Biological activity of the Euphorbiaceae and Moraceae families of medicinal plants present in the Northern Coast of Colombia: worldwide overview and their therapeutic potential

Atividade biológica das famílias de plantas medicinais Euphorbiaceae e Moraceae da Costa Norte da Colômbia: visão geral global e seu potencial terapêutico

Actividad biológica de las familias Euphorbiaceae y Moraceae de plantas medicinales presentes en la Costa Norte de Colombia: panorama mundial y su potencial terapéutico

Submitted: May 24th, 2024
Approved: Jun 14th, 2024

Fredys Sánchez-Hoyos
Master in Pharmaceutical Sciences
Institution: Advanced Center for Chronic Diseases, Faculty of Chemical and Pharmaceutical Sciences, University of Chile
Medicinal Organic Chemistry Research Group, Faculty of Pharmaceutical Sciences, University of Cartagena
Address: Santiago, Chile
E-mail: fsanchezh@unicartagena.edu.co

Jorge Sánchez-Hoyos
Graduate in Biology
Institution: Medicinal Organic Chemistry Research Group, Faculty of Pharmaceutical Sciences, University of Cartagena
Address: Cartagena, Colombia
E-mail: jsanchezh2@unicartagena.edu.co

Wendy Moreno-Díaz
Master in Biotechnology
Institution: Center for Oceanographic and Hydrographic Research of the Caribbean (CIOH)
Address: Cartagena, Colombia
E-mail: morenodiaz.w11@gmail.com

Ewaldo Zavala Urtecho
Master in Pharmacy and Biochemistry
Institution: Advanced Center for Chronic Diseases, Faculty of Chemical and Pharmaceutical Sciences, University of Chile
Address: Santiago, Chile
E-mail: zavurt_ed40@hotmail.com
ABSTRACT
The Euphorbiaceae and Moraceae families in Colombia are distributed along the northern coast of Colombia, have been traditionally used by native communities for different purposes, and represent a promising source of molecules with therapeutic activity, whose effectiveness has been verified internationally through biological assays. A systematic review of the existing literature was carried out and data on taxonomy, world distribution, phytocconstituents, ethnopharmacology and pharmacological activity of the Euphorbiaceae and Moraceae families were collected using several databases such as PubMed, CAplus, Medline, Latin America & Iberia database, Science Direct, Web of Science and Google Scholar, Abstracts. The pharmacological activities reported were antioxidant, anti-inflammatory, anti-hypertensive and antileishmanial. In conclusion, the Euphorbiaceae and Moraceae families are important producers of active metabolites with high impact on public health, which strengthens the Colombian Caribbean as a center for the generation of molecules for the pharmaceutical field.

Keywords: Euphorbiaceae, Moraceae, biological activity, pharmacology, phytocconstituents.

RESUMO
As famílias Euphorbiaceae e Moraceae na Colômbia estão distribuídas ao longo da costa norte da Colômbia, têm sido tradicionalmente usadas pelas comunidades nativas para diferentes fins e representam uma fonte promissora de moléculas com atividade terapêutica, cuja eficácia foi verificada internacionalmente por meio de ensaios biológicos. Foi realizada uma revisão sistemática da literatura existente e os dados sobre taxonomia, distribuição global, fitoconstituíntes, etnofarmacologia e atividade farmacológica das famílias Euphorbiaceae e Moraceae foram coletados usando vários bancos de dados, como PubMed, CAplus, Medline, Latin America & Iberia database, Science Direct, Web of Science e Google Scholar, Abstracts. As atividades farmacológicas relatadas foram antioxidantes anti-inflamatória, anti-hipertensiva e anti-
leishmanial. Em conclusão, as famílias Euphorbiaceae e Moraceae são importantes produtoras de metabólitos ativos com alto impacto na saúde pública, o que fortalece o Caribe colombiano como um centro para a geração de moléculas para o campo farmacêutico.

**Palavras-chave:** Euphorbiaceae, Moraceae, atividade biológica, farmacologia, fitoconstituintes.

**RESUMEN**
Las familias Euphorbiaceae y Moraceae en Colombia se distribuyen a lo largo de la costa norte de Colombia, han sido utilizadas tradicionalmente por las comunidades nativas para diferentes fines, representan una fuente promisora de moléculas con actividad terapéutica, cuya efectividad ha sido verificada a nivel internacional mediante ensayos biológicos. Se realizó una revisión sistemática de la literatura existente y se recopilaron datos sobre taxonomía, distribución mundial, fitoconstituyentes, etnofarmacología y actividad farmacológica de las familias Euphorbiaceae y Moraceae, utilizando varias bases de datos como PubMed, CAplus, Medline, Latin America & Iberia database, Science Direct, Web of Science y Google Scholar, Abstracts. Las actividades farmacológicas reportadas fueron antioxidantes, anti-inflamatorias, anti-hipertensivas y antileishmaniales. En conclusión, la familia Euphorbiaceae y Moraceae son importantes productoras de metabolitos activos con alto impacto en la salud pública, lo que fortalece al Caribe colombiano como centro de generación de moléculas para el campo farmacéutico.

**Palabras clave:** Euphorbiaceae, Moraceae, actividad biológica, farmacología, fitoconstituyentes.

**1 INTRODUCTION**

The therapeutic efficacy derived from the active principles of plants has contributed to the search for new molecules to treat some diseases (Chifa, 2010; Silva Azevedo et al., 2020). Around 250000 plant species represent the world's flora, 1% of which have been reported for traditional use (Chifa 2010; del Campo 2013). Different communities across the globe traditionally used plants to treat health problems, for food, and for daily life (Bussmann et al., 2010; Estrada et al., 2011; Cervantes Ceballos et al., 2017). Colombia has about 50000 plant species, and just around 3400 in the Caribbean are used in folk medicine (Beltrán Villanueva et al., 2013; Fonnegra- Gómez & Villa-Londoño, 2011).

Providing a window of many possibilities for obtaining new drugs for treating various pathologies that afflict society (Srivastava, 2018). Medicinal plants are an important source of new molecules that may have therapeutic applications in the pharmaceutical industry and primary healthcare. Currently, the pharmaceutical industry
is investigating these plants and their bioactive compounds in search of new drugs and therapies (Tungmunnithum et al., 2018). The discovery of promising molecules in medicinal plants may lead to the synthesis of similar or modified compounds, allowing for the mass production of these compounds for therapeutic use (Jain et al., 2019; Velu et al., 2018; Seca & Pinto, 2019). Additionally, the use of medicinal plants can be especially beneficial in rural and remote areas where healthcare services are limited. Many communities have developed traditional knowledge about medicinal plants and their use in treating various ailments. By supporting and promoting this knowledge, more accessible and effective healthcare solutions can be developed in these areas (Süntar 2020; Salmerón-Manzano, 2020; Balestrin et al., 2020).

A bibliographic review has been carried out on Euphorbiaceae and Moraceae to highlight their medicinal properties and therapeutic potential in disease treatment, taking into account the importance of the Colombian flora as a source of new medicines. This is due to the existence of scientific evidence supporting the presence of a large number of secondary metabolites such as flavonoids, tannins, phytosterols, alkaloids and others, which have shown promise and could have a positive impact on public health (Cavalcante et al., 2020; Kandar, 2021).

2 METHODOLOGY

The review was performed following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. We used the inclusion and exclusion criteria established by Cervantes-Ceballos et al., 2022 and modifications:

A systematic search in the catalog of plants and lichens of Colombia (http://catalogoplantasdecolombia.unal.edu.co/es/) was conducted to establish the number of species in the families Moraceae and Euphorbiaceae. Taking into account the Colombian Caribbean region, the following plant species were selected, creating a cluster of species that was subsequently added to the database (Peña-Lemus, 2020; Paton, 2013).

Websites where the names of the species mentioned in this review have a validated geographical distribution and are recognized in the following platforms: Taxonomic and Botanical World Plants (www.worldplants.de), World Flora Online (WFO) (http://www.worldfloraonline.org), World Checklist of Vascular Plants (WCVP) (https://wcvp.science.kew.org), Plants of the World Online (https://powo.science.kew.org), Tropicos (https://www.tropicos.org/home), and Tramil
Articles, abstracts, and university repositories that described phytoconstituents and implemented a clear methodology for obtaining extracts, fractions, compounds, and parts of the plant used. Additionally, they described pharmacological and biological aspects, using a clear methodology in the evaluation of doses, concentrations, biological models used, and controls.

3 GEOGRAPHIC DISTRIBUTION OF THE EUPHORBIACEAE AND MORACEAE FAMILIES IN COLOMBIA

The Euphorbiaceae and Moraceae families are distributed throughout the tropics in ecosystems ranging from humid to dry forests, located in xerophytic ecosystems and high mountains. In Colombia (Figure 1), the regions with more individuals within these two families are the Caribbean region, the Moraceae family distributed in the departments of Guajira, Cesar, Bolivar, and Cordoba, and the species of the Euphorbiaceae family in the departments of Guajira, Magdalena, Cesar, Bolivar and Sucre (Bernal et al., 2019).

Figure 1. The Geographic distribution of the Euphorbiaceae and Moraceae in Colombia.

Prepared by Biologist. Jorge Mario Sanchez Hoyos

4 FAMILY EUPHORBIACEAE

The Euphorbiaceae family is distributed throughout most of the tropics in Central
Brazil, South America, Asia, and North Africa (Barrera et al., 2016). Its biodiversity consists of about 300 genera and 7500 species (Rahman et al., 2013). Colombia has 311 species within 59 genera, and the Colombian Caribbean region has about 90 species reported.

List of species of the Euphorbiaceae family present in the Colombian territory:

Brazilian Journal of Development, Curitiba, v.10, n.6, p. 01-21, 2024


All parts of the plant, including leaves, stems, and roots, are used as traditional remedies to treat and manage various ailments (Caruzo et al., 2019; Seebaluck et al., 2015). Different researchers have described the presence of multiple phytoconstituents with biological properties, including antimicrobial and anticarcinogenic (Prado, 2017; Beltrán Villanueva et al., 2013).

4.1 ANTICANCER AND ANTIPROLIFERATIVE AGENTS

*Jatropha curcas* L. extracts have been used in traditional medicine for skin lesions. The molecule spirocurcasone, a diterpenoid "spirorhamnofolan", isolated from the root bark of *J. curcas* L., shows potent activity against a mouse lymphoma cell line (L5178Y) at IC$_{50}$ = 0.16µg/mL. The mechanism of this antiproliferative activity has been understudied. (Chianese et al., 2011; Abdelgadir & Van Staden, 2013).

*Euphorbia umbellata* (Pax) Bruyns is a medicinal plant used in traditional medicine for allergies, gastric disorders, and cancer. The nonpolar fraction and its subfractions of *S. Grantus* and *E. umbellate* stem exhibited a cytostatic effect on human tumor cell lines (glioma, breast, kidney, and lung), inhibited by 0.37 to 2.9 µg/mL, with the compound 3,4,12,13-tetraacetylphorbol-20-phenylacetate with antiproliferative activity against glioma (25.2 µg/mL), kidney (24.1 µg/mL), lung (31.1 µg/mL) and leukemia (65.3 µg/mL) cell lines (Campos et al., 2016).

*Cnidoscolus quercifolius* Pohl. popularly known in Brazil as "faveleira" or "urtiga-branca." Studies have shown that the ethyl acetate fraction possesses antiproliferative potential against prostate (PC3 and PC3-M) and breast (MCF-7) cancer cell lines with IC$_{50}$ = 15.75 and 46.97 µg/mL, respectively. Its leaves and stem bark are used in folk medicine for ailments and bruises (Paredes et al., 2016). Most of these pharmacological activities are related to the presence of phenolic compounds and terpenoids (Júnior et al., 2019).

Compounds isolated from the methylene chloride/methanol extract from the aerial
parts of *Euphorbia sanctae-Catharinae* Fayed., have shown in vitro antiproliferative activity against colon (Caco-2) and lung (A549) tumor cell lines, the compound 4,12,20-tridesoxyphorbol-13- (2,3-dimethyl) butyrate exhibited antiproliferative activity against A549 cells (IC<sub>50</sub>= 3.3 µM) (Hegazy et al., 2018).

*Croton macrobothrys* Baill is a tree from southern Brazil popularly known as "dragon's blood" (Caruzo et al., 2019). The n-hexane, dichloromethane, and methanol extracts of the leaf have in vitro antiproliferative activity against kidney (786–0), colon (HT-29) leukemia (K562), ovarian (NCI-ADR/RES), lung (NCI-H460), mammary (MCF-7), prostate (PC-3), ovarian (OVCAR-3), glioma (U251) and melanoma (UACC-62) cell lines. The dichloromethane extract exhibited activity against all cell lines at 25 µg/mL, with the NCI-H460 (GI<sub>50</sub>= 0.33 μg/mL) and K5662 (GI<sub>50</sub>= 0.91 μg/mL) cell lines having the highest activity. The compounds with the most increased activity are the alkaloids coridin and salutaridin (Motta et al., 2011).

### 4.2 GASTROINTESTINAL DISORDERS

The ethnobotanical study conducted in three Mayan communities in the Yucatan Peninsula, Mexico, reported 360 medicinal plants against various health problems. The polar and non-polar extracts of *Jatropha gaumeri* root. showed activity against *Helicobacter pylori* and *Bacillus cereus* (Brandelli et al., 2011).

*Croton zambesicus* Linn. is an ornamental tree cultivated in villages and towns in Nigeria, and communities use it to treat various ailments, such as diarrhea and dysentery. Studies of the aqueous extract of *Croton zambesicus* leaf. in albino rats have shown antispasmodic and antidiarrheal activity (Muchane, 2019). The total extract at 1.60 and 6.40 mg/mL inhibited acetylcholine-induced contraction of the rat ileum. Calcium chloride-induced contraction was inhibited at 6.40 mg/mL, tenfold less of the extract (0.64 mg/mL) in rats induced by angiotensin II. The extract at doses of 400 and 800 mg/kg reduced the frequency of gastrointestinal motility in rats (Ayanniyi et al., 2016).

### 4.3 ANTIMALARIALS

*Uapaca mole* Pax. trunk bark extracts showed antiplasmodial activity against *Plasmodium falciparum*. Compounds samvisterina, squalene, betulin and betulinic acid showed lower IC<sub>50</sub> activity from 0.7 to 10 µg/mL. However, compounds pentadecanoic
acid, palmitic acid, margaric acid, stearic acid and methyl palmitate at IC\textsubscript{50} < 10 μg/mL > 50 μg/mL were more active (Table 1) (Banzouzi et al., 2015).

Table 1. Inhibitory concentration (IC\textsubscript{50}) of compounds isolated from U. a mole trunk bark extracts against P. falciparum.

<table>
<thead>
<tr>
<th>Molecule Name</th>
<th>IC\textsubscript{50} [μg/mL]</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Samvisterina</td>
<td>7.5 μg/mL</td>
<td>Banzouzi et al., 2015</td>
</tr>
<tr>
<td>Squalene</td>
<td>0.7 μg/mL</td>
<td></td>
</tr>
<tr>
<td>lupeol</td>
<td>30 μg/mL</td>
<td></td>
</tr>
<tr>
<td>Betulonic acid methyl ester</td>
<td>Not Tested</td>
<td></td>
</tr>
<tr>
<td>β-sitosterol</td>
<td>13.2 μg/mL</td>
<td></td>
</tr>
<tr>
<td>Stigmasterol</td>
<td>IC\textsubscript{50} &gt; 50 μg/mL</td>
<td></td>
</tr>
<tr>
<td>Betulin</td>
<td>3.0 μg/mL</td>
<td></td>
</tr>
<tr>
<td>Betulinic acid</td>
<td>1.7 μg/mL</td>
<td></td>
</tr>
<tr>
<td>Pentadecanoic acid</td>
<td>Not tested</td>
<td></td>
</tr>
<tr>
<td>Palmitic acid</td>
<td>IC\textsubscript{50} &gt; 50 μg/mL</td>
<td></td>
</tr>
<tr>
<td>Margaric acid</td>
<td>Not tested</td>
<td></td>
</tr>
<tr>
<td>Stearic acid</td>
<td>Not Tested</td>
<td></td>
</tr>
<tr>
<td>Methyl palmitate</td>
<td>IC\textsubscript{50} &gt; 50 μg/mL</td>
<td></td>
</tr>
</tbody>
</table>

Source: Table prepared by Wendy Moreno with data taken from Banzouzi et al., 2015.

\textit{Euphorbia abyssinica} J.F.Gmel. is a thorny tree endemic to East Africa, Ethiopia, Eritrea, Somalia and Sudan (Hamid, 2015). The ethanol extract of fresh roots of E. abyssinica showed antimalarial activity against \textit{Plasmodium berghei}. The chemosuppressive antimalarial activities produced by the crude extract were 66.87%, 84.94%, and 93.69% at doses of 200, 400, and 600 mg/kg of the extract compared to the group treated with distilled water. The mice treated with 600 mg/kg extract survived with mice treated with distilled water. However, the crude extract did not cause any significant change in the body weight of mice (Muluye et al., 2019).

4.4 ANTI-EPILEPTIC AND ANTI-CONVULSANT DRUGS

The leaves of \textit{Acalypha fruticosa} Forsk. are used in communities in the Tanzanian region to treat certain conditions associated with cerebral neuronal synchronic disorders (Patro et al., 2015). A study demonstrated the activity of the chloroformic extract at doses of 30, 100, and 300 mg/kg in mice subjected to seizures induced by electroshock, pentylenetetrazol, and isoniazid. The extract significantly protected the mice from seizures induced using the three methods under study without protecting the mice against mortality (Govindu & Adikay, 2014).
Jatropha gossypiifolia L. leaves are used in the ethnomedicinal practice of northern Nigeria to treat epilepsy and infantile convulsions. (Gbadamosi & Erinoso, Sharma & Singh, 2016; Sharma & Singh, 2012). The leaves of Jatropha gossypiifolia L. present cardiac glycosides, steroids, triterpenes, tannins, and flavonoids (Yaro et al., 2018). The methanolic extract of the leaves at a dose of 150 mg/kg in mice delayed the onset of seizures in the STN model compared with the treatment control (Phenobarbitone).

4.5 ANTIBACTERIAL ACTIVITY

The antibacterial activity of methanolic and aqueous extracts of the flour of Jatropha curcas L. have activity against gram-positive and gram-negative pathogens at concentrations of 1 and 1.5 mg/disc. HPLC analysis showed phenolic compounds such as gallic acid and pyrogallol; flavonoids: rutin and myricetin; isoflavonoid: daidzein. The methanolic extract showed greater effectiveness than the aqueous extract (Oskoueian et al., 2011).

The methanolic extract of Jatropha multifida L., is used in Nigerian folk medicine as a remedy against infections at the topical level. J. multifida. The stem has in vitro activity against Staphylococcus aureus (ATCC 29213), S. aureus methicillin-resistant (ATCC 33591), Escherichia coli (ATCC 35218), Pseudomonas aeruginosa (ATCC 27853) and Mycobacterium intracellulare (ATCC 23068). The presence of two latirane-type diterpene secondary metabolites has been identified; 14-desoxy-1β-hydroxy-4 (4E)-jatrogrossidentadione and 15-desoxy-1β-hydroxy-41 (4E)-jatrogrossidentadione. These two compounds have activity against S. aureus with an IC₅₀ of 34.8 µg/mL and 23.6 µg/mL (Falodun et al., 2014).

Euphorbia drupifera (Thonn.) Stapf. (Euphorbiaceae) is used in folk medicine in Cameroon to treat ailments and diseases related to bacteria on the skin. The fractions and compounds isolated from the total ethanolic extract of the leaves have antibacterial activity against gram-negative and gram-positive bacteria. The bioactive components of the plant include 3,3′, 4′-tri-O-methylellagic acid, 3-O-rhamnopyranosyl quercetin and 3,3′, 4′-tri-O-methyleneleargic acid and 4-O-βD–glucopyranoside (Voukeng et al., 2017).

The compound 3,6-dihydroxy-1,7-dimethyl-9,10-phenanthroquinone was isolated from Neoboutonia macrocalyx Pax. root (CHCl-MeOH 1:1 extract). The compound structures were established based on their NMR and mass spectrometry data,
which were similar to those previously reported in the literature. The compound showed moderate antibacterial activity against *S. aureus* (ATCC 29213), *E. faecalis* (ATCC 29212) at MIC 10 and 100 μg/mL, and *S. typhimurium* (ATCC 14028) at 12.5-25 μg/mL. The compound Neomacrodione showed significant activity with MIC values <10 μg/mL against *S. aureus* ATCC 29213 and *E. faecalis* ATCC 29212 with MIC 3.12 μg/mL, moderate against *B. cereus* ATCC 14579 and *E. coli* ATCC 25922 (MIC = 12.5 and 50 μg/mL) (Maffo et al., 2018).

**5 FAMILY MORACEAE**

The family Moraceae comprises laticiferous and woody species distributed in tropical countries and the Old World (Garcia & Horley, 2014). It has 53 genera and approximately 1500 species worldwide (Carvajal, 2012; Ibarra-Manríquez et al., 2012). The Colombian Caribbean has the greatest diversity of these species, with about 42 species reported (Caruzo et al., 2019). In Colombia, 155 species are reported, with about 19 genera:

5.1 ANTICANCER AND ANTIPROLIFERATIVE AGENTS

The genus *Artocarpus* of the family Moraceae, consisting of approximately 60 species, is widely distributed in tropical and subtropical regions. Previous phytochemical work on *Artocarpus kemando* Miq. has isolated several types of prenylated flavonoids (de Sousa *et al.*, 2018). A new furanedihydrobenzoxanthone was isolated from the stem bark of *A. kemando*, along with four other flavonoid derivatives (artomandin,artoindonesianin C, artonol B, artochamin A). The results of the biological assay showed that compound artomandin was significantly cytotoxic against both cancer cell lines, human promyelocytic leukemia (HL-60) and human breast adenocarcinoma (MCF-7) at inhibitory concentrations of 2.4±0.5 µg/mL and 3.1±0.4 µg/mL respectively. It also possesses antioxidant properties toward DPPH at a concentration of 38±6.4 µg/mL (Ee, 2011).

For treating different types of cancer, the therapeutic use of an aqueous fraction rich in latex proteins from the bark of *Brosmimut utile* Kunth on the leukemia cell line (K562), six samples were evaluated at concentrations of 0.19–25 µg/mL. A significant cell growth suppression given by the proteins in *B. utile* latex was observed only before dialysis and in a protein dose-dependent manner (Chindoy-Luna, 2013).

Studies have shown partially suppressed growth and invasion of the highly metastatic breast cancer cell line (MDA-MB-231) through suppression of the Akt pathway. Morin, obtained from hydroalcoholic extraction of *Maclura pomifera* (Raf.) C.K.Schneid., *Maclura tinctoria* (L.) D.Don ex Steud. (Jangid *et al.*, 2018). The results showed that morin significantly inhibited the colony-forming ability of highly metastatic breast cancer cells (MDA-MB-231) at low doses (50 µM). Additionally, morin exerted a morphological change in MDA-MB-231 from the mesenchymal to epithelial form. In turn, it inhibits the dose-dependent invasion of MDA-MB-231 cells (Jin *et al.*, 2014).

5.2 ANTIOXIDANTS

Two medicinal species traditionally used in Burkina Faso were investigated for treating sickle cell disease and their relationship with the antioxidant capacity. Total phenol and tannin contents were determined using the Folin-Ciocalteu method, with significant results in extracts of *Ficus sycomorus* L., compared to *Ficus sur* Forssk., with respective values of 336.80±0.80 and 203.74±0.9 mg TAE/g of extract versus 247±0.52...
and 120.8±0.83 mg TAE/g of extract. Identically, using the 2,2-Diphenyl-1-Picrylhydrazyl (DPPH) method, the results indicated that *Ficus sycomorus* L. extracts produced the highest antiradical activity with IC$_{50}$ = 9.6±0.02 μg/mL compared to 31.83±0.55 μg/mL of *F. sur.* (Ramde-Tiendrebeogo *et al.*, 2012).

5.3 ANTIBACTERIAL

The leaves of *Ficus sycomorus* L. Vahl-Holl in many West African countries are used for infectious and inflammatory conditions (Mouho *et al.*, 2018). Compounds obtained from the hydroalcoholic extract of dried leaves showed antimicrobial activity against *E. coli* (NCTC 10418), *S. aureus* (NCTC 6571), *P. aeruginosa* (ATCC 10145), *Bacillus subtilis* (NCTC 8236) and *Candida pseudotropicalis* (NCYC 6). Compounds C8-glucoside of apigenin, isoquercitrin-6-O-4-hydroxybenzoate, and quercetin-3-O-β-rhamnoside were shown to be active against *S. aureus* (1.5 and 2 mm) and *B. subtilis* (1.2 and 2.5 mm) cell lines at a concentration of 20 mg/mL for both cases (Taiwo & Igbenehu, 2014).

5.4 ANTI-INFLAMMATORIES

*Ficus maintain* Pittier. is a species endemic to the tropical rainforests of the Venezuelan Andes. The genus Ficus is composed of approximately 800 species, one of the plant genera with the most significant number of species (Villalobos-Osorio *et al.*, 2017; Pederneiras *et al.*, 2018). Studies have shown that the aqueous extract of the leaves of *F. maintain* exhibited the highest anti-inflammatory activity (91.57%) in the method of auricular edema induced by xylol at a dose of 200 mg/kg compared to the technique of foot edema caused by carrageenan and the methanolic extract of the leaves at the amount of 200 mg/kg exhibited the highest percentage of inhibition (86.67%) in the third hour of the trial (Villalobos-Osorio *et al.*, 2017).

5.5 ANTI-LEISHMANIAL

In Brazil, the country most affected by leishmaniasis, extracts and fractions of leaves and branches were evaluated against *Leishmania amazonensis*, giving significant results in the antiprotozoal activity of *Brosimum glaziovii* Taub. The gas chromatographic
analysis identified the sterols campesterol, stigmasterol, and β-sitosterol, as well as the triterpenes α-amyrin, β-amyrin, β-amyrin acetate, and lupenone (Coqueiro et al., 2014). The hexane fractions of leaves and branches showed the highest leishmanicidal activities, with IC\(_{50}\) = 3.6 and 9.1 µg/mL.

5.6 ANTIHYPERTENSIVES AND CARDIOVASCULAR CONDITIONS

However, experiments were carried out to validate the use of an extract to treat hypertension, as claimed by traditional tribes, to support the importance of the conservation of local knowledge and the preservation of Cameroonian biodiversity (Ficus glumosa Del.) (Ntchapda et al., 2014).

6 CONCLUSIONS

The wide variety of plants of the Euphorbiaceae and Moraceae families in Colombia and worldwide is undeniable. In Colombia, Euphorbiaceae is relevant since it is one of the largest and most diverse populations of flora in the country. Despite the numerous studies conducted on these plant families, it is necessary to continue performing periodic bibliographic revisions on the mentioned plants. In this regard, botanical identification and classification of the species are still a challenge due to the great variability within these families. Furthermore, knowledge about the properties and uses of these plants is dynamic and constantly evolving.

Throughout the development of the review, the extensive range of biological activities encountered within the metabolites isolated from plants of the Euphorbiaceae and Moraceae families has been demonstrated, arousing great interest in the native flora of the Colombian Caribbean as a potential producer of promising biomolecules in the pharmaceutical industry, and modern research has shown that many of these compounds have the capacity to be the lead of new drugs. Therefore, these reviews serve as initial endpoints to evaluate the pharmacological characteristics of these molecules with therapeutic potential at the laboratory level, with the purpose of achieving a greater impact on community well-being and public health. Finally, all of this can be specifically applied in the treatment of chronic non-communicable oncological diseases, as well as in the context of infectious and zoonotic diseases.
ACKNOWLEDGEMENTS

This review was supported by the National Doctoral Training Program (Minciencias, 727-2015 and 885-2020), Beca de Doctorado Nacional ANID (Ref.: Postulación N° 21231043)-Año Académico 2023, Beca de Doctorado Nacional ANID (Ref.: Postulación N° 21212006) Año Académico 2020, Doctorate in Pharmaceutical Sciences of the University of Chile, Master in Microbiology- University of Cartagena, Vice-Rectory of Research- Universidad de Cartagena- Strengthening Plan Act N°031-2021. Proyecto Fondecyt 1211482, Fondap 15130011 y Fondap Apoyo 1523A0008.
REFERENCES


CHINDOY Luna LY. 2013. Evaluación de la actividad biológica de una fracción acuosa obtenida del látex de brosimum utile, tradicionalmente utilizado en el tratamiento del cáncer por la comunidad Indígena Camentsa. [Tesis de pregrado-Monografia].[Bogotá-Colombia]: Pontificia Universidad Javeriana. pp. 1-34.


https://doi.org/10.3390/ijms12095955.


