Ethnobotanical and Pharmacological Study of *Virola surinamensis* (Rol.) Warb. (Myristicaceae) – a Review

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Recebido em 15/07/2020 – Aceito em 12/09/2020

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ABSTRACT – *V. surinamensis* (Rol.) (Myristicaceae) is a pyramid-shaped tree, 25 to 35m tall, has a cylindrical trunk, simple leaves and small yellow flowers. It is native to the forests of the amazon region. The oil extracted from seeds is rich in trimististine and can be used in the manufacture of candles, soaps, cosmetics and perfumes. In addition to the use of cosmetics and perfumery. The plant also has therapeutic and pharmacological properties. Among the pharmacological properties are antimicrobial, larvicidal, antitumor, antinociceptive and anti-inflammatory, antioxidant, leishmanicidal, antimalarial, cercaricidal, trypanocidal, gastroprotective and antiulcerogenic activities. For antimicrobial activity were found phenolic compounds, lignan and neolignan compounds and α and β-pinene in the hydrophilic extract and ucuuba seeds. *V. surinamensis* leaves was found in lignin-grandsin that demonstrated for larvicidal activity. The compost tetrahydrofuran neolignan grandisina isolated in *V. surinamensis* leaves demonstrated antitumor activity. The compound grandsin was related to antinociceptive and anti-inflammatory property. The α-tocopherol and β-carotene compounds used in the rhizome methanolic extract were related to an antioxidant activity. The compounds such as neolignans, surinamensin, virolin, a mixture of hydrocarbons in the chain, glycerides, esters, steroids and arylpropanoids found in the hexane extract demonstrated in antileishmanicidal activity. The sesquiterpene nerolidol isolated from the *V. surinamensis* essential oil was directly related to the antimalarial property. The neolignan, virolin and surinamensin compounds found in the V. surinamenis leaves was related to cercaricidal activity. For trypanocidal activity, the compounds veraguensin and grandisin lignans are also isolated from the leaves of the plant demonstrated such activity. Compounds like flavonoids and epicatechin isolated from *V. surinamensis* ethanolic extract demonstrated gastroprotective activity. The compound epicatechin proven by the *V. surinamensis* resin was pointed to antiulcerogenic activity. The present work reviewed the *Virola surinamensis* medical, therapeutic and pharmacological properties.

Keywords: *Virola surinamensis* ethnobotanical; Myristicaceae properties; pharmacological properties of ucuuba; *Virola surinamensis* therapeutic and pharmacological activity.

Estudo Etnobotânico e Farmacológico de *Virola surinamensis* (Rol.) Warb. (Myristicaceae) – uma Revisão

RESUMO – *V. surinamensis* (Rol.) (Myristicaceae) é uma árvore com forma piramidal, com 25 a 35m de altura, que possui tronco cilíndrico, folhas simples e pequenas flores amarelas. É nativa das florestas alagádicas da região amazônica. O óleo extraído das sementes é rico em trimististina e pode ser usado na fabricação de velas, sabonetes, cosméticos e perfumes. Além do uso em cosméticos e perfumaria, a planta também possui propriedades terapêuticas e farmacológicas. Entre as propriedades farmacológicas estão as atividades antimicrobiana, larvicida, antitumoral, antinociceptiva e anti-inflamatória, antioxidante, leishmanicida, antimalárica, cercaricida, tripanocida, gastroprotetora e antiulcerogênica. Os metabólitos encontrados, relacionados às atividades mencionadas, foram compostos fenólicos, compostos lignanos e neolignanos e α e β-pineno no extrato hidrofílico, e sementes de ucuúba para atividade antimicrobiana. Nas folhas

de *V. surinamensis* foram encontradas lignina grandsina para atividade larvicida. Para atividade antitumoral foi encontrada a lignana tetraidrofurnica grandisina em folhas de *V. surinamensis*. O composto grandsina foi relacionado à propriedade antinociceptiva e anti-inflamatória. Já os compostos α tocoferol e β caroteno isolados do extrato metanólico dos rizomas foram relacionados à atividade antioxidante. Compostos como neolignanos, surinamensina, virolina, mistura de hidrocarbonetos em cadeia, glicéridos, ésteres, esteróides e arilpropanóides encontrados no extrato hexânico demonstraram atividade antileishmanicida. O sesquiterpeno nerolidol isolado do óleo essencial de *V. surinamensis* estava diretamente relacionado à propriedade antimalárica. Os compostos neolignanas virolina sirinamensina isolados das folhas de *V. surinamensis* estavam relacionados à atividade cercaricida. Para a atividade tripanocida, os compostos veraguensina e grandisina lignanas também isolados das folhas da planta demonstraram tal atividade. Compostos como flavonóides e epicatequina isolados do extrato etanólico de *V. surinamensis* demonstraram atividade gastroprotetora. Já a epicatequina proveniente da resina de *V. surinamensis* apontou atividade antiulcerogênica. O presente trabalho revisou as propriedades médicas, terapêuticas e farmacológicas de *Virola surinamensis.*

Palavras-chave: Atividade terapêutica e farmacológica de *Virola surinamensis*; etnobotânica de *Virola surinamensis*; propriedades da Myristicaceae; propriedades farmacológicas da ucuúba.

Estudio Etnobotánico y Farmacológico de *Virola surinamensis* (Rol.) Warb. (Myristicaceae) – una Reseña

RESUMEN – *V. surinamensis* (Rol.) (Myristicaceae) es un árbol en forma de pirámide, de 25 a 35m de altura, tiene un tronco cilíndrico, hojas simples y pequeñas flores amarillas. Es originaria de los humedales de la región amazónica. El aceite extraído de las semillas es rico en trimistina y puede utilizarse en la fabricación de velas, jabones, cosméticos y perfumes. Además de su uso en cosmética y perfumería, la planta también tiene propiedades terapéuticas y farmacológicas. Entre las propiedades farmacológicas se encuentran actividades antimicrobianas, larvicidas, antitumorales, antinociceptivas y antiinflamatorias, antioxidantes, leishmanicidas, antipalúdicas, cercaricidas, tripanocidas, gastroprotectoras y antiulcerogénicas. Los metabolitos encontrados relacionados con las actividades mencionadas fueron compuestos fenólicos, compuestos de lignanos y neolignanos y α y β-pineno en el extracto hidrofílico y semillas de ucuúba para actividad antimicrobiana. En las hojas de *V. surinamensis*, se encontró lignina grandsina para actividad larvicida. Para la actividad antitumoral, se encontró grandisina lignano tetrahidrofurno en hojas de *V. surinamensis*. El compuesto grandsina se relacionó con propiedades antinociceptivas y antiinflamatorias. Los compuestos α-tocoferol y β-caroteno aislados del extracto metanólico de rizomas se relacionaron con la actividad antioxidante. Los compuestos como neolignanos, surinamensina, virolina, una mezcla de hidrocarburos en cadena, glicéridos, ésteres, esteroides y arilpropanoides que se encuentran en el extracto hexánico demostraron actividad antileishmanicida. El sesquiterpeno nerolidol aislado del aceite esencial de *V. surinamensis* estaba directamente relacionado con la propiedad antipalúdica. Los compuestos neolignan viroline sirinamensin aislados de las hojas de *V. surinamensis* estaban relacionados con la actividad cercaricida. Para la actividad tripanocida, los compuestos veraguensina y grandisina lignanos también aislados de las hojas de la planta demostraron dicha actividad. Los compuestos como los flavonoides y la epicatequina aislados del extracto etanólico de *V. surinamensis* mostraron actividad gastroprotectora. La epicatequina de la resina de *V. surinamensis* mostró actividad antiulcerogénica. El presente trabajo revisó las propiedades médicas, terapéuticas y farmacológicas de Virola surinamensis.

Palabras clave: Actividad terapéutica y farmacológica de *Virola surinamensis*; etnobotánica de *Virola surinamensis*; propiedades de Myristicaceae; propiedades farmacológicas de ucuúba.

Introduction

Plant materials are used in whole world, such as home remedies, medicines and raw materials for the pharmaceutical industry, and represent a substantial part of the world medicine market (Sivapalan, 2013).

Virola surinamensis (Rol.) Warb. (Myristicaceae) is a native of alagadic forests of the Amazon region is a tree with a pyramidal shape, 25-35m high. It has a cylindrical trunk, simple leaves, and small yellow flowers (Lorenzi, 2002). The fruits are woody shells containing large seeds (23.3mm on average) (Riba-Hernandez *et al.*, 2014).

Phytochemical research demonstrates the presence of steroids, flavonoids, lignans, and polyketides (Stecanella *et al*., 2013).

V. surinamensis, popularly known as "ucuúba", "ucuúba-branca", "Ucuúba de igapó", "sucuba", is a tree that grows on dry land, floodplains and on the banks of rivers in the Amazon rainforest (Rodrigues, 1980). According to Santos *et al*. (2013), this especie is a typically lowland species, of great relevance in popular culture as it has good quality fat in the seeds. This fat is commonly used in the manufacture of soap, candles and home remedies, as well as for its wood.

In the 1980s there was a large-scale exploration of this species by the timber industry, making the plant susceptible and making it part of the official list of species of Brazilian flora threatened with extinction. According to Anderson *et al*. (1994), the rhythm of disordered exploration can lead to a possible exhaustion of this resource.

The use of medicinal plants for therapeutic treatment in developing countries like Brazil can be used as an alternative treatment (Pinto *et al*., 2011; Oliveira & Lehn, 2015). It is already using the use of medicinal plants in the treatment of diseases is related to human evolution within pharmacology. This activity was related to all periods, in all social strata and by almost all of humanity.

International attention from the general and scientific communities has been attracted by the potential pharmaceutical wealth of the Brazilian Amazon while the roles of the ethnopharmacological approach are the discovery and development of new drugs (Elisabetsky & Shanley, 1994).

Regarding pharmacological aspects, the resin of the bark of *V. surinamensis* is used in folk medicine to treat erysipelas and leaf tea is indicated for colic, dyspepsia and inflammatory processes (Schultes & Holmsted, 1971; Berger, 1992). *In vitro* studies have shown the antiplasmodium activity of essential oils extracted from *V. surinamensis*, with nerolidol being the main active constituent. Its activity was attributed to the inhibition of glycoprotein synthesis in the trophozoite phase of *Plamodium falciparum* (Lopes *et al*., 1999).

Anothers activities like anti-leishmania, anti-trypanosoma, anti-cercariae, anti-tumor activity have also been reported to *V. surinamensis* (Lopes *et al*., 1996; Lopes *et al*., 1998). *In vivo* studies with compounds extracted from *V. surina-mensis* are few, highlighting the study of the gastroprotective effect of the ethanolic extract of the resin administered orally (Hiruma-Lima *et al*., 2009).

The anti-inflammatory activity study of the neolignan grandisin isolated from *V. surinamensis* as well administered orally (Carvalho *et al*., 2010). Among the different classes of compounds that occur in *V. surinamensis*, the lignans and neolignans show diverses biological activities (Romoff & Yoshida, 1997). There are also reports of trypanosomide, cercaricide activities of *V. surinamensis* (Lopes *et al*., 1996; Lopes *et al*., 1998). Another studies in the literature mentioning several activities of this species, such as larvicide, antinociceptive, anti-inflammatory, gastroprotective, and trypanocidal activities (Stecanella *et al*., 2013; Carvalho *et al*., 2010). The hexane extract of the plant has an action against Schistossoma mansoni infections (Rodrigues, 1980; Lorenzi & Matos, 2002; Hiruma-Lima *et al*., 2009).

Another relevant factor is the studies aiming at the use of the agro-industrial residues of ucuúba (*Virola surinamensis*). The species of Amazonian origin stands out for its use in the treatment of malaria, anti-inflammatory and antifungal action, being directly related to the presence of its bioactive compounds such as lignans, neolignans, propylphenones, arylpropanoids and flavonoids (Hiruma-Lima *et al*., 2009; Wang *et al*., 2017).

Extracts rich in polyphenols, α-tocopherol and β-carotene are obtained from ucuuba residues. These bioactive compounds have great health benefits, as they have antioxidant (Chirinos *et al*., 2013), anti-inflammatory (Carvalho *et al*., 2010), antimicrobial (Graça *et al*., 2017), antifungal (Graça *et al*., 2016), antitumor (Xiang *et al*., 2017). These bioactive compounds may be present in agro-industrial residues from seeds (Laufenberg *et al*., 2003).

Thus, the objective of this review was to report the medicinal, therapeutic and pharmacological properties of *Virola surinamensis*. For this review, databases of *V. surinamensis* were consulted, such as Google, Scielo, Periódicos Capes and Coordination for the Improvement of Higher Education Personnel (CAPES) in the period from 15 to 19 June 2020, based on the ethnobotanical and pharmaceutical attributions of the plant.

Medicinal and therapeutic properties: An ethnobotanical study

In studies carried out in the Brazilian Amazon, *Virola surinamensis* was the most cited in terms of several therapeutic treatments, demonstrating its regional value and the certainty that this plant can become targets in pharmacological research in the region (Miranda *et al*., 2003; Filocreão *et al*., 2017).

According to Sarquis *et al*. (2019) about 43-68% of *Virola surinamensis* parts are widely used by the riverside community to treat microbial infections, gastrointestinal disorders, inflammatory conditions, leishmaniasis, and cancer by the use agreement index. The seeds, for example, present important oil for inflammatory skin processes (Table 1).

The *V. surinamensis* bark resin is used in folk medicine for the treatment of erysipelas and leaf tea is indicated for colic, dyspepsia and inflammatory processes (Schultes & Holmsted, 1971; Berger, 1992). The Waiãpi indians of Amapá use the *V. surinamensis* leaves, by inhaling their vapors, for the malaria treatment (Table 1) (Lopes *et al*., 1999).

This especie is used too as a repellent and for the healing of wounds, and the leaves and barks are used in oral preparations by decoction for inflammation of the digestive, urinary, and reproductive systems. The bark and fruit is used too as traditional use in born in the body (furunculosis) and intestinal infections through topical use 2 x a day for 7 days and decoction and exudate as poultice respectively (Table 1) (Sarquis *et al*., 2019). The ucuuba use occurs since the pre-Columbian period, with the use of seeds and bark by the Indians as hallucinogens in their rituals (Table 1). They also used sebum from the seeds for application to wounds (Lopes *et al*., 1999; Galupo *et al*., 2001). Therapeutically, in popular medicine, ucuuba leaf tea is used to treat rheumatism, arthritis, colic, inflammation, gastritis, dyspepsia, erysipelas. In addition, sebum from the seeds can help in the cure of thrush, hemorrhoids and has a healing effect (Table 1). The economic highlight started due to the logging of this genus, but currently it is the ucuuba seeds that have been the focus of interest in the cosmetic industry (Rodrigues, 1980; Lorenzi & Matos, 2002; Hiruma-Lima *et al*., 2009).

Table 1 – Medicinal and therapeutic properties of *Virola surinamensis*.

Medicinal and Therapeutic Properties				
Activity	**Used form**	**Part of the plant used**	**Who use**	**References**
Inflammatory processes of the skin	Oil	Seeds	Riverside community	Sarquis *et al*. (2019)
Erysipelas	Resin	Bark	Unknown	Schultes & Holmsted (1971), Berger (1992)
Colic, dyspepsia and inflammatory processes	Tea	Leaves	Unknown	Schultes & Holmsted (1971), Berger (1992)
Malaria treatment	Vapors	Leaves	Waiãpi indians of Amapá	Lopes *et al*. (1999)
Repellent and for the healing of wounds	Unknown used form	Whole plant	Unknown	Sarquis *et al*. (2019)
Inflammation of the digestive, urinary, and reproductive systems	Oral preparations by decoction	Leaves and barks	Unknown	Sarquis *et al*. (2019)
Born in the body (furunculosis), intestinal infections	Topical use 2 x a day for 7 days, decoction and exudate as poultice	Bark and fruit	Unknown	Sarquis *et al*. (2019)
Hallucinogens	Unknown used form	Seeds and bark	Indians	Lopes *et al*. (1999), Galuppo *et al*. (2001)
Application to wounds	Sebum	Seeds	Unknown	Lopes *et al*. (1999), Gallupo *et al*. (2001)

Rheumatism, arthritis, colic, inflammation, gastritis, dyspepsia, erysipelas	Tea	Leaves	Unknown	Rodrigues (1980), Lorenzi & Matos (2002), Hiruma-Lima *et al.* (2009)
Thrush, hemorrhoids and has a healing effect	Sebum	Seeds	Unknown	Rodrigues (1980), Lorenzi & Matos (2002), Hiruma-Lima *et al.* (2009)

Pharmacological properties

Antimicrobial activities

The antifungal and antibacterial action of the ucuuba seed oil extracts was assessed against *C. albicans* (yeast), *E. coli* (bacterium), and *S. aureus* (bacterium) and no zones of inhibition were observed (Cordeiro *et al.*, 2018). In another studies, Costa *et al.* (2008) studied the antimicrobial effect of ethanolic extracts of ucuuba tree bark and found results similar to Cordeiro studies, whereas *S. aureus* had a 10mm zone of inhibition.

Cordeiro *et al.* (2018) found in ucuuba seed oil various secondary metabolites like fatty acids, steroids, terpene, phenolic compounds, coumarins, and flavonoids and is predominantly made up of saturated fatty acids, particularly lauric acid, myristic acid, pentadecanoic acid, and palmitic acid. There is an interesting pharmacological activity in some of these compounds found in plants for their and for their potential in inhibiting lipid oxidation and the proliferation of fungi.

The presence of phenolic compounds are responsible for the antimicrobial activity highlighted in the *V. surinamensis* hydrophilic extract (Costa, 2015; Girondi *et al.*, 2017). In addition, the presence of these same compounds in the ucuuba residue has already been reported in this study. Ethanol has the property of breaking down the cell wall of plants and with that phenolic compounds are generated (Buriol *et al.*, 2009; Tiwari *et al.*, 2011). Thus, it is understood that the higher the concentration of these compounds, the more potent their antimicrobial action (Fuentealba *et al.*, 2016; Hu *et al.*, 2016; Wang *et al.*, 2017).

Virola surinamensis has described compounds such as arylpropanoids, neolignans, lignans, sesquilignoids, diveral lignoids, flavonoids, diarylpropanes, alfa-butyrolactones, polyketides, alkaloids, stylbenoids, and benzoic acid derivatives (Lopes, 1996). Among these compounds, lignans and neolignans stood out for their antifungal activities (Pagnocca *et al.*, 1996). Regarding antifungal activity Lopes *et al.* (1999) studied the ucuúba tree root extracts and obtained good inhibition results for the fungus *Cladosporium cladosporioides*. Costa *et al.* (2008) obtained inhibition against the bacteria *P. aeruginosa*, *S. aureus*, *S. epidermidis* and the fungus *A. flavus* using the ethanol extract from the bark of the ucuuba tree.

Larvicidal activity

According to Cabral *et al.*, (2009), *Aedes aegypti* is a widely distributed Neotropical species and is the main vector of dengue viruses. Another disease vector insect is the *Chrysomya megacephala* F. (Diptera: Calliphoridae) was introduced into southern Brazil during 1975-1976 and it is original from Africa (Guimarães *et al.*, 1978). Due to feeding and reproductive traits, it has important role as vector for several pathogens and diseases (Greenberg, 1973; Oliveira et al., 2002). According Lopes *et al.* (1998) grandisin was previously showed potent in vitro activity against larvae disease vectors and was isolated from *V. surinamensis* leaves. Based on Cabral *et al.* (2009), the lignan grandisin appears to be a potential mosquito larvicidal compound against the dengue vector. Further tests are needed to demonstrate its effects on mosquito physiology, morphology, and development. In another study, *in vitro* effectiveness of GRAN (tetrahydrofuran neolignan grandisin) isolated from *Virola surinamensis* (Rol. *ex* Rottb.) Warb., Myristicaceae as larvicidal agent against *Aedes aegypti* and *Chrysomya megacephala* has been too demonstrated (Nogueira *et al.*, 2009; Cabral *et al.*, 2009).

Anti-tumor activity

Stecanella *et al.* (2013) demonstrated its marked antitumoral activity of the isolated tetrahydrofuran neolignan grandisin from *Virola*

surinamensis leaves against Ehrlich ascites tumor experimental model (Valadares *et al*., 2009) and an important antileukemia activity on K-562 cell line (Valadares *et al*., 2011). This isolated compound was loaded in a Polymeric nanoparticles, such as poly (lactic-co-glycolic acid) (PLGA) nanoparticles dispersion. Nanoencapsulation sustained GRAN release, provided chemical stability.

Antinociceptive and anti-inflammatory activity

Carvalho *et al*. (2010) studied the compound grandisin that is present in several plant species from Brazil including *V. surinamensis*. This substance is used in popular medicine for the treatment of disorders such as colic, inflammation, rheumatism, dyspepsia and liver dysfunction.

In Carvalho *et al*. (2010) studies, the authors demonstrated that grandisin isolated from *V. surinamensis* is able to inhibit the acetic acid-induced writhing in mice dose-dependently producing an antinociceptive effect. This effect is not caused by motor incoordination or sedation due to depressant effect in the Central Nervous System (CNS). The anti-inflammatory activity test of GRA was characterized through the formalin, this substance reduced the time that mices licking the paw by 60.5% (only in the second phase (inflammatory pain).

According to Carvalho *et al*. (2010) the antinociceptive and anti inflammatory effects are associated with lignan (grandisin) from *V. surinamensis*. This study corroborate with the use in popular medicine of plants rich in grandisin for the treatment of symptoms caused by the inflammatory process, such as pain and edema.

Antioxidant activity

For energy production, there is the oxidation process that is fundamental to the organism. However, during this process oxygenated or nitrogenated free radicals are generated. The excess of these radicals in the body generates oxidative stress that can cause damage to cells, since it can cause damage to DNA (Wang *et al*., 2017; Santos *et al*., 2008; Soares *et al*., 2005). In this way, antioxidants are substances that have an inhibitory effect that is triggered by free radicals in the body. In addition, antioxidants are of great relevance because they inhibit or reduce oxidative processes, mitigating the development of different types of pathology such as Parkinson's, Alzheimer's, multiple sclerosis, cardiovascular diseases, liver diseases and various types of cancer (Santos *et al*., 2008; Abbas *et al*., 2014; Hatamnia *et al*., 2014).

According to Oliveira (2018), ucuuba residue showed significant antioxidant activity. As these are residues that have already undergone other processes, a result was obtained that was not only high and it is also known that the type of extractive process chosen can directly influence the obtainment of compounds that have antioxidant activity (Roesler *et al*., 2007). San & Yildirim (2010) reported that the strong interaction between α-tocopherol and β-carotene obtained from the ucuuba residue and that they have an antioxidant effect.

The literature reports that the parts of the fruit that mostly concentrate the presence of antioxidant compounds are the peel and the seed. The ucuuba residue is obtained from the seed pressing process, justifying the presence of this antioxidant activity in the residue (Abidille *et al*., 2005; Bergaschi, 2010).

Leishmanicidal activity

Three compounds were isolated from *Virola surinamensis*: neolignans surinamensin (Gottlieb, 1978), virolin (Oliveira & Sampaio, 1978) and grandisin (Carvalho *et al*., 2010) showed activity against leishmania. Surinamensin was active *in vitro* against *Leishmania donovani* promastigotes at 50μM. The neolignan presented no selective toxicity when tested against *L. donovani* amastigotes in the mouse peritoneal macrophage (Barata *et al*., 2000). In addition, in other studies, leishmanicidal activity in *V. surinamensis* was attributed to the presence of neolignans (Fernandes *et al*., 1994) such as surinamensine (Barata *et al*., 2000).

Veiga *et al*. (2017) reports the antipromastigote effect of hexane extract. The hexane extract of *V. surinamensis* presented high activity against promastigote of *L. chagasi* and *L. amazonenses*. The hexane extract of *V. surinamensis* should contain long chain hydrocarbons mixture, glycerides esters, steroids and aryl propanoides with antipromastigote activity (Saraiva, 2012). However, the major constituents are neolignans. Probably the antipromastigote activity must be related to a minority constituent of this extract.

Antimalarial activity

The antiparasitic activity of essential oils extracted from *V. surinamensis* was in line with *in vitro* studies. In these studies, sesquiterpene nerolidol was the main active constituent in inhibiting parasitic growth. The activity of this compound was attributed to the inhibition of glycoprotein synthesis in the trophozoite phase of *Plasmodium falciparum* (Lopes *et al*., 1999). In *in vitro* studies with *P. falciparum* were used 100mg/mL of nerolidol over 48h caused 100% inhibition in the development of young trophozoite.

Cercaricidal activity

Isolated from the *V. surinamensis* leaves, the neolignans virolin and surinamensin protected against the penetration of *Schistossoma mansoni* cercariae in the mice skin (Barata *et al*., 1978).

Trypanocidal activities

V. surinamensis leaves have substances that have trypanocidal activity against the etiologic agent of Chagas disease, which are blood trypomastigote forms of *Trypanosoma cruzi* (Lopes *et al*., 1996). According to Lopes *et al*. (1998) the veraguensin and grandisin lignans isolated from the *V. surinamensis* leaves were active against the trypanosomastigote form of *Trypanossoma cruzi*, the etiological agent of Chagas disease. In contrast, tetrahydrofuran lignans isolated from other parts of *V. surinamensis* such as wood and adult leaves showed trypanocidal activity this time against various forms of *T. cruzi* trypomastigote (Lopes *et al*., 1996; Lopes *et al*., 1998). The process of obtaining and using lignans from *V. surinamensis* against Chagas disease has already been patented (Br, INPI 9.903.472-7).

Gastroprotective activity

Flavonoids obtained from *V. surinamensis* sap are responsible for the gastroprotective activity (Hiruma-Lima *et al*., 2009). Hiruma-Lima *et al*. (2009) in a study *in vivo* involving mices showed gastroprotective activity using the ethanolic extract (500mg/kg). According to the authors there is the action of epicatechin present in its composition, which activated the defense mechanism of the gastric mucosa against aggressive factors. Its use demands great care because toxicological symptoms are mentioned by the population.

Antiulcerogenic activity

According to Hiruma-Lima *et al*. (2009) the *V. surinamensis* resin (Myristicaceae) is obtained by cuts on the stem bark and is a reputed folk remedy in its natural form for the treatment of ulcer, gastritis, inflammation and cancer. This resin is popularly known as “leite de mucuiba”.

The aforementioned authors evaluated the pharmacological activity of the ethanolic extract from *V. surinamensis* resin and found an antiulcer activity. This resin has a local action and not by the systemic action of this preparation. This study correlated the effect of the resin with their major chemical compounds that was mainly epicatechin. This compound was found on the literature present in many plant species with anti-inflammatory and antiulcer action (Murakami *et al*., 1990; Alarcón *et al*., 1993; Andreo *et al*., 2006; Hamaishi *et al*., 2006; Vasconcelos *et al*., 2008). According to Hiruma-Lima *et al*. (2009) it is possible that the epicatechin present in *V. surinamensis* may be among various active principles responsible for the antiulcer activity shown by the tested resin.

Table 2 – Pharmacological properties of *Virola surinamensis*.

Pharmacological Properties			
Activity	**Related metabolite**	**Part of the plant used**	**References**
Antimicrobial activity	Phenolic compounds, lignans and neolignans, α and β-pinene compounds	Hidrophilic extract, unknown parts, Ucuuba seed residue	Costa (2015), Girond *et al*. (2017), Pagnocca *et al*. (1996), Sam & Yildirim (2010)
Larvicidal activity	Lignin grandsin	*V. surinamensis* leaves	Cabral *et al*. (2009)
Anti-tumor activity	Tetrahydrofuran neolignan grandsin	*V. surinamensis* leaves	Scatenella *et al*. (2013)

Antinociceptive and anti-inflammatory activity	Grandsin	Unknown parts	Carvalho *et al.* (2010)
Antioxidant activity	α tocopherol and β carotene	Rizhomes methanolic extract	Chirinos *et al.* (2013), San & Yildirim (2010)
Leishmanicidal activity	Neolignans, surinamensin, virolin, chain hydrocarbons mixtures, glycerides, esters, steroids and arylpropanoids	Unknown parts, hexane extracts	Gottlieb (1978), Oliveira & Sampaio (1978), Saraiva (2012), Veiga *et al.* (2017)
Antimalarial activity	Sesquiterpene nerolidol	Essential oil	Lopes *et al.* (1999)
Cercaricidal activity	Neolignans virolin sirinamensin	*V. surinamensis* leaves	Barata *et al.* (1978)
Tripanocidal activity	Veraguensin and grandisin lignans	*V. surinamensis* leaves	Lopes *et al.* (1996), Lopes *et al.* (1998)
Gastroprotective activity	Flavonoids and epicatechin	Ethanolic extract	Hiruma-Lima *et al.* (2009)
Antiulcerogenic activity	Epicatechin	*V. surinamensis* resin	Hiruma-Lima *et al.* (2009)

Conclusion

Despite scientific studies be demonstrating antimicrobial, larvicidal, antitumor, antinociceptive and anti-inflammatory, antioxidant, leishmanicidal, antimalarial, cercaricidal, trypanocidal activities as well as gastroprotective and antiulcerogenic activities of the *Virola surinamensis* that could be useful in the treatment of several human diseases, more clinical studies in humans are necessary. There is a need for these studies is precisely to confirm all plant properties and to avoid possible side effects in humans. In addition, protocols for the use of the plant are necessary in relation to the quantities and concentrations of the formulations presented.

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Biodiversidade Brasileira – BioBrasil.
Fluxo Contínuo
n. 1, 2021

http://www.icmbio.gov.br/revistaeletronica/index.php/BioBR

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ISSN: 2236-2886