Antimicrobial activity of *Myracrodruon urundeuva*

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Myracrodruon urundeuva Allemão (Anacardiaceae) is a plant native to Brazil, disseminated naturally by South America. Its popular therapeutic use includes various home preparations and forms of use, to explore, especially its antimicrobial activity, anti-inflammatory and healing. Several studies confirm the pharmacological potentials of this plant, although there are still few studies about its antimicrobial potential, be it antibacterial, antifungal or antiviral. Although scarce, such studies are extremely relevant to encourage the search for chemical compounds isolated from this species, which confer this potential. In view of the need for a document that compiles the information regarding the chemical compounds already isolated from this plant and its antimicrobial potential, it was the focus of this manuscript to remedy this need. Several studies are carried out using extracts and essential oils, produced from the leaves, bark, stem-bark and stem of this plant. These preparations mostly contain compounds of pharmacological interest and considerable antimicrobial activity, while promoting pharmacological interactions with classic antibiotics in a synergistic way. In addition, it is interesting to note the antibiofilm activity against biofilms of several microorganisms, which is an area of great prospects.

Keywords: *Myracrodruon urundeuva*; Chemical composition; Antimicrobial activity; Synergism; Antibiofilm.

1. Introduction

Selection of microbial strains resistant to current antibiotics is considered a worldwide concern, making it necessary to constantly search for new antimicrobial compounds. Medicinal plants are a potential source to minimize this problem.

The use of plants with therapeutic purpose, known as phytotherapy, is a rich folk tradition preserved by people from different countries, practiced in the treatment of several pathologies, such as infections [1]. Popular knowledge about the beneficial effects of natural products use serves as the initial basis for studies that seek to prove their pharmacological actions [2].

Among the several plants of popular use, *Myracrodruon urundeuva* Fr. All., popularly known as aroeira-do-sertão, belonging to the Anacardiaceae family, stands out for its wide popular use as anti-inflammatory, healing, antiallergic and for the treatment of skin and mucosal infections [3, 4].

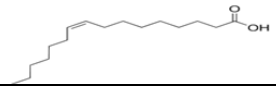
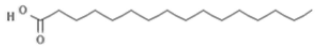
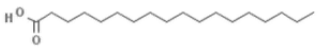
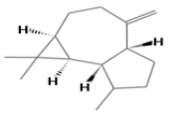
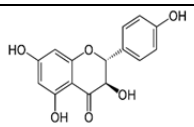
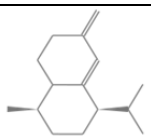
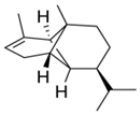
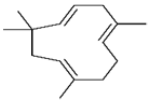
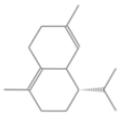
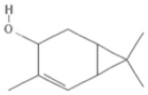
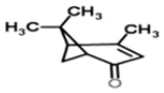
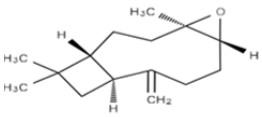
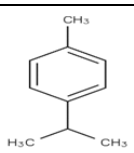
M. urundeuva is a typical tree of semi-arid vegetation and can be found in the sub-humid and dry forests or, more commonly, on the hillside, in tropical or subtropical climates [5,6]. Its natural distribution is limited to South America, mainly in Bolivia, Paraguay, Argentina and Brazil, being found in the Caatinga, Cerrado and sub-humid forests [7, 8]. In Brazil, country of origin of the plant, due to its exploitation, *M. urundeuva* was included in the official list of endangered species [9].

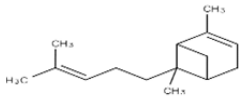
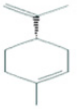
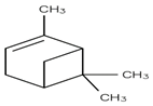
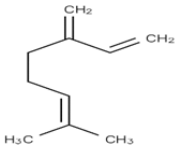
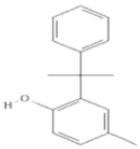
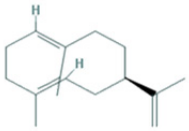
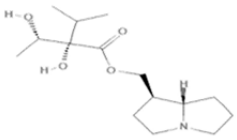
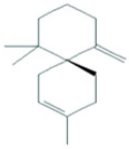
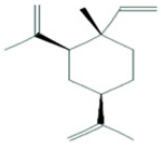
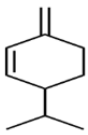
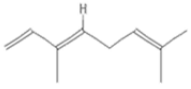
Several pharmacological studies demonstrated the antibacterial potential of the extracts, essential oils and decotos from *M. urundeuva* against several pathogens, as well as pharmacological synergistic interactions. The antimicrobial activity of natural products is mainly related to the production of secondary metabolites [10]. Several classes of metabolites exhibit antimicrobial activity, such as terpenoids, alkaloids, phenolic compounds (quinones, tannins and flavonoids), carotenoids and saponins. These metabolites are often present in complex combinations [11].

2. Chemical constituents

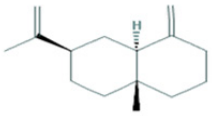
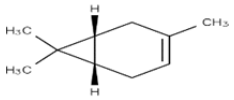
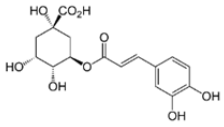
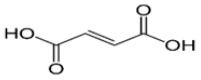
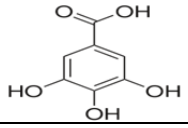
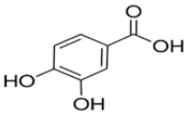
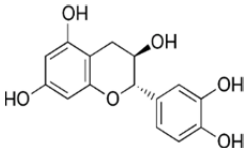
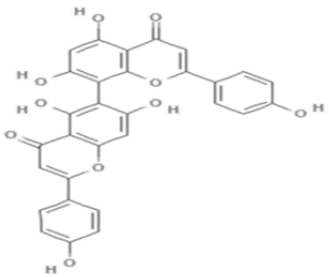
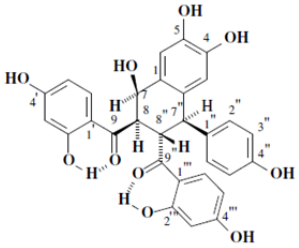
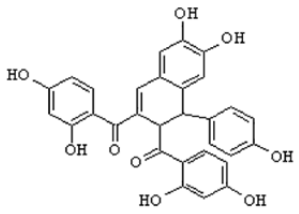
Several studies have been performed in order to elucidate the therapeutic properties of the chemical components and other molecules present in *M. urundeuva*. Chemical compounds isolated from the parts of *M. urundeuva* are described in Table 1. Regarding antimicrobial activity, some compounds already have established effectiveness, such as tannins, terpenes and phenols, besides the dimeric chalcones, called urundeuvins A, B and C, and matosin, substances primarily isolated from *M. urundeuva* [12–16].

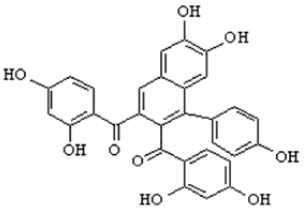
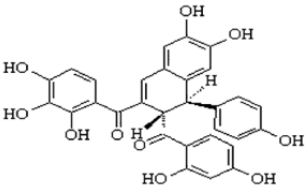
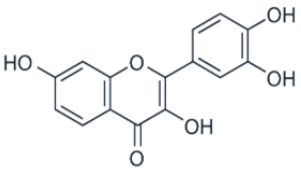
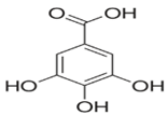
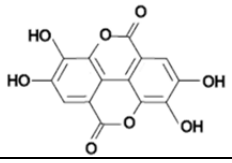
Table 1. Phytoconstituents present in different parts of *M. urundeuva*.

Plant parts	Constituent	Group	Chemical structure	Reference
Leaves	9-Hexadecenoic acid	Acid		[13]
	Hexadecanoic acid	Acid		
	Octadecanoico acid	Acid		
	Allo-aromadendrene	Sesquiterpene		
	Aromadendrin	Flavonoid		
	cis-muurola-4(14),5-diene	Sesquiterpene		
	Copaene	Sesquiterpene		
	α-humulene	Sesquiterpene		
	δ-amorphene	Terpene		
	2-caren-4-ol	Terpene		[17]
	2-Pinen-4-one	Terpene		
	Caryophyllene oxide	Sesquiterpene		
	p- cymene	Terpene		

Terpinolene	Terpene	
α- Bergamotene	Sesquiterpene	
α- Limonene	Terpene	
α-pinene	Terpene	
β- myrcene	Terpene	
ρ-cimen-8-ol	Terpene	
Germacrene A	Sesquiterpene	
Viridiflorene	Sesquiterpene	
β-camigrene	Sesquiterpene	
β-elemene	Sesquiterpene	
β-phellandrene	Terpene	
β-ocimene	Terpene	

[18]

	β-selinene	Sesquiterpene		
	δ-carene	Terpene		
Bark	Chlorogenic acid	Phenol		[19]
	Fumaric acid	Acid		
	Gallic acid	Tannin		
	Protocatechic acid	Phenol		
	Catechin	Phenol		
Stem bark	Agasthiflavone	Flavonoid		[12]
	Matosine	Chalcone		
	Urundeuvine A	Chalcone		[20]

	Urundeuvine B	Chalcone		
	Urundeuvine C	Chalcone		
Stem	Fisetin	Flavonoid		[15]
	Gallic acid	Phenol		
	Ellagic acid	Phenol		

3. Use in folk medicine

The first reports of the use of *M. urundeuva* in folk medicine refer to the handling of the bark, seeking antiseptic and healing effects, usually found in the preparation of infusions for washing fractures, exposed wounds and skin infections [8]. The bark is also used cooked to treat mucosal infections and is commonly applied in the presence of vaginal itching. In addition, bark decoction is used by women after delivery to assist in the healing process [21, 22].

Tea from *M. urundeuva* leaves has been reported for the treatment of headaches, oral infections and gastrointestinal disturbances. Depending on the combination used (tea and licker or tea and infusions), the plant is used for the treatment of fever, influenza, wounds, diarrhea and gastritis, also being indicated for rheumatism [23].

The soap prepared from *M. urundeuva* leaves is used for intimate personal hygiene and acts in the prevention of vaginal infections, also possessing potential healing activity [22].

4. Antimicrobial activity

Over the years, some *in vitro* studies have demonstrated the inhibitory activity of *M. urundeuva* extracts against bacteria and fungi (Table 2). This antimicrobial activity is attributed to the biocomposites present in the plant derivatives, such as a lectin purified extracted from the heartwood, which presents activity against *Staphylococcus aureus*, *Bacillus subtilis*, *Corynebacterium callunae*, *Streptococcus faecalis*, *Escherichia coli*, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa*, *Fusarium decemcellulare*, *Fusarium oxysporum* and *Fusarium fusarioides* [16].

Hydroalcoholic and aqueous extract from *M. urundeuva* leaves also showed antifungal activity against *Colletotrichum gloeosporioides* and *Corynespora cassiicola*, reducing up to 100% the fungal growth [24]. Alves et al. (2009) also observed that the hydroalcoholic extract has antifungal activity against strains of *Candida albicans*, *Candida tropicalis* and *Candida krusei*.

The study of the antiviral activity of *M. urundeuva* is an emerging area. Cecílio et al. (2012) demonstrated the antiviral activity of the extract of *M. urundeuva* leaves, observing that bioactive molecules present in the leaves of the plant are able to inhibit viral replication and, consequently, the cytopathic effect in the cells, presenting low toxicity. In subsequent studies, this antiviral effect was showed to be directly associated with the presence of flavonoids [14].

In addition to acting alone, *M. urundeuva* is capable of acting in association with antimicrobials, such as erythromycin, clindamycin, gentamicin and amikacin, potentializing its action [17, 19].

In addition to the free (planktonic) form, microorganisms can be found associated in biofilms. Biofilms of bacteria and/or fungi present high resistance to antimicrobial drugs and disinfectants, causing infections that persist even with adequate treatment. This is due to several factors present in the biofilm that can increase the resistance of cells to antimicrobials by up to 1000 times [27].

Some studies reported that *M. urundeuva* presents effects against microbial biofilms, such as those formed by *Lactobacillus casei*, *Streptoccoccus sanguis, Streptococcus sobrinus, Streptococcus imitis*, *Streptococcus mutans* [25], *Porphyromonas gingivalis* and *Fusobacterium nucleatum*, *in vitro* [28] and *in vivo* [29].

Table 2. Antimicrobial activity of *M. urundeuva* extracts expressed in inhibition diameter and minimum inhibitory concentration (MIC).

Microorganism	Extract	Disc-diffusion		MIC (mg/mL)	References
		Concentration (mg/mL)	Inhibition (mm)		
Aspergillus niger	Methanolic (bark)	0.1	12	0.78	[19]
Bacillus subtilis	Ethanolic (leaves)	1	-	6.78	[30]
	Methanolic (bark)	2	15	0.78	[19]
Candida albicans	Methanolic (bark)	0.1	13	1.56	[19]
Enterococcus faecalis	Ethanolic (leaves)	0.5	19.45	-	[31]
	Ethanolic (bark)	1	10.1	-	[32]
	Methanolic (bark)	2	14	0.78	[19]
Escherichia coli	Methanolic (bark)	2	13	1.56	[19]
Fusobacterium nucleatum	Hydroalcoholic (Leaves)	200	-	2	[28]
Klebsiella pneumoniae	Ethanolic (bark)	0.5	10.3	-	[32]
	Methanolic (bark)	2	12	3.13	[19]
Micrococcus luteus	Methanolic (bark)	2	26	0.39	[19]
Porphyromonas gingivalis	Hydroalcoholic (Leaves)	200	-	2	[28]
Proteus mirabilis	Hydroalcoholic (leaves)	250	14	≥250	[33]
	Hexanoic (leaves)	220	9	≥220	
	Dichloromethane (leaves)	190	10	≥190	
	Ethyl acetate (leaves)	140	10	≥140	
	Butanolic (leaves)	120	13	≥120	
Proteus vulgaris	Hydroalcoholic (leaves)	250	11	≥250	[33]
	Hexanoic (leaves)	220	11	≥220	
	Dichloromethane (leaves)	190	11	≥ 70	
	Ethyl acetate (leaves)	140	9	≥30	
	Butanolic (leaves)	120	13	≥ 30	
Pseudomonas aeruginosa	NaCl (Heartwood)	0.1	16.5	-	[16]
Staphylococcus aureus	Hydroalcoholic (leaves)	250	16	≥125	[33]
	Hexanoic (leaves)	220	16	≥110	
	Butanolic (leaves)	120	16	≥30	
	Ethanolic (bark)	0.5	7.3	-	[32]
	Methanolic (bark)	2	21	0.39	[19]

References

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