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Plant Review

Pharmacological and Biochemical Aspects of the Lamiaceae Family used in the Treatment of Intestinal Parasitosis in West and Central Africa

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ABSTRACT

Background: In the search for new molecules likely to treat intestinal parasitosis with less risk in the short, medium and long term, the potential of medicinal plants is explored. *Hyptis suaveolens* and *Ocimum gratissimum* are two species of the Lamiaceae family used by populations of intestinal parasitosis from Benin. The aim of this work is to make a bibliographic synthesis of these two species in order to orient research for their use in the control of intestinal parasitosis. **Results and Conclusion:** *H. suaveolens* and *O. gratissimum* are endowed with nutrients, mineral compounds and secondary metabolites (flavonoids, alkaloids, tannins, phenolic compounds, saponins, steroids, glycosides, and essential oils). Antibacterial, antifungal, antioxidant, antiparasitic, antidiabetic, anticancer, antiulcer, wound healing and insecticidal activities are reported. The antimicrobial activities that are reported for *H. suaveolens* and *O. gratissimum* may justify their uses in the treatment of gastrointestinal disorders. The gastrointestinal disorders are manifestations but not specific of intestinal parasitosis. However, few studies have investigated the anthelmintic activities of these two species. A strong variation was also noted in the essential oils composition of *H. suaveolens* and *O. gratissimum*. This variation is the consequence of several chemotypes of essential oils which can influence the biological activities of the species. Further investigations are therefore important for the use of *H. suaveolens* and *O. gratissimum* in the control of intestinal parasitosis.

Key words: Anthelmintics, Essential oil, *Hyptis suaveolens*, Intestinal parasites *Ocimum gratissimum*, Africa.

INTRODUCTION

Intestinal parasitosis is a real health problem in both veterinary and human medicine.[1-3] In small ruminants, they cause production loss while threatening food security.[3,4] In humans, they contribute to the perpetuation of poverty by compromising the physical and intellectual development of children and reducing the work capacity and productivity of adults.[5,6] In general, the treatment of these intestinal parasitoses relies on the administration of synthetic drugs (including anthelmintics). However, these drugs have more and more limitations related to side effects and reported parasite resistances.[7-9] It is then convenient to search for new substances, effective, accessible, without toxicity and with a wide spectrum of action, to face these parasitoses and medicinal plants are a great asset.[2] Thus, an ethnobotanical survey conducted in Benin targeted the species *Hyptis suaveolens* and *Ocimum gratissimum* which are used in the treatment of human and small ruminant intestinal parasitosis. The aim of this work is to make a bibliographic synthesis of the uses, compositions, biological activities of the species *Hyptis suaveolens* and *Ocimum gratissimum* for a better exploitation in the treatment of human and small ruminant's intestinal parasitosis.

MATERIALS AND METHODS

The material consists of published scientific journals. The collection of these articles was done in the Google scholar engine. The articles are selected according to their relevance to the subject. Some data were summarized in tables for a better visibility and analysis.

RESULTS AND DISCUSSION

Generalities, Biochemical and chemical composition

Hyptis suaveolens is a perennial, aromatic branching herb 0.4-3m long with a hairy, hollow stem that bears glandular and non-glandular hairs characterized by a minty odor.[10-12] In most countries in whichit is distributed, *H. suaveolens* is considered an invasive

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weed.[10,12-14] However, it has reported applications in traditional medicine. It is used in he treatment of respiratory, gastrointestinal, uterine infections, fever, burns cramps, skin lesions, malaria, weakness, kidney disorders, diabetes, headaches, jaundice hemorrhoid, breast abscesses and as an insecticide.[15-22] *Hyptis suaveolens* is rich in secondary metabolites which are flavonoids, alkaloids, tannins, phenolic compounds, saponins, steroids, glycosides and essential oils.[14,16,23,26] Also included are proteins, lipids, carbohydrates, fiber, ash;[27,25] mineral compounds such as potassium (K), nitrogen (N), calcium (Ca), Magnesium (Mg), Sodium (Na) phosphorus (P).[27] *Ocimum gratissimum* is an aromatic herb of the Lamiaceae family with a height of 1-3m. The leaves are broad and narrowly oval.[28] Widely used by people in cooking, *Ocimum gratissimum* is also involved in the preparation of medicinal recipes against fungal, urinary, HIV-1 infections, gonorrhea, bronchitis, vertigo, diarrhea, vomiting, respiratory, cardiovascular and liver diseases, fever, and malaria and as an insecticide.[28-32] Secondary metabolites present in *Ocimum gratissimum* are flavonoids, alkaloids, tannins, phenolic compounds, saponins, steroids, glycosides, and essential oils.[32-34,93] The presence of proteins, lipids, carbohydrates, fibers and mineral compounds that are Calcium (Ca), Magnesium (Mg), Potassium (K), Sodium (Na), Iron (Fe), Copper (Cu) and Zinc (Zn)[35,36] are also reported.

Variability of chemical compositions of essential oils

Essential oils extracted from *Hyptis suaveolens* and *ocimum gratissimum* experience a high variation in compounds. The essential oils of *Hyptis suaveolens* leaves collected in Benin are rich in β-caryophyllene, Eucalyptol, Sabinene, Fenchone.[37,38,22] It is noted a variation in chemical composition of essential oils. Indeed, according to the work of,[37] the predominant compounds are: β-caryophyllene, trans- α-bergamotene, caryophyllene oxide and bicyclogermacene. Following him,[38] reported: Sabinene, Eucalyptol, β-caryophyllene. And recently, according to,[22] the essential oils of *Hyptis suaveolens* leaves harvested in the south of the country are rich in monoterpoique compounds (Eucalyptol: 12.11%; fenchone: 11.81%) while those harvested in the center and north of the country are rich in sesquiterpenes with β-caryophyllene as the predominant compound (20.69-12.45%). However, there is a correlation between compound contents: when β-Caryophyllene content is low, Eucalyptol content is high (vice versa).[22]The variation in chemical compounds of *Hyptis suaveolens* essential oils is also observed in other countries of the world.[13,40] The oil of leaves and fruits from Vietnam was predominated β-caryophyllene, caryophyllene oxide, phytol and a-humulene.[41] The oil of leaves from Burkina-Faso was predominated Sabinène, β-Caryophyllen, Terpinolene.[39] This variability is due to the harvesting period, the edaphic characteristics related to the sampling station, the age of the plant.[22,38] It also influences the results obtained during the research work.[41,22] The essential oils of *Ocimum gratissimum* harvested in Benin, are rich in thymol, γ-terpinene and p-cymene.[29,42-46] Depending on the geographical areas, the harvest period, the chemical composition contents of *Ocimum gratissimum* essential oils experience a variation.[29] The stage of flowering, time of harvesting of the plant were also reported by[30] as factors of variation in the chemical composition contents of essential oils of *Ocimum gratissimum*. However, the compounds p-cymene, thymol, and g-terpinene present in the essential oils of *Ocimum gratissimum* can be easily converted to one or the other during the growth process, during the day, and after the plants are harvested.[30] The essential oil of leaves of *Ocimum gratissimum* from Brazil was predominated by Eugenol; 1, 8-Cineole;[71] by Thymole, γ-Terpinene, p-Cymene.[77] In Ivory Coast, the predominant compounds were Thymole, p-Cymene.[99] In Thaïlande it were Eugenole, cis-Ocimene, γ-muurolene.[98]

Pharmacological activities

Antimicrobial activities

Table 1 presents the antimicrobial activities evaluated on *Hyptis suaveolens* and *Ocimum gratissimum*. Different strains of micro-organisms are used to demonstrate the possible uses of extracts or essential oils of *Hyptis suaveolens* and *Ocimum grtissimum*. The result is that *Hyptis suavelons* and *Ocimum gratissimum* have a wide spectrum of action on pathogenic bacteria and fungi. The leaves are the most stressed organ. Figure 1 summarizes the most used micro-organisms in the evaluation of antimicrobial activities: *Bacillus subtilis; Candida albicans; Escherichia coli; Fusarium oxysporum; Staphylococcus aureus.* The essential oils of *Ocimum gratissimum* and *Hyptis suaveolens* are mostly used.

Antiparasitic activities

Table 2 presents the different antiparasitic activities that were evaluated on essential oils and extracts of *Hyptis suaveolens* and *Ocimum gratissimum* species. The parasites involved are protozoa (*Herpetomonas samuelpessoai*),[76] *Leishmania amazonensiss;*[67] mites *Rhipicephalus microplus*, *Rhipicephalus sanguinneus;*[68,69] ectoparasites[10] and helminths *Ascardia galli*, *Haemonchus contortus*, *Haemonchus placei.*[70,72]

The essential oil of *O. gratissimum*, were efficient in inhibiting eclodibility of *H. contortus* eggs[78] while the extract had a moderate action on adult *Haemonchus placei* worms.[72] The anthelminthic activity of the essential oil of *Ocimum gratissimum* would be due to Egenole. *Hyptis suaveolens* extract had paralyzed adult worms of *Ascardia galli* and *Pheretima posthuma.*[73]

Bioinsecticidal activity

The species *Hyptis suaveolens* and *Ocimum gratissium* can be used as bioinsecticides against field or food insect pests[11,39,79,80] and mosquito vectors of parasites.[25,81-86]

Antioxidant activities

Through the different techniques (DPPH; FRAP, ABTS), total phenols assay, it has been reported that the extracts and essential oils of *Hyptis suaveolens* and *Ocimum gratissimum* are endowed with the free radical scavenging abilities.[24,26,32,34,40,55,60,87] The antioxidant capacity average for all oil samples was about 75% of the thymol activity.[77]

Other activities

Hyptis suaveolens and *Ocimum gratissimum* have also been reported to have antidiarrheal,[88,89] antidiabetic;[16,19,90,91] anticancer;[40,92] antinflammatory,[15] antinociceptive, hepatoprotective, and in wound

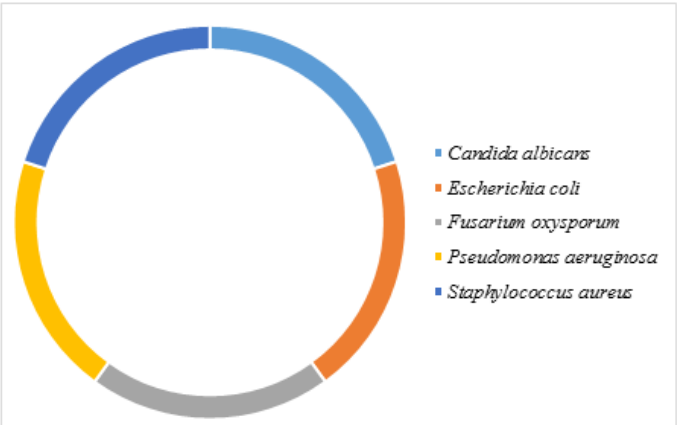

Figure 1: Species most commonly used in the evaluation of antimicrobial activities.

Table 1: Antimicrobial activity of *Hyptis suaveolens* and *Ocimum gratissimum*.

Plants	Parts	Species studied	Type of extract	Authors
Ocimum gratissimum	L	*Aeromonas hydrophila*	Et	[33]
Ocimum gratissimum	L	*Alternaria brassicicola*	EO	[47]
Hyptis suaveolens	L	*Antimycobacterium bovi*	EO	[48]
Hyptis suaveolens	L	*Aspergillus flavus*	EO	[17,49,50]
Ocimum gratissimum	L	*Aspergillus flavus*	Et; EO	[33,47,29, 49,46]
Hyptis suaveolens	P; L; S; R	*Aspergillus Niger*	Et; EO	[51,52,49, 23,53-55]
Ocimum gratissimum		*Aspergillus Niger*	EO	[44,49,46]
Hyptis suaveolens	L	*Aspergillus ochraceus*		[49]
Ocimum gratissimum	L	*Aspergillus ochraceus*	EO	[46,49]
Ocimum gratissimum	L	*Aspergillus tamarii*	EO	[29]
Hyptis suaveolens	L; F	*Bacillus cereus*	Et; EO	[56,55,41]
Ocimum gratissimum	L	*Bacillus cereus*	Et	[33]
Hyptis suaveolens	L	*Bacillus polymyxa*	Et;	[56]
Hyptis suaveolens	L	*Bacillus stearothermophilus*	Et;	[56]
Hyptis suaveolens	L	*Bacillus subtilis*	Et; EO	[40,54,56]
Ocimum gratissimum	L	*Bacillus* spp.	EO	[57]
Hyptis suaveolens		*Botrytis cinerea*	EO	[40]
Ocimum gratissimum	L	*Bipolaris oryzae*	EO	[47]
Ocimum gratissimum	L	*Botryodiplodia theobromae*	Et	[33]
Hyptis suaveolens	P; L; S; R; F	*Candida albicans*	Et; EO	[18,41,5,52, 54,55]
Ocimum gratissimum	L	*Candida albicans*	EO	[30,43,57,58]
Hyptis suaveolens	L	*Clostridium perfringens*	EO	[55]
Hyptis suaveolens	L	*Collectrotrichum capsici*	Et;	[18]
Hyptis suaveolens	P	*Cryptococcus*	Et;	[51]
Ocimum gratissimum	L	*Cryptococcus neoformans*	EO	[58]
Hyptis suaveolens	L; F	*Enterococcus faecalis*	Et; EO	[41,54,56]
Ocimum gratissimum	L	*Enterococcus faecalis*	EO	[43]
Hyptis suaveolens	L	*Epidermophyton floccosum*	Et;	[54]
Hyptis suaveolens	P; L; S; R	*Escherichia coli*	Et; EO	[17,18,52,40, 23,26,54]
Ocimum gratissimum	L	*Escherichia coli*	Et; EO	[33,100,44,43, 59,60,57,30, 61, 62,71,98]
Hyptis suaveolens	L	*Exerohilum turcicum*	EO	[40]
Hyptis suaveolens	P; L	*Fusarium*	Et;	[23,51]
Hyptis suaveolens	L	*Fusarium graminearum*	EO	[40,44,49]
Ocimum gratissimum		Fusarium graminearun		[49]
Hyptis suaveolens	L	*Fusarium oxysporum*	Et;	[18,49,63]
Ocimum gratissimum	L	*Fusarium oxsporium*	Et; EO	[33,44,49,49,64,46]
Ocimum gratissimum	L	*Fusarium moniliforme*	EO	[47]
Ocimum gratissimum	L	*Fusarium poae*	EO	[29,44]
Ocimum gratissimum	L	*Fusarium solani*	EO	[46,64]
Ocimum gratissimum	L	*Fusarium proliferatum*	EO	[47]
Ocimum gratissimum	L	*Fusarium verticillioides*	EO	[29,42,29]
Hyptis suaveolens	P; L; S; R	*Klebsiella pneumoneae*	Et;	[18,52]
Ocimum gratissimum	L	Klebsiella pneumoneae	EO	[57]
Hyptis suaveolens	L	*Lecannosticta acicola*	EO	[40]
Hyptis suaveolens	L	*Listeria monocytogenes*	Et ; EO	[17,55]
Ocimum gratissimum	L	*Listeria monocytogenes*	EO	[45]
Hyptis suaveolens	L	*Micrococcus luteus*	Et;	[56]
Ocimum gratissimum	L	*Macrophomina phaseolina*	EO	[64]
Ocimum gratissimum	L	*Microsporum canis*	EO	[58]
Ocimum gratissimum	L	*Microsporum gypseum*	EO	[58]
Ocimum gratissimum	L	*Malassezia pachydermatis*	EO	[58]
Hyptis suaveolens	L	*Phytophthora colocasiae*	Et;	[63]
Ocimum gratissimum	L	*Penicillium chrysogenum*	Et	[33]
Ocimum gratissimum	L	*Penicillium expansus*	EO	[65]
Ocimum gratissimum	L	*Penicillum verrucosum*	EO	[65]
Ocimum gratissimum	L	*Penicillium citrinum*	EO	[29]
Ocimum gratissimum	L	*Penicillium griseofulvum*	EO	[29]
Hyptis suaveolens	L	*Proteus vulgaris*	Et;	[23,54]
Ocimum gratissimum	L	*Pyricularia arisea*	EO	[47]
Hyptis suaveolens	P; L; S; R	*Pseudomonas aeruginosa*	Et; EO	[18,52,21,23, 54,40,55]
Ocimum gratissimum	L	*Pseudomonas aeruginosa*	Et; EO	[57,43,59,60]

Ocimum gratissimum	L	*Pyricularia arisea*	EO	[47]
Hyptis suaveolens	P; S; R	*Rhizophus stoloniphera*	Et;	[52]
Hyptis suaveolens	L	*Rhizopus*	Et;	[23]
Hyptis suaveolens	L;R	*Rhizopus nigricans*	Et;	[53]
Ocimum gratissimum	L	*Pyricularia arisea*	EO	[47]
Ocimum gratissimum	L	*Rhizoctonia solani*	EO	[47,64]
Ocimum gratissimum	L	*Rhizopus stolonifer*	Et	[33]
Hyptis suaveolens	L	*Salmonella typhimurium*	Et	[26]
Ocimum gratissimum	L	*Salmonella typhimurium*	Et; EO	[33,57,100, 60,98]
Ocimum gratissimum	L	*Scopulariopsis brevicaulis*	EO	[58]
Ocimum gratissimum	L	*Scytalidium dimidiatum*	EO	[58]
Hyptis suaveolens	P; L; S; R; F	*Staphylococcus aureus*	Et; EO	[17,18,52,21, 23,56,54,26, 40,55,41]
Ocimum gratissimum	L	*Staphylococcus aureus*	Et; EO	[57,30,43,44, 100,60,61,62, 71,98]
Hyptis suaveolens	L	*Serratia marcescens*	Et	[17]
Ocimum gratissimum	L	*T. interdigitale*	EO	[58]
Ocimum gratissimum	L	*T. rubrum*	EO	[58]
Ocimum gratissimum	L	*T. erinaceum*	EO	[58]
Ocimum gratissimum	L	*T. soudanense*	EO	[58]
Ocimum gratissimum	L	*T. violaceum*	EO	[58]
Hyptis suaveolens	L	*Trichophyton mentagrophytes*	Et;	[54]
Ocimum gratissimum	L	*Trichophyton mentagrophytes*	EO	[58]
Ocimum gratissimum	L	*Yersinia enterocolitica*,	Et	[33]

Legend: L: Leaf; S: Seed; R: Root; EO: Essential oil; Et: Extract

healing.[12] *Ocimum gratissimum* is reported to have beneficial actions on the immune system.[94]

Toxicity

Toxicity tests conducted on rats, showed that *Hyptis suaveolens* is not toxic.[16] According to the work of,[40] the essential oil of *Hyptis suaveolens* is toxic. However, according to the same author, this toxicity is beneficial in the treatment of cancers. It has been reported for *Ocimum gratissimum*, that it can be toxic.[61,93,95,96]

DISCUSSION

The species *Hyptis suaveolens* and *Ocimum gratissimum* of the Lamiaceae family have proven through various tests that they are endowed with antimicrobial, antioxidant, antiparasitic and insecticidal properties. Thus,

Table 2: Antiparasitic activities of *Hyptis suaveolens* and *Ocimum gratissimum*.

Plants	Species	Parasites	Extract	Authors
Hyptis suaveolens	*Pheretima posthuma*	Hemlminth	Et	[73]
	Ascardia galli		Et	[73]
	Rhipicephalus sanguinneus	Ascarian	Et	[68]
	Rhipicephalus (Boophilus) microplus		EO	[22,74]
Ocimum gratissimum	*Rhipicephalus lunulatus*		EO	[75]
Hyptis suaveolens		ectoparasite	Et	[10]
Ocimum gratissimum		Hemlminth	Et	[70]
	Haemonchus contortus	Hemlminth	EO	[76,78]
Ocimum gratissimum	*Haemonchus placei*	Hemlminth	Et	[72]
Ocimum gratissimum	*Rhipicephalus microplus*	Ascarian	EO	[69]
	Leishmania amazonensiss	Protozoa	EO	[77]
	Herpetomonas samuelpessoai	protozoa	EO	[66]
	Trypanosoma brucei brucei			[30]
	Plasmodium falcparum			

Legend: EO: Essential oil; Et: Extract

these two species can be used in several areas of life such as agriculture, industry, agri-food, health and livestock. Indeed, *Hyptis suaveolens* and *Ocimum gratissimum* can be used as bioinsecticides in the control of insect pests of fields[47,79,97] against insect vectors of parasites.[86] In Agri-food, *Hyptis suaveolens* can be used as a cereal preservative against aflatoxins [50, post-harvest protection of cabbage,[53] beef preservation[55] in the same way that *Ocimum gratissimum* can be involved in the protection of yam against rot,[81] conservation of local cheese "Wagachi".[29] It is noted that there is a correlation between the different results obtained. Indeed, the different micro-organisms used in the evaluation of antimicrobial activities, are responsible for the degradation of severalfood products, food and the cause of several diseases. Thus, the wide spectrum of antibacterial and antifungal activity of *Hyptis suaveolens* and *Ocimum gratissium* can justify their use in infectious diseases. These two species have not been studied as much for their antiparasitic activities. [70,76,68,10,69,72] According to an ethnobotanical study conducted in the DONGA, the species *Hyptis suaveolens* and *Ocimum gratissimum* are used in the treatment of human and small ruminant intestinal parasitosis in Benin. These observations are justified by the work of[73] and[76] who respectively demonstrated the anthelmintic activity of *Hyptis suaveolens* on *Pheretima posthuma* and *Ocimum gratissimum* on *Haemonchus contortus*. *Pheretima posthuma* is used as a model for studying human helminths. Also, anti-diarrheal activities of these two species have been reported.[20-89] Diarrhea is a manifestation but not specific to intestinal parasitosis. Diarrhea can also be associated with bacterial infections with *Staphylococcus aereus; Escherichia coli, Salmonella typhimurium*[72] (98; 100). In sum, *Hyptis suaveolens* and *Ocimum gratissimum* are good candidates for the research of new substances in the treatment of parasitic diseases and in particular intestinal parasitosis. However, the

results from the trials differ depending on the plant organ studied, the substance studied (extract, essential oils) the extraction solvent if it is an extract and also the type of micro-organism (Gram Positive bacteria, Gram Negative; fungus), parasites, insects involved.[56,52,23,54,41] It is in this vein that a harmonization of laboratory research is important to quantify the level of research progress and its directions for useful purposes. There is also a wide variation in the composition of essential oils, even within a given country.[13,22] These observed differences could be related to edaphic conditions and explained by chemical polymorphism.[98] According to,[13] latitude would be the most important environmental factor influencing the essential oil content. However, in Africa the essential oil of *Hyptis suaveoloens* seems to be characterized by the presence of βcaryophyllene.[101]

It would be very important to map the essential oil chemotypes of each aromatic plant with interesting biological properties; this would allow valuation and large-scale use of these aromatic plants.

CONCLUSION

The species *Hyptis suaveolens* and *Ocimum gratissimum* are endowed with several biological activities which justifies their uses in several fields. They are used by the populations in the treatment of intestinal parasitosis in Benin. The evaluation of their antiparasitic properties against intestinal parasites is important for their better use.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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