

# Phytotherapy for Healing of Invasive Infectious Lesions of Cutaneous Leishmaniasis: Effective Medicinal Plants and Analysis of Their Mechanisms of Action

Mahsa Aghaei<sup>1</sup>✉ , Asma Hosseini Manesh<sup>2</sup> 

<sup>1</sup> Islamic Azad University of Medical Sciences, Tehran, Iran

## Article Info

### Article type:

Review Article

### Article History:

Received: July. 17, 2024

Received: Nov. 11, 2024

Accepted: Nov. 12, 2024

Published Online: May. 17, 2025

### ✉ Correspondence to:

Mahsa Aghaei

### Email:

[mahsa.aghai74@gmail.com](mailto:mahsa.aghai74@gmail.com)

## ABSTRACT

**Objective:** Cutaneous leishmaniasis is a skin disease caused by the *Leishmania* parasite, prevalent in many tropical and subtropical regions. Current treatment options include various chemical drugs that often come with side effects and limited effectiveness. Recently, there has been growing interest in medicinal plants as alternative treatments for this disease. Due to their natural compounds, medicinal plants may offer effective solutions with minimal side effects. This study aims to review and assess the medicinal plants effective against cutaneous leishmaniasis, providing a comprehensive overview of the identified plants and their active compounds that could be beneficial in treating this condition.

**Methods:** In this review study, keywords such as *Leishmania*, leishmaniasis, traditional medicine, medicinal plants, and treatment were searched in databases like Google Scholar, SID, Magiran, and Scopus. Irrelevant articles were excluded, and relevant articles were selected for literature review.

**Results:** Based on the findings, several medicinal plants such as *Urtica dioica*, *Ferula assa-foetida*, *Artemisia absinthium*, *Allium sativum*, *Eucalyptus globulus*, *Achillea millefolium*, *Lavandula angustifolia*, *Myrtus communis*, *Satureja Khuzestanica*, *Onosma dichroanthum*, *Rosmarinus officinalis*, *Quercus* spp., *Cassia* spp., *Capparis spinosa*, *Linum usitatissimum*, *Ricinus communis*, *Juglans regia*, *Thymus vulgaris*, *Lawsonia inermis*, *Mimosa pudica*, *Aloe vera*, *Vigna mungo*, *Berberis vulgaris*, *Matricaria chamomilla*, and *Curcuma longa* are identified as effective for treating cutaneous leishmaniasis. The families Asteraceae and Lamiaceae, with a frequency of 16%, have the highest representation among the samples, indicating their significance. Other families account for smaller percentages of the overall data. The natural compounds in medicinal plants play a vital role in boosting the immune system, reducing inflammation, and inhibiting parasite growth. These compounds, with antioxidant properties, apoptosis induction in parasites, and anti-inflammatory effects, help cleanse the digestive system and improve general body health.

**Conclusion:** This study indicates that various medicinal plants, particularly from the Asteraceae and Lamiaceae families, could serve as effective treatments for cutaneous leishmaniasis. The natural compounds in these plants significantly enhance immune function, reduce inflammation, and inhibit parasite growth, leading to notable improvements in general health and disease control. Hence, further research is necessary to identify and utilize these plants in the treatment of cutaneous leishmaniasis.

**Keywords:** Parasite, *Leishmania*, Leishmaniasis, Medicinal plants, Lesion, Treatment

### ➤ How to cite this paper

Aghaei M and Hosseini M. Phytotherapy for Healing of Invasive Infectious Lesions of Cutaneous Leishmaniasis: Effective Medicinal Plants and Analysis of Their Mechanisms of Action. *Plant Biotechnology Persa* 2025; 7(2): 104-110.

## Introduction

Cutaneous leishmaniasis is a parasitic disease caused by the *Leishmania* parasite, transmitted to humans through the bite of infected female phlebotomine sandflies [1]. The disease primarily affects the skin and, if left untreated, can lead to persistent and significant ulcerations [2].

Transmission occurs when an infected sandfly bites a human [3]. These sandflies become carriers after feeding on the blood of a person infected with the *Leishmania* parasite. Risk factors for leishmaniasis include geographic location (tropical and subtropical areas), environmental conditions (such as poor housing and sanitation), and occupations

involving outdoor work, such as agriculture and construction [4]. The early signs of cutaneous leishmaniasis typically appear a few weeks to months after the bite of an infected sandfly [5]. Initial symptoms often include red bumps and itching at the bite site. If untreated, these lesions can develop into deeper ulcers, leaving permanent scars. Diagnosis of the disease involves a combination of clinical evaluations and specialized tests [6]. Healthcare providers examine skin lesions and take the patient's medical history, with a particular focus on recent travel to endemic areas. Confirmation of the diagnosis is achieved through methods like microscopic examination, parasite cultures, and molecular techniques such as PCR (Polymerase Chain Reaction) [7]. Treatment of cutaneous leishmaniasis depends on the severity of the disease and the specific *Leishmania* species involved [8]. Medications such as sodium stibogluconate and amphotericin B are commonly used. For milder cases, topical treatments and cryotherapy may be employed [9].

Prevention mainly involves protecting against sandfly bites through the use of insect repellents, wearing protective clothing, and sleeping under bed nets [10]. Environmental measures, such as improving sanitation and controlling sandfly populations, are also effective strategies [11]. In traditional medicine, herbal treatments are sometimes used to manage and alleviate the symptoms of cutaneous leishmaniasis [12-14]. However, these methods should be considered as complementary to conventional medical therapies and should be used under the guidance of healthcare professionals for proper management.

In Iran, a variety of medicinal plants have been traditionally used therapies for leishmaniasis. These plants, due to their anti-inflammatory and healing properties, aid in regions and alleviating symptoms. Additionally, certain native Iranian plants with immune-boosting properties are believed to help mitigate the effects of the disease. Nevertheless, while

## Results

The findings of the study indicate that several medicinal plants have shown significant therapeutic properties in controlling and alleviating the symptoms of cutaneous leishmaniasis. These plants include:

nettle (*Urtica dioica*), asafoetida (*Ferula assa-foetida*), wormwood (*Artemisia absinthium*), garlic (*Allium sativum*), eucalyptus (*Eucalyptus globulus*), yarrow (*Achillea millefolium*), lavender (*Lavandula angustifolia*), myrtle (*Myrtus communis*), Satureja Khuzestanica, mountain jewel (*Onosma dichroanthum*), rosemary (*Rosmarinus*

these plants may offer beneficial effects alongside standard treatments are necessary to verify their efficacy and safety as definitive treatments for leishmaniasis. The aim of this review study is to identify medicinal plants effective against cutaneous leishmaniasis t complementary treatments alongside conventional therapies. This comprehensive review seeks to report on these plants' potential role in the control and management of this skin disease.

## Methodology

In this review study, a comprehensive search was conducted to gather and evaluate scientific evidence regarding medicinal plants effective in treating cutaneous leishmaniasis. The search was performed across reputable databases including Google Scholar, the Scientific Information Database (SID), Magiran, and Scopus. The search process employed specific keywords such as *Leishmania*, *leishmaniasis*, *traditional medicine*, *medicinal plants*, and *treatment*, using Boolean operators (AND, OR) to identify all relevant articles. Initially, all retrieved articles were screened based on their titles and abstracts. Those that were not directly related to the primary topic were excluded. In the subsequent step, the remaining articles were evaluated according to specific inclusion and exclusion criteria. Studies that focused on traditional treatments for cutaneous leishmaniasis were included in the analysis. The data from various studies were then systematically categorized and analyzed to derive a comprehensive conclusion on the effectiveness of medicinal plants in the treatment of this disease. This structured approach aimed to provide a clear overview of the potential therapeutic roles of these plants in managing cutaneous leishmaniasis.

*officinalis*), oak (*Quercus* spp.), Cassia (*Cassia* spp.), caper (*Capparis spinosa*), flax (*Linum usitatissimum*), castor oil plant (*Ricinus communis*), walnut (*Juglans regia*), thyme (*Thymus vulgaris*), henna (*Lawsonia inermis*), mimosa (*Mimosa pudica*), aloe vera (*Aloe vera*), black bean (*Vigna mungo*), barberry (*Berberis vulgaris*), chamomile (*Matricaria chamomilla*), and turmeric (*Curcuma longa*).

These medicinal plants have been identified as effective in traditional medicine for treating cutaneous leishmaniasis. Their therapeutic effects are attributed to their anti-inflammatory, wound-healing, and antiparasitic properties. Table 1 presents a detailed list of these medicinal plants

used in traditional medicine for the treatment of cutaneous leishmaniasis.

**Table 1:** Medicinal Plants Used in Traditional Medicine for the Treatment of Cutaneous Leishmaniasis

Persian Name	English name	Scientific name	Herbal family	Mechanism [15-29]
Gazaneh	Nettle	<i>Urtica dioica</i>	Urticaceae	The enhancement of the immune system and the reduction of inflammation.
Anghouzeh	Asafoetida	<i>Ferula assa-foetida</i>	Apiaceae	Anti-inflammatory and antiparasitic effects.
Dermaneh	Wormwood	<i>Artemisia spp.</i>	Asteraceae	Inhibition of parasitic growth with artemisinin compounds.
Sir	Garlic	<i>Allium sativum</i>	Amaryllidaceae	Induction of apoptosis in parasites and inhibition of growth.
Okaliptus	Eucalyptus	<i>Eucalyptus spp.</i>	Myrtaceae	Anti-inflammatory effect and inhibition of parasitic growth.
Boumadaran	Yarrow	<i>Achillea millefolium</i>	Asteraceae	Antioxidant and antiparasitic properties.
Ostokhodos	Lavender	<i>Lavandula spp.</i>	Lamiaceae	Anti-inflammatory and soothing properties.
Mourd	Myrtle	<i>Myrtus communis</i>	Myrtaceae	Inhibition of parasitic growth with antioxidant effects.
Marzeh khozestani	Satureja	<i>Satureja khuzistanica</i>	Lamiaceae	Anti-inflammatory and antiparasitic effects.
Laele kouhestan	Mountain Cornflower	<i>Centaurea montana</i>	Asteraceae	Antioxidant and anti-inflammatory properties.
Rozmary	Rosemary	<i>Salvia rosmarinus</i>	Lamiaceae	Immune-boosting and antiparasitic effects.
Balout	Oak	<i>Quercus spp.</i>	Fagaceae	Anti-inflammatory and inhibition of parasitic growth.
Flous	Senna	<i>Cassia fistula</i>	Fabaceae	Cleansing of the digestive system and reduction of inflammation.

Kebr	Caper	<i>Capparis spinosa</i>	Capparaceae	Anti-inflammatory and antioxidant properties.
Katan	Flaxseed	<i>Linum usitatissimum</i>	Linaceae	Immune boosting and inhibition of parasitic growth.
Karchak	Castor	<i>Ricinus communis</i>	Euphorbiaceae	Antioxidant and antiparasitic effects.
Gerdou	Walnut	<i>Juglans regia</i>	Juglandaceae	Anti-inflammatory and antioxidant effects.
Avi9shan	Thyme	<i>Thymus vulgaris</i>	Lamiaceae	Inhibition of parasitic growth and immune enhancement.
Hanna	Henna	<i>Lawsonia inermis</i>	Lythraceae	Anti-inflammatory and antiparasitic properties.
Mimosa	Mimosa	<i>Mimosa pudica</i>	Fabaceae	Anti-inflammatory effects and inhibition of parasitic growth.
Aloevera	Aloe	<i>Aloe vera</i>	Asphodelaceae	Soothing and anti-inflammatory.
Lobiaye siah	Black Bean	<i>Phaseolus vulgaris</i>	Fabaceae	Immune system enhancement.
Zereshk	Barberry	<i>Berberis vulgaris</i>	Berberidaceae	Inhibition of parasitic growth with berberine compounds.
Babouneh	Chamomile	<i>Matricaria chamomilla</i>	Asteraceae	Soothing and anti-inflammatory effects.
Zardchoubeh	Turmeric	<i>Curcuma longa</i>	Zingiberaceae	Inhibition of parasitic growth with anti-inflammatory effects.

The plant families studied exhibit a considerable diversity in both their number and percentage representation. The Asteraceae and Lamiaceae families, each with four occurrences, account for 16% of the total data, making them the most abundant. Following them, the Fabaceae family, with three occurrences and a 12% share, ranks next. Myrtaceae, with two occurrences, represents 8% of the data. Other families, such as Urticaceae, Apiaceae, Table 1 presents the diverse effects of medicinal plants and natural compounds on enhancing the immune system and combating inflammation and parasitism. These effects can be categorized into several key areas. First, the strengthening of the immune system and reduction of inflammation, which help improve the body's defense and alleviate inflammatory symptoms. Compounds with anti-inflammatory and antiparasitic properties can play a crucial

Amaryllidaceae, Fagaceae, Capparaceae, Linaceae, Euphorbiaceae, Juglandaceae, Lythraceae, Asphodelaceae, Berberidaceae, and Zingiberaceae, each with a single occurrence, contribute only 4% of the total data. Based on these results, it can be concluded that the Asteraceae and Lamiaceae families, due to their higher frequency, hold greater significance among the samples under study.

role in preventing the progression of inflammation and combating parasites. The inhibition of parasitic growth, with specific compounds like artemisinin and berberine, demonstrates the targeted properties of certain plants in eliminating parasites. Additionally, traits such as the induction of apoptosis in parasites and the inhibition of their growth reflect the effective mechanisms of

these compounds in destroying parasitic cells. Other beneficial properties include antioxidant and antiparasitic effects, which help reduce oxidative stress and strengthen the body's defenses against parasites. Soothing and calming effects, which aid in reducing inflammation while providing relief and relaxation to the body, are also noteworthy. In

## Discussion

The results of this study indicate that plants such as nettle, Asafoetida, Artemisia, and garlic, due to their active compounds and unique physiological properties, can play a significant role in inhibiting parasitic growth and reducing inflammation [30]. Artemisia, with its artemisinin compounds, widely used in the treatment of parasitic diseases, directly inhibits the growth of Leishmania parasites responsible for leishmaniasis and Asafoetida, through the induction of apoptosis in parasitic cells, prevent parasite proliferation and help reduce the severity of infection [31,32]. Other tus and yarrow, with their strong antioxidant properties, counteract the destructive effects of free radicals caused by infection, thus being effective in reducing inflammation and improving the overall condition of the patient [33,34]. Plants from the Asteraceae, due to their phenolic and flavonoid compounds, exhibit antioxidant and anti-inflammatory effects, which can serve as complementary treatments to reduce the symptoms and severity of cutaneous leishmaniasis [35,36]. These antioxidant and immune-boosting properties have been observed in plants like nettle and rosemary, which help strengthen the body's defense mechanisms and accelerate wound healing [35,36]. Some plants such as barberry and turmeric, with curcumin compounds, act specifically in inhibiting parasitic growth and improving skin symptoms associated with cutaneous leishmaniasis [37,38]. These compounds have the ability to reduce inflammation, soothe wound healing, potentially serving as alternatives or complements to conventional treatments. Plants like henna, flax, and walnut, with their antioxidant and anti-inflammatory effects, contribute to boosting the immune system and preventing the progression of infection [39,40]. Overall, the findings of this study emphasize that medicinal plants can be used as effective for cutaneous leishmaniasis.

## Conclusion

Given their efficacy and low side effects, further research is necessary to identify optimal dosages, extraction methods, and the use of their active compounds. The integration of these plants in the treatment of cutaneous leishmaniasis can

summary, these compounds, through cleansing the digestive system, inhibiting parasitic growth, boosting immunity, and offering antioxidant properties, provide a range of benefits for maintaining general health and combating inflammation and parasitic infections.

provide a complementary solution with high effectiveness and lower costs, promoting the general health of patients.

## Statements and Declarations

### Funding support

The authors did not receive support from any organization for the submitted work.

### Competing interests

The authors have no competing interests to declare that are relevant to the content of this article.

### Ethics approval

This study was performed in line with the principles of the Declaration of Helsinki.

### Consent to participate

Informed consent was obtained from all individual participants included in the study.

### Author contributions

MA: Conceptualization, the original draft writing, investigation, writing including reviewing and editing and investigation and formal analysis; MHA: Conceptualization, supervision, and project administration; MHA and MA: Conceptualization, the original draft writing, investigation, writing including reviewing and editing

### Acknowledgments

The authors would like to express their gratitude to the clinical research development unit of Imam Khomeini Hospital, Urmia University of Medical Sciences, for English editing and nursing staff of the Imam Khomeini Hospital for their helping with data collection.

### References

1. Reithinger R, Dujardin JC, Louzir H, Pirmez C, Alexander B, Brooker S. Cutaneous leishmaniasis. *The Lancet*

- infectious diseases. 2007 Sep 1;7(9):581-96. doi: 10.1016/S1473-3099(07)70209-8.
2. Bailey MS, Lockwood DN. Cutaneous leishmaniasis. *Clinics in dermatology*. 2007 Mar 1;25(2):203-11.
  3. Hepburn NC. Cutaneous leishmaniasis: an overview. *Journal of postgraduate medicine*. 2003 Jan 1;49(1):50-4.
  4. Bailey MS, Lockwood DN. Cutaneous leishmaniasis. *Clinics in dermatology*. 2007 Mar 1;25(2):203-11. doi: 10.1016/j.clinidermatol.2006.05.008.
  5. de Vries HJ, Reedijk SH, Schallig HD. Cutaneous leishmaniasis: recent developments in diagnosis and management. *American journal of clinical dermatology*. 2015 Apr;16:99-109.
  6. de Vries HJ, Reedijk SH, Schallig HD. Cutaneous leishmaniasis: recent developments in diagnosis and management. *American journal of clinical dermatology*. 2015 Apr;16:99-109. doi: 10.1007/s40257-015-0114-z.
  7. Aronson NE, Joya CA. Cutaneous leishmaniasis: updates in diagnosis and management. *Infectious Disease Clinics*. 2019 Mar 1;33(1):101-17.
  8. Weigel MM, Armijos RX. The traditional and conventional medical treatment of cutaneous leishmaniasis in rural Ecuador. *Revista Panamericana de Salud Pública*. 2001;10:395-404.
  9. Soltani M. Cytotoxic evaluation of *Acanthophyllum glandulosum* bung. ex boiss: Comparative analysis of anticancer activity on ags gastric cancer cells and human dermal fibroblasts. *Journal of Biochemicals and Phytomedicine*. 2024; 3(1): 41-45. doi: 10.34172/jbp.2024.9.
  10. Khandan Barani, H., Rahdari, A., Sanchooli, N., Khosravanizadeh, A. Investigating the hatchability and nauplii biometry of *Artemia franciscana* in unconventional waters of Sistan region, Southeast Iran. *Aquatic Animals Nutrition*, 2024; 10(1): 57-75. doi: 10.22124/janb.2024.27411.1243
  11. Michael A, Sarah A, Blessing S. Assessment of antimicrobial, antimalarial, and antitrypanosomal activities of crude extracts and fractions from *Piliostigma thonningii* schum. leaves in vitro. *Journal of Biochemicals and Phytomedicine*. 2024; 3(1): 46-52. doi: 10.34172/jbp.2024.10.
  12. Akbary, P. Determination of antioxidant and phytochemical properties of premix extract of brown macroalgae *Padina australis*, *Sargassum licifolium* and *Stoechospermum marginatum* from Chabahar coast, Southeastern Iran. *Aquatic Animals Nutrition*, 2024; 10(1): 27-41. doi: 10.22124/janb.2024.26283.1229
  13. Taldybay, A., Aidarbayeva, D., Kurmantayeva, A., Musxaev, K., Amanbekova, D., Joltukova, B. Medicinal plants in the flora of Zhetysu Alatau, Zhetysu Region, Kazakhstan. *Caspian Journal of Environmental Sciences*, 2024; 22(3): 567-579. doi: 10.22124/cjes.2024.7831
  14. Kohzadi S, Shahmoradi B, Ghaderi E, Loqmani H, Maleki A. Concentration, source, and potential human health risk of heavy metals in the commonly consumed medicinal plants. *Biological trace element research*. 2019 Jan;187:41-50. doi: 10.1007/s12011-018-1357-3.
  15. Avicenna. *The Canon of Medicine*. Tehran: University of Tehran Press; 1991.
  16. Razi, Muhammad ibn Zakariya. *Al-Hawi (The Comprehensive Book)*. Tehran: University of Tehran Publishing Institute; 1996.
  17. Abu Mansur Muwaffaq Heravi. *Kitab al-Abniyah an Haqaiq al-Adwiyah*. Tehran: Farhang Mo'aser Publications; 1991.
  18. Jorjani, Esmail. *Zakhireye Khwarazmshahi*. Tehran: Ministry of Culture and Islamic Guidance Publishing Organization; 2001.
  19. Mohammad Mo'men Hussein. *Tohfat al-Mu'minin*. Tehran: Dar al-Elm Publications; 2002.
  20. Ghavami, Zakaria. *Medicinal Plants of Iran*. Tehran: Jahad Daneshgahi Publications; 2006. <https://www.scirp.org/reference/referencespapers?referenceid=894618>
  21. Mousavi, Seyed Mohammad. *Pharmacognosy*. Tehran: University of Tehran Press; 2011.
  22. Abbasi, Reza. *Atlas of Medicinal Plants of Iran*. Mashhad: Astan Quds Razavi Publications; 2009.
  23. Behzad, Mahmoud. *Encyclopedia of Medicinal Plants of Iran*. Tehran: Ney Publications; 2013.
  24. Iranian Medicinal Plants Research Center (IMPRC). *Iranian Medicinal Plants Database*. Tehran: Iranian Medicinal Plants Research Center; 2016.
  25. Specialized Journals. *Iranian Journal of Pharmaceutical Research [Internet]*. Tehran: Tehran University of Medical Sciences; [cited 2020]. Available from: <https://ijpr.sbmu.ac.ir>
  26. Amini, Hossein. *Herbal Pharmacology*. Tehran: Arjmand Publications; 2017.
  27. Kasai, Parviz. *Identification and Application of Medicinal Plants*. Tehran: Tarbiat Modares University Press; 2010.
  28. Iranian Medicinal Plants Research Center. "Iranian Medicinal Plants Research Center Website". [Internet]. [cited 2020]. Available from: <http://www.imprc.ir>
  29. Tehran University of Medical Sciences. "Tehran University of Medical Sciences Website". [Internet]. [cited 2020]. Available from: <https://tums.ac.ir>
  30. Tamargo B, Monzote L, Piñón A, Machín L, García M, Scull R, Setzer WN. In vitro and in vivo evaluation of essential oil from *Artemisia absinthium* L. formulated in nanocochleates against cutaneous leishmaniasis. *Medicines*. 2017 Jun 9;4(2):38. doi: 10.3390/medicines4020038.
  31. Ahmadi-Renani K, Mahmoodzadeh A, Cheraghali AM, Esfahani AA. Effect of garlic extract on cutaneous leishmaniasis and the role of nitric oxide. *Iranian Journal of Medical Sciences*. 2015 Nov 30;27(3):97-100.
  32. Bafghi AF, Bagheri SM, Hejazian SH. Antileishmanial activity of *Ferula assa-foetida* oleo gum resin against *Leishmania major*: An in vitro study. *Journal of Ayurveda and integrative medicine*. 2014 Oct;5(4):223. doi: 10.4103/0975-9476.146567.
  33. Torabi N, Mohebbali M, Shahverdi AR, Rezayat SM, Edrissian GH, Esmaeili J, Charehdar S. Nanogold for the treatment of zoonotic cutaneous leishmaniasis caused by *Leishmania major* (MRHO/IR/75/ER): an animal

- trial with methanol extract of *Eucalyptus camaldulensis*. JPHS. 2011 Jan 1;1(1):13-6. DOI:10.13140/2.1.4561.9840
34. Nilforoushzadeh MA, Shirani-Bidabadi L, Zolfaghari-Baghbaderani A, Saberi S, Siadat AH, Mahmoudi M. Comparison of *Thymus vulgaris* (Thyme), *Achillea millefolium* (Yarrow) and propolis hydroalcoholic extracts versus systemic glucantime in the treatment of cutaneous leishmaniasis in balb/c mice. J Vector Borne Dis. 2008 Dec 1;45(4):301-6. <https://pubmed.ncbi.nlm.nih.gov/19248657/>
  35. Moraes Neto RN, Setúbal RF, Higinio TM, Brelaz-de-Castro MC, Da Silva LC, Aliança AS. Asteraceae plants as sources of compounds against leishmaniasis and Chagas disease. Frontiers in Pharmacology. 2019 May 8;10:477. doi: 10.3389/fphar.2019.00477.
  36. Tajbakhsh E, Khamesipour A, Hosseini SR, Kosari N, Shantiae S, Khamesipour F. The effects of medicinal herbs and marine natural products on wound healing of cutaneous leishmaniasis: A systematic review. Microbial Pathogenesis. 2021 Dec 1;161:105235. doi: 10.1016/j.micpath.2021.105235.
  37. Shamsi MO, Abbasi NA, Mohajer AS, Hoseini MA, Rafieian-Kopaei MA. The most important native medicinal plants effective against cutaneous leishmaniasis in mouse. Int J Life Sci Pharma Res. 2018;8(2):7.
  38. Badirzadeh A, Alipour M, Najm M, Vosoogh A, Vosoogh M, Samadian H, Hashemi AS, Farsangi ZJ, Amini SM. Potential therapeutic effects of curcumin coated silver nanoparticle in the treatment of cutaneous leishmaniasis due to *Leishmania major* in-vitro and in a murine model. Journal of Drug Delivery Science and Technology. 2022 Aug 1;74:103576.
  39. Hejazi SH, Shirani-Bidabadi L, Zolfaghari-Baghbaderani A, Saberi SE, Nilforoushzadeh MA, Moradi SH, Mahmoudi MO, Khosravi SH, Ataei AT. Comparison effectiveness of extracts of thyme, yarrow, henna and garlic on cutaneous leishmaniasis caused by *L. major* in animal model (Balb/c). Journal of Medicinal Plants. 2009 May 10;8(30):129-36. <https://pubmed.ncbi.nlm.nih.gov/19248657/>
  40. Chegeni AS, Ezatpour B, Mohebbali M, Mahmoudvand H, Zibaei M, Ebrahimzadeh F, Rashidipour M, Babaei N, Dokhaharani SC. Effect of peel and leaf extract of walnut (*Juglans regia* L.) on cutaneous leishmaniasis caused by *Leishmania major* in BALB/c Mice. Journal of Chemical and Pharmaceutical Sciences. 2016;9(4):2490-5.