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Review Article

Medicinal Plants, Herbal Compounds, and Other Natural Products Used against *Echinococcus granulosus sensu lato*: A Narrative Review

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Abstract

Echinococcus granulosus sensu lato is a parasite that causes cystic echinococcosis in humans and herbivorous mammals, especially in the liver and lungs. The main treatment for cystic echinococcosis is surgery, but the primary risk of this method is the rupture of the cyst formed by the parasite and the spread of infectious protoscolices, leading to the formation of secondary cysts. Although many drugs are now used as scolicidal agents, their side effects have led to the acceptance of natural products as scolicidal agents. In this review, we aimed to investigate the scolicidal activities of various natural products. Studies on medicinal plants, herbal compounds, and other natural products with scolicidal activity against *Echinococcus granulosus sensu lato* protoscolices between 2000 and 2024 were searched using PubMed, Scopus, and Google Scholar databases. Information from the studies included the type of medicinal plant used, herbal compound or natural product information, concentration, exposure time, and scolicidal activity. This review analyzed 103 studies that assessed the efficacy of 60 natural products against *Echinococcus granulosus sensu lato*, including 39 medicinal plants, 15 herbal compounds, and six other natural products. The most frequently observed medicinal plants were from the *Lamiaceae* family, of which *Zataria multiflora* was the most studied species. In addition, thymol and propolis were the most commonly studied herbal compounds and other natural products. This review focuses on medicinal plants, herbal compounds and other natural products with potential scolicidal agents.

Introduction

Echinococcus granulosus sensu lato is a parasite that causes cystic echinococcosis (CE) in both humans and herbivorous mammals, especially in the liver and lungs. The parasite is found on almost all continents except Antarctica and is particularly prevalent in tropical and subtropical regions where livestock farming is common (1, 2). CE causes

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economic losses in the livestock sector due to increased weight loss and mortality in animals, as well as reduced milk production and fertility. It also poses a significant health risk, contributing to morbidity and mortality in human populations (2-4).

Previously, the only treatment option for CE was surgery. Today, in addition to surgery, the "watch and wait" approach, percutaneous treatment methods, and chemotherapy are also utilized (2). Currently, benzimidazoles such as albendazole and mebendazole are the primary treatment for CE. However, these drugs have several limitations, including poor gastrointestinal absorption. Prolonged administration is often necessary, which can lead to hepatotoxicity and gastrointestinal adverse effects. Furthermore, their teratogenic potential restricts their use during pregnancy. Additionally, their efficacy against certain parasite stages is limited, contributing to high recurrence rates (5, 6). Moreover, during surgical procedures, various scolicidal agents are used to prevent the rupture of the cyst and the formation of secondary cysts (7). However, studies have reported serious side effects from commonly used scolicidal agents, such as hypertonic saline, ethanol, and formaldehyde, including hypernatremia and sclerosing cholangitis (8-10).

Medicinal plants, herbal compounds, and other natural products, which are components of complementary and alternative medicine, have demonstrated antimicrobial properties (11-15). However, their effectiveness as alternatives for treating CE is still under scrutiny. Numerous *in vivo* and *in vivo* studies have been conducted, and ongoing research suggests that these natural substances may serve as scolicidal agents with reduced side effects (16).

This review evaluates the scolicidal potential of medicinal plants, herbal compounds, and other natural products against *E. granulosus s.l.*

Materials and Methods

Research published between 2000 and 2024 was searched for using the search terms “Echinococcus” or “hydatid” in combination with “natural scolicidal agents”, “medicinal plants”, “herbal compounds” or “natural products” via PubMed, Scopus and Google Scholar. Information extracted from the studies included the type of medicinal plant used, the herbal compound or natural product information, dosage, exposure time, and scolicidal activity. The “Tropicos” database (http://www.tropicos.org) was referenced for the correct and standard scientific names and families of the medicinal plants.

General Overview

This review examined 103 articles published between 2000 and 2024 that covered a variety of natural products evaluated for their scolicidal activity. Across these studies, 39 medicinal plant species belonging to 21 plant families (78 of the studies), 15 herbal compounds (17 of the studies), and six other natural products (11 of the studies) were investigated. The review included 103 articles, some of which compared multiple medicinal plant species and others of which evaluated both medicinal plants and herbal compounds simultaneously. Out of the 103 studies, 88 (85.4%) were conducted in vitro, 10 (9.7%) were conducted in vivo, and five (4.9%) were both *in vitro* and *in vivo* studies (Fig. 1). Data were extracted on plant species and families, extraction methods, plant parts used, herbal compounds, other natural products, tested concentrations, exposure durations, and scolicidal efficacy (Table 1). Analysis of these data revealed notable trends in the types of natural products investigated and their prominence in the literature. Medicinal plants emerged as the predominant focus, likely due to their widespread availability and relatively simple extraction processes compared to herbal compounds and other natural products.

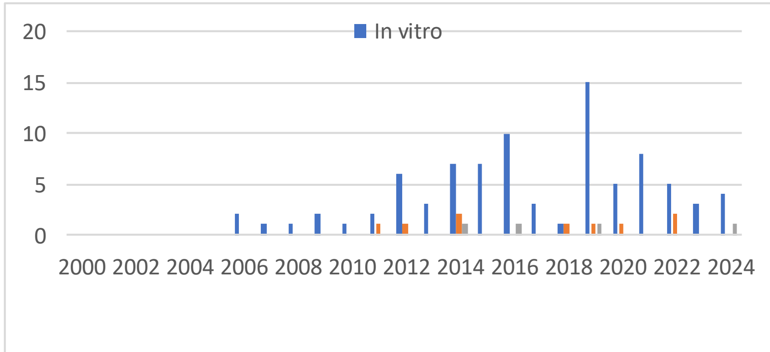

Fig. 1: Comparison of *in vitro* and *in vivo* studies over the years

Table 1: *In vitro* activity of medicinal plants, herbal compounds, and other natural products against *Echinococcus granulosus s.l.* protoscoleces

Scolicidal agent	Extraction method	Part used	Concentration	Exposure time	Scolicidal efficacy (%)
β-pinene (17)			10 µg/ml	60 min	>80
***Allium cepa/Amaryllidaceae* (Onion) (18)**	Methanolic	Leave	100 mg/ml	60 min	16.3
***Allium sativum/ Amaryllidaceae* (Garlic) (19, 20, 21, 22, 23, 24)**	Methanolic Chloroformic Methanolic Chloroformic Methanolic Chloroformic	Garlic clove Garlic clove Garlic clove Garlic clove Flower Garlic clove	50% mg/ml 200 mg/ml 50 mg/ml 50 mg/ml 200 mg/ml 200 mg/ml	15 min 60 min 10 min 60 min 180 min 2 min	100 99.97 100 98 100 100
Ampelopsin (25)			160 µM	7 d	100
***Artemisia/Asteraceae* (Wormwood) (26, 27)**	Methanolic Hydro-alcoholic	Fruit Aerial	100 mg/ml 250 mg/ml	60 min 60 min	17.33 100
Berberine (28)			0.5 mg/ml	10 min	100
***Berberis vulgaris/Berberidaceae* (Barberry) (28, 29, 30, 31)**	Aqueous Methanolic Methanolic Ethanolic	Fruit Root Seed Aerial	4 mg/ml 2 mg/ml 25 mg/ml 50 mg/ml	5 min 10 min 5 min 30 min	100 100 100 97.92
***Buxus wallichiana/Buxaceae* (Himalayan boxwood) (31)**	Ethanolic	Aerial	50 mg/ml	30 min	65.98
***Calendula officinalis/Asteraceae* (Pot marigold) (27)**	Hydro-alcoholic	Aerial	250 mg/ml	60 min	42.33
Cannabidiol (32)			50 µg/ml	2 d	100
Carvacrol (33, 34)			10 µg/ml 100 µl/ml	60 d 5 min	100 100

Table 1: Continued…

Cinnamaldehyde (35, 36)			50 µg/ml 50 µg/ml	8 d 120 min	100 35
***Cinnamomum zeylanicum/Lauraceae* (Cinnamon) (35, 37)**	Hydrodistillation Hydrodistillation	Bark Bark	50 µl/ml 200 µg/mL	5 min 28 d	100 100
Cineole (38)			100 µl/ml	60 min	100
Citronellol (17)			10 µg/ml	60 min	>80
***Citrullus colocynthis/Cucurbitaceae* (Bitter apple) (39, 40, 41)**	Methanolic Methanolic Methanolic	Fruit Seed Fruit and seed	16 mg/ml 40 mg/ml 300 µg/ml	120 min 24 h 3 d	100 15.3 100
***Curcuma longa/Zingiberaceae* (Turmeric) (42, 43)**	Ethanolic Hydrodistillation	Rhizome Rhizome	50 mg/ml 200 µl/ml	30 min 5 min	93.2 100
***Elettaria cardamomum/Zingiberaceae* (Cardamon) (38)**	Hydrodistillation	Seed	100 µL/mL	30 min	100
Endophytic fungi (44)			20 mg/ml	30 min	97
***Eucalyptus spp/Myrtaceae* (Gum tree) (26, 41, 45, 46, 47)**	Methanolic N/A Hydrodistillation Methanolic Hydro-alcoholic	Leave Leave Leave Leave Leave	50 mg/ml 1% 10 mg/ml 600 µg/ml 10 mg/ml	40 min 1 min 96 h 6 d 20 min	100 100 97 100 100
***Euphorbia helioscopia/Euphorbiaceae* (Sun spurge) (31)**	Ethanolic	Aerial	50 mg/ml	30 min	61.22
***Ferula* spp./*Apiaceae* (Giant fennel) (17, 27, 48, 49)**	Hydrodistillation Hydrodistillation Hydrodistillation Hydro-alcoholic	Leave Gum Leave Gum	60 µg/ml 50 µg/ml 150 µl/ml 250 mg/ml	10 min 60 min 30 min 60 min	100 100 100 100
***Foeniculum vulgare/Apiaceae* (Fennel) (50, 51)**	Hydrodistillation Methanolic	Seed Seed	1 mg/ml 200 mg/ml	5 min 10 min	100 100
Fungal chitosan (52, 53)			400 µg/ml 200 µg/ml	180 min 180 min	100 100
Gingerol (54)			100 µg/ml	48 h	85
Harmine (55, 56)			25 µg/ml 100 µM	3 d 1 d	100 13.49
Honey (57)			10%	3 min	100
Larval excretion-secretion (14)			1:1	5 h	27
***Laurus nobilis/Lauraceae* (Bay laurel) (58)**	Aqueous	Leave	10 mg/ml	60 min	98
***Mentha spp./Lamiaceae* (Mint) (59, 60, 61, 62, 63)**	Hydrodistillation Hydrodistillation Methanolic Hydrodistillation Ethanolic	Leave Leave Leave Leave Leave	10 µg/ml 10 µg/ml 200 mg/ml 10% 75 mg/ml	18 d 7 d 30 min 5 min 20 min	100 23 99.54 100 100
Menthol (64)			50 µg/ml	3 d	100

Table 1: Continued…

Myrtus communis/Myrtaceae **(Myrtle) (65, 66, 67)**	Hydrodistillation Methanolic Ethanolic	Leave Leave Leave	100 µl/ml 25 mg/ml 150 mg/ml	5 min 20 min 5 min	100 100 100
Nigella sativa/Ranunculaceae **(Black cumin) (68, 69, 70)**	Aqueous Methanolic Aqueous	Seed Seed Seed	10 mg/ml 50 mg/ml 100 mg/ml	10 min 10 min 120 min	100 100 100
Ocimum basilicum/Lamiaceae **(Sweet basil) (18, 63)**	Methanolic Ethanolic	Leave Leave	100 mg/ml 75 mg/ml	60 min 30 min	24.1 100
Olea europaea/Oleaceae **(Olive) (71, 72, 73)**	Aqueous Hydro-alcoholic Ethanolic	Leave Leave Leave	0.01% 300 mg/ml 16 mg/ml	120 min 20 min 60 min	96.1 100 97.6
Oleuropein (74)			1%	20 min	100
Origanum vulgare/Lamiaceae **(Oregano) (62, 75)**	Hydrodistillation Hydrodistillation	Leave Leave	Containing a thymol concentration of 10 µg/ml 10%	72 d 5 min	100 100
Osthole (76)			120 µM	3 d	100
Peganum harmala/Nitrariaceae **(Syrian rue) (30, 40)**	Methanolic Methanolic	Seed Aerial	100 mg/ml 40 mg/ml	40 min 24 h	17 50
Pelargonium roseum/Geraniaceae **(Rose geranium) (17)**	Hydrodistillation	Leave	50 µg/ml	60 min	100
Pinus spp/Pinaceae **(Pine) (77)**	Hydrodistillation	Leave	50 mg/ml	60 min	100
Pistacia spp/Anacardiaceae **(Pistachio) (78, 79, 80, 81, 82)**	Hydrodistillation Methanolic Methanolic Hydrodistillation Methanolic	Leave Fruit Fruit Aerial Fruit	128 µg/ml 0.1 % mg/ml 100 mg/ml 200 µl/ml 50 mg/ml	48 h 120 min 10 min 5 min 10 min	N/A 100 100 100 100
Propolis (83, 84, 85)			1 µg/ml 0.1 mg/ml 25 mg/ml	3 min 1 min 10 min	100 100 100
Punica granatum/Lythraceae **(Pomegranate) (73)**	Ethanolic	Flower	16 mg/ml	60 min	91.7
Quercus spp/Fagaceae **(Oak) (39)**	Methanolic	Bark	16 mg/ml	120 min	100
Rhus coriaria/Anacardiaceae **(Sumac) (86)**	Methanolic	Fruit	10 mg/ml	30 min	100
Rosmarinus officinalis/Lamiaceae **(Rosemary) (60, 87, 88)**	Hydrodistillation Hydrodistillation Aqueous	Leave Leave Aerial	10 µg/ml 10 µg/ml 1.6 mg/ml	7 d 54 d 60 min	29 90.2 19.57
Ruta graveolens/Rutaceae **(Rue) (40, 89)**	Methanolic Methanolic	Aerial Aerial	40 mg/ml 40 mg/ml	75 min 3 h	100 100
Salvia officinalis/Lamiaceae **(Sage) (64)**	Ethanolic	Leave	2500 µg/ml	6 d	100
Satureja spp/Lamiaceae **(Savory) (71, 90)**	Hydro-alcoholic Hydrodistillation	Aerial Leave and flower	0.1% 5 mg/ml	30 min 60 min	100 100

Table 1: Continued…

***Silybum marianum/Asteraceae* (Milk thistle) (91)**	Ethanolic	Seed	500 µg/ml	60 min	77
Thymol (34, 60, 64, 92, 93)			50 µg/ml 200 µg/ml 5 µg/ml 10 µg/ml 100 µg/ml	5 d 10 min 7 d 80 d 5 min	100 100 37 100 100
Thymoquinone (68)			1 mg/ml	10 min	100
***Thymus spp/Lamiaceae* (Thyme) (63, 64, 75, 94, 95, 96)**	Ethanolic Hydrodistillation Hydrodistillation Ethanolic Hydrodistillation Hydrodistillation	Leave Leave Leave Leave Aerial Leave	2500 µg/ml Containing a thymol concentration of 10 µg/ml 3 mg/ml 75 mg/ml 2500 ppm 9,25 mg/ml	6 d 72 d 1 min 10 min Immediately after the procedure 5 min	100 100 100 100 100 100
***Tripleurospermum disciforme/Asteraceae* (Disciform mayweed) (66)**	Methanolic	Leave	100 mg/ml	30 min	15
Vinegar (97, 98)			50% 100%	1 min 5 min	100 100
***Vitis vinifera/Vitaceae* (Grapevine) (99)**	Methanolic	Leave	50 mg/ml	30 min	100
***Xanthium strumarium/Asteraceae* (Cocklebur) (100)**	Hydrodistillation	Leave	20 mg/ml	60 min	79.22
***Zataria multiflora/Lamiaceae* (Shirazi thyme) (30, 34, 48, 62, 101, 102, 103, 104)**	Methanolic Hydrodistillation Hydrodistillation Methanolic Hydrodistillation Methanolic N/A Hydrodistillation	Leave Leave Aerial Leave Aerial Aerial N/A Leave	25 mg/ml 17 µg/ml 1 mg/ml 20 mg/ml 12 µl/ml 25 mg/ml 20 µL/ml 10%	1 min 10 min 5 min 10 min 5 min 5 min 15 min 1 min	100 100 100 100 100 100 100 100
***Zingiber officinale/Zingiberaceae* (Ginger) (26, 42, 54, 105, 106, 107)**	Methanolic Ethanolic Methanolic Aqueous Ethanolic Ethanolic	Rhizome Rhizome Rhizome Rhizome Rhizome Rhizome	25 mg/ml 50 mg/ml 100 mg/ml 100 µg/ml 30 mg/ml 200 mg/ml	60 min 120 min 60 min 48 h 20 min 30 min	100 100 100 100 100 100

Geographical Distribution of Studies

In terms of geographical distribution, most studies originated from endemic regions such as Iran and Türkiye, reflecting the significant clinical impact of CE in these countries. This may be related to the frequent use of plants such as thyme in culinary practices and traditional medicine in these regions. While this concentration of research highlights regional expertise, it also indicates the necessity for wider international validation.

Scolicidal Agents

The findings of this review reveal that 21 distinct plant families and 39 individual medicinal plants were investigated as scolicidal agents.

The *Lamiaceae* family was the most frequently studied, representing 41.0% (32/78) of all medicinal plants studies (Fig. 2). Among these medicinal plants, *Zataria multiflora* (14.1%) emerged as the most extensively investigated species (Table 1). This review also examined 15 herbal compounds, of which thymol (35.3%) was the most frequently studied (Table 1). The prominence of *Lamiaceae* species in the literature is likely attributable to their high concentrations of phenolic compounds with established antiparasitic activity. Similarly, *Zataria multiflora* appeared repeatedly across independent studies and was identified as the most significant scolicidal medicinal plant. Its strong activity at low concentrations has been linked to elevated levels of phenolic monoterpenic compounds, particularly thymol and carvacrol (Tables 1 and 2).

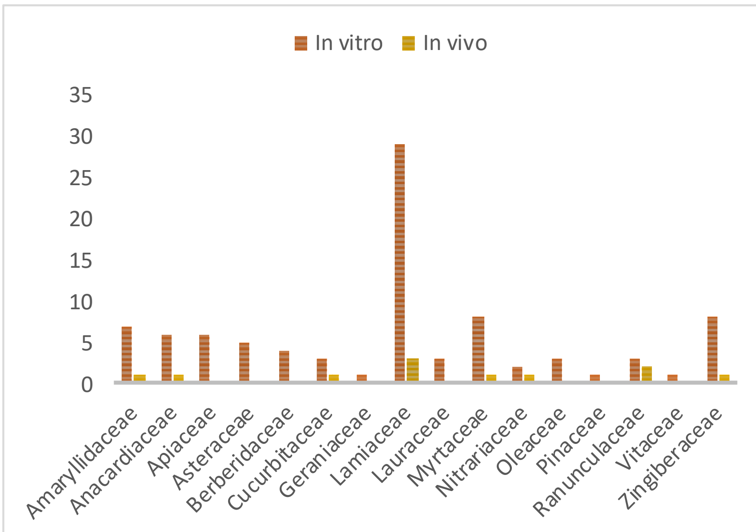

Fig. 2: Comparison of *in vitro* and *in vivo* studies on medicinal plants based on plant families

In addition to medicinal plants and herbal compounds, this review identified six other natural products investigated for their scolicidal effects. Among these, propolis was the most frequently studied, accounting for 27.3% (3/11) of all included studies.

Although several natural products—including thymol, carvacrol, and propolis—demonstrated strong scolicidal effects, their mechanisms of action differ considerably. It is thought that the lipophilic properties of both monoterpenoid phenols, thymol and carvacrol, disrupt parasite membranes, leading to loss of membrane integrity and cell lysis (119, 120). They also disrupt microbial homeostasis by inhibiting enzymes such as hydrolase and alkaline phosphatase (121). In contrast, the antimicrobial activity of propolis is primarily attributable to its flavonoid content, and it is likely to exert immunomodulatory effects in addition to direct scolicidal activity (122). These distinctions highlight the importance of considering both efficacy and mechanistic plausibility when selecting compounds for translational research

Table 2: *In vivo* activity of medicinal plants, herbal compounds, and other natural products against *Echinococcus granulosus s.l.* protoscoleces

Scolicidal agent(Reference)	Extraction method	Part used	Concentration	Exposure time	Scolicidal activity
Allium sativum **(Garlic) (108)**	Methanolic	Fruit	40 ml/L	30 d	Significant
Cannabidiol (32)			20 mg/kg	30 d	Not significant
Carvacrol (33, 109)			40 mg/kg 40 mg/kg	20 d 30 d	Significant Significant
Citrillus colocynthis **(Bitter apple) (110)**	Methanolic	Seed	150 mg/kg	30 d	Not significant
Myrtus communis **(Myrtle) (111)**	Aqueous	Leave	6 mg/ml	7 d	Significant
Nigella sativa **(Black cumin) (112, 133)**	Aqueous N/A	Seed N/A	25 mg 1.14 g/kg	7 d 60 d	Significant Significant
Peganum harmala **(Syrian rue) (110)**	Methanolic	Aerial	200 mg/kg	30 d	Not significant
Propolis (85)			100 mg/ml	80 d	Significant
Rhus coriaria **(Sumac) (114)**	Methanolic	Fruit	200 mg/kg	45 d	Significant
Ruta graveolens **(Rue) (110)**	Methanolic	Aerial	400 mg/kg	30 d	Significant
Thymol (115)			40 mg/kg	10 d	Significant
Zataria multiflora **(Shirazi thyme) (116, 117, 118)**	Hydrodistillation Methanolic Hydrodistillation	Aerial Leave Aerial	40 ml/L 8 g/L 100 ml/L	30 d 30 d 60 d	Significant Significant Significant
Zingiber officinale **(Ginger) (107)**	Ethanolic	Rhizome	50 mg/ml	N/A	Significant

Study Types

Among studies evaluating medicinal plants, 9 studies (11.5%) were conducted in vivo, 1 study (1.3%) involved both *in vitro* and *in vivo* methods, and the majority, 68 studies (87.2%) were carried out in vitro. The plants examined *in vivo* included *Allium sativum, Citrillus colocynthis, Myrtus communis, Nigella sativa, Peganum harmala, Rhus coriaria, Ruta graveolens, Zataria multiflora*, and *Zingiber officinale*, as detailed in Table 2. Of the studies evaluating herbal compounds, one of the studies (5.9%) was in vivo, 3 (17.7%) were both *in vitro* and in vivo, and the rest (76.5%) were *in vitro* studies. Of these compounds, thymol, carvacrol, and cannabidiol were studied *in vivo* (Table 2). Among other natural products, one study (9.1%) utilized both *in vitro* and *in vivo* methodologies, while the remaining studies (91.9%) utilized an *in vitro* approach exclusively. The efficacy of propolis was evaluated in both *in vitro* and *in vivo* studies (Tables 1 and 2).

An ideal scolicidal agent should have maximum effect in minimum time, be well absorbed, and have no toxic effects on host cells (123). To achieve this, understanding the pharmacodynamics and pharmacokinetics of these substances is crucial. This review indicates a preference among researchers for *in vitro* studies, which are often favored due to their lower costs and faster results when compared to *in vivo* studies (124). However, it is important to emphasize that a substance demonstrating efficacy *in vitro* may not always translate to the same level of effectiveness in vivo. Variations in effectiveness can arise, particularly with antiparasitic substances, and may be attributed to the bioavailability of the substance within the host's body or to the host's immune responses (125). More *in vivo* testing is necessary to thoroughly analyze the pharmacokinetics and pharmacodynamics of new natural products that present fewer side effects, lower toxicity, and quicker scolicidal activity, as well as to evaluate the host immune response. While *in vivo* studies offer significant advantages, they also come with disadvantages: they tend to be more time-consuming, more expensive, and more challenging to replicate than *in vitro* tests (126). Ultimately, both *in vitro* and *in vivo* studies play distinct and critical roles in research, and both are essential for a comprehensive understanding of the substances being studied.

In vivo studies generally indicate that a variety of medicinal plants, herbal compounds and other natural products exhibit scolicidal activity against *E. granulosus s.l.*; however, the quantity and quality of *in vivo* evidence varies between agents (Table 2). While many agents demonstrated statistically significant *in vivo* effects (33, 85, 107, 109, 113, 115, 118), certain plants (notably *Citrullus colocynthis* and *Peganum harmala* (110)) are primarily supported by *in vitro* data or produced inconsistent results in animal studies. This highlights the need for further well-designed *in vivo* investigations. In all *in vivo* CE studies, mice have been used as guinea pigs, probably because of the high similarity of the mouse genome to the human genome (127). They are also small, easy to genetically manipulate, and inexpensive to produce (128).

Extraction Methods and Used Parts

In efficacy studies conducted on medicinal plants, it was observed that methanolic extraction (35.5%) was the most preferred extraction method. This was followed by hydrodistillation (30%), ethanolic extraction (15%), aqueous extraction (8%), hydroalcoholic extraction (5%) and chloroform extraction (3%). Information on extraction methods could not be obtained from 3% of the studies. It was observed that the leaf part (40.5%) of medicinal plants was most commonly used as a scolicidal agent, followed by the aerial part (17.1%), fruit (12.6%), seed (11.7%), and rhizome (8.1%) (Fig. 3). Apart from these parts, bark, flower, resin, and root parts were also used in the studies. In two studies, it was not possible to determine which part of the medicinal plant was used (Table 1). These findings are consistent with broader trends reported in the literature, which highlight leaves as the most frequently utilised plant part due to their rich content of bioactive compounds and ease of collection (129, 130). Similarly, methanol remains the most commonly used extraction solvent, likely due to its polarity and high efficiency in extracting a wide range of active phytochemicals (131).

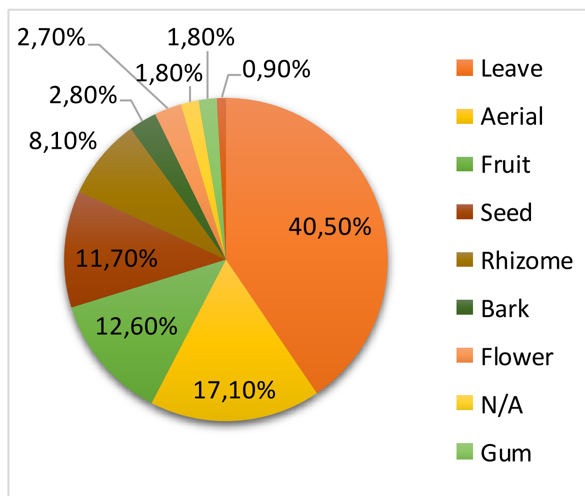

Fig. 3: Comparison of used parts of medicinal plants

Conclusion

Despite promising efficacy, toxicity and bioavailability of natural products remain critical barriers to their clinical application. Several natural products, including herbal compunds such as thymol and carvacrol, can cause hepatotoxicity, neurotoxicity or mucosal irritation when taken in high doses (132, 133). Furthermore, the low water solubility and rapid metabolism of many phytochemicals limit their systemic bioavailability. Formulation strategies such as nanoencapsulation or liposomal delivery have been proposed to overcome these challenges (134). However, very few studies have rigorously evaluated the safety and pharmacokinetics of these approaches in animal models.

In conclusion, medicinal plants, herbal compounds, and other natural products are essential components of complementary and alternative medicine across the globe. While several natural products have shown promising scolicidal activity, their successful translation into clinical use will depend on rigorous *in vivo* validation, detailed toxicological profiling, and development of optimized formulations. Future research should prioritize systematic safety studies and explore novel delivery platforms to enhance bioavailability. Such efforts are essential to realize the full therapeutic potential of natural products in the management of CE.

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Conflict of interests

Authors have no potential conflict of interest pertaining to this submission to Iranian Journal of Parasitology.

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