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# *Eugenia uniflora* L.: potential uses as a bioactive plant

## **Eugenia uniflora** *L.: potenciais usos como planta bioativa*

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**ABSTRACT:** Natural products extracted from plants have always played an important role in the discovery of bioactive substances. This work carried out a review of the literature on the bioactive activities of *Eugenia uniflora* L. (Surinam cherries), as a potential plant in the various uses, be it medicinal, antimicrobial, antioxidant, insecticide and protective. In the literature, studies were found to confirm the antibacterial activity of *E. uniflora* leaves extract on *Streptococcus*, *Staphylococcus aureus*, *Pseudomonas aeruginosa* and *Escherichia coli*. The presence of antioxidant compounds as total phenolics, such as anthocyanins and flavonoids, induction in the protection of plants by phytoalexins, as well as insecticidal and anthelmintic effects by the use of the extract of the *E. uniflora* tree. Although these different potential biotics of *E. uniflora* have already been reported, further studies are still needed on the use of natural products extracted from *E. uniflora* for employment for different purposes.

**KEYWORDS:** antimicrobial; antioxidant; protective effect.

**RESUMO:** Os produtos naturais extraídos de plantas sempre exerceram papel importante na descoberta de substâncias bioativas. Este trabalho realizou uma revisão da literatura acerca das atividades biotivas da *Eugenia uniflora* L. (pitanga) como planta potencial em várias utilizações, podendo ser medicinal, antimicrobiana, antioxidante, inseticida e protetora. Foram encontrados trabalhos que comprovam a atividade antibacteriana do extrato de folhas de *E. uniflora* L. sobre *Streptococcus*, *Staphylococcus aureus*, *Pseudomonas aeruginosa* e *Escherichia coli*, além da presença de compostos antioxidantes, tais como fenólicos totais (antocianinas e flavonoides), a indução na proteção das plantas pelas fitoalexinas, bem como efeitos inseticida e anti-helmíntico pela utilização do seu extrato. Embora esses diferentes potenciais bioativos da pitangueira já tenham sido relatados, ainda são necessários mais estudos quanto à utilização de produtos naturais extraído de *E. uniflora* para o emprego em diferentes finalidades.

**PALAVRAS-CHAVE:** antimicrobiano; antioxidante; efeito protetor.

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## INTRODUCTION

*Eugenia uniflora* L., known as Surinam cherries, belongs to the family Myrtaceae, that has a wide diversity of plants, with 142 genera and 5,500 species (HEYWOOD et al., 2007; WILSON, 2011). Native to South America, the *E. uniflora* is widely distributed in Brazil, Argentina, Uruguay and Paraguay (CONSOLINI; SARUBBIO, 2002). This tree species can also be found in the southern United States, Caribbean islands, India, China, Egypt, Nigeria and Australia (WEYERSTAHL et al., 1988; KANAZAWA et al., 2000; BEZERRA et al., 2000).

The *E. uniflora* is often used for therapeutic purposes (SCHAPOVAL et al., 1994; OGUNWANDE et al., 2005; OLIVEIRA et al., 2005), by the cosmetics industry (MELO et al., 2007) and in forest restoration areas, being ecologically important as a colonizing species in disturbed areas (RODRIGUES; NAVE, 2000; BOTREL et al., 2002; BIANCHINI et al., 2003; PINTO et al., 2005), as well as food for local wildlife (MARGIS et al., 2002).

As a plant with medicinal potential, the leaves and fruits of *E. uniflora* are known for their innumerable therapeutic properties. In Brazilian popular medicine, *E. uniflora* leaves and fruits have been widely used in the form of infusions to obtain exciting, antifebrile, antidiarrheal, antihypertensive and anti-rheumatic effects (AURICCHIO et al., 2007). CARVALHO (2006) also emphasizes that leaf tea or alcohol extract combats diarrhea, worm infestation, bronchitis, cough, fever, anxiety, and hypertension.

Other researches highlight the importance of the chemical composition of the essential oil extracted from the leaves of the *E. uniflora*, with its diverse biological activities, such as antimicrobial and antioxidant (VICTORIA et al., 2012), hepatoprotective (VICTORIA et al., 2013), antifungal (COSTA et al., 2010), antinociceptive, hyperthermic (AMORIM et al., 2009), antitumor (OGUNWANDE et al., 2005), insecticide (JUNG et al., 2013), and phytoalexin inducer (MAZARO et al., 2008).

Research performed by SANTOS et al. (2015) evaluating the chemical composition of the essential oil obtained from young and mature leaves of *E. uniflora* from the city of Seropédica (Rio de Janeiro, Brazil), showed that leaf age influences the chemical composition and concentration of the substances present in the essential oil. The same authors verified the presence of sesquiterpenes, such as germacrone (35.59%), a substance found only in oil samples obtained from young leaves. Comparing this chemical composition with the essential oil samples extracted from the leaves of *E. uniflora* collected in Nigeria, it was found that the components and concentrations of the substances in the oil prove to be very complex. The percentage of the composition of essential oil constituents of the *E. uniflora* samples obtained from Nigeria were: atractylone (16.90%), curzerene (19.70%), selina-1,3,7-trien-8-one (17.80%), and furanodiene (9.60%) (SANTOS et al., 2015).

COSTA et al. (2009) suggest that this difference in the composition and concentration of the substances in the oil can be determined by the edaphoclimatic conditions of each region.

OGUNWANDE et al. (2005) and AMORIM et al. (2009) observed in their research that the hydroalcoholic extract of the leaves of *E. uniflora* diminishes the levels of the enzyme xanthine-oxidase linked to the appearance of gout. In addition, the hydroalcoholic extract of the leaves presents vaso-relaxing, antioxidant, antidiarrheal, hypotriglyceridemia, hypoglycemia, antibacterial property (OGUNWANDE et al., 2005; AMORIM et al., 2009) and antifungal actions (HOLETZ et al., 2002; VICTORIA et al., 2012).

The benefits attributed to *E. uniflora* are due to secondary metabolites endowed with potent antibacterial and antifungal activity in their leaves, including phenolic compounds such as flavonoids, terpenes, tannins, anthraquinones and essential oils (AMORIM et al., 2009). There is still limited information on the antiviral action of *E. uniflora*, although this activity has been also reported in other species of the genus *Eugenia* (SOOD et al., 2012).

Several studies have observed on the leaves of the *E. uniflora* tree the presence of anthraquinones, steroids, triterpenes, flavonoid heterosides, saponin heterosides and tannins (FIUZA et al., 2008; COUTO et al., 2009; AZEVEDO et al., 2010), sesquiterpenes, phenolic compounds (AURICCHIO; BACCHI, 2003), anthocyanins, flavonoids and carotenoids (LIMA et al., 2002), suggesting an important phytotherapeutic potential to be investigated.

In addition to antimicrobial properties, several plant species of the Myrtaceae family have been used as bioindicators of air quality (FURLAN et al., 2006; PINA; MORAES, 2007; ALVES et al., 2008). It has been also recommended the use of the *E. uniflora* tree for heterogeneous reforestation destined to the recomposition of degraded areas, of permanent preservation, aiming to provide food to avifauna (SCALON et al., 2001).

Due to the diversity of plants in Brazil, there are still few studies on the bioactive effects of the *E. uniflora*, being necessary more incentive, research and diffusion for adoption of the phytotherapic practice. The objective of this study was to make a bibliographical survey about the bioactive activities of *E. uniflora*, as a potential plant in the various uses, be it medicinal, antioxidant, insecticidal and protective.

## Antibacterial activity

SOBEH et al. (2016) showed in their study that the essential oil extracted from *E. uniflora* L. presented antimicrobial activity against six species of gram-positive bacteria: *Staphylococcus aureus*, *Staphylococcus epidermidis*, *Bacillus licheniformis*, *Bacillus subtilis*, *Enterococcus faecalis* and *Staphylococcus aureus* (isolated number — 10442), besides three species of gram-negative bacteria (*Escherichia coli*, *Klebsiella pneumoniae* and *Pseudomonas* *aeruginosa*) and two species of fungi (*Candida parapsilosis* and *Candida albicans*). In this study, the species *B. licheniformis* was the most sensitive to *E. uniflora* essential oil, with minimal inhibitory concentration and minimum microbicide of 0.63 mg/mL. The authors also report that the biological activity of essential oils differs according to its geographical origin. Thus, they observed that samples of essential oils of Egyptian origin did not present significant antimicrobial activity under the tested microorganisms, except for the *bacterium B. licheniformis*. On the other hand, they noticed antimicrobial activity of *E. uniflora* essential oil of Indian origin under gram-positive bacteria (*Staphylococcus aureus*, *Bacillus subtilis*, *Streptococcus faecalis* and *Staphylococcus albus*).

Studies have shown that the extraction of *E. uniflora* essential oil from the same geographical origin may present different chemo-types for this species and that factors such as soil conditions, climate, seasonality and fertilization may influence the chemical composition and, consequently, the biological activity of essential oil (BASER; BUCHBAUER, 2010).

When testing the use of hydroalcoholic extracts of the green and mature fruit, as well as the infusion of the fresh *E. uniflora* leaf, OLIVEIRA et al. (2008) demonstrated the *in vitro* antibacterial activity of *E. uniflora* on *Streptococcus* bacterial strains.

NASCIMENTO (2013) also verified antibacterial activity of leaves and fruits (hydroalcoholic extract) of *E. uniflora* under strains of *Staphylococcus aureus*. The results showed in the disc diffusion test the formation of inhibition halos of 13 mm at concentrations of 100 and 50% for the hydroalcoholic extract of the leaves, confirming the antibacterial activity due to the formation of the halo being greater than 8 mm. For the hydroalcoholic extract of the fruits, there was the formation of inhibition halo only at the concentration of 100%. However, for the *E. uniflora* stem extract, at concentrations of 100, 50 and 25%, there was no inhibition halo formation.

When reviewing the bioactive effect of some plants, CATÃO et al. (2012) verified the medicinal effects of *E. uniflora* on gingival diseases caused by the agent *Streptococcus mutans salivary* in a group of 40 people aged 21 to 24 years, observing that the hydroalcoholic extract of the ripe *E. uniflora* fruit has similar efficacy to the dentifrice of Colgate Total 12 (Colgate-Palmolive, New York, United States) in the control group.

In the management of dairy cattle, two diseases have been the main causes of economic damages in the dairy activity: mastitis in milk matrices, caused by several microorganisms, being the most common agent *Staphylococcus aureus*; and diarrhea, considered one of the main causes of mortality in calves, caused mainly by the *bacterium Escherichia coli*.

When SILVA (2010) tested the antibacterial action of hydrometanolic extracts and essential oils of four species of plants (*Eugenia uniflora*, *Baccharis dracunculifolia*, *Vernonia polyanthes* and *Matricaria chamomilla*) on lineages of *S. aureus* and *E. coli*, he observed the effectiveness of extracts of *E. uniflora* and *V. polyanthes* on the two strains studied. For the *S. aureus* pathogen, extracts of *E. uniflora* and *V. polyanthes* had a minimum inhibitory concentration of 2.9 and 1.24 mg/mL, respectively. For the bacterial line *E. coli*, the extracts of *E. uniflora* and *V. polyanthes* had a minimum inhibitory concentration of 23.2 and 27.28 mg/mL, respectively. In relation to the oils, the most efficient were the essential oil of *E. uniflora* and rosemary of the field on *S. aureus*.

Another study verified the antimicrobial effect of *E. uniflora* crude extract in bacteria present in the water of a fish pond and bacteria present in the air. The authors observed that the crude ethanolic extract of *E. uniflora* presented an inhibitory action of 8% greater than the antibiotic amoxilin (positive control) for bacteria present in nursery water and 9% more efficient for bacteria present in the air (LORENZONI et al., 2012).

HOLETZ et al. (2002) evaluated the antimicrobial activity of 13 medicinal plants of Brazil under bacteria and yeasts *in vitro*. Among the medicinal plants used, the authors showed that the crude hydroalcoholic extract of *E. uniflora* presented moderate antimicrobial activity for the bacteria *Staphylococcus aureus* and *Escherichia coli* with a minimum inhibitory concentration of 250 and 500 μg/mL, respectively. The same authors verified that, of the 13 evaluated plants, nine species (*Psidium guajava*, *Eugenia uniflora*, *Punica granatum*, *Arctium lappa*, *Tanacetum vulgare*, *Mikania glomerata*, *Lippia alba*, *Piper regnellii*, and *Plantago major*) presented antifungal activity under *Candida krusei* and *Candida tropicalis*, both with a minimum inhibitory concentration of 31.2 μg/mL, and moderate activity for *Candida parapsilosis* (125 μg/mL).

AURICCHIO et al. (2007) demonstrated that *E. uniflora* extract has more expressive antimicrobial activity against *Staphylococcus aureus*, *Salmonella choleraesuis* and *Pseudomonas aeruginosa*.

It is noted that other species belonging to the genus *Eugenia* present bioactive compounds with antimicrobial activity in their composition. Studies by MAGINA et al. (2009) evaluated the antimicrobial activity of the essential oils of the leaves of *Eugenia brasiliensis*, *Eugenia beaurepaireana* and *Eugenia umbelliflora* under *S. aureus*, *P. aeruginosa* and *E. coli*. The results showed that the essential oils have antimicrobial activity that varied from moderate to strong, and they were more pronounced for *E. umbelliflora* and *E. brasiliensis* oils that strongly inhibited the growth of *S. aureus* with minimal inhibitory concentration of 119.2 and 156.2 μg/mL, respectively.

Studies by THAMBI et al. (2013) evaluated *in vitro* the essential oil antimicrobial activity of *E. uniflora* (Myrtaceae) as gram-positive bacteria (*Staphylococcus aureus*, *Bacillus subtilis*, *Streptococcus faecalis* and *Staphylococcus albus*) and gram-negative bacteria (*Escherichia coli*, *Pseudomonas aeruginosa*, *Klebsiella aerogenes* and *Proteus vulgaris*). The results showed that the oil has antimicrobial action against the four gram-positive microorganisms and is less active against gram-negative.

CHAVASCO et al. (2014) evaluated the antimicrobial activity of raw extracts of leaves, fruits and seeds of *Eugenia pyriformis* Cambess (Myrtaceae). The authors showed that *E. pyriformis* leaf extract inhibited the growth of microorganisms *Bacillus cereus*, *Bacillus subtilis*, *Enterococcus faecalis*, *Micrococcus luteus*, *Staphylococcus aureus*, *Enterobacter cloacae*, *Escherichia coli*, *Proteus mirabilis*, *Pseudomonas aeruginosa*, *Salmonella typhimurium*, *Serratia marcescens*, *Candida albicans* and *Saccharomyces cerevisiae*, with the exception of *Mycobacterium bovis* and *Mycobacterium tuberculosis*. For the evaluation of *E. pyriformis* fruit extract, no activity was observed on the microorganisms *P. mirabilis*, *E. coli*, *C. albicans*, *S. cerevisiae*, *M. bovis* and *M. tuberculosis*, and the minimal inhibitory concentration results were between 12 and 50 mg/mL. The authors also verified antimicrobial activity of the seed extract of the *E. uniflora* on 13 microorganisms of the 15 evaluated in the study.

## Antioxidant action

Natural antioxidants, especially those of plant origin, have the potential protective effect on the human body against diseases associated with oxidative stress (ÖZEN et al., 2011), but also in nutraceuticals, bio-pharmaceutical and food industries (BRAITHWAITE et al., 2014; XIN et al., 2012) as preservatives.

Recently, some studies have reported the antioxidant effect of leaf extract (OLIVEIRA et al., 2017; CUNHA et al., 2016; MARTINEZ-CORREA et al., 2011; MICHEL et al., 2008) and *E. uniflora* essential oil (VICTORIA et al., 2012; RATTMANN et al., 2012).

Considering the pharmacological potential of leaf extract from *E. uniflora*, CUNHA et al. (2016) investigated the cytotoxicity and antioxidant activity of ethanolic extract of *E. uniflora* in human leukocytes and erythrocytes. The authors observed that the leaves of *E. uniflora* do not present cytotoxicity and genotoxicity to human cells at the concentrations tested (1–480 mg/mL). They also showed that the extract inhibited the free radical 2,2 diphenyl — 1-picrilhydrazine (DPPH), in comparison with the ascorbic acid used as standard, suggesting that the chemical constituents in the plant extract reacted slowly with the DPPH radical, presenting antioxidant activity. The ethanolic extract of *E. uniflora* presented some polyphenolic compounds with high content, such as quercetin, quercitrin, isoquertin, luteolin and elagic acid, which may be at least partly responsible for its beneficial effects (CUNHA et al., 2016).

BAGETTI (2009) and BAGETTI et al. (2011) analyzed the antioxidant capacity of the *E. uniflora* pulp (purple, red and orange) from Rio Grande do Sul, Brazil, and found that the orange pulps had a higher antioxidant effect than the red color pulps, and it was rich in carotenoids, while those of purple color presented a higher content of total phenolics, anthocyanins and high antioxidant activity, being considered as a source of bioactive compounds. According to MATSUMURA et al. (2000), these natural compounds present in the *E. uniflora* produce beneficial effects to the organism such as anti-inflammatory activity.

SOBRAL-SOUZA et al. (2014) evaluated *in vitro* the antioxidant activity of *E. uniflora* and *Psidium sobraleanum* extracts by 2,2-diphenyl-1-picryl-hydrazila (DPPH) and thiobarbituric acid reactive substances (TBARS), besides quantifying phenols and flavonoids, demonstrating the protective effect of these compounds on heavy metals in cells of *Escherichia coli* and *Candida albicans*. The authors observed that the ethanolic extract of *E. uniflora* presented better antioxidant activity for the TBARS test with egg phospholipid, reducing the basal levels in the process of lipid peroxidation.

On the other hand, the hydroalcoholic extract of *P. sobraleanum* showed to be more efficient with significant inhibition in all the concentrations used, having as best result the concentrations of 40 and 10 μg/mL, when the oxidative stress was induced with the aid of iron sulphate II. For the evaluation of the protective effect, the authors concluded that the extracts, when in conjunction with iron II sulphate concentrations, did not present cytoprotective activity *in vitro*, and did not interfere in the bacterial strains survival profile (SOBRAL-SOUZA et al., 2014). HENTZE et al. (2004) point out that in most prokaryotic cells, as well as in eukaryotic cells, iron is an essential element for survival and propagation, presenting as a diverse group of hemoproteins involved in oxygen transport and storage, transfer of electrons and deoxyribonucleic acid (DNA) synthesis.

The total carotenoid and phenolic contents of the mature and semi-ripe *E. uniflora* fruits were determined spectrophotometrically. In mature purple cherry and in its film the anthocyanins, flavonols and total carotenoids were also determined. Phenolic compounds and total carotenoids in mature purple *E. uniflora* are found at higher levels than in red *E. uniflora* at the same maturation stage (LIMA et al., 2002).

VICTORIA et al. (2012), in their study, verified the antioxidant activity of *E. uniflora* essential oil administered orally in rats, showing that there was reduction of lipid peroxidation in rat kidney and antioxidant activity.

VELÁZQUEZ et al. (2003) carried out a study to prove the antioxidant properties of six plants used in popular medicine in Paraguay, including *E. uniflora*. In order to perform the experiment, the authors used rats that received the methanolic extract of aerial parts of the plants, in order to check the scavenger capacity of free radicals and their antioxidant activity. The results of the study led the authors to consider that the leaves of *E. uniflora* present high inhibitory activity of lipid peroxidation, superoxide ions and potent efficacy in the reduction of free radical 2,2 diphenyl — 1-picrilhydrazine (DPPH).

Another study, carried out by LUZIA et al. (2010), confirmed that the *E. uniflora* seeds have high antioxidant potential. Using the ethanolic extract of *E. uniflora* seeds, the authors demonstrated values of maximum antioxidant activity and

EC50 (concentration sufficient to obtain 50% of the maximum effect, estimated at 100%) of 92.15% and 30.72 $mg.mL^{-1}$, respectively. The phytochemical studies showed that the seeds had a high amount of total phenolic compounds.

According to OLIVEIRA et al. (2009), compounds with antioxidant action are known for their bioactive properties and include vitamins C and E, carotenoids, polyphenols, furanoids and thiols. *E. uniflora* is one of the fruits that have higher levels of total carotenoids (CAVALCANTE, 1991).

## Plant protection effect

In recent years, the search for more sustainable alternatives in agricultural production has led many plant protection studies to evaluate the potential of medicinal plant derivatives in disease control, both for their direct effect on potential phytopathogens and for inducing defense mechanisms in plants (ITAKO et al., 2008; OOTANI et al., 2013).

The information on the effect of *E. uniflora* is still scarce in this sense. In one of the few studies, MAZARO et al. (2008) tested the potential of the *E. uniflora* plant on the induction of phytoalexins in soybean cotyledons (*Glycine max*). Besides the alcoholic extract, infusion, maceration and decoction were used. With the leaves of crocuses, it used the concentrations of 0.1; 1; 10 and 40%, in addition to essential oil. Water was used as control and chitosan (1%) as resistance inducer. The phytoalexins were able to induce phytoalexins in soybean cotyledons, responding to higher concentrations of the preparations. The essential oil presented a remarkable effect on the induction of phytoalexins, and it was superior to the other preparations.

MARQUES (2014) evaluated the potential of extracts and essential oil of *E. uniflora* in the control of *Sclerotinia sclerotiorum*, causal agent of the disease known as white mold. The author observed a direct inhibitory effect of *E. uniflora* derivatives on phytopathogen growth, as well as inhibition of necrosis formation in common bean leaves at 48 hours after inoculation. In addition, the inducing activity of the plant-related proteins of the plants chitinases, β-1,3-glucanase, phenylalanine ammonia-lyase, peroxidases, and polyphenoloxidases was demonstrated, indicating the presence of bioactive molecules capable of reducing the severity of this disease in common bean.

The inducer effect of *E. uniflora* was demonstrated by XIN et al. (2012) in rice cultivation. The authors observed activity of linalool, a compound commonly found in essential oil of *E. uniflora*, as a defense inducer in rice in herbivory situations.

Studies by DOTTO et al. (2014) did not obtain promising results with hydroalcoholic extracts of *E. uniflora* leaves, marigold flowers (*Calendula officinalis*) and floral clove of India (*Syzygium aromaticum*) and Bordeaux syrup, applied in the strawberry preharvest on the induction of resistance to post-harvest diseases.

## Insecticide action

Although pyrantharine derivatives have been reported with a potential bioactive effect on arthropods, research on their insecticidal action is still scarce. JUNG et al. (2013), in their work, evaluated the insecticidal activity of the Bordeaux syrup tree, in the concentration of alcoholic extract to 10%, noting a significant effect on the mortality of *Atta laevigata* Smith of 84.6% when compared with the control.

SOUZA et al. (2008) evaluated the bioprospection of insecticidal substances native to the state of Mato Grosso do Sul, Brazil, analyzing the insecticidal effect of 10% Bordeaux syrup extract on adults of the weevil (*Sitophilus zeamais*), observing that on the fifth and tenth day after application of treatment there was mortality of adults around 20 and 30%, respectively.

A study by PEGORINI (2016), about different concentrations of *E. uniflora* essential oil (0, 0.25, 0.50, 0.75% 1.0, 1.25 and 1.5%) on larvae and adults of *Alphitobius diaperinus* Panzer (Coleoptera: Tenebrionidae) *in vitro*, observed that *E. uniflora* essential oil at 0.75% concentration caused 70.83% mortality in the larvae, not differing from the concentration of 1% that caused 50% mortality. For adults, there was no evidence of insecticidal action at the concentrations tested.

## Anti-helminth effect

Worm infestation in sheep is one of the main causes of mortality, which causes high losses in sheep rearing in Brazil. HASSUM et al. (2013) found a promising result in the concentration of 200 $mg.mL^{-1}$ of the *E. uniflora* extract, contributing to reduce the number of nematode larvae of the genus *Trichostrongylus* of gastrointestinal action to the species *Haemonchus contortus*, considered difficult to control by anthelmintic, available in the market. Therefore, the plant stands out as a bioactive plant with potential to be further researched and exploited.

OLIVEIRA (2003), studying the efficacy of different medicinal plants in the control of endoparasites of sheep, found that the combination of the plants *Campomanesia guazumifolia* (Camb.) Berg. + *Eugenia uniflora* L. + *Polygonum punctatum* Ell., administered orally in sheep, showed efficacy in reducing the production of eggs of the super family Trichostrongyloidea of 63.52% and *Strongyloides* of 86.58% on the $14^{th}$ day after its application, thus contributing with lower levels of contamination in the pastures. It was also verified reduction of adult helminths of the genus *Ostertagia*, *Trichostrongylus*, *Cooperia* and *Strongyloides*.

Research by DIAS DE CASTRO (2014) verified the *in vitro* anthelmintic action of the aqueous and hydroalcoholic extract of *E. uniflora* on gastrointestinal nematodes of ruminants. The authors point out that the hydroalcoholic extract was more promising in inhibiting the hatchability of *Haemonchus contortus* (between 20.35 and 99.75%) when compared to aqueous extracts, in which inhibition of nematodes varied from 14.56 to 76.04%.

With the objective of investigating compounds that are more effective in reducing the incidence of the protozoan belonging to the genus *Leishmania*, which causes cutaneous Leishmaniasis, RODRIGUES et al. (2013) investigated the potential of *E. uniflora* essential oil under the parasite forms of *Leishmania*, promastigote and amastigote, the mechanism of action and its cytotoxicity under these microorganisms. The authors concluded that essential oil extracted from the leaves of the *E. uniflora*, characterized by containing sesquiterpenes, has anti-*Leishmania* activity in both forms of the protozoan (amastigote and promastigote). In the determination of cytotoxicity, *E. uniflora* essential oil was 20 times more toxic for *Leishmania* amastigote forms than for phagocytic cells called macrophages.

## Final considerations

There is still little information on the bioactive effects of *E. uniflora* in terms of plant protection and antifungal, antiviral and insecticidal activity. However, the results already obtained and the different properties and purposes of derivatives of this plant indicate its use potential and the importance regarding further studies on it.

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## REFERENCES

ALVES, E.S.; TRESMONDI, F.; LONGUI, E.L. Análise estrutural de folhas de *Eugenia uniflora* L. (Myrtaceae) coletadas em ambientes rural e urbano, SP, Brasil. *Acta Botanica Brasileira*, v.22, n.1, p.241-248, 2008. http://dx.doi.org/10.1590/S0102-33062008000100023

AMORIM, A.C.L.; LIMA, C.K.F.; HOVELL, A.M.C.; MIRANDA, A.L.P.; REZENDE, C.M. Antinociceptive and hypothermic evaluation of the leaf essential oil and isolated terpenoids from *Eugenia uniflora* L. (Brazilian Pitanga). *Phytomedicine*, v.16, n.10, p.923-928, 2009. 10.1016/j.phymed.2009.03.009

AURICCHIO, M.T.; BACCHI, E.M. Folhas de *Eugenia uniflora* L. (pitanga): Revisão. *Revista do Instituto Adolfo Lutz*, v.62, n.1, p.55-61, 2003.

______.; BUGNO, A.; BARROS, S.B.M.; BACCHI, E.M. Atividades antimicrobiana e antioxidante e toxicidade de *Eugenia uniflora*. *Latin American Journal Pharmacy*, v.26, n.1, p.76-81, 2007.

AZEVEDO, M.L.; CHIM, J.F.; SILVA, J.A. Avaliação do potencial antioxidante de extratos de Pitanga (*Eugenia uniflora* L.) obtidos com diferentes solventes. In: ENCONTRO DE PÓS-GRADUAÇÃO, 12., 2010, Pelotas. *Anais...* Pelotas: UFPEL, 2010.

BAGETTI, M. *Caracterização físico-química e capacidade antioxidante de pitanga* (Eugenia uniflora *L.*). 2009. 84p. Dissertação (Mestrado em Tecnologia de Alimentos) – Universidade Federal de Santa Maria, Santa Maria, 2009.

______.; FACCO, E.M.P.; PICCOLO, J.; HIRSCH, G.E.; RODRIGUEZ-AMAYA, D.; KOBORI, C.N.; VIZZOTTO, M.; EMANUELLI, T. Physicochemical characterization and antioxidante capacity of pitanga fruits (*Eugenia uniflora* L.). *Ciência e Tecnologia de Alimentos*, v.31, n.1, p.147-154, 2011. http://dx.doi.org/10.1590/S0101-20612011000100021

BASER, K.H.C.; BUCHBAUER, G. *Handbook of essential oils:* science, technology, and applications. Boca Raton: CRC Press, 2010.

BEZERRA, J.E.F.; SILVA JUNIOR, J.F.; LEDERMAN, I.E. *Série Frutas Nativas —Pitanga (Eugenia uniflora L.)*. Jaboticabal: FUNEP, 2000. p. 2-6.

BIANCHINI, E.; POPOLO, R.S.; DIAS; M.C.; PIMENTA, J.A. Diversidade e estrutura de espécies arbóreas em área alagável do município de Londrina, sul do Brasil. *Acta Botanica Brasilica*, v.17, n.3, p.405-419, 2003. http://dx.doi.org/10.1590/S0102-33062003000300008

BOTREL, R.T.; OLIVEIRA-FILHO, A.T.; RODRIGUES, L.A.; CURI, N. Influência do solo e topografia sobre as variações da composição florística e estrutura da comunidade arbóreo-arbustiva de uma floresta estacional semidecidual em Ingaí, MG. *Revista Brasileira Botânica*, v.25, n.2, p.195-213, 2002.

BRAITHWAITE, M.C.; TYAGI, C.; TOMAR, L.K.; KUMAR, P.; CHOONARA, Y.E.; PILLAY, V. Nutraceutical-based therapeutics and formulation strategies augmenting their efficiency to complement modern medicine: an overview. *Journal of Functional Foods*, v.6, p.82-99, 2014.

CARVALHO, P.E.R. *Espécies arbóreas brasileiras*. v.2. Brasília, DF: Embrapa Informação Tecnológica; Colombo: Embrapa Florestas, 2006.

CATÃO, M.H.C.V.; SILVA, M.S.P.; SILVA, A.D.L.; COSTA, R.O. Estudos clínicos com plantas medicinais no tratamento de afecções bucais: uma revisão de literatura. *UNOPAR Cient Ciênc Biol Saúde*, v.14, n.4, p.279-285, 2012. http://dx.doi.org/10.17921/2447-8938.2012v14n4p%25p

CHAVASCO, J.M.; FELIPHE, B.H.M.P.; CERDEIRA, C.D.; LEANDRO, F.D.; COELHO, L.F.L.; SILVA, J.J.; CHAVASCO, J.K.; DIAS, A.L.T. Evaluation of antimicrobial and cytotoxic activities of plant extracts from Southern Minas Gerais Cerrado. *Revista do Instituto de Medicina Tropical de São Paulo*, v.56, n.1, p.13-20, 2014. http://dx.doi.org/10.1590/S0036-46652014000100002

CAVALCANTE, M.L. *Composição de carotenóides e valor de vitamina A em pitanga (Eugenia uniflora L.) e acerola (Malpighia glabra L.)*. 1991. 73p. Dissertação (Mestrado) – Instituto de Nutrição, Centro de Ciências da Saúde, Universidade Federal do Rio de Janeiro, Rio de Janeiro, 1991.

CONSOLINI, A.E.; SARUBBIO, M.G. Pharmacological effects of *Eugenia uniflora* (Myrtaceae) aqueous crude extract on rats heart. *Journal of Ethnopharmacology*, v.81, n.1, p.57-63, 2002.

COSTA, D.P.; ALVES FILHO, E.G.; SILVA, L.M.A.; SANTOS, S.C.; PASSOS, X.S.; SILVA, M.R.R.; SERAPHIN, J.C.; FERRI, P.H. Influence of fruit biotypes on the chemical composition and antifungal activity of the essential oils of *Eugenia uniflora* leaves. *Journal of the Brazilian Chemical Society*, v.21, n.5, p.851-858, 2010. http://dx.doi.org/10.1590/S0103-50532010000500012

______.; SANTOS, S.C.; SERAPHIN, J.C.; FERRI, P.H. Seasonal variability of essential oils of *Eugenia uniflora* leaves. *Journal of the Brazilian Chemical Society*, v.20, n.7, 2009. http://dx.doi.org/10.1590/S0103-50532009000700013

COUTO, R.O.; VALGAS, A.V.; BORA, M.T.F.; PAULA, J.R. Caracterização físico-química do pó das folhas de *Eugenia dysenterica* dc. (Myrtaceae). *Revista Eletrônica de Farmácia*, v.6, n.3, p.59-69, 2009. https://doi.org/10.5216/ref.v6i3.7651

CUNHA, F.A.B.; WACZUK, E.P.; DUARTE A.E.; BARROS L.M.; ELEKOFEHINTI, O.O.; MATIAS, E.F.F.; DA COSTA, J.G.M.; SANMI, A.A.; BOLIGON, A.A.; ROCHA, J.B.T; SOUZA, D.O.; POSSER, T.; COUTINHO, H.D.M.; FRANCO, J.L.; KAMDEM, J.P. Cytotoxic and antioxidative potentials of ethanolic extract of *Eugenia uniflora* L. (Myrtaceae) leaves on human blood cells. *Biomedicine & Pharmacotherapy*, v.84, p.614-621, 2016. doi: 10.1016/j.biopha.2016.09.089

DIAS DE CASTRO, L.L. *Avaliação do potencial anti-helmíntico de* Origanum vulgare *e* Eugenia uniflora *em nematódeos gastrointestinais de ruminantes*. 2014. 44f. Dissertação (Mestrado em Veterinária) – Universidade Federal de Pelotas, Pelotas, 2014.

DOTTO, M.; PIROLA, K.; WACLAWOVSKY, A.J.; MAZARO, S.M.; WAGNER JUNIOR, A. Pre-harvest application of plant extracts on strawberry. *Revista Brasileira de Agroecologia*, v.9, n.1, p.240-247, 2014.

FIUZA, T.S.; REZENDE, M.H.; SABÓIA-MORAIS, S.M.T.; BARA, M.T.F.; TRESVENZOL, L.M.F.; PAULA, J.R. Caracterização farmacognóstica das folhas de *Eugenia uniflora* L. (Myrtaceae). *Revista Eletrônica de Farmácia*, v.5, n.2, p.1-11, 2008. https://doi.org/10.5216/ref.v5i2.5148

FURLAN, C.M.; SANTOS, D.Y.A.C.; SALATINO, A.; DOMINGOS, M. n-Alkane distribution of leaves of *Psidium guajava* exposed to industrial air pollutants. *Environmental and Experimental Botany*, v.58, n.1-3, p.100-105, 2006. DOI: 10.1016/j.envexpbot.2005.06.020

HASSUM, I.C.; VENTURI, C.R.; GOSMANN, G.; DEIRO, A.M.G. Ação dos extratos de quatro plantas sobre larvas infectantes de nematoides gastrintestinais de ovinos. *Revista Cubana de Plantas Medicinales*, v.18, n.2, 2013.

HENTZE M.W.; MUCKENTHALER, M.U.; ANDREWS, N.C. Balancing acts: molecular control of mammalian iron metabolism. *Cell*, v.117, n.3, p.285-297, 2004.

HEYWOOD, V.H.; BRUMMIT, R.K.; CULHAM, A.;SEBERG, O. *Flowering plant families of the world*. Richmond Hill: Firefly Books, 2007. p. 225-226.

HOLETZ, F.B.; PESSINI, G.L.; SANCHES, N.R.; CORTEZ, D.A.; NAKAMURA, C.V.; DIAS FILHO, B.P. Screening of some plants used in the Brazilian folk medicine for the treatment of infectious diseases. *Memórias do Instituto Oswaldo Cruz*, v.97, n.7, p.1027-1031, 2002. http://dx.doi.org/10.1590/S0074-02762002000700017

ITAKO, A.T.; SCHWAN-ESTRADA, K.R.F.; TOLENTINO JÚNIOR, J.B.; STANGARLIN, J.R.; CRUZ, M.E. Atividade antifúngica e proteção de tomateiro por extratos de plantas medicinais. *Tropical Plant Pathology*, v.33, n.3, p.241-244, 2008. http://dx.doi.org/10.1590/S1982-56762008000300011

JUNG, P.H.; SILVEIRA, A.C.; NIERI, E.M.; POTRICH, M.; SILVA, E.R.L.; REFATTI, M. Atividade Inseticida de *Eugenia uniflora* L. e *Melia azedarach* L. sobre *Atta laevigata* Smith. *Floresta e Ambiente*, v.20, n.2, p.191-196, 2013. http://dx.doi.org/10.4322/floram.2013.015

KANAZAWA, A.; PATIN, A.; GREENE, A.E. Efficient highly enantioselective synthesis of Selina-1.3.7.(11)-trien-8-one, a major component of the essential oil of *Eugenia uniflora*. *Journal of Natural Products*, v.63, p.1292-1294, 2000.

LIMA, V.L.A.G.; MÉLO, E.A.; LIMA, D.E.S. Fenólicos e carotenóides totais em pitanga. *Scientia Agricola*, v.59, n.3, p.447-450, 2002. http://dx.doi.org/10.1590/S0103-90162002000300006

LORENZONI, L.S.; BERNARDO, F.PA.; MOULIN, T.; GANDINE, S.M.S.; SOUZA, T.S. de. Utilização do extrato bruto de *Eugenia uniflora L*. (Pitanga) em teste antibacteriano in vitro. In: INIC ENCONTRO LATINO AMERICANO DE INICIAÇÃO CIENTIFICA, 15.; EPG ENCONTRO LATINO AMERICANO DE PÓS-GRADUAÇÃO, 11.; ENCONTRO LATINO AMERICANO DE INICIAÇÃO CIENTÍFICA JÚNIOR, 5. *Anais...* Espírito Santo: IFECT-ES, 2012.

LUZIA, D.M.M.; BERTANHA, B.J.; JORGE, N. Sementes de pitanga (*Eugenia uniflora* L.): potencial antioxidante e perfil de ácidos graxos. Pitanga (*Eugenia uniflora* L.). *Revista do Instituto Adolfo Lutz*, v.69, n.2, p.175-180, 2010.

MAGINA, M.D.A.; DALMARCO, E.D.; WISNIEWSKI JR, A.; SIMIONATTO, E.L.; DALMARCO, J.B.; PIZZOLATTI, M.G.; BRIGHENTE, I.M.C. Chemical composition and antibacterial activity of essential oils of *Eugenia* species. *Journal of Natural Medicines*, v.63, n.3, p.345-350, 2009. DOI: 10.1007/s11418-009-0329-5

MATSUMURA, T.; KASAI, M.; HAYASHI, T.; ARISAWA, M.; MOMOSE, Y.; ARAI, I.; AMAGAYA S.; KOMATSU Y. a-Glucosidase inhibitors from Paraguayan natural medicine, Nangapiry, the leaves of *Eugenia uniflora*. *Pharmaceutical Biology*, v.38, n.4, p.302-307, 2000. doi: 10.1076/1388-0209(200009)3841-AFT302.

MAZARO, S.M.; CITADIN, I.; GOUVÊA, A.; LUCKMANN, D.; GUIMARÃES, S.S. Indução de fitoalexinas em cotilédones de soja em resposta a derivados de folhas de pitangueira. *Ciência Rural*, v.38, n.7, p.1824-1829, 2008. http://dx.doi.org/10.1590/S0103-84782008000700004

MARGIS, R.; FELIX, D.; CALDAS, F.J.; SALGUEIRO, F.; DE ARAUJO, D.S.D.; BREYNE, P.; MONTAGU, M.V.; OLIVEIRA, D.; MARGIS-PINHEIRO, M. Genetic differentiation among three neighboring Brazil Cherry (*Eugenia uniflora* L.) populations within the Brazilian Atlantic rain forest. *Biodiversity & Conservation*, v.11, n.1, p.149-163, 2002. https://doi.org/10.1023/A:1014028026273

MARQUES, J.S. *Compostos ativos de folhas de Eugenia uniflora e seus efeitos contra o mofo branco causado por Sclerotinia sclerotiorum em plantas de feijoeiro*. 2014. 81f. Dissertação (Mestrado em Biologia) ⊠ Universidade Federal de Goiás, Goiânia, 2014.

MARTINEZ-CORREA, H.A.; MAGALHÃES, P.M.; QUEIROGA, C.L.; PEIXOTO, C.A.; OLIVEIRA, A.L.; CABRAL, F.A. Extracts from pitanga (*Eugenia uniflora* L.) leaves: influence of extraction process on antioxidant properties and yield of phenolic compounds. *The Journal of Supercritical Fluids*, v.55, n.3, p.998-1006,. 2011.

MELO, R.M.; CORRÊA, V.F.S.; AMORIM, A.C.L.; MIRANDA, A.L.P.; REZENDE, C.M. Identification of impact aroma compounds in *Eugenia uniflora* L. (Brazilian Pitanga) leaf essential oil. *Journal of the Brazilian Chemical Society*, v.18, n.1, p.179-183, 2007. http://dx.doi.org/10.1590/S0103-50532007000100020

MICHEL, F.; BONNEFONT-ROUSSELOT, D.; MAS, E.; DRAI, J.; THÉROND, P. Biomarkers of lipid peroxidation: analytical aspects. *Annales de Biologie Clinique*, v.66, n.6, p.605-620, 2008. DOI: 10.1684/abc.2008.0283

NASCIMENTO, A.L.D.R. Ação antimicrobiana do extrato de *Eugenia uniflora* L. (Pitanga) sobre *Staphylococcus aureus Pseudomonas aeroginosa e Escherichia coli*. 2013. 27f. Trabalho de Conclusão de Curso (Graduação em Farmácia) – Universidade Estadual da Paraíba, Campina Grande, 2013.

OGUNWANDE, I.A.; OLAWORE, N.O.; EKUNDAYO, O.; WALKER, T.M.; SCHMIDT, J.M.; SETZER, W.N. Studies on the essential oils composition, antibacterial and cytotoxicity of *Eugenia uniflora* L. *International Journal Aromatherapy*, v.15, n.3, p.147-152, 2005. DOI: 10.1016/j.ijat.2005.07.004

OLIVEIRA, A.L.; LOPES, R.B.; CABRAL, F.A.; EBERLIN, M.N. Volatile compounds from pitanga fruit (*Eugenia uniflora* L.). *Food Chemistry*, v.99, n.1, p.1-5, 2005.

OLIVEIRA, C.B.; SOARES, D.G.S.; PAULO, M.Q.; PADILHA, W.W.N. Atividade Antimicrobiana *in vitro* da *Eugenia uniflora L.* (Pitanga) sobre Bactérias Cariogênicas. *Revista Brasileira de Ciências da Saúde*, v.12, n.3, p.239-250, 2008.

OLIVEIRA, A.C.; VALENTIM, I.B.; GOULART, M.O.F.; SILVA, C.A.; BECHARA, E.J.H.; TREVISAN, M.T.S. Fontes vegetais naturais de antioxidantes. *Química Nova*, São Paulo, v.32, n.3, p.689-702, 2009.

OLIVEIRA, P.S.; CHAVES, V.C.; BONA, N.P.; SOARES, M.S.P.; CARDOSO, J.S.; VASCONCELLOS, F.A.; TAVARES, R.G.; VIZZOTTO, M.; SILVA, L.M.C.D; GRECCO, F.B.; GAMARO, G.D.; SPANEVELLO, R.M.; LENCINA, C.L.; REGINATTO, F.H.; STEFANELLO, F.M. *Eugenia uniflora* fruit (red type) standardized extract: a potential pharmacological tool to diet-induced metabolic syndrome damage management. *Biomedicine & Pharmacotherapy*, v.92, p.935-941, 2017. doi: 10.1016/j.biopha.2017.05.131

OLIVEIRA, R.G. *Avaliação in vivo da ação anti-helmíntica de plantas consideradas medicinais como recurso potencial no controle de endoparasitos gastrintestinais de ovinos.* 2003. 153f. Dissertação (Mestrado) — Universidade Federal do Rio Grande do Sul, Faculdade de Veterinária, Programa de Pós-Graduação em Ciências Veterinárias, Porto Alegre, 2003.

OOTANI, M.A.; AGUIAR, R.W.; RAMOS, A.C.C.; BRITO, D.R.; SILVA, J.B.; CAJAZEIRA, J.P. Use of essential oils in agriculture. *Journal of Biotechnology and Biodiversity*, v.4, n.2, p.162-174, 2013.

ÖZEN, T.; DEMIRTAS, I.; AKSIT, H. Determination of antioxidant activities of various extracts and essential oil compositions of *Thymus praecox* subsp. *skorpilii* var. *skorpilii*. *Food Chemistry*, v.124, n.1, p.58-64, 2011. DOI: 10.1016/j.foodchem.2010.05.103

PINA, J.M.; MORAES, R.M. Ozone-induced foliar injury in saplings of *Psidium guajava* 'Paluma' in São Paulo, Brazil. *Chemosphere*, v.66, v.7, p.1310-1314, 2007. DOI: 10.1016/j.chemosphere.2006.07.021

PEGORINI, C.S. *Associação do óleo essencial de* Eugenia uniflora *e* Bacillus thuringiensis *sobre* Alphitobius diaperinus *(Panzer) (Coleop.: Tenebrionidae)*. 2016. 64f. Dissertação (Mestrado em Zootecnia) – Universidade Tecnológica Federal do Paraná, Dois Vizinhos, 2016.

PINTO, J.R.R.; OLIVEIRA-FILHO, A.T.; HAY, J.D.V. Influence of soil and topography on the composition of a tree community in a central Brazilian valley Forest. *Edinburgh Journal of Botany*, v.62, n.1-2, p.69-90, 2005. https://doi.org/10.1017/S0960428606000035

RATTMANN, Y.D.; SOUZA, L.M.; MALQUEVICZ-PALVA, S.M.; DARTORA, N.; SASSAKI, L.; GORIN, P.A.J.; IACOMINI, M. Analysis of flavonoids from Eugenia uniflora leaves and its protective effect against murine sepsis. *Evidence-Based Complementary and Alternative Medicine*, v.2012, Article ID 623940, 9 p., 2012. doi: http://dx.doi.org/10.1155/2012/623940

RODRIGUES, K.A.F.; AMORIM, L.V.; OLIVEIRA, J.M.G.; DIAS, C.N.; MORAES, D.F.C.; ANDRADE, E.H.A.; MAIA, J.G.S.; CARNEIRO, S.M.P.; CARVALHO, F.A.A. *Eugenia uniflora* L. Essential oil as a potential anti-leishmania agent: effects on *leishmania amazonensis* and possible mechanisms of action. *Evidence-Based Complementary and Alternative Medicine*, v.2013, Article ID 279726, 10 p. 2013. http://dx.doi.org/10.1155/2013/279726

RODRIGUES, R.R.; NAVE, A.G. Heterogeneidade florística das matas ciliares. In: RODRIGUES, R.R.; LEITÃO FILHO, H.F. (Eds.). *Matas ciliares.* São Paulo: EDUSP, 2000. p. 45-71.

SANTOS, F.R.; BRAZ-FILHO, R.; CASTRO, R.N. Influência da idade das folhas de *Eugenia uniflora* L. na composição química do óleo essencial. *Química Nova*, v.38, n.6, p.762-768, 2015. http://dx.doi.org/10.5935/0100-4042.20150072

SCALON, S.P.Q.; SCALON FILHO, H.; RIGONI, M.R.; VERALDO, F. Germinação e crescimento de mudas de pitangueira (*Eugenia uniflora* L.) sob condições de sombreamento. *Revista Brasileira de Fruticultura*, v.23, n.3, p.652-655, 2001. http://dx.doi.org/10.1590/S0100-29452001000300042

SCHAPOVAL, E.E.; SILVEIRA, S.M.; MIRANDA, M.L.; ALICE, C.B.; HENRIQUES, A.T. Evaluation of some pharmacological activities of *Eugenia uniflora* L. *Journal of Ethnopharmacology*. v.44, n.3, p.137-142, 1994.

SILVA, N.C.C. *Estudo comparativo da ação antimicrobiana de extratos e óleos essenciais de plantas medicinais e sinergismo com drogas antimicrobianas.* Dissertação (Mestrado em Biologia de Parasitas e Microrganismos) – Universidade Estadual Paulista “Júlio de Mesquita Filho”, Botucatu, 2010.

SOBEH, M.; BRAUN, M.S.; KRSTIN, S.; YOUSSEF, F.S.; ASHOUR, M.L.; WINK, M. Chemical profiling of the essential oils of *Syzygium aqueum*, *Syzygium samarangense* and *Eugenia uniflora* and their discrimination using chemometric analysis. *Chemistry & Biodiversity*, v.13, n.11, p.1537-1550, 2016. doi: 10.1002/cbdv.201600089

SOBRAL-SOUZA, C.E.; LEITE, N.F.; CUNHA, F.A.B.; PINHO, A.I.; COSTA, J.G.M.; COUTINHO, H.D.M. Avaliação da atividade antioxidante e citoprotetora dos extratos de *Eugenia uniflora Lineau* e *Psidium sobraleanum* Proença & Landrum contra metais pesados. *Revista Ciencias de la Salud*. v.12, n.3, p.401-409, 2014. http://dx.doi.org/10.12804/revsalud12.03.2014.08

SOOD, R.; SWARUP, D.; BATHIA, S.; KULKARNI, D.D.; DEY, S.; SAINI, M.; DUBEY, S.C. Antiviral activity of crude extracts of *Eugenia jambolana* Lam. against highly pathogenic avian influenza (H5N1) virus). *Indian Journal of Experimental Biology*, v.50, n.3, p.179-186, 2012.

SOUZA, A.P.; MARQUES, M.R.; MAHMOUD, T.S.; CAPUTO, B.A.; CANHETE, G.M.; LEITE, C.B.; LIMA, D.P. Bioprospecção de substâncias inseticidas de plantas nativas de Mato Grosso do Sul, Brasil. *Acta Botanica Brasilica*, v.22, n.4, p.1136-1140, 2008. http://dx.doi.org/10.1590/S0102-33062008000400024

THAMBI, M.; TAVA, A.; MOHANAKRISHNAN, M.; SUBBURAJ, M.; PRADEEPKUMAR, K.M.; SHAFI, P.M. Composition and antimicrobial activities of the essential oil from *Eugenia uniflora* L. leaves growing in India. *International Journal Pharma and Biomedical Sciences*, v.4, n.1, p.46-49, 2013.

VELÁZQUEZ, E.; TOURNIER, H.A.; MORDUJOVICH DE BUSCHIAZZO, P.; SAAVEDRA, G.; SCHINELLA, G.R. Antioxidant activity of Paraguayan plants extracts. *Fitoterapia*, v.74, n.1-2, p.91-97, 2003.

VICTORIA, F.N.; LENARDÃO, E.J.; SAVEGNAGO, L.; PERIN, G.; JACOB, R.G.; ALVES, D.; DA SILVA, W.P.; DA MOTTA ADE, S.; NASCENTE, P.S. Essential oil of the leaves of *Eugenia uniflora* L. antioxidant and antimicrobial properties. *Food and Chemical Toxicology*, v.50, n.8, p.2668-2674, 2012. 10.1016/j.fct.2012.05.002

______.; ANVERSA, R.G.; SAVEGNAGO, L.; LENARDÃO, E.J. Essential oils of *E. uniflora* leaves protect liver injury induced by acetaminophen. *Food Bioscience*, v.4, p.50-57, 2013. https://doi.org/10.1016/j.fbio.2013.09.001

WEYERSTAHL, P.; MARSSCHALL-WEYERSTAHL, H.; CHRISTIANSEN, C.; OGUNTIMEIN, B.O.; ADEOYE, A.O. Volatile constituents of *Eugenia uniflora* leaf oil. *Planta Medica*, v.54, n.6, p.546-549, 1988.

WILSON, P.G. Myrtaceae. In: KUBITZKI, K. (Ed.). *Flowering plants. Eudicots:* The families and genera of vascular plants. v.10. Berlin; Heidelberg: Springer-Verlag, 2011. p.212-271.

XIN, Z.; YU, Z.; ERB, M.; TURLINGS, T.C.; WANG, B.; QI, J.; LIU, S.; LOU, Y. The broad-leaf herbicide 2, 4-dichlorophenoxyacetic acid turns rice into a living trap for a major insect pest and a parasitic wasp. *The New Phytologist*, v.194, n.2, p.498-510, 2012. doi: 10.1111/j.1469-8137.2012.04057.x