**Antiparasitic treatment using herbs and spices: A review of the literature of the phytotherapy**

Tratamento antiparasitário utilizando plantas condimentares e aromáticas: Uma revisão de literatura

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**Abstract**

This study sought to make a literature review of the medicinal plants *Origanum majorana*, *Origanum vulgare* L., *Thymus vulgaris* L., *Cuminum cyminum* L., and *Rosmarinus officinalis* L. with antiparasitic potential. Articles and theses were selected from the LILACS, PubMed, and Google Scholar databases, which comprised the period from 2000 to 2021 (22 years). In all, 49 studies were selected, and the majority were with the plant *Origanum vulgare* L. (oregano), followed by *Thymus vulgaris* L. (thyme). Twenty-five genera of parasites were detected, which were described being tested with phytotherapeutic. The nematode *Haemonchus* spp. was the most evaluated in these studies, followed by the parasite genera *Leishmania*, *Trichostrongylus*, and *Toxocara*. All plants showed antiparasitic effects, with more or less action, therefore with the potential to continue research in the search for biomolecules to control these parasites.

**Keywords:** phytotherapy, endoparasites, alternative control.

**Resumo**

O presente trabalho faz uma revisão bibliográfica das plantas medicinais *Origanum majorana*, *Origanum vulgare* L., *Thymus vulgaris* L., *Cuminum cyminum* L. e *Rosmarinus officinalis* L. com potencial antiparasitário. Foram selecionados artigos e teses nos bancos de dados LILACS, PubMed e Google Acadêmico que compreendiam o período de publicação de 2000 a 2021 (22 anos). Ao todo, foram selecionados 49 estudos, sendo que na maioria constava a planta *Origanum vulgare* L. (órgano), seguido de *Thymus vulgaris* L. (tomilho). Foram detectados 25 gêneros de parasitos, os quais foram descritos sendo testados frente a algum fitoterápico. O nematodo *Haemonchus* spp. foi o mais avaliado nestes estudos, seguido dos gêneros dos parasitos *Leishmania*, *Trichostrongylus* e *Toxocara*. Todas as plantas apresentaram efeitos antiparasitários, com maior ou menos ação, portanto com potencial para dar continuidade aos estudos em busca de biomoléculas para controle destes parasitos.

**Palavras-chave:** fitoterapia, endoparasitos, controle alternativo.

**Introduction**

Man’s relationship with natural resources to improve his living conditions and increase his chances of survival is ancient (Taufner et al., 2006). Medicines derived from plants (i.e., herbal medicines) present a wide spectrum of use, especially by groups of people in vulnerable situations and those concerned about consuming a more naturally produced food (Nery et al., 2009; Silva et al., 2017). When used correctly, these molecules present fewer side effects (Andrade et al., 2018). It is esteemed that at least 80% of the world population uses traditional medicine, and of these, 85% utilize medicinal plants (Barata, 2003; Fenalti et al., 2016; Gadelha et al., 2013).

In Brazil, phytotherapy was included as a practice in the public health network in 2006 (Brasil, 2006). In 2011, ANVISA created a manual with instructions for using medicinal plants with...
therapeutic potential, which had been described and scientifically accepted (Brasil, 2010). The intention was to guide the proper use, especially for users of the Unified Health System (SUS), because the population uses many plants without any guidance, which may bring risks since there are various toxic species (Giordani et al., 2016).

Diseases caused by parasites are a major public health problem (Estancial & Marini, 2014). Evidence has shown that roughly 300 helminth species and 70 protozoa species have already been diagnosed infecting humans, being the cause of death of about 200,000 people per year (Melo et al., 2017). Given that it affects the neediest population, since the mid-twentieth century, the pharmacopoeia used to control neglected tropical diseases remains unchanged (Hotez et al., 2006).

Only the use of drugs to treat diseases transmitted by parasites is not enough since the environment, water, and food are important sources of infection (Andrade et al., 2010). In addition, with the indiscriminate use of drugs, parasite resistance to available drugs emerges, especially among production animals (Fortes & Molento, 2013).

Thus, medicinal plants have been described with importance in research because they constitute an alternative treatment for parasitic diseases. Given this context, this study sought to perform a literature review of research that used the medicinal plants *Cuminum cyminum* (cumin), *Origanum vulgare* (oregano), *Origanum majorana* (marjoram), *Rosmarinus officinalis* (rosemary), and *Thymus vulgaris* (thyme) and the evaluation of these molecules in parasites of medical and veterinary importance.

**Methodology**

This review selected papers in the LILACS, PubMed, and Google Scholar databases that comprised the publication period between 2000 and 2021. The descriptors chosen to find the selection of studies were “anti-helminthic medicinal plants,” “*Rosmarinus officinalis* L.,” “*Origanum majorana*,” “*Origanum vulgare* L.,” “*Thymus vulgaris* L.,” and “*Cuminum cyminum* L.” and their correspondents in English: “medicinal plants” and “anthelmintic,” and in Spanish: “plantas medicinales” and “antihelmíntico” for the LILACS and PubMed databases. As for Google Scholar, the words used were “anti-helminthic medicinal plants” and the name of each species; in Portuguese, English and Spanish.

**Results and discussion**

Brazil has a plethora of different plant species (approximately 55,000 species). Among the species that compose the registered herbal medicines, 25% originate from South America, estimating that less than 15% of the species have been studied for medicinal purposes (Zago, 2018). Thus, research pointing to their biological proof is necessary as the population routinely uses some of these plants as medicine and because they may be important sources for discovering new therapeutic options (Marinho et al., 2007; Zago, 2018).

In this review, 49 papers were selected, in which *Rosmarinus officinalis* L., *Origanum majorana*, *Origanum vulgare* L., *Thymus vulgaris* L., and *Cuminum cyminum* L. were tested against parasites of medical or veterinary importance. Of the 49 studies selected for review, 34 consisted of experimental work, and of these, 28 were only *in vitro* studies and 6 were *in vitro* and *in vivo* or just *in vivo* experimental studies.

Oregano was the most commonly studied plant (n = 15), followed by thyme (n = 14), rosemary (n = 7), marjoram (n = 4), and cumin (n = 2) (Figure 1). Six studies tested more than one plant: Santoro et al. (2007b) investigated oregano and thyme, Sanchez-Suarez et al. (2013) analyzed thyme, oregano, and rosemary, Castro (2018) used cumin and dill, and Štrbac et al. (2021) and Pensel et al. (2014) evaluated thyme and oregano.

The list of plants tested *in vitro* or *in vivo* and their effects on different parasite stages are listed in Tables 1–5. Some papers appear duplicated in the tables because the authors used two plants for the study or more than one parasite for the same plant.

Multiple biological activities have already been attributed to these plants in research. In a literature review of cumin by Al-Snafi (2016), the authors reported various activities, such as antimicrobial, insecticide, anti-inflammatory, analgesic, hypotensive, bronchodilator, antioxidant, anticancer, and antidiabetic activities, among others. Its anthelmintic activity seems to be little studied.
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Since few studies were found in this review. For marjoram, its biological activities documented by science include antioxidant, anxiolytic, anticonvulsant, anti-diabetic, anti-drop, antimutagenic activity, anti-ulcer, antibacterial, antifungal, and antiprotozoal activities (Prerna & Vasudeva, 2015). Documented properties of oregano include antimicrobial, antioxidant, hepatoprotective (Oniga et al., 2018), anticancer (Elshafie et al., 2017), and antiparasitic properties, as reported in this study. Rosemary has been reported to have antibacterial, anti-diabetic, anti-inflammatory, antitumor, antioxidant, antinociceptive, and analgesic properties, among others. In contrast, thyme has anti-septic, anti-spasmodic, anti-tussive, antimicrobial, antifungal, antioxidant, antiviral, and antiparasitic properties (Dauqan & Abdullah, 2017).

In this review, a total of 25 genera of parasites were found that have been tested with these plants (Figure 2). Of the 25 genera found, 20 were classified at the species level. The species belonging to the genus Haemonchus were the most tested, followed by Leishmania, Trichostrongylus, and Toxocara. Most of the parasite species found in this review can infect humans.

The large number of studies observed is justified by the important role of medicinal plants in modern medicine, which is an economically viable alternative for the population. In addition, they have natural compounds that, with the advancement in research, present an easy method of
Table 2. Relationship of *Origanum majorana* with parasites that have already been studied in *in vitro* and/or *in vivo* tests.

| Parasite                | Product            | Concentration | Activity                                      | Reference                  |
|-------------------------|--------------------|---------------|-----------------------------------------------|----------------------------|
| *Toxoplasma gondii*     | Essential oil      | 50 µg/mL      | Growth inhibition rate: 63.36 ± 6.66;          | Elazab et al. (2021)       |
|                         |                    |               | Embryo inhibition: 0.18 to 6 mg/mL: 92.32% to 100%;  |
|                         |                    |               | Larvicidal activity: 1.5 to 6 mg/mL: 100%;     |
| *Toxocara spp.*         | Essential oil      | 6, 3, 1.5, 0.75, 0.37, 0.18 mg/mL; Embryo & Larvicidal activity: 1.5 to 6 mg/mL: 100%; | Capella (2017) |
| *Haemonchus contortus*  | Essential oil      | Essential oil (eggs): 8, 4, 2, 1 mg/mL; Essential oil (adult nematodes): 0.5, 0.25, 0.125 mg/mL; Adult nematode mortality: 0.5 mg/mL: 50% after 8 h | Abidi et al. (2020)       |
| *Haemonchus polygyrus*  | Essential oil in mice diet | 5000 and 4000 mg/kg | Total worm reduction: 76.33 to 62.59%; Reduction of the number of eggs in the feces: 5000 mg/kg: 74%; | Abidi et al. (2020)       |

Figure 2. Genera of endoparasites most frequently found in *in vitro* and/or *in vitro* studies in the LILACS, PubMed, and Google Scholar databases from 2000 to 2021.

manipulation so that they are less toxic and more efficient and also because they have biological activities similar to allopathic medicines (Gadelha et al., 2013).
## Table 3. Relationship of *Origanum vulgare* with parasites that have already been studied in *in vitro* and/or *in vivo* tests.

| Parasite                  | Product                  | Concentration | Activity                                                                 | Reference                                                                 |
|---------------------------|--------------------------|---------------|--------------------------------------------------------------------------|---------------------------------------------------------------------------|
| *Trypanosoma cruzi*       | Essential oil            | For epimastigotes: 25 to 250 μg/mL | Inhibition of epimastigotes growth: 200 μg/mL: 50% and 200 μg/mL: 95%       | Santoro et al. (2007a)                                                     |
|                           |                          | For trypomastigotes: 25 to 400 μg/mL | Trypomastigote cell lysis: 200 μg/mL: ± 95%                              |                                                                           |
| *Cryptosporidium parvum*  | Essential oil            | 60 μg/mL      | *In vitro* growth reduction: 55.6 ± 10.4%                                 | Gaur et al. (2018)                                                         |
| *Eimeria spp.*            | Essential oil in chicken diets | 500 ppm     | Fewer intestinal lesions and more weight gain                             | Mohiti-Asl & Ghanaatpanast-Rashki (2015)                                  |
| *Giardia lamblia*         | Hydroalcoholic extract   | 100 and 200 mg/mL per 120 min | Cyst viability: 100 mg/mL: 20% and 200 mg/mL: ± 5%                       | Davoodi & Abbasi-Maleki (2018)                                             |
| *Leishmania major*        | Essential oil            | 640 to 10 μg/mL | Increased leishmanicidal effects on *L. panamensis*                      | Sanchez-Suarez et al. (2013)                                              |
| *Leishmania braziliensis* |                          |               |                                                                          |                                                                           |
| *Leishmaniasis panamensis*|                          |               |                                                                          |                                                                           |
| *Haemonchus spp.*         | Dye                      | 80 to 0.62 mg/mL | Hatchability inhibition: tincture of 80 to 20 mg/mL: 100%               | Dias de Castro et al. (2013)                                              |
| *Trichostrongylus spp.*   | Hydroalcoholic extract (HAE) |            | HAE: 80 mg/mL: 96.7 ± 1.5% and 40 mg/mL: 80 ± 14.4%                      |                                                                           |
| *Oesophagostomum*         | Aqueous extract (AQE)    | 80 mg/mL: 49.8 ± 2.24%          |                                                                          |                                                                           |
| *Toxocara spp.*           | Essential oil            | 6, 3.15, 0.75, 0.37, 0.18 mg/mL | Embryo inhibition: 6 to 0.18 mg/mL: 100 to 88.15%                        |                                                                           |
|                           |                          |               |                                                                          |                                                                           |
| *Haemonchus spp.*         | Essential oil            | 50, 12.5, 3.125, 0.195, 0.049 mg/mL | Embryo inhibition: 50 to 0.049 mg/mL: 100%                              | Štrbac et al. (2021)                                                      |
| *Trichostrongylus spp.*   |                          |               |                                                                          |                                                                           |
| *Teladorsagia spp.*       |                          |               |                                                                          |                                                                           |
| *Chabertia spp.*          | Essential oil            | 10 μg/mL      | Scholex viability: 22.3 ± 1.2% after 60 d                                | Persel et al. (2014)                                                      |
| *Echinococcus granulosus* |                          |               |                                                                          |                                                                           |
| *Eimeria spp.*            | Supplementation in sheep and lamb diet | 4 g/day sheep 2 g/day lambs | Oocyst reduction and helps with weight gain                              | Dudiko et al. (2018)                                                     |
| *Ascaridia galli*         | Ethanol extract          | 50 mg/mL      | % infectile eggs from day 10 to day 21: 100 to 61%                      | Villanueva et al. (2015)                                                  |
| *Cooperia spp.*           | Essential oil            | 10000, 5000, 1000, 100, 10, and 1 ppm | Surviving larvae: 0% at 1000 ppm/day to 1.3 ± 1.3% at 1 ppm/day28     | Galuppi et al. (2009)                                                     |
| *Trichostrongylus spp.*   |                          |               |                                                                          |                                                                           |
| *Ostertagia spp.*         |                          |               |                                                                          |                                                                           |
| *Oesophagostomum spp.*    |                          |               |                                                                          |                                                                           |
| *Haemonchus spp.*         |                          |               |                                                                          |                                                                           |
| *Bunostomum spp.*         |                          |               |                                                                          |                                                                           |
| *Nematodirus spp.*        |                          |               |                                                                          |                                                                           |
| *Haemonchus contortus*    | Aqueous suspension in sheep diet | 260 mg/kg | Reduction in parasite load: 64.9%                                      | Munguía- Xóchichua et al. (2013)                                           |
| *Giardia lamblia*         | supplementation canine dog diet | 100 g/animal/day | 82.33% reduction in symptoms and parasite load                           | Mosquera Rodriguez (2016)                                                |
| *Echinococcus spp.*       | Microemulsion (MAE)      | MAE: 10%      | Protostrongylosis mortality rate: 100% after 15 min in all three concentrations | Soleimani et al. (2021)                                                   |
|                           | Microemulsion (MIE)      | MIE: 0.6 to 1% |                                                                          |                                                                           |

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Table 4. Relationship of *Rosmarinus officinalis* with parasites that have already been studied in *in vitro* and/or *in vivo* tests.

| Parasite                     | Product       | Concentration       | Activity                                                                 | Reference                  |
|------------------------------|---------------|---------------------|--------------------------------------------------------------------------|----------------------------|
| *Trypanosoma cruzi*          | Essential oil | 50 and 100 μL/mL    | Epimastigote inviability: OE 50 μL/mL 96.2% and 100 μL/mL 100%.          | Rojas et al. (2010)        |
| *Acanthamoeba polyphaga*     | Essential oil | 1, 2, and 4 mg/mL   | Cell death: 2 and 4 mg/mL 100% in 144 h. 1 mg/mL 86% after 144 h. Change in trophozoite morphology | Anacarso et al. (2019)     |
| *Leishmania major*           | Essential oil | 0.875, 1.75, 2.5, 5, and 10 μg/mL | Cellular alteration causing infeasibility. | Bouyahya et al. (2017)     |
| *Leishmania infantum*        | Essential oil | 0.0625, 0.125, 0.25, 0.5, and 1 μg/mL | Mean macrophage infection rate: OE 0.125 μg/mL: 39.33 ± 6.02%. | Shokri et al. (2017)       |
| *Leishmania tropica*         | Essential oil | NE 0.0625 μg/mL     | Embryo inhibition: 6 to 0.18 mg/mL: 70.52 to 68.45%. Larvicidal activity: 6 to 3 mg/mL: 97.97 to 95.13%. | Pinto et al. (2019)        |
| *Toxocara spp.*              | Essential oil | 6, 3, 1.5, 0.75, 0.37, and 0.18 mg/mL | Embryo inhibition: 227.5 to 71 mg/mL: 100 to 97.4%. |                          |
| *Haemonchus spp.*            | Essential oil | 227.5, 113.7, 56.8, 28.4, 14.2, and 7.1 mg/mL | Inhibition of larval migration: 227.5 and 113.7 mg/mL: 74 and 70.1%. |                          |
| *Ostertagia spp.*            | Essential oil | 56.8 to 71 mg/mL    | Embryo viability: 71% on day 7 | Albani et al. (2014)       |
| *Trichostrongylus spp.*      | Essential oil | 56.8 to 71 mg/mL    | Reduced cell viability: 71% on day 7 | Albani et al. (2014)       |
| *Echinococcus granulosus*    | Essential oil | 10 μg/mL            | Reduced cell viability: 71% on day 7 | Albani et al. (2014)       |
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Table 5. Relationship of *Thymus vulgaris* with parasites that have already been studied in *in vitro* and/or *in vivo* tests.

| Parasite                        | Product               | Concentration          | Activity                                                                 | Reference                                      |
|---------------------------------|-----------------------|------------------------|---------------------------------------------------------------------------|-----------------------------------------------|
| *Trypanosoma cruzi*             | Essential oil         | For epimastigotes: 25 to 250 μg/mL For trypomastigotes: 25 to 400 μg/mL | Growth inhibition: 200 μg/mL: 100%. Cell lysis: 100 μg/mL: 100% | Santoro et al. (2007a)                        |
| *Trichinella spiralis*          | Alcoholic extract mice diet | 500 and 1000 mg/kg | 500 mg/kg: Decrease of adult worm in the intestine: 79.4%. | Attia et al. (2015)                           |
| *Haemonchus contortus*          | Essential oil (EO)    | EO (hatchability and motility): 50, 25, 12.5, 6.25, 3.125, 1.562, 0.781 mg/mL | Hatchability inhibition: 50 to 0.78 mg/mL: >94%. L3 larval motility inhibition: 50 to 0.78 mg/mL: >84% | Ferreira et al. (2016)                        |
| *Caenorhabditis elegans*        | Essential oil         | 2, 3, and 4%          | Dead adult nematodes: 2%, 80% in 48 h. Larval hatching: 2, 3, and 4%: >10%. Decreased adult motility at the concentrations tested. |                                              |
| *Haemonchus contortus*          | Essential oil         | 9.4, 4.7, 2.35, 1.17, 0.58, and 0.29 mg/mL | Embryo inhibition: 94 to 0.29 mg/mL: 100 to 77.6%. Developmental inhibition: 94 to 2.3 mg/mL: 100 to 65.68%. Larval migration inhibition: 9.4 to 0.117 mg/mL: 95.3 to 69.6%. | Castro et al. (2021a); Castro et al. (2021b) |
| *Haemonchus* spp.                | Essential oil         | 50, 12.5, 3.125, 0.195, and 0.049 mg/mL | Embryo inhibition: 50 to 0.049 mg/mL: 100 to 98.5 ± 0.58%. | Štrbac et al. (2021)                         |
| *Trichostrongylus* spp.         | Ethanol extract       | 4, 2, 1, and 0.5 mg/mL | Scolex viability: 35.3 ± 2.8% after 60 d | El-Sayed (2009)                               |
| *Blastocystis hominis*          | Ethanolic extract     | 2500, 1500, 1000, and 500 μg/mL | Scox death: 2500 μg/mL: 100% after 6 days. Other concentrations: 100% after 7 days | Yones et al. (2011)                          |
| *Toxocara vitulorum*            | Essential oil in rats’ diet | 42.5 mg/kg          | Decreased number of larvae in the organs of infected rats. | Amin & El-Kabany (2013)                       |
| *Trichostrongylus* spp.         | Diluted in water with nor in lambs’ diets | 0.3 g/kg           | Decreased number of eggs in the feces of 37.5% of the animals on day 14 | Cruz et al. (2017)                           |
| *Eimeria stiedae*               | Essential oil in rabbits’ diet | 500 mg/kg          | Decrease in stool oocysts: 0% day 34 | Abu El Ezz et al. (2020)                     |
| *Giardia lamblia*               | Methanolic extract    | 300 μg/mL           | In vitro growth inhibition: 95.86% |                                              |
| *Trichomonas vaginalis*         | Methanolic extract    | 300 μg/mL           | In vitro growth inhibition: 95.42% |                                              |
Conclusions

All the plants investigated in this review have antiparasitic activity against the endoparasites tested, with *Origanum vulgare* L. (oregano) and *Thymus vulgaris* L. (thyme) standing out as the plants that have been studied the most. *Cuminum cyminum* L. (cumin) was the plant with the least number of evaluations in studies regarding antiparasitic action. The endoparasite genera most studied were *Haemonchus*, *Leishmania*, *Trichostrongylus*, and *Toxocara*, respectively. The plants evaluated in the identified studies showed action at different stages of parasite development, indicating the potential of these molecules for their use as phytotherapy.

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Ethics statement

Not apply

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ALS, MEAB, GAC, MQM, WDST, CMC and NBP - No conflict of interest

Authors' contributions

ALS - Development of methodology; preparation and writing the initial draft. MEAB, GAC, MQM, WDST, CMC and NBP - Writing, Review and Editing manuscript.

Availability of complementary results

The study was carried out at Laboratório de Helmintologia, Departamento de Microbiologia e Parasitologia do Instituto de Ciências Biológicas, Universidade Federal de Pelotas - UFPel, Pelotas, RS, Brazil.

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