

Antileishmanial activity of *Artemisia sieberi* essential oil against *Leishmania infantum* in vitro

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ABSTRACT

Background and aims: VL (Viseral Leishmaniosis) the second- most dreaded parasitic disease after malaria is currently endemic in 88 countries. *Artemisia sieberi* is native medicinal plants in Iran and their effects are scientifically proven to be effective on leishmaniasis. The aim of this study was to investigate antileishmanial effects of *A.sieberi* essential oil on *Leishmania infantum* in vitro. This is the first application of *A. sieberi* for treatment of *L.infantum*.

Methods: Promastigotes of *L. infantum* were treated by *A. sieberi* in 1, 5, 10, 15, 20 µg/ml concentration. MTT test ([3-(4, 5-dimethyl-2-thiazolyl)-2, 5-diphenyl-2H-tetrazolium bromide] was done in 48h after treatment to determine the effect on promastigote viability. The data were analyzed by SPSS, and using one-way ANOVA and Mann Whitney tests.

Results: Fewer than 15 µg /ml concentrations of *A. sieberi* essential oil were no appreciable effect on the parasite. A dose of 15, 20 µg/ml showed growth inhibitory on *L. infantum* in 24h/48h compared to control group (P<0.05).

Conclusion: The *A. sieberi* essential oil had antileishmanial effects against *L.infantum* in vitro. Therefore, they might be a reliable source for preparation of new drugs. More in vivo investigations are required to clarify details of effects of *A.sieberi* on leishmania spp and analysis of its natural components.

Keywords: *Leishmania infantum*, Artemisia, Promastigote, In vitro technique.

Original article

INTRODUCTION

Leishmaniasis including Cutaneous, mucocutaneous and visceral forms of clinical syndrome is one of the important health care problems in the world, especially in Iran. Because of a long time duration of

treatment, being expensive, many side effects of drugs and resisted cases to conventional therapy, enormous efforts have been performed to replace herbal and new therapeutic strategies as alternative choices.

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Visceral leishmaniasis (VL) is a parasitic disease caused by *Leishmania infantum* and *Leishmania donovani* that are transmitted by the bites of phlebotomus in the old world and lutzomyia in the new world.^{1,2} Visceral leishmaniasis is regarded as a protozoan zoonotic disease affecting incidence rate of 0.5 million and mortality rate of 60,000. Iran is one of the important foci of VL in the world that caused by *L.infantum* and transmitted by *Ph.larroussius*.³ The available treatment options for VL have problems relating on efficacy, adverse effects, costs, resistance to treatment and side effects, especially in women and childbearing age.⁴

Artemisia sieberi with the common Persian name of “dermane”, is a well-known medicinal plant that has been used in traditional medicine of the Middle East countries as an herbal medicine for treating various diseases.⁵ *Artemisia* is included in the tribe Anthemideae and comprises over 500 species, which are mainly found in Asia, Europe and North America.⁶ In the flora of Iran, the genus *Artemisia* has been introduced by 64 species.⁷ that the most famous species were Turkish, Kermani and Caspian *Artemisia*. *Artemisia* species are frequently utilized for the treatment of diseases such as malaria, hepatitis, cancer, inflammation and infections by fungi, bacteria and viruses. It was previously reported that the aqueous extract and essential oil of *A. herba alba* have antileishmanial activity against *L. tropica* and *L. major* promastigotes.⁸ In northern Africa, essential oil of this plant was very healing in *L. major* and *L. tropica* lesions.⁹ Also, the aqueous extract of leaves of *A. indica* exhibited leishmanicidal activity (IC₅₀: 430 µg/ml).¹⁰ A lot of volatile molecules exist in essential oils and cause pleasant perfume in plants. Vast presence of monoterpenes and sesquiterpenes in Asteraceae are used as taxonomic markers

for this family and especially *Artemisia* genus.¹¹ *Siberian Artemisia* contains bioactive substances including monoterpenes categories acid glycosides and 4-sezquitrepens derivatives of Oplonanon and germcran, derivatives bisabolene, salsolene ketones, camphor, 8,1 cineole of oxygenated monoterpene, sesquiterpene dehydroepiandrostrone, 1,8-cineole, b-thujon, thujon, alpha-dimethyl cyclopentane, carboxylic acid and camphor.¹² The combination of camphor, camphene, 1, 8-cineole, alpha and beta-tojone, alpha-pinnene are components of *Siberia Artemisia*.¹³ *Artemisia* is the native plant in Iran and it grows in many provinces especially warm and dry areas. In addition, untreated leishmaniasis was reported 15% from glucantim drug and it is toxicity for heart, kidney and liver.¹⁴

The aim of this study were to study *A. sieberi* effect on leishmania and finding effective suitable doses of this herbal compound and compared to glucantime.

METHODS

Promastigotes of *L. infantum* (KT201383 strain) were maintained by RPMI-1640 medium supplemented with 10% bovine serum (FBS), 100 µg of Streptomycin/ml, and 100U of Penicillin/ml, with passage each 3 or 4 days at 26 °C. Promastigotes of *L. infantum* were incubated at 26 °C 48 hours. The parasites were not used after 3 *in vitro* passages. A negative control (with Glucantime: 150 mg/ml) and one DMSO + promastigotes were included in this study. Promastigotes are diluted to a concentration of 1.0×10^6 per ml of cultivation medium in a 24-well plate. *Artemisia sieberi* in appropriate concentrations is added to the experimental culture.

Standard *A. sieberi* essential oil was obtained from Barij Essence Pharmaceutical Company, Kashan, and Iran. Serial concentration was prepared (1,5,10,15,20 µg/ml) from standard stock solutions in DMSO as the solvent. *A. sieberi* inappropriate serial

concentrations (1,5,10,15 and 20 $\mu\text{g}/\text{mL}$) are added to the experimental culture. Overall, 5 different concentrations on five of 24-well plate containing 1.0×10^6 per ml *L. infantum* promastigote were evaluated. This survey was *in vitro* interventional study that describes the effectiveness of *A. sieberi* essential oil on *L. infantum* protozoa.

To find the effect on promastigote viability was assessed by MTT test ([3-(4, 5-dimethyl-2-thiazolyl)-2, 5-diphenyl-2H-tetrazolium bromide]. After 24h and 48h of treatment by *Artemisia sieberi*, MTT (1mg/ml, pH: 7.4) was added in each sample and it was incubated overnight in the dark at 25 °C. After that, isopropanol 50% and SDS (sodium 10% Dodecyl sulphate) were added and it incubated at 37 °C for 5h. Finally, samples were read at 540nm in a microplate reader. This test was repeated 2 times to make ensure repeatability.

All experiments were performed in duplicated. The data were analyzed by SPSS with one-way ANOVA and Bonfirony tests.

RESULTS

In the current study, the effect of 1,5,10,15,20 $\mu\text{g}/\text{ml}$ concentrations of *Artemisia sieberi* were evaluated under *in vitro* conditions on promastigotes of *L. infantum*. It was showed at dose of 15 $\mu\text{g}/\text{ml}$ ($P=0.040$), 20 $\mu\text{g}/\text{ml}$ ($P=0.027$) that was extremely effective against *L. infantum* demonstrating growth inhibitory in 48h compared to control (Figure 1). 1,5,10 $\mu\text{g}/\text{ml}$ concentrations of *Artemisia* essential oil were no appreciable effect on the parasite. Parasite was grown *in vitro* culture under various concentrations of this object with MTT measurement.

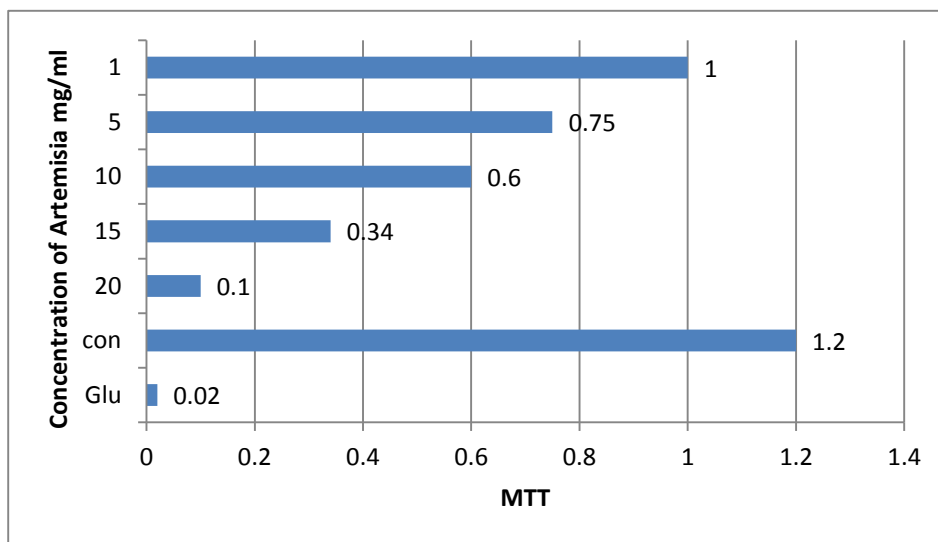


Figure 1: Growth curves of *L. infantum* culture were

Treated with different concentrations of *Artemisia sieberi*, glucantim and determination of parasite viability in MTT/48h (Con: control, Glu: Glucantime).

DISCUSSION

Screening of medicinal plants for antiparasitic activities is important for finding potential new compounds for medicinal and industrial purposes. In many cultures, some infectious diseases are known

to have been treated with herbal remedies. The genus of *Artemisia* belongs to the family Asteraceae is presented by 34 species in Iran that are found wild all over Iran.¹⁵ *A. sieberi* showed antifungal, antimalarial,

antiviral, antitumor, antihemorrhagic, anticoagulant, antioxidant, anti-hepatitis, and antiulcerogenic effects.¹⁶⁻²⁰ The WHO recommends artemisinin combination therapies as the first-line treatment for malaria.²¹ Ethiopian *Artemisia* species, *A. absinthium* and *A. abyssinica*, also showed an activity against promastigote and axenic amastigote forms of two *Leishmania* strains, *Leishmania aethiopica* and *Leishmania donovani*.²² Also, *Artemisia* is one of the most common plants used for removing intestinal helminthiasis and schistosomiasis.^{23,24}

Results in the current study demonstrate 15 and 20 µg/mL concentrations of *A. sieber*i on growth inhibitory of *L.infantum* that was statistically significant compared to control groups (P=0.032). This result agrees with Tariko et al. that inhibitory effect concentration of *Artemisia absinthium* essential oil was 20 µg/mL on *L. aethiopica* and *L. donovani*.²⁵ It is important to find an herbal medicine with the least side effects from internal resources (native pharmaceutical drugs) that can economically compete with the available chemical remedies in the present pharmaceutical markets and to determine the effect of *A. sieber*i essential oil on *L. infantum* *in vitro*. This is the first study of *A. sieber*i effect on the agent of visceral leishmaniasis. In another study 5,10,25,50, and 100 µg/mL concentrations of aqueous extract of *A. sieber*i and were tested on promastigotes of *L. major*, uninfected macrophages, and infected macrophages intracellular amastigotes of *L. major*, in comparison with the control groups. The effective dose was determined 25 µg/mL for *A. sieber*i.²⁶

%1,%3 and %5 concentrations of *A. sieber*i hydro alcohol lotions wasn't observed in any treated mouse by *Artemisia* concentrates on *L. major* at the end of 30-day.²⁷ Inhibitory concentrations of essential oils of *A. sieber*i on *Fusarium moniliforme* and *Tribolium castaneum* showed

750 µM/L and 16.8 µ M/L.^{28,29} Effectiveness against *L. major* promastigotes *A. sieber*i essential oils > *Pelargonium roseum* essential oils > glucantime was reported.³⁰ In another study ethanol, ethyl acetate, dichloromethane and hexane extracts of eleven *Artemisia* spp. native to Khorasan Province was checked out *L. major* promastigotes. All ethyl acetate extracts and *A.kulbadica* and *A.ciniformis* (IC50:0.025) have the most potent leishmanicidal activity.³¹ Rostami et al. Studied *in vivo* efficacy of *Artemisia auchery* extract on *Leishmania major* cutaneous infection in the murine model and they introduced this extract was more effective on leishmaniasis.³² The results of other studies on treatment effects of *A. sieber*i on leishmanial showed no toxicity even with the high concentration of the herbal extract, which confirms its minimal side effects.³³ Therapies were well tolerated, however; nausea, vomiting, dizziness, sleep disorders, and other neurological side effects were also reported in some studies.³⁴ The clinical use and the toxicity and teratogenicity of *Artemisia* and its derivatives, however, raise some queries and requirements for further studies. The oil of the species *A. absinthium* was also tested against eleven pathogenic bacterial strains with a minimum inhibitory concentration (MIC) of 0.14, 0.8 and 0.62 µL/mL, respectively.³⁵ It seems the extract of this plant is more effective on bacterial, fungal and insects rather than parasites. Due to their high volatility of this compound, it has fumigant activity that might be in high importance for controlling stored-product insects.

Artemisia.absinthium essential oil has been reported to show activity against the promastigotes and amastigote forms of *L.aethiopica* and *L. donovani*.³⁶ In another study, it was shown the leishmanicidal effect of essential oil from *Artemisia. annua* leaves against *L. donovani in vitro* and *in vivo*.³⁷ The action mechanism of *A. sieber*i against *Leishmania* is unknown. Furthermore, it is

important the kind of application *A. sieberi*. It was shown that ointment and intraperitoneal injection were effective than dropped essence of *A. sieberi* on the lesions in BALB/c mice. Even the group that treated with artemisinin ointment had better results in comparison with the group that treated with peritoneal injection form.³⁸ Dehkordi et al. study showed better therapeutic effects could be obtained treating visceral leishmaniasis by *A. sieberi* in 4 times per day, To find the effective concentration and the mechanism of the effectiveness of the drug, further investigations with fewer concentrates of *A. sieberi* essence are recommended.³⁹

CONCLUSION

In conclusion, this study demonstrated that *A. sieberi* in 15 and 20 µg/mL has inhibitory effects on the *in vitro* growth on *L.infantum*. These results demonstrated the potential use of this compound as novel agents for the treatment of leishmaniasis. It seemed others compounds like carvacrol, thymol and linalool especially thymol have lower effective dose on leishmania spp. as under 1 µg/mL. Therefore it is more affordable and effective to produce a new drug from these compounds in comparison of *A. sieberi*.

CONFLICT OF INTEREST

Authors declare that there was no conflict of interest.

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REFERENCES

1. Alvar J, Velez ID, Bern C, Herrero M, Desjeux P, Cano J, et al. Leishmaniasis

worldwide and global estimates of its incidence. PLoS One. 2012; 7(5): e35671.

2. Sharma U, Singh S. Insect vectors of Leishmania: distribution, physiology and their control. J Vector Borne Dis. 2008; 45(4): 255-72.

3. Parvizi P, Alaeenovin E, Mohammadi S, Baghban N. Occurrence of low density of *Leishmania infantum* in sandflies from a new focus of visceral leishmaniasis in northwest of Iran. J Vector Borne Dis. 2013; 50(2): 127-32.

4. Moore EM, Lockwood DN. Treatment of visceral leishmaniasis. J Glob Infect Dis. 2010; 2(2): 151-8.

5. Mansi K, Lahham J. Effects of Artemisia sieberi Besser (A. herba-alba) on heart rate and some hematological values in normal and alloxan-induced diabetic rats. J Basic ApplSci. 2008; 1(4): 57-62.

6. Abad MJ, Bedoya LM, Apaza L, Bermejo P. The artemisia L. Genus: A review of bioactive essential oils. Molecules. 2012; 17(3): 2542-66.

7. Khosravi A, Shokri H, Darabi M, Kashani A, Mansouri P, Naser A. Comparative study on the effects of a new antifungal lotion (Artemisia sieberi essential oil) and a clotrimazole lotion in the treatment of pityriasis versicolor. J Mycol Med. 2009; 19(1): 17-21.

8. Hatimi S, Boudouma M, Bichichi M, Chaib N, Guessous Idrissi N. Evaluation *in vitro* de l'activité antileishmanienne d'Artemisia herba-alba Asso. Bull Soc Pathol Exot. 2001; 94: 29-31.

9. Hatimi S, Boudouma M, Bichichi M, Chaib N, Idrissi NG. [In vitro evaluation of antileishmania activity of Artemisia herba alba Asso]. Bull Soc Pathol Exot. 2001; 94(1): 29-31.

10. Ganguly S, Bandyopadhyay S, Bera A, Chatterjee M. Antipromastigote activity of an ethanolic extract of leaves of *Artemisia indica*. Indian J Pharmacol. 2006; 38(1): 64-5.

11. Rabie M, Jalili A, Azarnivand H, Jamzad Z, Arzani H. A contribution to the *Artemisia sieberi* (Asteraceae) based on phytochemical studies in Iran. *Iran J Bot.* 2006; 13(2): 120-7.
12. Bahmani M, Saki K, Ezatpour B, Shahsavari S, Eftekhari Z, Jelodari M, et al. Leishmaniosis phytotherapy: Review of plants used in Iranian traditional medicine on leishmaniasis. *Asian Pac J Trop Biomed.* 2015; 5(9): 695-701.
13. Razavi SM, Nourouzi Z, Ghasemiian A, Ghorbani A, Latifi S. Chemical composition of the essential oil of *Artemisia austriaca* JACQ. growing wild in Iran. *Turk J Biochem.* 2014; 39(3).
14. Khan MA, Maruno M, Khaskhely NM, Ramzi ST, Hosokawa A, Uezato H, et al. Inhibition of intracellular proliferation of *Leishmania* parasites *in vitro* and suppression of skin lesion development in BALB/c mice by a novel lipid A analog (ONO-4007). *Am J Trop Med Hyg.* 2002; 67(2): 184-90.
15. Mahboubi M, Farzin N. Antimicrobial activity of *Artemisia sieberi* essential oil from central Iran. *Iran J Microbiol.* 2009; 1(2): 43-8.
16. Burits M, Asres K, Bucar F. The antioxidant activity of the essential oils of *Artemisia afra*, *Artemisia abyssinica* and *Juniperus procera*. *Phytother Res.* 2001; 15(2): 103-8.
17. Juteau F, Masotti V, Bessiere JM, Dherbomez M, Viano J. Antibacterial and antioxidant activities of *Artemisia annua* essential oil. *Fitoterapia.* 2002; 73(6): 532-5.
18. Nahrevanian H, Esmaeili B, Kazemi M, Nazem H, Amini M. *In vivo* antimalarial effects of Iranian flora *Artemisia khorassanica* against *Plasmodium berghei* and pharmacology of its natural components. *Iran J Parasitol.* 2010; 5(1): 6-19.
19. Nahrevanian H, Esmaeili B, Kazemi M, Nazem H, Amini M. *In vivo* antimalarial effects of Iranian flora *Artemisia khorassanica* against *Plasmodium berghei* and pharmacology of its natural components. *Iran J Parasitol.* 2010; 5(1): 6-19.
20. Shafi PM, Nambiar MG, Clery RA, Sarma Y, Veena S. Composition and antifungal activity of the oil of *Artemisia nilagirica* (Clarke) Pamp. *J Essent Oil Res* 2004; 16(4): 377-9.
21. WHO T. Strategic direction for research: Leishmaniasis. 2002.
22. Tariku Y, Hymete A, Hailu A, Rohloff J. Essential-oil composition, antileishmanial, and toxicity study of *Artemisia abyssinica* and *Satureja punctata* ssp. *punctata* from Ethiopia. *Chem Biodivers.* 2010; 7(4): 1009-18.
23. Amirmohammadi M, Khajoenia S, Bahmani M, Rafieian-Kopaei M, Eftekhari Z, Qorbani M. *In vivo* evaluation of antiparasitic effects of *Artemisia abrotanum* and *Salvia officinalis* extracts on *Syphacia obvelata*, *Aspiculoris tetrapetra* and *Hymenolepis nana* parasites. *Asian Pac J Trop Dis.* 2014; 4: S250-S4.
24. Xiao S, Tanner M, N'Goran EK, Utzinger J, Chollet J, Bergquist R, et al. Recent investigations of artemether, a novel agent for the prevention of schistosomiasis japonica, mansoni and haematobia. *Acta Trop.* 2002; 82(2): 175-81.
25. Tariku Y, Hymete A, Hailu A, Rohloff J. *In vitro* evaluation of antileishmanial activity and toxicity of essential oils of *Artemisia absinthium* and *Echinops kebericho*. *Chem Biodivers.* 2011; 8(4): 614-23.
26. Esavand Heydari F, Ghaffarifar F, Soflaei S, Dalimi A. Comparison between *in vitro* effects of aqueous extract of *Artemisia sieberi* and *Artemisinin* on *Leishmania major*. *Jundishapur J Nat Pharm Prod.* 2013; 8(2): 70-5.
27. Doroodgar A, Arbabi M, Razavi MR, Mohebali M, Sadr F, Tashakkor Z. Effect of *Artemisia sieberi* extract on *Leishmania major* ulcers in BALB/c mice. *KAUMS J.* 2007; 11(3): 52-6.

28. Farzaneh M, Ahmadzadeh M, Hadian J, Tehrani AS. Chemical composition and antifungal activity of the essential oils of three species of *Artemisia* on some soil-borne phytopathogens. *Commun Agric Appl Biol Sci*. 2006; 71(3 Pt B): 1327-33.
29. Negahban M, Moharramipour S, Sefidkon F. Chemical composition and insecticidal activity of *Artemisia scoparia* essential oil against three coleopteran stored-product insects. *J Asia Pac Entomol*. 2006; 9(4): 381-8.
30. Pirali Kh, Hejazi Sh, Layeghi S GS. Cytotoxic effect of essential oil of *Artemisia Siberi* and *Pelargonium roseum* on *Leishmania major* Promastigotes. *J Shahrekord Univ Med Sci*. 2015; 17: (5): 13-22.
31. Emami A, Mahmudi M, Zamani Taqizadeh Rabe S, Ahi A. Assessment of *in vivo* leishmanicidal effect of *Artemisia spp.* native to Khorasan Razavi province. *Sci J Kurdistan Univ Med Sci*. 2008; 13(3): 15-20.
32. Rostami M, Nahrevanian H, Farahmand M, Ziaee H, Sharif M, Maghsudloorad FS. Evaluation of anti-leishmanial efficacy by extract of *Artemisia auchery Boiss.* on *Leishmania major* in Balb/c. *J Herbal Drugs*. 2012; 2(4): 269-74.
33. Nahrevanian H, Sheykhkanlooye Milan B, Kazemi M, Hajhosseini R, Soleymani Mashhadi S, Nahrevanian S. Antimalarial effects of iranian flora *Artemisia Sieberi* on plasmodium berghei *in vivo* in mice and phytochemistry analysis of its herbal extracts. *Malar Res Treat*. 2012; 2012: 727032.
34. Van Vugt M, Brockman A, Gemperli B, Luxemburger C, Gathmann I, Royce C, et al. Randomized comparison of artemether-benflumetol and artesunate-mefloquine in treatment of multidrug-resistant falciparum malaria. *Antimicrob Agents Chemother*. 1998; 42(1): 135-9.
35. Belay G, Tariku Y, Kebede T, Hymete A, Mekonnen Y. Ethnopharmacological investigations of essential oils isolated from five Ethiopian medicinal plants against eleven pathogenic bacterial strains. *Phytopharmacol*. 2011; 1(5): 133-43.
36. Tariku Y, Hymete A, Hailu A, Rohloff J. *In vitro* evaluation of antileishmanial activity and toxicity of essential oils of *Artemisia absinthium* and *Echinops kebericho*. *Chem Biodivers*. 2011; 8(4): 614-23.
37. Islamuddin M, Chouhan G, Tyagi M, Abdin MZ, Sahal D, Afrin F. Leishmanicidal activities of *Artemisia annua* leaf essential oil against Visceral Leishmaniasis. *Front Microbiol*. 2014; 5: 626.
38. Ghaffarifar F, Esavand Heydari F, Dalimi A, Hassan ZM, Delavari M, Mikaeiloo H. Evaluation of apoptotic and antileishmanial activities of Artemisinin on promastigotes and BALB/C Mice infected with *Leishmania major*. *Iran J Parasitol*. 2015; 10(2): 258-67.
39. Dehkordi NM, Ghaffarifar F, Hassan ZM, Heydari FE. *In vitro* and *in vivo* studies of anti-leishmanial effect of Artemether on *Leishmania infantum*. *Jundishapur J Microbiol*. 2013; 6(5): e6379.

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