> , sugar, honey	[29]
	Depurative	bee, and fat of ram, prepared by grinding, applied topically	[79]
	Detoxificant	Not specified	[91]
	Eczema	Squeezed, the juice obtained is drunk	[92]
	Emetic	Not specified	[25]
	Gastrointestinal disorders	Ash of leaves	[91]
	Gingivitis	Squeezed, the juice obtained is drunk	[79]
	Gonorrhoea	Not specified	[89]
	Healing	Leaf juice	[25]
		Ash of leaves	[5]
		Bath prepared from the leaves	[30]
		Decoction	[80]
	Hemorrhoids	Decoction or infusion	[93]
	Hemostatic	Used in association with leaves of <i>Nicotiana tabacum</i> and copper sulphate, boiled in water, and used as steam directed at the anal region	[80]
	Hepatitis	Decoction or infusion	[12]
	Itching skin	Not specified	[90]
	Leprosy	Application of the pounded leaves	[89]
		Leaf juice	[81]
		Decoction	[82]
Leaves	Malaria	Decoction by oral route	[94]
		Used in association with leaves of <i>Azadirachta indica</i> and <i>Combretum</i> sp., boiled, for steam baths and by oral route	[94]
		Used in association with leaves of <i>Combretum ghasalense</i> and whole plant of <i>Ocimum canum</i> , by oral route or for steam baths	[94]
		Pounded leaves applied on swollen breasts	[90]
	Mastitis	Ash of leaves	[25]
	Mycosis	Not specified	[79]
	Psychoactive	Not specified	[3, 88]
	Purgative	Ash of leaves	[25]
	Rheumatism	Ash of leaves	[25]
	Scabies	Not specified	[3]
	Skin diseases	Decoction by oral route	[30]
		Not specified	[88, 92]
	Stomachic	Ash of leaves	[25]
	Syphilis	Ash of leaves	[25]
	Thrush (oral candidiasis)	Ash of leaves	[25]
	Treatment of "cultural syndromes," "derrame," "quebrante," "espante," "vento-caído," "panema," "doença-do-ar," "mãe-do-corpo"	Not specified	[79]
	Vaginal infection	Slightly boiled, used as vaginal wash	[91]
	Veneral diseases	Not specified	[92]
	Vermifuge	Ash of leaves	[25]
	Vertigo	Not specified	[3]

TABLE 3: Continued.

Plant part	Popular use	Preparation and/or mode of use	Reference
	Wounds and rashes	Bath of the leaves Decoction by oral route	[24] [30]
	Wound disinfectant	Decoction used as baths for cleaning wounds in dogs Slightly boiled, used as wound wash	[95] [91]
	Analgesc (toothache)	Not specified	[96]
	Antianemic	Decoction by oral route	[82]
Stem	Anticancer	Decoction by oral or topical route	[26]
	Emmenagogue	Decoction of barks	[70, 92]
	Malaria	Decoction by oral route	[82]
	Rheumatism	Not specified	[77]
	Thick blood	Not specified	[77]
	Anticancer	Decoction by oral or topical route	[26]
	Anticonvulsivant	Root bark used for cancer of the lungs	[73]
	Antidiarrheal	Not specified	[83]
	Antimicrobial	Not specified	[89]
	Impotence	Root bark used in bacterial infections Decoction of the association of roots of <i>J. gossypifolia</i> , <i>Chiococca alba</i> , <i>Citrus aurantifolia</i> , <i>Desmodium canum</i> , <i>Roystonea regia</i> , <i>Senna occidentalis</i> , <i>Stachytarpheta jamaicensis</i> , and <i>Waltheria indica</i> with the whole plant of <i>Commelina erecta</i> , <i>Cyperus rotundus</i> , and sugar, by oral route	[73] [29]
Roots	Leprosy	Not specified	[3, 92]
	Snakebites	Not specified	[22, 92, 97, 98]
	Urinary pain	Not specified	[92]
	Uterus diseases	Decoction by oral route	[99, 100]
	Analgesc (body pain)	Not specified	[101]
	Analgesc (headache)	Not specified	[79]
	Antigripal	Used in strong colds	[5]
	Antihemorrhagic	Not specified	[9]
	Antitumorogenic	Seed oil	[3]
	Contraceptive and oxiotoxic	Not specified	[79]
	Depurative	Not specified	[91]
	Emetic	Not specified	[70, 91, 101]
Seeds	Gastrointestinal disorders	Not specified	[79]
	Leprosy	Seed oil	[3]
	Mycosis	Seed oil	[3]
	Psychoactive	Not specified	[79]
	Purgative	Not specified	[3, 9, 101, 102]
	Treatment of "cultural syndromes," "derrame," "quebrante," "espante," "vento-caído," "panema," "doença-do-ar," "mãe-do-corpo"	Not specified	[79]
	Vaginal infection	Slightly boiled, used as vaginal wash	[91]
	Wound infection	Slightly boiled, used as wound wash	[91]

TABLE 3: Continued.

Plant part	Popular use	Preparation and/or mode of use	Reference
	Analgesic	Massaging pregnant women's bellies with tea or <i>garrafada</i> * when they are in pain	[77]
Fruits	Analgesic (headache)	Tea or <i>garrafada</i> *	[77]
	Analgesic (toothache)	Tea or <i>garrafada</i> *	[77]
	Laxative	Ingestion <i>in natura</i> of the powder fruit	[102]
	Numbness after bug stings	Tea or <i>garrafada</i> *	[77]
	Alopecia	Not specified	[25]
	Analgesic (eye pain)	Not specified	[78]
	Analgesic (pain in general)	Drink or massage the affected area with latex	[80]
	Analgesic (toothache)	Cotton soaked with latex kept in contact with the sore tooth	[103]
	Anticancer	Drink or massage the affected area with latex	[80]
	Antihemorrhagic	Not specified	[25]
Antithrombotic	Oral route	[9, 24, 86, 95]	
Antitumorogenic	Not specified	[80]	
Bite of venomous animals	Application of fresh latex at the affected site	[20, 89]	
Diuretic	A few drops of fresh latex in water	[5]	
Eczema	Not specified	[6]	
Gingivitis	Not specified	[25]	
Gonorrhea	Not specified	[89]	
Hemostatic	Not specified	[25]	
Infected wounds	Not specified	[25, 80]	
Leprosy	Application of fresh latex at the affected site	[5, 20]	
Mycosis	Not specified	[89]	
Purgative	Not specified	[25]	
Rheumatism	A few drops of fresh latex in water	[6]	
Scabies	Not specified	[9]	
Skin burns	Not specified	[25]	
Stop of itching of cuts and scratches	Not specified	[25]	
Syphilis	Application of fresh latex at the affected site	[104]	
Thrush (oral candidiasis)	Not specified	[25]	
Vermifuge	Not specified	[25]	
Wound healing	Application of latex at the affected site	[5]	
		Drink or massage the affected site with latex	[80]
		Not specified	[74, 75]
Resin	Toothache	Toothpowder	[27]
	Wounds in lips and tongue	Topical application	[27]
Oil	Arthritis	Applied locally	[89]
	Purgative	Not specified	[89]
	Skin disease	Applied locally	[89]

TABLE 3: Continued.

Plant part	Popular use	Preparation and/or mode of use	Reference
	Alopecia	Tea applied locally in dogs	[105]
	Analgesic	Not specified	[13]
		Poultices	[95]
	Anticancer	Not specified	[13, 66]
	Antidiarrheal	Not specified	[28, 45, 106]
	Antihypertensive	Not specified	[45]
	Anti-inflammatory	Not specified	[13, 28]
	Antipyretic	Not specified	[28]
	Antiseptic	Not specified	[45]
	Antulcerogenic	Not specified	[28]
	Coughs and colds	Bark juice (4 spoonfuls, 3 times a day) by oral route	[107]
	Detoxication	Not specified	[28]
	Diuretic	Not specified	[45]
	Eczema	Not specified	[28]
	Gum infection	Not specified	[28]
	Healing	Not specified	[45, 108]
	Hydropsy	Not specified	[5]
	Leprosy	Not specified	[28]
	Obstructions of the abdominal tract	Not specified	[5]
	Purgative	Not specified	[109]
	Regulate menses	Not specified	[5]
	Rheumatism	Not specified	[3, 22]
	Snake and scorpion bites	Not specified	[28]
	Stomach pain	Not specified	[28]
	Veneral diseases	Not specified	[95]
	Wounds	Poultices	[28]
		Used as bath	[28]

* *Garrafeira*: preparation done by macerating plant parts in alcohol or hydroalcoholic mediums, in general, brandies.

TABLE 4: Pharmacological studies of *Jatropha gossypifolia* L. described in the literature.

Pharmacological activity	Plant part	Extract/compounds	Detail	Reference
Analgesic	Aerial parts	Methanol and petrol ether extracts	At 100 and 200 mg/kg/day, over 7 days, by oral route in mice, only the methanol extract presented significant analgesic activity in Eddy's hot plate and tail-flack models	[92]
	Fruits	Methanol extract	At 200 and 400 mg/kg, by oral route in mice, highly significantly inhibited the writhing responses induced by acetic acid	[110]
	Leaves	Methanol extract	At 200 and 400 mg/kg, by oral route in mice, significantly inhibited the writhing responses induced by acetic acid	[111]
Antibacterial	Latex	Crude latex	At 100 μ L volume inhibited <i>in vitro</i> <i>Listeria monocytogenes</i> , <i>Salmonella typhimurium</i> , <i>Salmonella typhi</i> , and <i>Staphylococcus aureus</i>	[112]
	Latex	Not specified	Presented bactericidal effect <i>in vitro</i> against <i>Shigella dysenteriae</i> and <i>Staphylococcus aureus</i> *	[113]
	Leaves	Fractions obtained by sequential extraction of the vegetal material with petrol ether, benzene, chloroform, acetone, ethanol, methanol, and water	Petrol ether fraction was inactive against <i>Escherichia coli</i> and <i>Bacillus subtilis</i> . Benzene fraction was the most active, against both microorganisms. Chloroform and methanol fractions were active only against <i>Bacillus subtilis</i> . Acetone and ethanol fractions were active only against <i>Escherichia coli</i> . Aqueous fraction was active against both microorganisms, although to a much lesser degree than the other fractions.	[52]
		Methanol, chloroform, and water extracts	All extracts were active <i>in vitro</i> against <i>Shigella dysenteriae</i> *	[113]
	Whole plant	Petrol ether and ethyl acetate fractions from ethanol : dichloromethane (1:1, v/v) extract	The petrol ether fraction (1 mg/mL) inhibited <i>in vitro</i> <i>Pseudomonas aeruginosa</i> , <i>Staphylococcus epidermidis</i> , and <i>Salmonella typhimurium</i> . The ethyl acetate fraction (1 mg/mL) was active against <i>Staphylococcus aureus</i>	[87]
Aerial parts	Jatropenone	Presented <i>in vitro</i> antibacterial activity against <i>Staphylococcus aureus</i> comparable to penicillin	[41]	
	Water and ethyl acetate fractions from methanol extract	Both fractions, at 1 mg, did not produce zones of inhibition for <i>Escherichia coli</i> , <i>Staphylococcus aureus</i> , <i>Saccharomyces cerevisiae</i> , nor <i>Candida albicans</i>	[114]	
	Leaves	Chloroform extract	Presented antibacterial activity against <i>Salmonella typhi</i> , <i>Pseudomonas aeruginosa</i> , and <i>Staphylococcus aureus</i> and antifungal activity against <i>Candida albicans</i> . Did not produce inhibition zones against <i>Escherichia coli</i> , <i>Bacillus subtilis</i> , <i>Proteus mirabilis</i> , <i>Corynebacterium diptheriae</i> , <i>Shigella dysenteriae</i> , and <i>Streptococcus penumoniae</i>	[50]
		Dichloromethane : methanol (1:1, v/v) extract	At 0.5 and 1 mg/mL, showed significant antibacterial activity <i>in vitro</i> against <i>Bacillus cereus</i> var <i>mycoides</i> , <i>Bacillus pumilus</i> , <i>Bacillus subtilis</i> , <i>Bordetella bronchiseptica</i> , <i>Micrococcus luteus</i> , <i>Staphylococcus aureus</i> , <i>Staphylococcus epidermidis</i> , <i>Klebsiella pneumoniae</i> , and <i>Streptococcus faecalis</i> and antifungal activity <i>in vitro</i> against <i>Candida albicans</i>	[88]
	Leaves	Methanol extract	Presented antibacterial activity against <i>Salmonella typhi</i> , <i>Pseudomonas aeruginosa</i> , and <i>Staphylococcus aureus</i> and antifungal activity against <i>Candida albicans</i> . Did not produce inhibition zones against <i>Escherichia coli</i> , <i>Bacillus subtilis</i> , <i>Proteus mirabilis</i> , <i>Corynebacterium diptheriae</i> , <i>Shigella dysenteriae</i> , and <i>Streptococcus penumoniae</i>	[50]

TABLE 4: Continued.

Pharmacological activity	Plant part	Extract/compounds	Detail	Reference
Antibacterial and antifungal	Not specified	Extracts obtained by sequential extraction of the vegetal material with <i>n</i> -hexane, chloroform, acetone, methanol, and water	<i>n</i> -Hexane extract had inhibitory activity <i>in vitro</i> against <i>Escherichia coli</i> , <i>Salmonella typhi</i> , <i>Pseudomonas aeruginosa</i> , <i>Bacillus cereus</i> , <i>Klebsiella aerogenes</i> , and <i>Candida albicans</i> but was inactive against <i>Shigella boydi</i> , <i>Aspergillus fumigatus</i> , <i>Aspergillus flavus</i> , and <i>Aspergillus niger</i> . Chloroform extract inhibited <i>in vitro</i> <i>Salmonella typhi</i> , <i>Pseudomonas aeruginosa</i> , <i>Bacillus cereus</i> , and <i>Candida albicans</i> but was inactive against <i>Escherichia coli</i> , <i>Staphylococcus aureus</i> , <i>Shigella boydi</i> , <i>Aspergillus fumigatus</i> , <i>Aspergillus flavus</i> , and <i>Aspergillus niger</i> . Acetone extract inhibited <i>in vitro</i> <i>Escherichia coli</i> , <i>Pseudomonas aeruginosa</i> , <i>Staphylococcus aureus</i> , <i>Klebsiella aerogenes</i> , <i>Proteus vulgaris</i> , and <i>Candida albicans</i> but was inactive against <i>Salmonella typhi</i> , <i>Aspergillus fumigatus</i> , <i>Aspergillus flavus</i> , and <i>Aspergillus niger</i> . Methanol extract inhibited <i>in vitro</i> <i>Escherichia coli</i> , <i>Salmonella typhi</i> , <i>Pseudomonas aeruginosa</i> , <i>Staphylococcus aureus</i> , <i>Bacillus cereus</i> , and <i>Candida albicans</i> but was inactive against <i>Aspergillus fumigatus</i> , <i>Aspergillus flavus</i> , and <i>Aspergillus niger</i> . Water extract was active <i>in vitro</i> against <i>Escherichia coli</i> , <i>Salmonella typhi</i> , <i>Pseudomonas aeruginosa</i> , <i>Staphylococcus aureus</i> , <i>Bacillus cereus</i> , <i>Klebsiella aerogenes</i> , <i>Proteus vulgaris</i> , and <i>Candida albicans</i> but was inactive against <i>Aspergillus fumigatus</i> , <i>Aspergillus flavus</i> , and <i>Aspergillus niger</i>	[89]
		Methanol and petrol ether extracts from bark	At 200 μ g/100 μ L, only the methanol extract showed <i>in vitro</i> antibacterial activity upon <i>Staphylococcus aureus</i> , <i>Streptococcus pyogenes</i> , and <i>Escherichia coli</i> and antifungal activity upon <i>Aspergillus niger</i> , <i>Candida albicans</i> , <i>Penicillium notatum</i> , and <i>Saccharomyces cerevisiae</i>	[115]
Anticholinesterase	Latex	Lyophilized latex	Inhibited time- and dose-dependently the acetylcholinesterase enzyme in nervous tissue of freshwater air breathing fish <i>Channa marulius</i>	[116]
	Leaves	Fractions obtained by sequential extraction of the vegetal material with ethyl acetate and methanol	At 2 mg/mL concentration, the ethyl acetate and methanol fractions presented inhibitory activities <i>in vitro</i> of 71 and 100%. The methanol fraction presented IC ₅₀ of 0.05 mg/mL	[117]
Antidiarrheal	Fruits	Methanol extract	At 200 and 400 mg/kg, by oral route in mice, inhibited the castor oil induced diarrhea	[110]
	Leaves	Methanol extract	At 200 and 400 mg/kg, by oral route in mice, inhibited the castor oil induced diarrhea	[111]
Antifungal (antidermatophytic fungi)	Aerial parts	Water and ethyl acetate fractions from methanol extract	The minimal concentration producing 75% of inhibition or higher against <i>Microsporus canis</i> , for both fractions, was 1 μ g/mL. For the fungus <i>Microsporus gypseum</i> , <i>Microsporus fulvum</i> , and <i>Microsporus gallinae</i> , none of the fraction presented inhibitory activity	[114]

TABLE 4: Continued.

Pharmacological activity	Plant part	Extract/compounds	Detail	Reference
Anti-inflammatory	Aerial parts	Methanol and petrol ether extracts	At 100 and 200 mg/kg/day, over 7 days, by oral route in mice, only the methanol extract presented significant anti-inflammatory activity on carrageenan-induced paw edema	[92]
		Aqueous extract	At 100 and 200 $\mu\text{g/mL}$, significantly prevented the lysis of human red blood cells in membrane stabilization method <i>in vitro</i>	[118]
	Leaves	Ethanol extract	At 100 $\mu\text{g/mL}$, significantly prevented the lysis of human red blood cells in membrane stabilization method <i>in vitro</i>	[118]
		Methanol extract and leaf paste	At 500 and 1000 mg/kg, by oral route in rats, inhibited the carrageenan-induced paw edema. At 50 and 100 mg/kg, by oral route in rats, inhibited the cotton pellet induced granuloma formation in rats. At 0.5 and 1 mg/ear, the leaf paste reduced the inflammation response in mouse ear edema model	[28]
	Not specified	Methanol and petrol ether extracts from bark	At 200 mg/kg, by oral route in rats, both extracts reduced the carrageenan-induced paw edema	[115]
Antimalarial	Leaves	Aqueous extract Dichloromethane extract	30 μg inhibited <i>in vitro</i> the growth of <i>Plasmodium falciparum</i> Active <i>in vitro</i> against <i>Plasmodium falciparum</i> , with IC_{50} of about 35 $\mu\text{g/mL}$	[31] [81]
Antineoplastic		Ethanol extract and jatrophone	The ethanol extract, as well as jatrophone, exhibited significant inhibitory activity <i>in vitro</i> against cells derived from human carcinoma of the nasopharynx and lymphocytic leukemia P-388 and <i>in vivo</i> against four standard animal tumor systems	[66]
	Roots	Falodone 2 α -Hydroxyjatrophone, 2 β -hydroxy-5,6-isojatrophone and 2 β -hydroxyjatrophone, diterpenes isolated from petrol ether extract	Showed potent proliferation inhibitory activity against A-549 human cancer cell line, with IC_{50} of 120 $\mu\text{g/mL}$	[13]
	Not specified	Abiodone	Presented antineoplastic activity upon P-388 lymphocytic leukemia test system both <i>in vivo</i> and <i>in vitro</i> , as well as for the Eagle's carcinoma of the nasopharynx test system <i>in vitro</i>	[64]
Antioxidant	Leaves	Methanol, ethyl acetate, and aqueous extract	Not specified*	[73]
	Whole plant	Petrol ether, chloroform, ethyl acetate, and <i>n</i> -butanol extracts	All extracts showed significant antioxidant activity <i>in vitro</i> in DPPH free radical, ferric thiocyanate, and nitric oxide scavenging methods* All extracts showed only poor DPPH scavenging activity. The total antioxidant capacity was higher in ethyl acetate and <i>n</i> -butanol extracts, having the petrol ether and chloroform showing only poor activity. The lipid peroxidation was inhibited only partially by the extracts, with the ethyl acetate being the most active and the petrol ether being the least	[55] [48]
Antispasmodic	Aerial parts	Ethanol extract, fractions, and subfractions	At 500, 1000, and 2000 mg/kg, by oral route in mice, showed significant antispasmodic activity in mouse intestinal transit model and at 0.5, 1.0, and 2.0 mg/mL inhibited <i>in vitro</i> the acetylcholine and calcium-induced contractions of isolated rat jejunum. Only the organic fraction of the extract had a calcium-antagonist effect, whereas both chloroformic and aqueous fractions had anticholinergic effect	[119]

TABLE 4: Continued.

Pharmacological activity	Plant part	Extract/compounds	Detail	Reference
Antiviral	Aerial parts	Water and ethyl acetate fractions from methanol extract	At 1, 10, and 100 µg/mL, both fractions presented 100% of inhibition of plaque-forming ability of <i>Sindbis virus</i> in treatment preinfection protocol (IC ₅₀ < 1 µg/mL), while in treatment postinfection, the IC ₅₀ of water fraction increased to 512 and acetate fraction increased to 37 µg/mL. For murine cytomegalovirus, IC ₅₀ of 1.7 and 1.5 to water and ethyl acetate fractions were observed, respectively, in treatment preinfection protocol. In the treatment postinfection, however, no inhibition was observed in this microorganism	[114]
	Not specified	Methanol extract from barks	Partially active against <i>Sindbis virus</i> and herpes simplex virus-1. Inactive against human poliovirus	[107]
Bronchodilator	Stems	Aqueous extract	The extract was inactive in bronchodilator activity in guinea pigs	[120]
Contraceptive	Leaves	Ethanol extract	At 450 mg/kg/day, over 21 days, by oral route, caused an antifertility activity in female mice	[121]
	Aerial parts	Ethanol 70% extract	At 1 mL/kg dose, by intraperitoneal route in rats, presented beneficial activity in healing process of colonic anastomosis	[122]
	Aerial parts	Ethanol 70% extract	At 200 mg/kg, by intraperitoneal route in rats, favored the healing process of gastrorrhaphies and reduced the acute inflammatory reaction <i>in vivo</i>	[123]
Healing	Leaves	Hydroethanol extract	At 200 mg/kg, by intraperitoneal route, decreased the inflammation and increased vascular neoformation and collagen deposition when compared to the control group in healing process of sutures performed on the bladder of rats. However, in general, no favorable healing effect was observed.	[108]
	Not specified	Ethanolic extract	Although some improvement could be observed in suture healing of ventral abdominal wall of rats treated with 100 mg/kg of extract (intraperitoneal instillation intraperitoneal cavity), in general, only a poor healing activity was observed.	[124]
		Not specified	At 0.1 mL volume, by topical application, the crude extract presented significant differences concerning the macroscopic and microscopic aspects of healing process occurring in open skin lesions in rats	[125]
Hemostatic	Latex	Crude fresh latex	Decreased clotting and bleeding time in healthy subjects	[101]
Hepatoprotective	Aerial parts	Petrol ether, methanol, and water extracts	At 200 mg/kg/day, over 7 days, by oral route in rats, both extracts presented hepatoprotective activity in carbon tetrachloride induced liver damage, with the petrol ether being the most active and the methanol being the least	[126]
Hypotensive and vasorelaxant	Aerial parts	Ethanolic extract	At 125 and 250 mg/kg/day, over 4 weeks, by oral route in rats, in a dose-dependent manner, reduced the systolic blood pressure and produced a concentration-dependent relaxant effect in rat isolated (<i>ex vivo</i>) endothelium-deprived mesenteric artery precontracted with norepinephrine or CaCl ₂	[45]
Immunomodulatory	Whole plant	Petrol ether extract	At 100, 200, and 400 µg/mL increased the proliferation of mouse spleen cell <i>in vitro</i>	[127]
Local anesthetic	Not specified	Methanol and aqueous extracts	Both extracts presented significant local anesthetic activity by plexus anesthesia in frogs*	[128]

TABLE 4: Continued.

Pharmacological activity	Plant part	Extract/compounds	Detail	Reference
Relaxant effect on uterine smooth muscle (tocolytic activity)	Aerial parts	Ethanollic extract and chloroformic and aqueous fractions	At 0.5 and 1.0 mg/mL, the ethanollic extract reduced the calcium-evoked contractile response of the uterine smooth muscle, as well as the chloroformic fraction. The aqueous fraction presented only slight effect	[129]
Sedative and anxiolytic	Fruits	Methanol extract	At 200 and 400 mg/kg, by oral route in mice, presented sedative effect in the hole cross test; At 200 mg/kg, presented anxiolytic activity in hole board test; At 400 mg/kg, presented anxiolytic activity in elevated plus-maze test	[110]
	Leaves	Methanol extract	At 200 and 400 mg/kg, by oral route in mice, presented sedative effect in the hole cross test; At 200 mg/kg, presented anxiolytic activity in hole board test; At 400 mg/kg, presented anxiolytic in elevated plus-maze test	[111]

*The complete version of the paper was not accessible, so the information was obtained from its abstract.
 IC₅₀: concentration that inhibits 50% of the referred activity.

about extract preparation and plant part not specified), the authors also observed an absence of healing action, although some histological improvement was shown [125].

However, studying the influence of *J. gossypifolia* on the healing process of colonic anastomosis in rats, Servin et al. showed that the administration of 1 mL/kg single dose of the hydro alcoholic extract from aerial parts has beneficial effect on the healing process [122]. However, according to these authors, on the seventh day of the experiment, there was a decrease in the action of the extract, suggesting that the extract, in this experiment, was less active in later stages of healing process [122]. A plausible hypothesis, not raised by the authors, could be the fact that the extract was administered in a single dose, which may not have been sufficient to maintain the effect throughout the time of the experiment. Additionally, Vale et al. showed that the ethanolic extract from aerial parts of *J. gossypifolia*, at single intraperitoneal dose of 200 mg/kg, favored the healing process of gastrorrhaphies and reduced the acute inflammatory reaction *in vivo* [123].

6.5. Hemostatic Action. The use of *J. gossypifolia*, especially the latex, is widespread as a hemostatic agent for preventing bleeding disorders. The results of whole blood clotting time using Lee and White method and bleeding time using Ivy's method were significantly reduced when stem latex was introduced, suggesting procoagulant activity [101]. Regarding the possible mechanism of action, based on experiments that show the precipitating action of the latex upon bovine albumin, the authors suggest that the latex precipitates clotting factors thereby bringing the coagulation factors into close contact, and then the activation of coagulation cascade leads to the generation of thrombin and formation of a clot takes place in a matter of seconds when compared to the control experiment, which took minutes to complete coagulation [101]. It is important to emphasize that, to the best of our knowledge, this is the only study performed on human subjects.

6.6. Anticholinesterase Action. Based on the cholinergic hypothesis, acetylcholinesterase inhibitors are widely used to treat Alzheimer's disease. *J. gossypifolia* presented an important anticholinesterase activity since the methanolic extract from leaves showed an IC_{50} of 0.05 mg/mL [117]. Another study showed that the lyophilized latex of the plant was able to inhibit time- and dose-dependently the acetylcholinesterase enzyme in nervous tissue of freshwater air breathing fish *Channa marulius* [116].

6.7. Antioxidant Action. The antioxidant activity of extracts from *J. gossypifolia* was evaluated by Kharat et al. [55]. In this work the high content of phenols, tannins, and flavonoids in the leaves prompted the authors to evaluate the antioxidant activity of the leaves. DPPH free radical, ferric thiocyanate, and nitric oxide scavenging methods were used to analyze the antioxidant activity *in vitro* of methanol, ethyl acetate, and aqueous extracts, demonstrating positive results. The authors attributed the free radical scavenging activity to the presence

of flavonoids [55]. On the other hand, a study showed that different extracts (petrol ether, chloroform, ethyl acetate, and *n*-butanol) from whole plant of *J. gossypifolia* had only partial antioxidant activity in DPPH scavenging, total antioxidant capacity, and lipid peroxidation tests [48]. Among them, the ethyl acetate extract was the most active, which correlates positively with its higher content of phenolic compounds in comparison with the other extracts [48].

6.8. Contraceptive Action. Based on its popular use, *J. gossypifolia* was assessed for its antifertility activity, as an alternative to oral contraceptive agents. *J. gossypifolia* leaf extract, by oral route, altered the major hormones involved in estrous cycle regulation, indicating its antifertility effect on mice [121]. Evaluating other parameters (estrogenic and early abortifacient activities) the anti-infertility effect of the extract was once more demonstrated later [130].

6.9. Tocolytic Action. Based on the ethnopharmacological application of the plant as tocolytic remedy, the effects on calcium-evoked uterine smooth muscle contraction of the ethanolic extract and fractions were evaluated [129]. The crude extract and, to a higher extent, the chloroformic fraction reduced the calcium-evoked contractile response of the uterine smooth muscle, promoting a rightward displacement of calcium cumulative curves, as well as reducing the maximal contractions [129].

6.10. Antineoplastic Action. One of the most well-known pharmacological activities of *J. gossypifolia* is its antineoplastic action, which is frequently associated with the content of lignoids and terpenoids. One of the first reports was made by Kupchan et al. [66], when the authors found that the ethanolic extract from roots, as well as the isolated diterpene jatrophone, exhibited significant inhibitory activity *in vitro* against cells derived from human carcinoma of the nasopharynx and lymphocytic leukemia P-388 and *in vivo* against four standard animal tumor systems, such as sarcoma 180, Lewis lung carcinoma, P-388 lymphocytic leukemia, and Walker 256 intramuscular carcinosarcoma [66]. Later, three new antitumor derivatives of jatrophone were isolated from petrol ether extracts from roots of *J. gossypifolia*: 2 α -hydroxyjatrophone, 2 β -hydroxy-5,6-isojatrophone, and 2 β -hydroxyjatrophone [64]. Recently, two other diterpenes with potent antineoplastic activity were isolated from *J. gossypifolia*: falodone and abiodone. Falodone was isolated from methanol extract from roots and showed potent proliferation inhibitory activity against A-549 human cancer cell line [13]. Abiodone, a lathyran diterpenoid compound, was isolated from *J. gossypifolia* and presented potent anticancer activity [73].

6.11. Local Anesthetic Action. The local anesthetic action of *J. gossypifolia* was evaluated by plexus anaesthesia in frogs [128]. The authors observed that the aqueous and methanol extract (plant part not specified) presented significant anesthetic action when compared to control group.

6.12. Neuropharmacological Action. The neuropharmacological action of the methanol extract of the leaves of *J. gossypifolia* was evaluated by Apu et al. [111]. The authors observed that in hole cross test the extract at 200 and 400 mg/kg, by oral route, showed significant sedative effect in mice. In hole board test, the extract showed highly significant anxiolytic activity at a dose of 200 mg/kg, whereas the same activity was observed at 400 mg/kg dose in elevated plus-maze test [111]. Similar results were observed in the methanolic extract from fruits [110].

6.13. Antidiarrheal Action. Although it may seem contradictory as shown in Table 3, *J. gossypifolia* species is popularly used both as purgative and as antidiarrheal remedy. However, in literature, there are interesting results about the antidiarrheal properties of different extracts of this species.

At 200 and 400 mg/kg oral doses in mice, the methanol extract of *J. gossypifolia* leaves produced highly significant antidiarrheal activity upon castor oil-induced diarrhea, decreasing the mean number of stool and total weight of fecal output when compared to control group [111]. Similar results were observed in the methanolic extract from fruits [110].

Aiming to determine the possible action mechanism of *J. gossypifolia* aerial parts ethanol extract as antidiarrheal agent, Silva et al. [119] have investigated the effect of this extract on intestinal transit velocity and on isolated rat jejunum. At 500, 1000, and 2000 mg/kg, by oral route in mice, the extract showed significant antispasmodic activity in mouse intestinal transit model when compared to control. At 0.5, 1.0, and 2.0 mg/mL, the crude extract inhibited *in vitro* the acetylcholine and calcium-induced contractions of isolated rat jejunum. The chloroform and aqueous fractions were obtained and it was observed that only the chloroform fraction of the extract had a calcium-antagonist effect, whereas both chloroformic and aqueous fractions had anticholinergic effect, suggesting that the antispasmodic effect of *J. gossypifolia* may be due to a combination of anticholinergic and calcium-antagonist mechanisms [119].

6.14. Immunomodulatory Action. The immunomodulatory action of synthetic lignan compounds was evaluated by the assay of proliferation of mouse spleen cell *in vitro* and compared with petrol ether extract of whole plant of *J. gossypifolia*, since it is a natural source of this kind of compound [127]. The authors showed that both synthetic and naturally occurring 1-phenyl-naphthalene lignans could positively modulate the immunity of the host, since they significantly increased the proliferation of mouse spleen cell *in vitro* [127].

6.15. Hepatoprotective Action. Despite some studies having shown the hepatotoxic potential of *J. gossypifolia*, a study was performed to analyze the possible hepatoprotective action of extracts of this plant in carbon tetrachloride-induced liver damage in rats [126]. In fact, the petrol ether, methanol, and water extracts from the aerial parts of *J. gossypifolia* presented significant hepatoprotective action in this model,

substantially restoring towards normalization the serum levels of serum glutamate oxaloacetate transaminase, serum glutamate pyruvate transaminase, serum alkaline phosphatase, total bilirubin, superoxide dismutase, and catalase [126]. The authors also discuss the close relationship between the hepatoprotective action observed and the possible antioxidant mechanism present in the extracts.

7. Other Actions and Biotechnological Applications

In addition to studies demonstrating scientific evidences of the pharmacological properties of *J. gossypifolia*, several studies have demonstrated the potential of this species to obtain molecules with various applications, thus showing its multipurpose character.

Among the main applications described, the use of *J. gossypifolia* seed oil for biodiesel production could be mentioned. *Jatropha* species has drawn the attention of researchers in recent years due to its emergence as a highly suitable feedstock plant for biodiesel production [11]. Among the species, *J. gossypifolia*, *J. curcas*, and *J. pohliana* produce seeds with high oil content [11]. In a study investigating the potential of two plants of the *Jatropha* genus (including *J. gossypifolia*), the authors observed that the studied physicochemical properties of the produced biodiesel are in the acceptable range for use as biodiesel in diesel engines, showing a promising economic exploitation of these raw materials [131].

Studies have shown the potential of the species for the development of new tools for biochemical analysis. A recent study showed that the diluted fresh latex *J. gossypifolia* can be used as precipitating agent for biochemical determination of proteins in plasma, urine, and cerebrospinal fluid, with values comparable to those obtained from the conventional protein precipitants sodium tungstate and trichloroacetic acid [24]. According to the authors, the precipitating potential could be related to the capacity of the latex to form clots when applied to a bleeding sore or wound when it is used in folk medicine [24]. Another study showed the potentiality of the juice extracted from the fresh leaves of *J. gossypifolia* as an anticoagulant for haematological analyses [86]. 0.1 mL of extract per mL of blood proved to be suitable for obtaining plasmas for biochemical analysis comparable with conventional anticoagulants [86]. However, the authors emphasize that the extract must be purified to remove interfering substances for it to be perfectly suitable for biochemical analysis [86].

Some studies have demonstrated the potentiality of *J. gossypifolia* as a source of pesticide biomolecules. Bullangpoti et al. [49] isolated ricinine from the ethyl acetate extract from senescent leaves, the main compound responsible for the toxicity of the crude extract in *Spodoptera exigua* larvae, thus demonstrating that it could be an alternative choice to chemical insecticides. In another study, Bullangpoti et al. [132] showed that the ethanol extract of *J. gossypifolia* in association with the ethanol extract of *Melia azedarach* was toxic and inhibited some enzymes from *Spodoptera*

frugiperda larvae, demonstrating once more the potentiality of the species as insecticide agent. Calatayud et al. [56] showed the presence of proteins of about 100 kDa with toxic activity upon *Phenacoccus herreni*, another type of insect. In this work, the authors performed a strategy of extraction that eliminated nonprotein compounds, being able to demonstrate the potential of the species to obtain insecticidal proteins [56]. Leaf extract of *J. gossypifolia* reduced the fecundity and egg viability against stored product insect pests *Tribolium castaneum* [133].

The potential molluscicidal activity of *J. gossypifolia* has also been evaluated as an alternative mode of prevention of schistosomiasis. Sukumaran et al. [134] showed that the methanol and *n*-butanol extracts from unripened seeds of *J. gossypifolia* was toxic against eggs and adults of two species of freshwater snails, *Lymnaea luteola* and *Indoplanorbis exustus*. The results indicated that *n*-butanol extract was the most effective and that the eggs were more susceptible than adults [134].

8. Toxicology

Species of *Jatropha* are notably known for their toxic potential [135, 136]. This toxicity is related primarily to latex and seeds. The latex is released from the aerial parts of the plant by mechanical injury and it is extremely caustic and irritating to skin and mucous membranes. The seeds are rich in toxalbumins that cause agglutination and hemolysis to erythrocytes as well as damage to other cell types and contain a lipoid resin complex that can cause dermatitis [3, 12, 135]. The symptomatology consists, in general, of gastrointestinal disorders (abdominal pain, nausea, vomiting, and diarrhea). Additionally, the clinical course can bring cardiovascular, neurological, and renal complications [136]. Cases of poisoning in humans usually occur by eating fruit and seeds because of its similarity to edible chestnuts [136].

Some toxicological studies have demonstrated the toxic properties of *J. gossypifolia*, while others show the absence of toxicity. However, it is important to observe the models used, doses administered, and types of extract employed (solvent and plant part), among other aspects, to make the proper conclusions about the toxicity.

The study of experimental poisoning in sheep showed that the intake of fresh plant leaves in a single dose of 40 g/kg was lethal to these animals [137]. The clinical and pathological picture in the experimental sheep was characterized by digestive, lung, and heart disturbances and also by slight regressive changes evidenced in hepatic and renal histological examinations [137]. However, as observed by Mariz et al. [7], it is important to note that the medicinal use of the plant is rarely *in natura*, but instead by different preparations, such as infusions or decoctions, sometimes of the dried material, which could inactivate the possible toxic components. However, this is only a hypothesis, and so the toxicity of extracts from leaves cannot be discarded.

One of the first studies relating the identification of the constituents responsible for the toxic effects of the *Jatropha* species was published by Adolf et al. [69]. In this work,

by a bioguided isolation, the irritant polyunsaturated ester 12-deoxy-16-hydroxylphorbol was isolated from the ether extract from the seeds of *J. gossypifolia* by countercurrent chromatography [69]. The irritant activity was visualized in mouse ear after 24 h of the application of the fractions and isolated compounds [69].

The *in vitro* cytotoxicity assay using brine shrimp larvae test revealed that ethanol and methanol extracts (plant organ unspecified) showed low toxicity [138]. An earlier study showed that the water and ethyl acetate fraction of a methanol extract from aerial parts of *J. gossypifolia* did not present toxicity against the same organisms [114].

A study performed in Wistar rats evaluated the toxicity of the ethanolic root extract of *J. gossypifolia* at 10, 20, and 30 mg/kg by oral route [139]. The authors observed that the extract was toxic to the kidney and caused increased urea retention in the blood, as observed by histological studies and biochemical analysis of blood [139].

A preclinical toxicological assessment of the crude ethanol extract from *J. gossypifolia* leaves showed that the extract presents relatively low oral acute toxicity in Wistar rats [18, 19]. Rats treated with single doses of 1.2–5.0 g/kg by oral route were observed for 14 days, and the most important signs of toxicity were ptosis, reduction of body weight, and hind limb paralysis. Other significant alterations occurred only in males treated with 5.0 g/kg dose: increase in creatinine, aspartate aminotransferase, sodium and potassium serum levels, reduction of urea and albumin, leucopenia and small alteration in color, and consistency of viscera. The median lethal dose (LD₅₀) was higher than 4.0 g/kg for males and higher than 5.0 g/kg for females [19]. In the histopathological evaluation some alteration was observed in liver and lung only at 5.0 g/kg, suggesting the relatively low toxicity of the extract [18]. However, in the chronic toxicological study (thirteen weeks of treatment), this extract showed significant oral chronic toxicity in rats [17]. The most significant toxic signs indicated a reduction of the activity in the central nervous system and digestive disturbances. The histopathological analysis revealed hepatotoxicity and pulmonary damages. The lethality was 46.6% and 13.3% among males and females under the higher tested dose (405 mg/kg), respectively [17]. Based on this, Mariz et al. [7] discussed that the development of herbal medicine based on this species needs to prioritize the chemical refinement of the crude extracts to obtain less toxic fractions, which should be tested for their safety and therapeutic efficacy.

Another study, on the other hand, evaluating the oral acute toxicity of the aqueous and ethanol extracts from leaves of *J. gossypifolia*, did not show any sign of toxicity in up to 2 g/kg in rats, enabling the authors to conclude that this extract could be considered safe [118]. This is an interesting result since in most cases the plant is used popularly as tea (aqueous extract).

The toxicity of the stem latex of *J. gossypifolia* was studied in Wistar rats by applying different doses of crude latex on incised skin daily for 18 days, based on the popular use of the latex as hemostatic agent in skin lesions [140]. The authors observed that the application of the latex did not produce any significant difference in results of biochemical

and hematological parameters obtained from the control and experimental animals, leading to the conclusion that the stem latex has no harmful effects [140].

9. Conclusions

As demonstrated by this review, *J. gossypifolia* presents an important potential for the generation of pharmacological and/or biotechnological products, based on popular uses and biological studies scientifically showing its properties. However, regarding specifically its medicinal properties, further studies are still necessary to assay important folk uses of the species and characterize the major compounds responsible for the bioactivity. Thus, studies of bioprospecting could prioritize this species, since many popular uses for various medical purposes are reported, demonstrating a great potential to originate bioactive molecules with pharmacological relevance. Furthermore, future phytochemical studies of this plant are important to obtain the best knowledge of the chemical composition of different extracts of the plant, in order to recognize the really important compounds in the pharmacological actions, aspiring to the chemical refinement of the products to eliminate the eventual toxic effects that could reduce the medicinal value of the species. In conclusion, the data presented in this review could provide insights for future research aimed at both ethnopharmacological validation of the popular use of *J. gossypifolia* and its exploration as a new source of bioactive molecules for herbal drugs and/or bioactive natural products for potential application in complementary and alternative medicine.

Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

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References

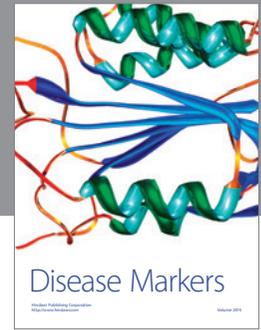
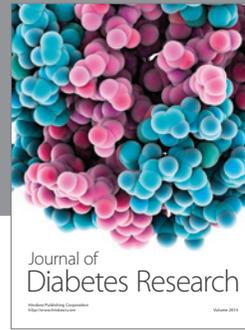
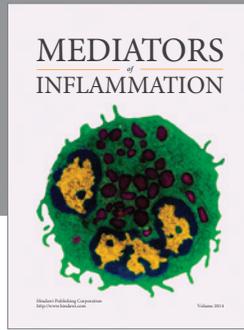
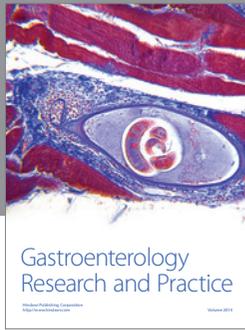
- [1] G. L. Webster, "Classification of the euphorbiaceae," *Annals of the Missouri Botanical Garden*, vol. 81, pp. 3–143, 1994.
- [2] M. V. Alves, "Checklist das espécies de Euphorbiaceae Juss. ocorrentes no semi-árido pernambucano, Brasil," *Acta Botânica Brasileira*, vol. 12, no. 3, pp. 485–495, 1998.
- [3] C. W. Sabandar, N. Ahmat, F. M. Jaafar, and I. Sahidin, "Medicinal property, phytochemistry and pharmacology of several *Jatropha* species (Euphorbiaceae): a review," *Phytochemistry*, vol. 85, pp. 7–29, 2013.
- [4] C. K. A. Leal and M. D. F. Agra, "Estudo farmacobotânico comparativo das folhas de *Jatropha molissima* (Pohl) Baill," *Acta Farmaceutica Bonaerense*, vol. 24, no. 1, pp. 5–13, 2005.
- [5] L. C. Di Stasi and C. A. Hiruma-Lima, *Plantas medicinais na Amazônia e na Mata Atlântica*, UNESP, São Paulo, Brazil, 2nd edition, 2002.
- [6] M. D. F. Agra, K. N. Silva, I. J. L. D. Basílio, P. F. De Freitas, and J. M. Barbosa-Filho, "Survey of medicinal plants used in the region Northeast of Brazil," *Brazilian Journal of Pharmacognosy*, vol. 18, no. 3, pp. 472–508, 2008.
- [7] S. R. Mariz, A. C. R. Borges, M. F. F. Melo-Diniz, and I. A. Medeiros, "Possibilidades terapêuticas e riscos toxicológicos de *Jatropha gossypifolia* L.: uma revisão narrativa," *Revista Brasileira De Plantas Medicinai*s, vol. 12, no. 3, pp. 346–357, 2010.
- [8] I. Cordeiro and R. Secco, "*Jatropha gossypifolia* L. Lista de espécies da flora do Brasil," *Jardim Botânico do Rio de Janeiro*, <http://floradobrasil.jbrj.gov.br/jabot/floradobrasil/FB17581>.
- [9] U. P. de Albuquerque, P. M. de Medeiros, A. L. S. de Almeida et al., "Medicinal plants of the caatinga (semi-arid) vegetation of NE Brazil: a quantitative approach," *Journal of Ethnopharmacology*, vol. 114, no. 3, pp. 325–354, 2007.
- [10] U. P. Albuquerque, L. H. C. Andrade, and J. Caballero, "Structure and floristics of homegardens in Northeastern Brazil," *Journal of Arid Environments*, vol. 62, no. 3, pp. 491–506, 2005.
- [11] S. A. Ceasar and S. Ignacimuthu, "Applications of biotechnology and biochemical engineering for the improvement of *Jatropha* and Biodiesel: a review," *Renewable and Sustainable Energy Reviews*, vol. 15, no. 9, pp. 5176–5185, 2011.
- [12] U. P. de Albuquerque, J. M. Monteiro, M. A. Ramos, and E. L. C. de Amorim, "Medicinal and magic plants from a public market in northeastern Brazil," *Journal of Ethnopharmacology*, vol. 110, no. 1, pp. 76–91, 2007.
- [13] A. Falodun, Q. Sheng-Xiang, G. Parkinson, and S. Gibbons, "Isolation and characterization of a new anticancer diterpenoid from *Jatropha gossypifolia*," *Pharmaceutical Chemistry Journal*, vol. 45, no. 10, pp. 636–639, 2012.
- [14] BRASIL, "Fitoterapia: plantas de interesse ao SUS," *Brazilian Health Ministry*, <http://portal.saude.gov.br/portal/arquivos/pdf/RENISUS.pdf>.
- [15] X.-P. Zhang, M.-L. Zhang, X.-H. Su, C.-H. Huo, Y.-C. Gu, and Q.-W. Shi, "Chemical constituents of the plants from genus *Jatropha*," *Chemistry and Biodiversity*, vol. 6, no. 12, pp. 2166–2183, 2009.
- [16] S. K. Sharma and H. Singh, "A review on pharmacological significance of genus *Jatropha* (Euphorbiaceae)," *Chinese Journal of Integrative Medicine*, vol. 18, no. 11, pp. 868–880, 2012.
- [17] S. R. Mariz, G. S. Cerqueira, W. C. Araújo et al., "Chronic toxicologic study of the ethanolic extract of the aerial parts of *Jatropha gossypifolia* in rats," *Revista Brasileira de Farmacognosia*, vol. 22, no. 3, pp. 663–668, 2012.
- [18] S. R. Mariz, M. S. T. Araujo, G. S. Cerqueira et al., "Histopathological evaluation in rats after acute treatment with the ethanolic extract from aerial parts of *Jatropha gossypifolia* L.," *Revista Brasileira De Farmacognosia*, vol. 18, no. 2, pp. 213–216, 2008.
- [19] S. R. Mariz, G. S. Cerqueira, W. C. Araújo et al., "Estudo toxicológico agudo do extrato etanólico de partes aéreas de *Jatropha gossypifolia* L. em ratos," *Revista Brasileira de Farmacognosia*, vol. 16, no. 3, pp. 372–378, 2006.
- [20] C. Auvin-Guette, C. Baraguey, A. Blond, J. L. Pousset, and B. Bodo, "Cyclogossine B, a cyclic octapeptide from *Jatropha gossypifolia*," *Journal of Natural Products*, vol. 60, pp. 1155–1157, 1997.

- [21] V. S. Parvathi, B. S. Jyothi, T. Lakshmi, P. S. Babu, and R. Karthikeyan, "Morpho-anatomical and physicochemical studies of *Jatropha gossypifolia* (L.)," *Der Pharmacia Lettre*, vol. 4, no. 1, pp. 256–262, 2012.
- [22] M. N. S. Rios and F. Pastore Junior, *Plantas da Amazônia: 450 Espécies de Uso Geral*, Universidade de Brasília—Biblioteca Central, Brasília, 2011.
- [23] S. R. Mariz, *Estudo toxicológico pré-clínico de Jatropha gossypifolia L. [Ph.D. thesis]*, Universidade Federal da Paraíba, João Pessoa, Brazil, 2007.
- [24] O. G. Adeosun, T. Oduola, F. A. Fagbomedo et al., "Suitability of stem latex of *Jatropha gossypifolia* as a protein precipitant for biochemical analysis," *Indian Journal of Clinical Biochemistry*, vol. 29, no. 2, pp. 210–212, 2014.
- [25] F. O. A. Ajose, "Some Nigerian plants of dermatologic importance," *International Journal of Dermatology*, vol. 46, no. 1, pp. 48–55, 2007.
- [26] J. S. Ashidi, P. J. Houghton, P. J. Hylands, and T. Efferth, "Ethnobotanical survey and cytotoxicity testing of plants of South-western Nigeria used to treat cancer, with isolation of cytotoxic constituents from *Cajanus cajan* Millsp. leaves," *Journal of Ethnopharmacology*, vol. 128, no. 2, pp. 501–512, 2010.
- [27] M. Ayyanar and S. Ignacimuthu, "Ethnobotanical survey of medicinal plants commonly used by Kani tribals in Tirunelveli hills of Western Ghats, India," *Journal of Ethnopharmacology*, vol. 134, no. 3, pp. 851–864, 2011.
- [28] R. Bhagat, S. D. Ambavade, A. V. Misar, and D. K. Kulkarni, "Anti-inflammatory activity of *Jatropha gossypifolia* L. leaves in albino mice and Wistar rat," *Journal of Scientific and Industrial Research*, vol. 70, no. 4, pp. 289–292, 2011.
- [29] J. H. Cano and G. Volpato, "Herbal mixtures in the traditional medicine of Eastern Cuba," *Journal of Ethnopharmacology*, vol. 90, no. 2-3, pp. 293–316, 2004.
- [30] F. G. Coe and G. J. Anderson, "Screening of medicinal plants used by the Garifuna of Eastern Nicaragua for bioactive compounds," *Journal of Ethnopharmacology*, vol. 53, no. 1, pp. 29–50, 1996.
- [31] M. Gbeassor, Y. Kossou, K. Amegbo, C. De Souza, K. Koumaglo, and A. Denke, "Antimalarial effects of eight African medicinal plants," *Journal of Ethnopharmacology*, vol. 25, no. 1, pp. 115–118, 1989.
- [32] National Center for Biotechnology Information, "*Jatropha gossypifolia*," *Taxonomy Browser*, <http://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id=454931>.
- [33] Tropicos, "*Jatropha gossypifolia* L.," <http://www.tropicos.org/NamePrint.aspx?nameid=12802174&tab=details>.
- [34] The Plant List, "*Jatropha gossypifolia* L.," <http://www.theplantlist.org/tpl/record/kew-104621>.
- [35] M. S. Khyade and N. P. Vaikos, "Pharmacognostical and phytochemical evaluation of leaf of *Jatropha gossypifolia* L.," *International Journal of Research in Ayurveda & Pharmacy*, vol. 2, no. 1, pp. 177–180, 2011.
- [36] D. O. Aworinde, D. U. Nwoye, A. A. Jayeola, A. O. Olagoke, and A. A. Ogundele, "Taxonomic significance of foliar epidermis in some members of euphorbiaceae family in Nigeria," *Research Journal of Botany*, vol. 4, no. 1, pp. 17–28, 2009.
- [37] J. D. Olowokudejo, "Comparative epidermal morphology of West African species of *Jatropha* L. (Euphorbiaceae)," *Botanical Journal of the Linnean Society*, vol. 111, no. 2, pp. 139–154, 1993.
- [38] B. Das and B. Venkataiah, "A minor coumarino-lignoid from *Jatropha gossypifolia*," *Biochemical Systematics and Ecology*, vol. 29, no. 2, pp. 213–214, 2001.
- [39] B. Das, B. Venkataiah, and A. Kashinatham, "Venkatasin, a new coumarino-lignoid from *Jatropha gossypifolia*," *Natural Product Letters*, vol. 13, no. 4, pp. 293–297, 1999.
- [40] B. Das and B. Venkataiah, "A rare diterpene from *Jatropha gossypifolia*," *Biochemical Systematics and Ecology*, vol. 27, no. 7, pp. 759–760, 1999.
- [41] N. Ravindranath, B. Venkataiah, C. Ramesh, P. Jayaprakash, and B. Das, "Jatrophene, a novel macrocyclic bioactive diterpene from *Jatropha gossypifolia*," *Chemical and Pharmaceutical Bulletin*, vol. 51, no. 7, pp. 870–871, 2003.
- [42] B. Das and J. Banerji, "Arylnaphthalene lignan from *Jatropha gossypifolia*," *Phytochemistry*, vol. 27, no. 11, pp. 3684–3686, 1988.
- [43] J. Banerji, B. Das, A. Chatterjee, and J. N. Shoolery, "Gadain, a lignan from *Jatropha gossypifolia*," *Phytochemistry*, vol. 23, no. 10, pp. 2323–2327, 1984.
- [44] A. Chatterjee, B. Das, C. Pascard, and T. Prange, "Crystal structure of a lignan from *Jatropha gossypifolia*," *Phytochemistry*, vol. 20, no. 8, pp. 2047–2048, 1981.
- [45] I. C. Abreu, A. S. S. Marinho, A. M. A. Paes et al., "Hypotensive and vasorelaxant effects of ethanolic extract from *Jatropha gossypifolia* L. in rats," *Fitoterapia*, vol. 74, no. 7-8, pp. 650–657, 2003.
- [46] B. Das and R. Das, "Gossypifan, a lignan from *Jatropha gossypifolia*," *Phytochemistry*, vol. 40, no. 3, pp. 931–932, 1995.
- [47] R. Das, B. Das, and A. Kashinatham, "Gossypiline, a new lignan from *Jatropha gossypifolia*," *Natural Product Sciences*, vol. 4, no. 4, pp. 238–240, 1998.
- [48] D. Shahwar, S.-U. Shafiq, N. Ahmad, S. Ullah, and M. A. Raza, "Antioxidant activities of the selected plants from the family Euphorbiaceae, Lauraceae, Malvaceae and Balsaminaceae," *African Journal of Biotechnology*, vol. 9, no. 7, pp. 1086–1096, 2010.
- [49] V. Bullangpoti, N. Khumrungsee, W. Pluempanupat, Y. Kainoh, and U. Saganpong, "Toxicity of ethyl acetate extract and ricinine from *Jatropha gossypifolia* senescent leaves against *Spodoptera exigua* Hubner (Lepidoptera: Noctuidae)," *Journal of Pesticide Science*, vol. 36, no. 2, pp. 260–263, 2011.
- [50] A. O. Ogundare, "Antimicrobial effect of *Tithonia diversifolia* and *Jatropha gossypifolia* leaf extracts," *Trends in Applied Sciences Research*, vol. 2, no. 2, pp. 145–150, 2007.
- [51] N. Nwokocha, A. Blessing, I. O. Agbagwa, and B. E. Okoli, "Comparative phytochemical screening of *Jatropha* L. Species in the Niger Delta," *Research Journal of Phytochemistry*, vol. 5, no. 2, pp. 107–114, 2011.
- [52] R. Seth and R. Sarin, "Analysis of the phytochemical content and anti-microbial activity of *Jatropha gossypifolia* L.," *Archives of Applied Science Research*, vol. 2, no. 5, pp. 285–291, 2010.
- [53] S. Sankara Subramanian, S. Nagarajan, and N. Sulochana, "Flavonoids of the leaves of *Jatropha gossypifolia*," *Phytochemistry*, vol. 10, no. 7, p. 1690, 1971.
- [54] A. C. Pilon, R. L. Carneiro, F. Carnevale Neto, V. S. Bolzani, and I. Castro-Gamboa, "Interval multivariate curve resolution in the dereplication of HPLC-DAD data from *Jatropha gossypifolia*," *Phytochemical Analysis*, vol. 24, no. 4, pp. 401–406, 2013.
- [55] A. R. Kharat, A. K. Dolui, and S. Das, "Free radical scavenging potential of *Jatropha gossypifolia*," *Asian Journal of Chemistry*, vol. 23, no. 2, pp. 799–801, 2011.
- [56] P.-A. Calatayud, D. F. Munera, S. Calatayud, A. Valencia-Jimenez, and A. C. Bellotti, "*Jatropha gossypifolia* (Euphorbiaceae), a source of proteins toxic to *Phenacoccus herreni* (Sternorrhyncha: Pseudococcidae)," *Florida Entomologist*, vol. 94, no. 3, pp. 649–654, 2011.

- [57] W. F. Tinto, L. M. D. John, W. F. Reynolds, and S. McLean, "Triterpenoids of *Jatropha gossypifolia*," *Journal of Natural Products*, vol. 55, no. 6, pp. 807–809, 1992.
- [58] R. Das, K. Venkateswarlu, V. Saidi Reddy, and B. Das, "4'-O-demethyl retrochinensin a minor new lignan from *Jatropha gossypifolia*," *Indian Journal of Heterocyclic Chemistry*, vol. 14, no. 2, pp. 169–170, 2004.
- [59] B. Das, A. Kashinatham, B. Venkataiah, K. V. N. S. Srinivas, G. Mahender, and M. R. Reddy, "Cleomiscosin A, a coumarinolignoid from *Jatropha gossypifolia*," *Biochemical Systematics and Ecology*, vol. 31, no. 10, pp. 1189–1191, 2003.
- [60] B. Das and G. Anjani, "Gossypidien, a lignan from stems of *Jatropha gossypifolia*," *Phytochemistry*, vol. 51, no. 1, pp. 115–117, 1999.
- [61] B. Das, S. P. Rao, and K. V. Srinivas, "Isolation of isogadain from *Jatropha gossypifolia*," *Planta Medica*, vol. 62, no. 1, article 90, 1996.
- [62] B. Das, S. P. Rao, K. V. N. S. Srinivas, and R. Das, "Jatrodien, a lignan from stems of *Jatropha gossypifolia*," *Phytochemistry*, vol. 41, no. 3, pp. 985–987, 1996.
- [63] A. Chatterjee, B. Das, R. Chakrabarti et al., "Prasanthaline: a new lignan from *Jatropha gossypifolia* Linn.," *Indian Journal of Chemistry*, vol. 27, pp. 740–741, 1988.
- [64] M. D. Taylor, A. B. Smith III, G. T. Furst et al., "New antileukemic jatrophone derivatives from *Jatropha gossypifolia* structural and stereochemical assignment through nuclear magnetic resonance Spectroscopy," *Journal of the American Chemical Society*, vol. 105, no. 10, pp. 3177–3183, 1983.
- [65] K. K. Purushothaman, S. Chandrasekharan, A. F. Cameron et al., "Jatropholones A and B, new diterpenoids from the roots of *Jatropha gossypifolia* (Euphorbiaceae)—crystal structure analysis of Jatropholone B," *Tetrahedron Letters*, vol. 20, no. 11, pp. 979–980, 1979.
- [66] S. M. Kupchan, C. W. Sigel, M. J. Matz, J. A. S. Renault, R. C. Haltiwanger, and R. F. Bryan, "Jatrophone, a novel macrocyclic diterpenoid tumor inhibitor from *Jatropha gossypifolia*," *Journal of the American Chemical Society*, vol. 92, no. 14, pp. 4476–4477, 1970.
- [67] Y. R. Prasad, G. S. J. G. Alankararao, and P. Baby, "Constituents of the seeds of *Jatropha gossypifolia*," *Fitoterapia*, vol. 64, no. 4, p. 376, 1993.
- [68] O. Ogbobe and V. Akano, "The physico-chemical properties of the seed and seed oil of *Jatropha gossypifolia*," *Plant Foods for Human Nutrition*, vol. 43, no. 3, pp. 197–200, 1993.
- [69] W. Adolf, H. J. Opferkuch, and E. Hecker, "Irritant phorbol derivatives from four *Jatropha* species," *Phytochemistry*, vol. 23, no. 1, pp. 129–132, 1984.
- [70] K. M. Hosamani and K. S. Katagi, "Characterization and structure elucidation of 12-hydroxyoctadec-cis-9-enoic acid in *Jatropha gossypifolia* and *Hevea brasiliensis* seed oils: a rich source of hydroxy fatty acid," *Chemistry and Physics of Lipids*, vol. 152, no. 1, pp. 9–12, 2008.
- [71] S. F. A. J. Horsten, A. J. J. Van Den Berg, J. J. Kettenes-Van Den Bosch, B. R. Leeflang, and R. P. Labadie, "Cyclogossine A: a novel cyclic heptapeptide isolated from the latex of *Jatropha gossypifolia*," *Planta Medica*, vol. 62, no. 1, pp. 46–50, 1996.
- [72] M. U. Ahmad, M. R. Islam, A. H. Mirza, B. H. Chowdhury, and N. Nahar, "Alkaloids of *Jatropha gossypifolia* Linn.," *Indian Journal of Chemistry B: Organic Chemistry Including Medicinal Chemistry*, vol. 31, no. 1, pp. 67–69, 1992.
- [73] A. Falodun, U. Kragl, S.-M. T. Touem, A. Villinger, T. Fahrenwaldt, and P. Langer, "A novel anticancer diterpenoid from *Jatropha gossypifolia*," *Natural Product Communications*, vol. 7, no. 2, pp. 151–152, 2012.
- [74] G. D. Wadankar, S. N. Malode, and S. L. Sarambekar, "Traditionally used medicinal plants for wound healing in the Washim district, Maharashtra (India)," *International Journal of PharmTech Research*, vol. 3, no. 4, pp. 2080–2084, 2011.
- [75] B. Kumar, M. Vijayakumar, R. Govindarajan, and P. Pushpanagan, "Ethnopharmacological approaches to wound healing—Exploring medicinal plants of India," *Journal of Ethnopharmacology*, vol. 114, no. 2, pp. 103–113, 2007.
- [76] K. Koudouvo, D. S. Karou, K. Kokou et al., "An ethnobotanical study of antimalarial plants in Togo Maritime Region," *Journal of Ethnopharmacology*, vol. 134, no. 1, pp. 183–190, 2011.
- [77] M. Coelho-Ferreira, "Medicinal knowledge and plant utilization in an Amazonian coastal community of Marudá, Pará State (Brazil)," *Journal of Ethnopharmacology*, vol. 126, no. 1, pp. 159–175, 2009.
- [78] F. C. S. Oliveira, R. F. M. Barros, and J. M. Moita Neto, "Plantas medicinais utilizadas em comunidades rurais de Oeiras, semiárido piauiense," *Revista Brasileira de Plantas Medicinais*, vol. 12, no. 3, pp. 282–301, 2010.
- [79] J. D. F. L. Santos, E. Pagani, J. Ramos, and E. Rodrigues, "Observations on the therapeutic practices of riverine communities of the Unini River, AM, Brazil," *Journal of Ethnopharmacology*, vol. 142, no. 2, pp. 503–515, 2012.
- [80] S. L. Cartaxo, M. M. de Almeida Souza, and U. P. de Albuquerque, "Medicinal plants with bioprospecting potential used in semi-arid northeastern Brazil," *Journal of Ethnopharmacology*, vol. 131, no. 2, pp. 326–342, 2010.
- [81] O. Jansen, L. Angenot, M. Tits et al., "Evaluation of 13 selected medicinal plants from Burkina Faso for their antiplasmodial properties," *Journal of Ethnopharmacology*, vol. 130, no. 1, pp. 143–150, 2010.
- [82] M. H. Yetein, L. G. Houessou, T. O. Lougbégnon, O. Teka, and B. Tente, "Ethnobotanical study of medicinal plants used for the treatment of malaria in plateau of Allada, Benin (West Africa)," *Journal of Ethnopharmacology*, vol. 146, no. 1, pp. 154–163, 2013.
- [83] L. J. Quintans Junior, J. R. G. S. Almeida, J. T. Lima et al., "Plants with anticonvulsant properties—a review," *Revista Brasileira de Farmacognosia*, vol. 18, pp. 798–819, 2008.
- [84] A. Diallo, M. S. Traore, S. M. Keita et al., "Management of diabetes in Guinean traditional medicine: an ethnobotanical investigation in the coastal lowlands," *Journal of Ethnopharmacology*, vol. 144, no. 2, pp. 353–361, 2012.
- [85] S. O. Olabanji, A. C. Adebajo, O. R. Omobuwajo et al., "PIXE analysis of some Nigerian anti-diabetic medicinal plants (II)," *Nuclear Instruments and Methods in Physics Research B: Beam Interactions With Materials and Atoms*, vol. 318, pp. 187–190, 2014.
- [86] T. Oduola, O. G. Avwioro, and T. B. Ayanniyi, "Suitability of the leaf extract of *Jatropha gossypifolia* as an anticoagulant for biochemical and haematological analyses," *African Journal of Biotechnology*, vol. 4, no. 7, pp. 679–681, 2005.
- [87] C. M. Chariandy, C. E. Seaforth, R. H. Phelps, G. V. Pollard, and B. P. S. Khambay, "Screening of medicinal plants from Trinidad and Tobago for antimicrobial and insecticidal properties," *Journal of Ethnopharmacology*, vol. 64, no. 3, pp. 265–270, 1999.
- [88] V. P. Kumar, N. S. Chauhan, H. Padh, and M. Rajani, "Search for antibacterial and antifungal agents from selected Indian

- medicinal plants," *Journal of Ethnopharmacology*, vol. 107, no. 2, pp. 182–188, 2006.
- [89] R. Dabur, A. Gupta, T. K. Mandal et al., "Antimicrobial activity of some medicinal plants," *African Journal of Traditional, Complementary and Alternative Medicines*, vol. 4, no. 3, pp. 313–318, 2007.
- [90] H. C. Ong and M. Nordiana, "Malay ethno-medico botany in Machang, Kelantan, Malaysia," *Fitoterapia*, vol. 70, no. 5, pp. 502–513, 1999.
- [91] J. Sanz-Biset, J. Campos-de-la-Cruz, M. A. Epiqui n-Rivera, and S. Ca nigueral, "A first survey on the medicinal plants of the Chazuta valley (Peruvian Amazon)," *Journal of Ethnopharmacology*, vol. 122, no. 2, pp. 333–362, 2009.
- [92] B. B. Panda, K. Gaur, M. L. Kori et al., "Anti-inflammatory and analgesic activity of *Jatropha gossypifolia* in experimental animal models," *Global Journal of Pharmacology*, vol. 3, no. 1, 2009.
- [93] S. S. Ningthoujam, A. D. Talukdar, K. S. Potsangbam, and M. D. Choudhury, "Traditional uses of herbal vapour therapy in Manipur, North East India: an ethnobotanical survey," *Journal of Ethnopharmacology*, vol. 147, no. 1, pp. 136–147, 2013.
- [94] A. Asase, A. A. Oteng-Yeboah, G. T. Odamttten, and M. S. J. Simmonds, "Ethnobotanical study of some Ghanaian anti-malarial plants," *Journal of Ethnopharmacology*, vol. 99, no. 2, pp. 273–279, 2005.
- [95] C. Lans, T. Harper, K. Georges, and E. Bridgewater, "Medicinal and ethnoveterinary remedies of hunters in Trinidad," *BMC Complementary and Alternative Medicine*, vol. 1, article 10, 2001.
- [96] L. Rasingam, S. Jeeva, and D. Kannan, "Dental care of Andaman and Nicobar folks: medicinal plants use as tooth stick," *Asian Pacific Journal of Tropical Biomedicine*, vol. 2, no. 2, pp. S1013–S1016, 2012.
- [97] P. J. Houghton and I. M. Osibogun, "Flowering plants used against snakebite," *Journal of Ethnopharmacology*, vol. 39, no. 1, pp. 1–29, 1993.
- [98] M. Molander, C. H. Saslis-Lagoudakis, A. K. J ger, and N. R nsted, "Cross-cultural comparison of medicinal floras used against snakebites," *Journal of Ethnopharmacology*, vol. 139, no. 3, pp. 863–872, 2012.
- [99] A. Jain, S. S. Katewa, B. L. Chaudhary, and P. Galav, "Folk herbal medicines used in birth control and sexual diseases by tribals of southern Rajasthan, India," *Journal of Ethnopharmacology*, vol. 90, no. 1, pp. 171–177, 2004.
- [100] A. Jain, S. S. Katewa, P. K. Galav, and P. Sharma, "Medicinal plant diversity of Sitamata wildlife sanctuary, Rajasthan, India," *Journal of Ethnopharmacology*, vol. 102, no. 2, pp. 143–157, 2005.
- [101] T. Oduola, G. O. Adeosun, T. A. Oduola, G. O. Avwioro, and M. A. Oyeniyi, "Mechanism of action of *Jatropha gossypifolia* stem latex as a haemostatic agent," *European Journal of General Medicine*, vol. 2, no. 4, pp. 140–143, 2005.
- [102] D. Garcia, M. V. Domingues, and E. Rodrigues, "Ethnopharmacological survey among migrants living in the Southeast Atlantic Forest of Diadema, S o Paulo, Brazil," *Journal of Ethnobiology and Ethnomedicine*, vol. 6, article 29, 2010.
- [103] S. S. Hebbar, V. H. Harsha, V. Shripathi, and G. R. Hegde, "Ethnomedicine of Dharwad district in Karnataka, India—plants used in oral health care," *Journal of Ethnopharmacology*, vol. 94, no. 2–3, pp. 261–266, 2004.
- [104] S. B. Kosalge and R. A. Fursule, "Investigation of ethnomedicinal claims of some plants used by tribals of Satpuda Hills in India," *Journal of Ethnopharmacology*, vol. 121, no. 3, pp. 456–461, 2009.
- [105] R. A. Ritter, M. V. B. Monteiro, F. O. B. Monteiro et al., "Ethnoveterinary knowledge and practices at Colares island, Par  state, eastern Amazon, Brazil," *Journal of Ethnopharmacology*, vol. 144, no. 2, pp. 346–352, 2012.
- [106] S. K. Dash and S. Padhy, "Review on ethnomedicines for diarrhoea diseases from Orissa: prevalence versus culture," *Journal of Human Ecology*, vol. 20, no. 1, pp. 59–64, 2006.
- [107] R. S. L. Taylor, J. B. Hudson, N. P. Manandhar, and G. H. N. Towers, "Antiviral activities of medicinal plants of southern Nepal," *Journal of Ethnopharmacology*, vol. 53, pp. 97–104, 1996.
- [108] J. M. A. Maia, N. G. Czczeczko, J. M. R. Filho et al., "Estudo da cicatriza o de suturas na bexiga urin ria de ratos com e sem utiliza o de extrato bruto de *Jatropha gossypifolia* L. intraperitoneal," *Acta Cir rgica Brasileira*, vol. 21, no. 2, pp. 23–30, 2006.
- [109] A. L. Ososki, P. Lohr, M. Reiff et al., "Ethnobotanical literature survey of medicinal plants in the Dominican Republic used for women's health conditions," *Journal of Ethnopharmacology*, vol. 79, no. 3, pp. 285–298, 2002.
- [110] A. S. Apu, F. Hossain, F. Rizwan et al., "Study of pharmacological activities of methanol extract of *Jatropha gossypifolia* fruits," *Journal of Basic and Clinical Pharmacy*, vol. 4, no. 1, pp. 20–24, 2013.
- [111] A. S. Apu, K. Ireen, S. Hossan Bhuyan et al., "Evaluation of analgesic, neuropharmacological and anti-diarrheal potential of *Jatropha gossypifolia* (Linn.) leaves in mice," *Journal of Medical Sciences*, vol. 12, no. 8, pp. 274–279, 2012.
- [112] F. A. G. Rocha and L. I. S. Dantas, "Atividade antimicrobiana *in vitro* do l tex do aveloz (*Euphorbia tirucalli* L.), pinh o bravo (*Jatropha mollissima* L.) e pinh o roxo (*Jatropha gossypifolia* L.) sobre microrganismos patog nicos," *Holos*, vol. 25, no. 4, 2009.
- [113] O. M. David and J. O. Oluyeye, "In vitro susceptibility of selected pathogenic bacteria to leaf extracts and latex of *Jatropha gossypifolia*(L) and *Jatropha curcas* (L)," *Biosciences Biotechnology Research Asia*, vol. 3, no. 1, pp. 91–94, 2006.
- [114] W. D. MacBae, J. B. Hudson, and G. H. N. Towers, "Studies on the pharmacological activity of amazonian euphorbiaceae," *Journal of Ethnopharmacology*, vol. 22, no. 2, pp. 143–172, 1988.
- [115] M. C. Purohit and R. Purohit, "Evaluation of antimicrobial and anti-inflammatory activities of bark of *Jatropha gossypifolia*," *World Journal of Science and Technology*, vol. 1, no. 10, pp. 1–5, 2011.
- [116] D. Singh and A. Singh, "The toxicity of four native Indian plants: effect on AChE and acid/alkaline phosphatase level in fish *Channa marulius*," *Chemosphere*, vol. 60, no. 1, pp. 135–140, 2005.
- [117] C. M. Feitosa, R. M. Freitas, N. N. N. Luz, M. Z. B. Bezerra, and M. T. S. Trevisan, "Acetylcholinesterase inhibition by some promising Brazilian medicinal plants," *Brazilian Journal of Biology*, vol. 71, no. 3, pp. 783–789, 2011.
- [118] Y. Nagaharika, V. Kalyani, S. Rasheed, and R. Karthikeyan, "Anti-inflammatory activity of leaves of *Jatropha gossypifolia* L. by HRBC membrane stabilization method," *Journal of Acute Disease*, vol. 2, no. 2, pp. 156–158, 2013.
- [119] S. D. N. Silva, I. C. Abreu, S. M. D. F. Freire et al., "Antispasmodic effect of *Jatropha gossypifolia* is mediated through dual blockade of muscarinic receptors and Ca²⁺ channels," *Brazilian Journal of Pharmacognosy*, vol. 21, no. 4, pp. 715–720, 2011.
- [120] D. Carabajal, A. Casaco, L. Arruzazabala, R. Gonzalez, and V. Fuentes, "Pharmacological screening of plant decoctions commonly used in Cuban folk medicine," *Journal of Ethnopharmacology*, vol. 33, no. 1–2, pp. 21–24, 1991.

- [121] S. Jain, G. P. Choudhary, and D. K. Jain, "Pharmacological evaluation of anti-fertility activity of ethanolic extract of *Jatropha gossypifolia* leaf in female albino mice," *Asian Pacific Journal of Tropical Biomedicine*, vol. 2, no. 3, pp. S1671–S1674, 2012.
- [122] S. C. N. Servin, O. J. M. Torres, J. E. F. Matias et al., "Ação do extrato de *Jatropha gossypifolia* L., (pião roxo) na cicatrização de anastomose colônica: estudo experimental em ratos," *Acta Cirúrgica Brasileira*, vol. 21, no. 3, pp. 89–96, 2006.
- [123] J. R. Vale, N. G. Czczeko, J. U. Aquino et al., "Estudo comparativo da cicatrização de gastrorrafias com e sem o uso do extrato de *Jatropha gossypifolia* L., (pião roxo) em ratos," *Acta Cirúrgica Brasileira*, vol. 21, no. 3, pp. 40–48, 2006.
- [124] J. U. Aquino, N. G. Czczeko, O. Malafaia et al., "Avaliação fitoterápica da *Jatropha gossypifolia* L. na cicatrização de suturas na parede abdominal ventral de ratos," *Acta Cirúrgica Brasileira*, vol. 21, no. 2, pp. 61–66, 2006.
- [125] M. F. D. S. Santos, N. G. Czczeko, P. A. N. Nassif et al., "Avaliação do uso do extrato bruto de *Jatropha gossypifolia* L. na cicatrização de feridas cutâneas em ratos," *Acta Cirúrgica Brasileira*, vol. 21, no. 3, pp. 2–7, 2006.
- [126] B. B. Panda, K. Gaur, R. K. Nema, C. S. Sharma, A. K. Jain, and C. P. Jain, "Hepatoprotective activity of *Jatropha gossypifolia* against carbon tetrachloride- induced hepatic injury in rats," *Asian Journal of Pharmaceutical and Clinical Research*, vol. 2, no. 1, pp. 50–54, 2009.
- [127] S. S. Deo, T. M. Chaudhari, and F. Inam, "Evaluation of the immunomodulatory effects of 1-phenyl-naphthalene and pericarbonyl lactone lignan compounds," *Der Pharma Chemica*, vol. 4, no. 2, pp. 771–776, 2012.
- [128] S. K. Rasheed, S. Kunapareddy, and R. Karthikeyan, "Local anesthetic activity of *Jatropha gossypifolia* L. on frogs," *Biomedical and Pharmacology Journal*, vol. 5, no. 2, pp. 395–397, 2012.
- [129] A. M. A. Paes, A. L. Camara, S. M. F. Freire, and M. O. R. Borges, "Relaxant effect of *Jatropha gossypifolia* L. on uterine smooth muscle," *International Journal of Phytomedicine*, vol. 4, no. 3, pp. 310–313, 2012.
- [130] S. J. Jain, G. P. Choudhary, and D. K. Jain, "Pharmacological evaluation and antifertility activity of *Jatropha gossypifolia* in rats," *BioMed Research International*, vol. 2013, Article ID 125980, 5 pages, 2013.
- [131] J. S. de Oliveira, P. M. Leite, L. B. de Souza et al., "Characteristics and composition of *Jatropha gossypifolia* and *Jatropha curcas* L. oils and application for biodiesel production," *Biomass and Bioenergy*, vol. 33, no. 3, pp. 449–453, 2009.
- [132] V. Bullangpoti, E. Wajnberg, P. Audant, and R. Feyereisen, "Antifeedant activity of *Jatropha gossypifolia* and *Melia azedarach* senescent leaf extracts on *Spodoptera frugiperda* (Lepidoptera: Noctuidae) and their potential use as synergists," *Pest Management Science*, vol. 68, no. 9, pp. 1255–1264, 2012.
- [133] S. N. K. Jilani, W. Islam, and M. Kamsh, "Potential of pyrethroid insecticides and plant extracts on fecundity and egg viability of *tribolium castaneum* (Herbst)," *Journal of Bio-Science*, vol. 19, no. 1, pp. 95–97, 2011.
- [134] D. Sukumaran, B. D. Parashar, and K. M. Rao, "Toxicity of *Jatropha gossypifolia* and *Vaccaria pyramidata* against freshwater snails vectors of animal schistosomiasis," *Fitoterapia*, vol. 66, no. 5, pp. 393–398, 1995.
- [135] R. K. Devappa, H. P. S. Makkar, and K. Becker, "*Jatropha* toxicity—a review," *Journal of Toxicology and Environmental Health B: Critical Reviews*, vol. 13, no. 6, pp. 476–507, 2010.
- [136] E. P. Schenkel, M. Zannin, L. A. Mentz, S. A. L. Bordignon, and B. Irgang, "Plantas tóxicas," in *Farmacognosia: Da Planta ao Medicamento*, C. M. O. Simões, E. P. Schenkel, G. Gosmann, J. C. P. Mello, L. A. Mentz, and P. R. Petrovick, Eds., pp. 959–993, Editora da UFRGS/UFSC, Porto Alegre, Brazil, 3d edition, 2007.
- [137] L. I. Oliveira, F. F. Jabour, V. A. Nogueira, and E. M. Yamasaki, "Intoxicação experimental com as folhas de *Jatropha gossypifolia* (Euphorbiaceae) em ovinos," *Pesquisa Veterinária Brasileira*, vol. 28, no. 6, pp. 275–278, 2008.
- [138] P. I. A. Awachie and F. O. Ugwu, "Preliminary investigation of the antimicrobial and brine shrimp lethality properties of some nigerian medicinal plants," *International Journal of Pharmacognosy*, vol. 35, no. 5, pp. 338–343, 1997.
- [139] L. J. Medubi, V. O. Ukwenya, O. T. Aderinto et al., "Effects of administration of ethanolic root extract of *Jatropha gossypifolia* and prednisolone on the kidneys of Wistar rats," *Electronic Journal of Biomedicine*, vol. 2, pp. 41–48, 2010.
- [140] T. Oduola, G. B. Popoola, G. O. Avwioro et al., "Use of *Jatropha gossypifolia* stem latex as a haemostatic agent: how safe is it?" *Journal of Medicinal Plants Research*, vol. 1, no. 1, pp. 14–17, 2007.



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