



Transatlantic and Ancestral Routes and the Pharmacological and Biological Potential of *Ocimum basilicum* L.: A Review

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Authors' contributions

This work was carried out in collaboration among all authors MMAP, LCM, JMQL, MP and JD. All authors were involved in all stages of planning, execution, statistical evaluation and final writing of the article. All authors read and approved the final manuscript.

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ABSTRACT

Basil (*Ocimum basilicum* L.) is not endemic in Brazil; however, it is a symbolic plant for traditional peoples and was present in ancestral cultural resistance. Several species were introduced to Brazil through the slave trade on the Africa-Brazil transatlantic route. In addition, the active constituents of basil are of great pharmaceutical and biological importance, and the plant has been used for therapeutic purposes by a wide variety of people, from quilombola communities to the pharmaceutical industry. Thus, based on African ethnobotany and modern science, this review article aimed to contextualize the endemic and epistemic importance of the origin, traditional, ancestral, medicinal and therapeutic uses of basil, consumed en masse in Brazil (during and after) the slavery period. The bibliographic review was carried out by consulting historical books and Scopus scientific databases. Scielo, transatlantic slave traffic database and Web of Science. The results showed that traditional communities, quilombos and terreiros, already made medicinal and liturgical uses of basil, before its use by the pharmaceutical industry. And that after the period of slavery, several studies carried out by researchers with basil proved that this species has several therapeutic properties, already reported by traditional communities. Thus, it is concluded that O.

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basilicum L. is an endemic species of the African continent, introduced in Brazil on the transatlantic route and that the traditional and ancestral knowledge for therapeutic use and application was already present in the territory, before the studies of proof of activity, post slavery period. Currently, the species is widely applied in the pharmaceutical and biological industry. However, there is a need for strategies that recognize, value and integrate the knowledge of the traditional peoples of the African diaspora, scientific productions.

Keywords: Medicinal plants; ethnopharmacobotany; *Ocimum basilicum* L.; transatlantic; ethnobotany; traditional peoples; phytochemistry.

1. INTRODUCTION

Basil (*Ocimum basilicum* L.) is an aromatic plant grown for religious, medicinal, and culinary purposes as well as for its essential oil (EO). The species is one of the 4,000 species belonging to the family Lamiaceae, which is composed of 200 genera. Among them, the genus *Ocimum* stands out due to its ethnobotanical, pharmaceutical, biological, and economic value based on its medicinal properties [1].

The species is not endemic to Brazil, although during the slavery period, it was brought to the country by enslaved Africans, and Afro-Brazilians continue to use it in the everyday lives [2,3]. The historical process of colonialism in Brazil left gaps related to the origin of Afro-descendants and their knowledge, which increases the difficulty of confirming the origin of African medicinal plants.

To obtain such knowledge, modern science would have to be decolonized [4,5] and the Brazilian racial democracy myth would have to be abandoned since the recovery of ethnobotanical knowledge allows for the historical recovery of the use of medicinal plants and their pharmaceutical and biological potential.

In Brazil, species of the genus *Ocimum* are popularly known as Alfavaca or favacão, a name of European origin that spread among African slaves on the transatlantic routes [4], and some regional variations include Basilicão, manjeriçãõ branco, roxo, and folha larga; it is also known by Yoruba speakers as akéroro, efinrin, and quioiô and is used in the religious practices of African religions [5-7].

In the African religions in Brazil (Candomblé, Umbanda, Tambor de Mina, and Xangô), the species of *O. basilicum* L. takes on a primary role in religious ceremonies and is used in ritual baths for the release of negative energies, for the purification of the body, and for spiritual

cleansing, to bring protection to the practitioner of the religion and peace of mind [8]. It is also used in candomblé Kêto, Jêje, Nagô, and Angola initiation rituals to bathe the head of the initiates. In addition, the plant is used as a flavoring and has therapeutic properties in the treatment of various diseases [9].

The species has also been used in the composition of "altars"/ registration, for entities whose elements and symbols of nature represent the orixás/Nkisi. In this symbolic process, *O. basilicum* L. is associated with orixá/nkisi Oxalá/Lemba, the god of Earth, which is associated with the creation of the world and the human species, to the air element [10]. Basil is thus a symbolic plant for traditional peoples and was present in their ancestral cultural resistance.

Evidence indicates that the first African slaves arrived in the Brazilian northeast region in 1531. It is estimated that 40% of the African slaves came to the country throughout this process [11] and that they were from approximately 280 different ethnic groups [12]. According to Morales [13], *O. basilicum* L. was already used by these peoples since antiquity.

Several plants were introduced to different regions of Brazil by these enslaved ethnic groups. In North and Northeast Brazil, plants were propagated by the Yorubas, Sudanese, Jêjes of Benin, and Nagôs of West Africa, Nigeria and Benin. In the Southeast region, the Bantus of Congo, Angola, and Mozambique were responsible for the spread of the species *Thymus vulgaris* L.; *Origanum majorana* L. and *Solenostemon scutellarioides* (L.) Codd. and *Mentha pulegium* L. [4-14].

During the period between the fifteenth and seventeenth centuries, Asia, Africa, America, and Europe experienced various degrees of botanical and ecological exchange and expropriation as a result of the colonization/slavery situation between the regions. In this process, Africans

were responsible for spreading the experience of cultivating tropical plants and agriculture throughout Brazil.

It is worth mentioning that not only enslaved peoples arrived as labor forces in the Brazilian territory. The Africans who arrived here brought in addition to their culture, political and economic relations, the knowledge of food, medicines, quilombos (both formed by runaway's slave communities) and terreiros (or places of worship) [2].

Therefore, in the absence of studies that substantiate the historical contribution of the African population taken to Brazil on the transatlantic route during the colonial period, about the introduction of species, cultivation and use of medicinal plants.

The present review article aimed to contextualize the endemic and epistemic importance of the origin, traditional, ancestral, medicinal and therapeutic uses of basil (*O. basilicum* L.), consumed en masse in Brazil (during and after) the period slavery. Demystifying the myth of racial democracy in Brazil and reaffirming the historical contribution of traditional peoples, originally and brought from the African continent, to the advances of modern science applied to the use of medicinal plants.

2. METHODOLOGY

A bibliographic review was carried out, compiling publications from the Scopus, Web of Science, Scielo databases, transatlantic slave traffic database and consultation in books that systematized and characterized the historical contribution of the African population brought to Brazil on the transatlantic route, regarding the introduction of the species *O. basilicum* L., its traditional, ancestral, medicinal, pharmacological and biological use in traditional territories.

In sequence, a survey of studies proving therapeutic medicinal activity of the species *O. basilicum* L. was carried out after the scracocratic period and a comparative study was carried out on traditional use, the endemic center of the species, modern studies on economic importance, biological and pharmaceutical species.

The following keywords were used in the research: medicinal plants, ethnopharmaco-

botany, *Ocimum basilicum* L., transatlantic, ethnobotany, traditional peoples and phytochemistry. The method applied was the collection of information contained in the objectives, results and conclusions of the articles, which were subsequently analyzed and compared with the historical records of Brazil in the colonial period up to the current period.

3. DISCUSSION

3.1 Transatlantic and Ancestral Routes of *O. basilicum* L.

Historical reports claim that basil is a species of African-Asian origin that was widely cultivated and distributed from tropical Africa through Asia to New Guinea, Australia, and America [15]. However, in modern science, its botanical occurrence and distribution was only recorded in 1753 by Linnaeus in the book *Species Plantarum* and in 1910 in the *Bibliography for North Africa* [16].

With the colonization on the transatlantic route, African slaves developed a rich pharmacopoeia based on plants as a form of resistance, and this pharmacopoeia remains to this day because of popular beliefs and medical traditions native to Africa as well as symbolic and ancestral heritages preserved by herbalists (*raizeiros*), healers, and midwives, who use roots and plants to treat various diseases and conditions [17]. The cultural heritages related to the use of medicinal plants were preserved for subsistence, survival, and rituals and are still present today in the territorial units of resistance, such in the quilombos and terreiros of the African diaspora.

However, the origin of various medicinal species is uncertain because many plants are part of the ancient history of exchanges/expropriation between Africa and Asia. In addition, before the arrival of these species in the Americas, several plants were already cultivated in Africa in the millennium preceding the transatlantic trade slave [18].

Therefore, considering the transatlantic slave trade to Brazil in the colonial period and due to the ethnicities and territories of origin of these peoples, territorial and spatial similarity is observed among the species *O. basilicum* L. that are endemic to and cultivated in the African territory because the various ethnic groups from these areas transported to Brazil brought seeds

from various species (Fig. 1). Thus, based on indigenous knowledge associated with the African diaspora, medicinal plants remain part of

Afro-Brazilian rituals rooted in traditional African customs [19], and they are still present in the territories.

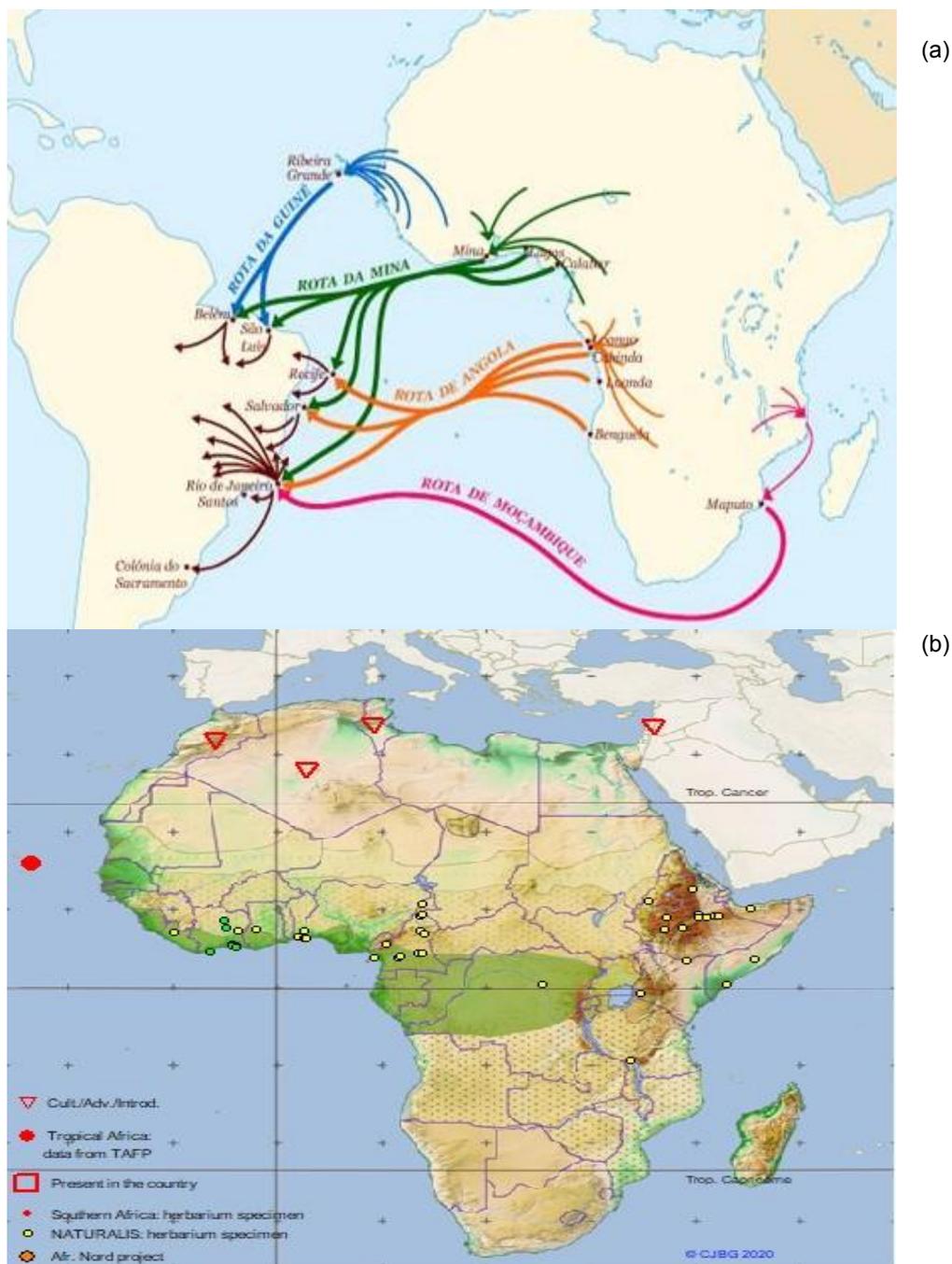


Fig. 1. Transatlantic route of African slaves brought to the Americas in the 15th century (a) and endemic center of *Ocimum basilicum* L. in Africa (b). Image: prepared by Pereira, 2018

Source: African plant database. Accessed on April 23, 2018 (<http://www.village.ch/musinfo/bd/cjb/africa/details.php?langue=en&id=174891>) and (www.google.com.br)

Therefore, considering the transatlantic slave trade to Brazil in the colonial period and due to the ethnicities and territories of origin of these peoples, territorial and spatial similarity is observed among the species *O. basilicum* L. that are endemic to and cultivated in the African territory because the various ethnic groups from these areas transported to Brazil brought seeds from various species (Fig. 1). Thus, based on indigenous knowledge associated with the African diaspora, medicinal plants remain part of Afro-Brazilian rituals rooted in traditional African customs [19], and they are still present in the territories.

These territorial units have maintained the ancestral heritage of land cultivation, medicinal plant use for treating peoples' health and souls, and ancestral knowledge, which allows for the symbolic preservation of their sociocultural practices passed down through generations by word of mouth [20]. Because of their isolation, phytotherapeutic products and preparations and medicinal plants remain the only possible therapeutic option for certain territorial units [21].

3.2 Use of *O. basilicum* L. by Traditional Communities

Even after the slavery period, several quilombos persisted in Brazil, and ethnobotanical studies have recorded over time the diversity of medicinal species used by these peoples. The reviewed studies revealed that the species *O. basilicum* L. remains present in culinary, therapeutic, and religious practices [22-24].

Thus, in the Sangrador quilombo (Maranhão-MA), the species *O. basilicum* L. is indicated for skeletomuscular diseases [25] in the da Barra II (Bahia-BA) and Rio de Contas (BA) quilombos, it is indicated for the treatment of flu, blood pressure, and cough [26,27], in the Carreiros quilombo (Minas Gerais-MG), it is indicated for heart disease and palpitation [28], in the Pontinha de Paraopeba (MG) quilombo, it is indicated for its antihypertensive and sedative effects [29] and in the urban home gardens of the Ituiutaba community (MG), it is used as a sedative and to treat migraine, flu, and intestinal problems [30], where the use of its leaves in infusions (tea) and for preparing syrups is recommended.

These findings indicate the constant use of this species by traditional peoples [31-33], thus demonstrating its importance in the preservation

of ancestral knowledge about its therapeutic, cultural, and symbolic uses.

3.3 Pharmacological and Biological Potential of *O. basilicum* L.

3.3.1 Phytochemistry

The species is rich in chemical compounds with pharmacological and biological activity; however, such compounds may vary according to the geographic and edaphoclimatic characteristics, and the main biochemical pathways for synthesis of the compounds are the mevalonic acid and shikimic acid pathways [34]. In regards to the classes of secondary metabolites, the species has monoterpenes, hydrocarbons, triterpenes, aliphatic alcohols, aliphatic aldehydes, aliphatic esters, aliphatic ketones [35] flavonoids (quercetin, compounds, kaempferol, and rutin), coumarin (aesculetin and p-coumaric acid), cinnamate (caffeic acid and caftaric acid), polyphenols (rosmarinic acid), phenylpropanoids (estragole), and glycosides (aesculin) [36-41].

3.3.2 Antiplatelet and antithrombotic effects

In the Mediterranean, the species is used in the prevention and treatment of cardiovascular diseases, as it exhibits antiplatelet and antithrombotic effects. In addition, clinical tests in rats have found that basil can reduce blood pressure and cardiac hypertrophy, indicating that the plant, which has been traditionally used as a sedative, can be used in the treatment of cardiovascular and metabolic disorders [42].

3.3.3 Bronchitis

The isolation of sesquiterpenoids (farnesol and caryophyllene), flavonoids (apigenin), monoterpenes (linalool, cineol, fenchone, carvone, myrcene, geraniol, and thujone), and triterpenoids (ursolic acid) [36] revealed antiviral activity against the viruses responsible for bronchitis. Apigenin, linalool, and ursolic acid act directly against different types of human adenoviruses involved in bronchitis, the triterpenoid saponins of the oleanane group inhibit viral activity and DNA synthesis, while the urasan group inhibits the viral protein capsid [43].

3.3.4 Cardiotonic activity

Clinical trials with frogs performed by Umar et al. [44] concluded that the aqueous extract of *O. basilicum* L. produced a significant increase in

amplitude and heart rate and thus presents cardioactive potential and a broad therapeutic index through the production of β -adrenergic effect. In addition, the species has an antihypertensive effect and reduces both systolic and diastolic blood pressure, decreases cardiac hypertrophy and angiotensin levels [45] and exhibits an antithrombotic effect [46].

3.3.5 Anxiolytic and antidepressant effects

The presence of the metabolites linalool, camphor, eugenol, and 1-8 cineol in the EO imparts anxiolytic and antidepressant properties capable of neutralizing anxiety and depression in patients with Alzheimer's disease [47].

3.3.6 Antacid effect

Basil leaf (*O. basilicum* L.) strengthens the stomach and nervous system; possesses carminative, anti-inflammatory, and antibacterial properties; and reduces acidity and pepsin secretion [48]. It is recommended for the treatment of symptoms of functional dyspepsia, a functional gastrointestinal disorder with high prevalence [49].

3.3.7 Analgesic effect

Studies on the chemical composition, acute toxicological effects and antinociceptive activity of the EO of *O. basilicum* L. performed by Venâncio et al. [50] suggest that the EO has peripheral and central antinociceptive effects related to inhibition of the biosynthesis of pain mediators, such as prostaglandins and prostacyclins, and can interact with opioid receptors.

3.3.8 Anti-cryptococcal activity

Studies by Cardoso et al. [51] evaluating the anti-cryptococcal activity of the crude ethanol extract and the hexane fraction obtained from *O. basilicum* var. Maria Bonita found that the hexane fraction had low minimum inhibitory concentration (156 $\mu\text{g/mL}$ against *Cryptococcus neoformans* T444 and 312 $\mu\text{g/mL}$ against *Cryptococcus neoformans* H99 serotype A and *Cryptococcus gattii* WM779 serotype C). In addition, the combination of the ethanolic extract and hexane fraction with amphotericin B and EO increased the antifungal activity, reduced the concentration of each substance required to kill 100% of the inoculum, and decreased

pigmentation, capsule size, and ergosterol synthesis.

3.3.9 Effects on the central nervous system

Studies in mice performed by Bora et al. [52] demonstrated that the species has active constituents involved in neurological protection due to the presence of phenolic compounds, flavonoids, and tannins and the subsequent recovery of endogenous antioxidants. In addition, the EO of basil leaves has an anti-hyperalgesic effect, increases the Fos protein expression in the central nervous system, and can be applied in the treatment of fibromyalgia because it reduces mechanical hyperalgesia and increases protein expression; thus, it has an analgesic effect on chronic pain [53]. In addition, the EO has depressant and anticonvulsive effects on the central nervous system that can be mediated through interactions with central GABAergic receptors [54].

3.3.10 Antioxidant effect

Studies conducted by Del Ré et al. [55] analyzed the antioxidant capacity of aglycones present in the EO and identified that the volatile compounds eugenol, chavicol, linalool and α -terpineol are potential antioxidants applied in food production to avoid lipid oxidation and prevent oxidative deterioration. Thus, the plant extract may be a substitute for synthetic antioxidants.

3.3.11 Antiviral effect

Extracts and purified components rich in apigenin, linalool, and ursolic acid showed broad antiviral activity against the herpes simplex virus (HSV), adenovirus (ADV), and hepatitis B virus [43].

3.3.12 Antidiabetic effect

Basil extracts improve glucose metabolism in patients with type 2 diabetes due to the associated increase in insulin activity, and it allows cells to efficiently absorb insulin because it increases blood lipoprotein levels [56,57]. This plant extract acts is involved in hypoglycemic and hyperglycemic activity and in the restoration of glucose levels [58].

3.3.13 Cosmetic applications

Ocimum basilicum L. seeds are used in the cosmetic industry, namely, in antiaging products

to improve skin viscoelasticity. This property is due to the presence of antioxidants, such as quercetin, isoquercetin, kaempferol, caffeic acid, rosmarinic acid, rutin, catechin, ferulic acid, rutinolide, and apigenin, in the leaf extract [35,59]. In addition, the extract has been applied in the treatment of acne in adolescents and adults with promising results [60].

3.3.14 Antimicrobial activity

The methanolic extract has antifungal properties and can inhibit *Fusarium* species (*Fusarium oxysporum*, *Fusarium proliferatum*, *Fusarium subglutinans*, *Fusarium subglutinans*, and *Fusarium verticillioides*) based on agar tests. In addition, the EO is an alternative to commercial fungicides and presents up to 100-fold stronger activity than commercial fungicidal agents, such as ketoconazole and bifonazole [61,62].

Studies using basil EOs have observed antimicrobial activity against *Staphylococcus aureus*, *Escherichia coli*, *Bacillus subtilis*, and *Pasteurella multocida* as well as against the pathogenic fungi *Aspergillus niger*, *Mucor mucedo*, *Fusarium solani*, *Botryodiplodia theobromae*, and *Rhizoctonia solani* [63]. In addition, changes in the crop cycle caused by edaphoclimatic characteristics altered the chemical composition of the EO by potentiating its action in the control of these fungal species. Kocic-Tanackov et al. [64] also observed antimicrobial activity in the control of 10 bacteria and 4 yeasts, and they noted that the control by EO is superior to the action of ampicillin for some bacteria [62]. Furthermore, the active compound methyl chavicol inhibited the bacterium *Morganella morganii* [65] and foodborne yeasts [66].

3.3.15 Biological insecticidal activity

Studies carried out in central Ethiopia by Dugassa et al. [67] using thermal expulsion and direct burning on traditional stoves in the field against two important malaria vectors (*Anopheles arabiensis* and *Anopheles pharoensis*) observed repellent activity with 78.7% protection against *Anopheles arabiensis* and 79.2% protection against *Anopheles pharoensis* in disease-transmitting vectors. The EO is also a potential insecticide against mosquitoes [68]. The EO also showed insecticidal activity against three species of Tephritidae fruit flies, *Ceratitis capitata* (Wiedemann), *Bactrocera dorsalis* (Hendel), and *Bactrocera cucurbitae* (Coquillett) by the

chemical compounds trans-anethole, estragole, and linalool [69].

4. CONCLUSIONS

It was concluded that the species *Ocimum basilicum* L. has been present in quilombola communities and in terreiros, historically, even before validation studies regarding therapeutic or biological activity, by modern science. The endemic center of the *Basilicum* species is the African continent and basil was introduced into Brazilian territory through the transatlantic and ancestral route, during the colonial period. Reaffirming that the black population in diaspora, introduced medicinal species into the territory, as well as traditional sabers for use and application.

Modern science has advanced in terms of botanical, structural, phytochemical classification and scientific validation of the development of the study of the species. However, the symbolic, religious and cultural values of plant species that may have industrial applications, due to their biological and pharmacological potential, have been lost or emptied, and *Basilicum* reduced only to molecules of economic interest. Thus, a medicinal species has not only therapeutic value, the knowledge of plants is of cultural, symbolic and ancestral value and is present in the cultural resistance of traditional peoples.

In addition, these plants were used in therapeutic and religious ways, even before the advances of modern science. Thus, it is necessary to recognize the production of traditional sabers for the advancement of research, the importance of ethnobotanical science in the historical rescue and ethnic cultural valorization of science production. Finally, braiding a strategy that integrates scientific production with the knowledge of the traditional peoples of the African Diaspora, regarding agricultural, pharmacological and biological production.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Zucchi MR, Oliveira Júnior VF, Gussoni MA, Silva FCE, Marques NE. Ethnobotanical survey of the city of Ipameri-GO. Rev. Bras. Plants Med. 2013; 15(2):273-279.
Available:<https://doi.org/10.1590/S1516-05722013000200016>
2. Carney J. Navigating against the current: The role of slaves and african flora in the botanics of the colonial period. Africa: Journal From the Center for African Studies. 2001;25-47.
3. Almeida SE, Pasa MC, Guarim VL. Use of biodiversity in backyards of traditional communities in chacorore bay, Barão de Melgaço, Mato Grosso, Brazil. Biodiversity. 2014;13(1):141-55.
4. Albuquerque UP, Andrade LHC. Etnobotânica del genero *Ocimum* L. (Lamiaceae) en las comunidades afrobrasilenas. Anales Jard. Bot. Madrid. 1998;56(1):107-118.
5. Gomes ÂMS. Routes and dialogues of knowledge of the Black-African transatlantic ethnobotany: Routes and Dialogues of Knowledge of the Transatlantic Ethnobotany. Thesis – UFMG. 2009;220f.
6. Verger PF. Ewé: Use of plants in Yoruba society. São Paulo: Companhia das Letras; 1995.
7. Silva NCB, Regis ACD, Almeida MZ. Ethnobotanical study in remaining quilombo communities in Rio de Contas. Fitos Magazine. 2012;7(2):99-109.
8. Bastide R. Candomblé from Bahia: Nagó Rite. Sao Paulo; 1978.
9. Verger Pierre. Notes on the cult of the Orixás and Voduns. São Paulo: Ed. USP; 2000.
10. Barros JFP. The secret of the leaves: Vegetable classification system in Brazil's jéje-nagó candomblé. Rio de Janeiro; 1993.
11. Cardoso M. The black movement in Belo Horizonte 1978-1998. Belo Horizonte: Mazza Edições; 2002.
12. Fonseca Júnior E. Yoruba Dictionary (Nagô) - Portuguese. Rio de Janeiro: Civilization; 1993.
13. Morales R. La albahaca, una planta cultivada de origen remoto. Quercus. 1996;126:12-14.
14. Silva WG. Candomblé and Umbanda - Paths of Brazilian devotion. São Paulo; 1994.
15. Conn BJ. *Ocimum* L. (Lamiaceae) in Australia and Papua New Guinea. Telopea. 2014;17(1):169-181.
16. Durand E, Baratte. Florae Libycae Prodromus ou catalogue raisonné des plantes de Tripolitaine; 1910.
17. Savitt TL. Medicine and slavery. The diseases and health care of blacks in antebellum Virginia. Urbana: University of Illinois Press; 1978.
18. Harlan J, de Wet J, Stemler A. Origins of African plant domestication. The Hague: Mouton; 1976.
19. Camargo MTL. DEA. Trayectoria histórica de las plantas rituales en las religiones afrobrasileras. Relaciones interculturales. Montalbán. 1994;27:151-183.
20. Rocha JGDA, Silva CDAC. The transmission of knowledge in popular cultures of african matrices. Journal ABPN. 2014;7(15):240-254.
21. Oliveira Filho GR. The earth system and the problem of exploiting natural resources. CES Journal. 2011;25:83-94.
22. Morais RF, Serrano CS, Morais FF. Traditional ecological knowledge of the limpo grande community on vegetation, várzea grande, mato grosso, Brazil. Bulletin of the Museu Paraense Emilio Goeldi: Human Sciences. 2015;10(1):65-83.
Available:<https://doi.org/10.1590/1981-81222015000100004>
23. Almeida SE, Pasa MC, Guarim VL. Use of biodiversity in backyards of traditional communities in Chacorore Bay, Barão de Melgaço, Mato Grosso, Brazil. Biodiversity. 2014;13(1):141-55
24. Brito MR, SENNA-VALE L. Medicinal plants used in the Caiçara Da Praia Do Sono Community, Paraty, Rio de Janeiro, Brazil. Acta Botanica Brasilica. 2011;25(2): 363-72.
Available:<https://doi.org/10.1590/S0102-33062011000200012>
25. Monteles R, Pinheiro B. Plants in a Quilombola community in the state of Maranhão: An Ethnobotanical Approach. Revista De Biologia E Ciências Da Terra. 2007;7(2):38-48.
26. Barboza S, Nina C, Regis DC, Esquibel MA, Santos JES, Almeida MZ. Medicinal plants use in Barra II Quilombola Community - Bahia, Brazil. Boletín

- Latinoamericano y Del Caribe de Plantas Medicinales y Aromáticas. 2012;11(5): 435–53.
Available:<https://www.scopus.com/inward/record.url?eid=2-s2.0-84867144596&partnerID=40&md5=428ec51821db526fd400a95308a4adde>
27. Silva NCB, Regis ACD, Almeida MZ. Ethnobotanical study in remaining quilombo communities in Rio de Contas. *Journal Fitos*. 2012;7(2):99–109.
 28. Ferreira FMC, Lourenço FJC, Baliza DP. Ethnobotanical survey of medicinal plants In The Quilombo Community Carreiros, Mercês - Minas Gerais. *Revi. Verde.*, Pombal. 2014;9(3):205–12.
 29. Almeida LKML, Silva Ah, Viana GSB. *Justicia pectoralis*, a coumarin medicinal plant have potential for the development of antiasthmatic drugs ? *Revista Brasileira de Farmacognosia*. 2017;27(6):794–802.
Available:<http://dx.doi.org/10.1016/j.bjp.2017.09.005>.
 30. Liporacci HSN, Simão DG. Ethnobotanical survey of medicinal plants in the backyards of Bairro Novo Horizonte, Ituiutaba, Mg. *Brazilian Journal Of Medicinal Plants*. 2013;15(4):529–540.
 31. Guerra AMNM, Pessoa MF, Souza CSM, Maracajá PB. Use of medicinal plants by the rural community Moacir Lucena, Apodi-RN. *Bioscience Journal*. 2010;26(3):442–50.
 32. Cunha MMC, Dondim SD, Bonfim BF, Batalha Júnior NJP, Barroso WA, Vilanova CM. Ethnobotanical profile of medicinal plants commercialized in São Luís, Maranhão, Brazil. *Scientia Plena*. 2015;11(12):1–12.
Available:<https://doi.org/10.14808/sci.plena.2015.121202>.
 33. Silva IC, Moura RB. Species of asteraceae and lamiaceae used in folk medicine in the Southeast for respiratory problems: What scientific evidence indicates. *Fitos Journal*. 2011;6(1):21–28.
 34. Veloso RA, Castro HG, Cardoso DP, Chagas LFB, Chagas Júnior AF. Essential oils of basil and citronella grass to control *Aedes aegypti* larvae. *Green Magazine of Agroecology and Sustainable Development*. 2015;10(2):101–5.
Available:<https://doi.org/10.18378/rvads.v10i2.3322>.
 35. Marwat SK, et al. Phytochemical constituents and pharmacological activities of sweet Basil-*Ocimum basilicum* L. (Lamiaceae). *Asian Journal of Chemistry*. 2011;23(9):3773-3782.
 36. Amber R, Adnan M, Tariq A, Mussarat S. A review on antiviral activity of the Himalayan medicinal plants traditionally used to treat bronchitis and related symptoms. *Journal of Pharmacy and Pharmacology*. 2017; 69(2):109-122.
 37. Berim A, Gang DR. Methoxylated flavones: Occurrence, importance, biosynthesis. *Phytochemistry Reviews*. 2016;15(3):363-390.
 38. Vasconcelos MGS, Matos FJA, Machado MIL, Craveiro AA. Essential oils of *Ocimum basilicum* L., *O. basilicum*. var. *minimum* L. and *O. basilicum*. var. *purpurascens* Benth. grown in north-eastern Brazil. *Flavour and Fragrance Journal*. 2003; 18(1):13-14.
 39. Qing Liu, Xiao Meng, YA LI, Cai-Ning Zhao, Guo-Yi Tang, Hua-Bin Li. Antibacterial and antifungal activities of spices. *International Journal of Molecular Sciences*. 2017;18(6):1283.
DOI: 10.3390 / ijms18061283
 40. Palombo EA. Phytochemicals from traditional medicinal plants used in the treatment of diarrhoea: Modes of action and effects on intestinal function. *Phytotherapy Research*. 2006;20(9):717-724.
 41. Panuwat S, Miltz J, Kees Sonnevelde SWB. Antimicrobial properties of basil and its possible application in food packaging. *Journal of Agricultural and Food Chemistry*. 2003;51(11):3197-3207.
 42. Moore N, Hamza N, Berke B, UMAR A. News from Tartary: an ethnopharmacological approach to drug and therapeutic discovery. *British Journal of Clinical Pharmacology*. 2017;83(1):33-37.
 43. Chiang LC, Lean TNG, Cheng P, Chiang WW, Ching CL. Antiviral activities of extracts and selected pure constituents of *Ocimum basilicum*. *Clinical and Experimental Pharmacology and Physiology*. 2005;32(10):811–16.
Available:<https://doi.org/10.1111/j.1440-1681.2005.04270.x>
 44. Muralidharan A, Dhananjayan R. Cardiac stimulant activity of *Ocimum basilicum* Linn. extracts. *Indian Journal of Pharmacology*. 2018;36(3):163–166.
 45. Umar A, Imam G, Yimin W, Kerim P, Tohti I, et al. Antihypertensive effects of *Ocimum*

- basilicum* L. (OBL) on blood pressure in renovascular hypertensive rats. *Hypertens Res.* 2010;33(7):727-730.
46. Umar A, Imam G, Yimin W, Kerim P, Tohti I, et al. Effect of *Ocimum basilicum* L. on cyclo-oxygenase isoforms and prostaglandins involved in thrombosis. *J Ethnopharmacol.* 2014;152(1):151-155.
 47. Gradinariu V, et al. Comparative efficacy of *Ocimum sanctum* L. and *Ocimum basilicum* L. essential oils against amyloid beta (1-42) -induced anxiety and depression in laboratory rats. *Phytochemistry Reviews.* 2015;14(4):567-575.
 48. Suanarunsawat T, Devakul WNAA, Songsak T, Thirawarapan S, Pongshompoo S. Antioxidant activity and lipid-lowering effect of essential oils extracted from *Ocimum sanctum* L. leaves in rats fed with a high cholesterol diet. *J Clin Biochem Nutr.* 2010;46(1):52-9.
 49. Babaeian M, Naseri M, Kamalinejad M, Ghaffari F, Emadi F, Feizi A, Yekta NH, Adibi P. Herbal remedies for functional dyspepsia and traditional Iranian medicine perspective. *Iranian Red Crescent Medical Journal.* 2015;17(11):e20741. DOI: 10.5812 / ircmj.20741
 50. Venâncio AM, Onofre ASC, Lira AF, Alves PB, Blank AF, Antonioli AR, Marchioro M, Estevam CS, Araujo BS. Chemical composition, acute toxicity, and antinociceptive activity of the essential oil of a plant breeding cultivar of Basil (*Ocimum basilicum* L.). *Planta Med.* 2011; 7(8):825-829.
 51. Cardoso NNR, Alviano CS, Blank AF, Arrigoni-Blank MF, Romanos MTV, Cunha MML, Silva AJR, Alviano DS. Anticryptococcal activity of ethanol crude extract and hexane fraction from *Ocimum basilicum* var. Maria bonita: Mechanisms of action and synergism with amphotericin B and *Ocimum basilicum* essential oil. *Pharmaceutical Biology.* 2017;55(1):1380-1388.
 52. Bora KS, Arora S, Shri R. Role of *Ocimum basilicum* L. in prevention of ischemia and reperfusion-induced cerebral damage, and motor dysfunction in mice brain. *J Ethnopharmacol.* 2011;137(3):1360-1365.
 53. Nascimento SS, Araújo AAS, Brito RG, Serafini MR, Menezes PP, Desantana JM, Lucca Júnior W. Cyclodextrin-complexed *Ocimum Basilicum* leaves essential oil increases fos protein expression in the central nervous system and produce an antihyperalgesic effect in animal models for fibromyalgia. *International Journal of Molecular Sciences.* 2015;16(1):547-63. Available:https://doi.org/10.3390/ijms16010547
 54. Oliveira J, Porto LA, Estevam CS, Siqueira RS, Alves PB, Niculau ES, Blank AF, Almeida RN, Marchioro M, Quintans-Júnior LJ. Phytochemical screening and anticonvulsant property of *Ocimum basilicum* leaf essential oil. *Boletín Latinoamericano y del Caribe de Plantas Medicinales y aromáticas.* 2009;8(3):195-202.
 55. Del Ré V, Jorge N. Spices as natural antioxidants: Food applications and health implications. *Brazilian Journal of Medicinal Plants.* 2012;14(2):389-399.
 56. Broadhurst CL, Polansky MM, Anderson RA. Insulin-like biological activity of culinary and medicinal plant aqueous extracts *in vitro*. *Journal of Agricultural and Food Chemistry.* 2000;48(3):849-852.
 57. Dunning T. Complementary therapies: Considerations for diabetes care. *Practical Diabetes International.* 2004;21(39):118-125.
 58. Grover JK, Yadav S, Vats V. Medicinal plants of India with anti-diabetic potential. *Journal of Ethnopharmacology.* 2002; 81(1):81-100.
 59. Jadoon S, Karim S, Asad MHHB, Akram MR, Khan AK, Malik A, Chen C, Murtaza G. Anti-aging potential of phytoextract loaded-pharmaceutical creams for human skin cell longevity. *Oxidative medicine and Cellular Longevity,* 2015;ID:709628. Available:https://doi.org/10.1155/2015/709628.
 60. Fisk WA, Lev-Tov HA, Sivamani RK. Botanical and phytochemical therapy of acne: A systematic review. *Phytotherapy Research.* 2014;28(8):1137-1152.
 61. Kaya I, Yigit N, Benli M. Antimicrobial activity of various extracts of *Ocimum basilicum* L. and observation of the inhibition effect on bacterial cells by use of scanning electron microscopy. *Afr. J. Tradit. Complement. Altern. Med.* 2008; 5(4):363-369.
 62. Beatovic D, Krstic-Milosevic D, Trifunovic S, Siljegovic J, Glamoclija J, Ristic M, Jelacic S. Chemical composition, antioxidant and antimicrobial activities of the essential oils of twelve *Ocimum*

- basilicum* L. cultivars grown in Serbia. Rec. Nat. Prod. 2015;9(1):62–75.
63. Hussain AI, Anwar F, Sherazi S, Przybylski R. Chemical composition, antioxidant and antimicrobial activities of basil (*Ocimum basilicum*) essential oils depends on seasonal variations. Food Chem. 2008; 108(3):986–995. Available:doi.org/10.1016/j.foodchem.2007.12.010
64. Kocic-Tanackov S, Dimic G, Levic J, Tanackov I, Tuco D. Antifungal activities of basil (*Ocimum basilicum* L.) extract on *Fusarium* species. Afr. J. Biotechnol. 2011; 10(50):10188– 10195 DOI: 10.5897 / AJB11.1330
65. Lomarat P, Phanthong P, Wongsariya K, Chomnawang MT, Bunyapraphatsara N. Bioautography-guided isolation of antibacterial compounds of essential oils from Thai spices against histamine-producing bacteria. Pak. J. Pharm. Sci. 2013;26(3):473–477.
66. Kunicka-styczyńska A. Activity of essential oils against food-spoiling yeast. A review. Flavour and Fragrance Journal. 2011; 26(5):326-328.
67. Dugassa S, Medhin G, Balkew M, Seyoum A, Gebre-michael T. Field investigation on the repellent activity of some aromatic plants by traditional means against *Anopheles arabiensis* and *An. pharoensis* (Diptera: Culicidae) around Koka, central Ethiopia. Acta. Tropica. 2009;112(1):38-42.
68. Rehman JU, Ali A, Khan IA. Plant based products: Use and development as repellents against mosquitoes: A review. Fitoterapia. 2014;95:65-74.
69. Chang CL, Cho IK, Li QX. Insecticidal activity of basil oil, trans-anethole, estragole, and linalool to adult fruit flies of *Ceratitis capitata*, *Bactrocera dorsalis*, and *Bactrocera cucurbitae*. J Econ Entomol. 2009;102(1):203-209. DOI: 10.1603/029.102.0129

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