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Antifungal activity of plant extracts against dermatophytes

Antimyzetische Aktivität von Pflanzenextrakten gegen Dermatophyten

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Key words. Dermatophytes, medicinal plants, antifungal activity.

Schlüsselwörter. Dermatophyten, offizinelle Pflanzen, antimyzetische Aktivität.

Summary. The aqueous extracts (15 μg ml^{-1} medium) of 22 plants used in folkloric medicine in Palestine were investigated for their antifungal activity and minimum inhibitory concentrations (MICs) against nine isolates of *Microsporum canis, Trichophyton mentagrophytes* and *Trichophyton violaceum.* The extract of the different plant species reduced colony growth of the three dermatophytes by 36 to 100% compared with the control treatment. Antimycotic activity of the extract against the three dermatophytes varied significantly ($P < 0.05$) between test plants. Extracts of *Capparis spinosa* and *Juglans regia* completely prevented growth of *M. canis* and *T. violaceum.* The most active extracts (90–100% inhibition) were those of *Anagallis arvensis, C. spinosa, J. regia, Pistacia lentiscus* and *Ruta chalapensis* against *M. canis; Inula viscosa, J. regia* and *P. lentiscus* against *T. mentagrophytes*; and *Asphodelus luteus*, *A. arvensis*, *C. spinosa*, *Clematis cirrhosa*, *I. viscosa*, *J. regia*, *P. lentiscus*, *Plumbago europea*, *Ruscus aculeatus*, *Retema raetam* and *Salvia fruticosa* against *T. violaceum.* The MICs of these most active plants ranged from 0.6 to 40 μg ml^{-1}. The three dermatophytes differed significantly with regard to their susceptibility to plant extracts. *Trichophyton violaceum* was the most susceptible being completely inhibited by 50% of the extracts followed by *M. canis* and *T. mentagrophytes* which were completely inhibited by only 23 and 14% of the extracts, respectively.

Zusammenfassung. Die wässrigen Extrakte (15 μg ml^{-1} Medium) von 22 in der palästinensischen Volksmedizin benutzten Pflanzen wurden auf ihre antimyzetische Aktivität gegen neun Isolate *von Microsporum canis*, *Trichophyton mentagrophytes* und *T. violaceum* untersucht. Die Pflanzenextrakte reduzierten das Koloniewachstum in der Größenordnung zwischen 36 und 100% verglichen mit der Kontrolle. Die antimykotische Aktivität auf die drei Dermatophyten-Arten varierte unter den Testpflanzen beträchtlich. Die MHK-Werte der wirksamsten Pflanzenextrakte lagen zwischen 0.6–40 μg ml^{-1} Unter den geprüften Dermatophyten war *T. violaceum* der empfindlichste, gefolgt von *M. canis* und *T. mentagrophytes*.

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Introduction

Mycotic infection of the scalp, tinea capitis, is a common disease in developing countries including the Palestinian area [1, 2]. The use of medicinal herbs in the treatment of skin diseases including mycotic infections, is an age-old practice in many parts of the world [3]. This use has been supported by the isolation of active antifungal compounds from plant extracts [4]. These compounds represent secondary metabolites that serve as defence agents against invading micro-organisms.

By literature review and ethnobotanical surveys [5–9], in addition to a survey carried out by the first author between 1984 and 1997, a list of 47 plants used for the treatment of skin diseases suggestive of dermatophyte infections in Palestine was prepared (Table 1). Recent screenings of some of these medicinal plants in the Palestinian area have yielded extracts with antibacterial, anticandidal [7] and antidermatophytic efficacy [6], and active compounds could also be isolated [8]. Antimycotic agents were slow in their development, and are few, compared with antibacterial

Table 1. Twenty-two plants[a], used in folkloric medicine in Palestine for the treatment of skin diseases suggestive of dermatophyte infections, that were selected for antifungal susceptibility testing

Plant species (Family)	Common name	Part used*	Active constituents	References
Anchusa strigosa (Boraginaceae) 5412**	Alkanet (Hemhem)	RT, LF 17	5, 14–16	
Asphodilus microcarpus (Liliaceae) 5409	Asphodel (Buslan)	RT	30	17
Asphodelus luteus (Liliaceae) 5413	Jacob's rod (Otat)	WP		
Anagallis arvensis (Primulaceae) 5408	Red Pimpernes (Ein EL -Jamal)	WP	10, 11, 6, 19, 17	5, 15, 16, 18–21
Capparis spinosa (Capparidaceae) 5402	Caper bush (Qubbar)	RT, FL, FR 21, 22	5, 15, 16, 22	
Clematis cirrhosa (Ranunculaceae) 5411	Clematis (Ghashia)	AP	11, 10,12	23–25
Eryngium creticum (Umbiliferae) 5416	Snake root (Qarsa'na)	LF, S, RT	10, 17	5, 14–16
Inula viscosa (Compositae) 5445	Inula (Erq Tayoon)	WP, LF, AP, FL, FR, RT	6, 7, 1, 14, 2, 27, 30	5, 6, 15–17, 26–30
Juglans regia (Juglandaceae) 5401	Walnut (Jouz)	LF, FR	13, 7, 14, 15, 16, 17	5, 6, 15, 16, 31–33
Lycium europeum (Solanaceae) 5407	Boxthorn (Awsaj)	LF,WP 3, 23	5, 15, 16, 34, 35	
Micromeria nervosa (Labiatae) 5444	(Zatar – Naem)	LF	1, 4, 5, 6	5, 6, 15, 16, 30, 36, 37
Parietaria diffusa (Urticaceae) 5432	(Oshbet – Dam)	AP	17	5, 6, 14–16
Paronychia argentea (Caryophyllaceae) 5410	(Masah)	LF		
Phagnalon rupestre (Compositae) 5405	(Qadeeh)	WP, AP	1, 2, 3	30, 38, 39
Pistacia lentiscus (Anacardiaceae) 5430	Mastic (Sarrees)	LF, YB	1, 11, 25, 30	5, 15, 16, 30, 40–45
Plumbago europaea (Plumbaginaceae) 5414	(Khamsheh)	LF	28	6, 46
Ruscus aculeatus (Liliaceae) 5403	Butcher's broom (Safander)	R T	6, 18, 10, 26, 27	47–51
Ruta calapensis (Rutaceae) 5420	Rue (Faijen)	LF, RT, WP	20, 6, 17, 11, 3	5, 6, 15, 16, 52–55
Retema raetam (Papilionaceae) 5422	Ratame (Retem)	LF, S, YB	5, 6, 15, 16	
Solanum nigrum (Solanaceae) 5406	Black night-shade (Enab Eltha'lab)	LF, FR	24, 10	5, 15, 16, 56
Salvia fruticosa (Labiatae) 5418	White sage (Mariamia)	L F	1, 2, 6, 9, 10, 14, 29, 8	5, 6, 14–16, 27, 57–59
Ziziphus spina-christi (Rhamnaceae) 5417	Syrian Christ thorn (Doum, seder)	LF, S, YB, FR, RT	30, 6, 11	5, 15, 16, 60

[a]Another 25 medicinal plants have been found to be used for the treatment of skin diseases suggestive of dermatophyte infections (see text for references): *Ammi visnaga*, *Ceratonia siliqua*, *Coridothymus capitatus*, *Cyclamen persicum*, *Cyperus rotundus*, *Ecballium elaterium*, *Euphorbia hierosolymitana*, *Glaucium flavum*, *Hyoscyamus amnens*, *Laurus nobilis*, *Majorana syriaca*, *Malva micaemsis*, *Mandragora autamnalis*, *Marrubium vulgare*, *Marticaria aurea*, *Myrtus communis*, *Nerium oleander*, *Raphnus sativus*, *Rumex cyprius*, *Sarcopoterium spinosum*, *Tamarix aphylla*, *Teucrium polium*, *Trigonella foenum-graecum*, *Urginea maritima*, *Urtica pilulifera*.

*Parts used: AP, aerial parts; FR, fruits; LF, leaves; RT, roots; WP, whole plant; S, seeds; YB, young branches; FL, flowers.

**Plants were collected by Ali-Shtayeh, Yaghmour, Al-Nuri, & Abu-Ghdeib, University, Nablus. Active constituents: 1, Tymol; 2, Carvacrol; 3, Quinones; 4, Menthol; 5, Pulegone; 6, Flavanoids (Narigenin, Neoponcirin, Flavanoid glycosides); 7, Sesquiterpenoids; 8, Flavone aglycones; 9, Rosmarinic acid; 10, Saponins; 11, Triterpenoids; 12, Oleanolic acid; 13, Juglone; 14, Monoterpenoids (Terpenes, Gamma-terpinene); 15, Juglandin (Naphthoquinones); 16, Pyrogallic acid; 17, Tannins; 18, Euparone sterol mixture; 19, Arvenins; 20, Coumarines; 21, Capparenol (12, 13, 14); 22, Capparidis; 23, Terpenes; 24, Spirostanol glycosides; 25, Procyanidin polymer; 26, Chryso-phanic acid; 27, Phenols; 28, Plumbagin; 29, 1–8-Cineole; 30, Essential oils (volatile oils).

agents, because mycotic infections are less common than bacterial infections [10]. The objective of this study was, therefore, to investigate the *in vitro* effect of aqueous extracts of 22 of the above-mentioned plants, that have been used in the traditional medicine of Palestine, on three selected species of dermatophytes isolated from tinea capitis cases.

Materials and methods

Plant material

Plant material (aerial parts of mature plants) of 20 plant species belonging to 17 botanical families, commonly used in folk medicine in Palestine, mainly for the treatment of dermatomucosal infections [7, 8], were collected from various locations in the northern part of the West Bank (Palestinian area) in the current work (Table 1). The aerial parts of the mature plants were collected during the spring and summer seasons (April–June) of 1996. The material was dried in the shade, and ground into a powdered material using an appropriate seed mill, and the mince was hermetically sealed in polythene bags until extraction if not extracted immediately. All plants were collected by the authors, and were authenticated by the first author. Voucher specimens of the plants were deposited at the Department of Biologic Science, An-Najah University, West Bank.

Extraction

To prepare aqueous extracts, 100 g of each dry powdered plant were infused in distilled water until complete exhaustion (usually for 72 h). The extract was then filtered using muslin or Whatman filter paper No. 1, and the filtrate was evaporated using a freeze drier [11]. The final dried material was stored in labelled sterile screw-capped bottles and kept in the freezer at −20 °C.

Screening for antifungal activities

Fungal isolates. The test species and isolates used for this investigation were: *Microsporum canis* (S14, S20, and SH41), *Trichophyton mentagrophytes* (SH13, SH1, SH8), and *Trichophyton violaceum* (S5, SH32, SH38). These were isolated from different clinical specimens of tinea capitis collected from schoolchildren and from tinea capitis cases attending a clinic in the Nablus area and identified using standard methods [12]. The fungi were maintained on Sabouraud dextrose agar (SDA) slants at 10 °C and subcultured monthly throughout this study.

Agar dilution method. All test isolates were inoculated onto SDA plates and incubated at 25 °C for 7–10 days to obtain young, actively growing cultures consisting of mycelia and conidia. Antimycotic activity was carried out by the poisoned-food technique [13]. The required amount of the dried plant extract or reference antimycotic drug was dissolved in 2 ml sterile distilled water or 10% aqueous dimethylsulfoxide (DMSO), sterilized by filtration through a 0.45-μm membrane filter, and then mixed with the amount of presterilized SDA medium required in order to give a final concentration of 15 μg ml^{-1}. A mycelial disc, 5 mm in diameter, cut from the periphery of the 7–10-day-old cultures, was aseptically inoculated onto the medium. In controls, sterile DMSO or distilled water was used instead of plant extract. The inoculated plates were then incubated at 25 °C and the colony diameter measured and recorded after 7 days. The percentage of mycelial inhibition was calculated as follows: % mycelial inhibition $=[(d_c-d_t)/d_c]\times 100$; $d_c=$ colony diameter in control, $d_t=$ colony diameter in treatment. Three replicate plates were used for each treatment.

Minimum inhibitory concentration (MIC) determination was performed by a serial agar dilution plate technique, where solutions containing reconstituted extracts (0.01–3 mg ml^{-1} concentrations) were incorporated into SDA sterilized pre-poured medium, the medium poured and the agar in the plates allowed to set. The plates were then inoculated with the test fungi and incubated as described above. Control plates, which contained no plant extracts, were also made with the test. The MIC of each plant was determined after 7 days, this being the lowest concentration at which no visible growth was observed. The minimum fungicidal concentration (MFC) was determined by re-inoculating the inhibited discs of each fungal isolate on SDA medium separately. Absence of mycelial growth on the seventh day indicated fungicidal nature. MFC was regarded as the lowest concentration of the test compound that prevented growth of the fungus, indicating more than 99.5% killing of the original inoculum [4].

Statistical analysis. Data were analysed and treatments compared using analysis of variance with Duncan multiple-range test ($P<0.05$).

Results

Results of fungitoxic activity test on aqueous extracts (15 μg ml^{-1} medium) of 22 medicinal

Table 2. Means* of percentage mycelial inhibition of tinea capitis dermatophytes by selected plant extracts

Extract ($15\ \mu g\ ml^{-1}$ medium)	Dermatophytes			
	M. canis	*T. mentagrophytes*	*T. violaceum*	Total
Anchusa strigosa	50.1 ± 9.84 gh**	36.7 ± 3.80 h	71.7 ± 1.91 cd	52.8 ± 5.96 gh
Asphodelus microcarpus	70.5 ± 4.79 ef	42.2 ± 15.60 gh	81.4 ± 0.08 bc	64.7 ± 7.50 defgh
Asphodelus luteus	62.7 ± 5.33 fg	78.3 ± 9.14 abcde	92.1 ± 4.56 ab	77.7 ± 5.39abcdefgh
Anagallis arvensis	94.1 ± 5.90 ab	78.3 ± 7.33 abcde	100 ± 0.00 a	90.8 ± 4.23 abcdef
Capparis spinosa	100 ± 0.00 a	83.2 ± 9.66 abcd	100 ± 0.00 a	94.4 ± 3.95 abcd
Clematis cirrhosa	33.7 ± 4.33 i	63.9 ± 7.12 defg	93.7 ± 3.62 ab	63.8 ± 9.05 fgh
Eryngium creticum	12.4 ± 4.26 j	56.6 ± 7.41 efgh	38.8 ± 7.98 e	35.9 ± 7.25 I
Inula viscosa	88.4 ± 8.25 abc	92.8 ± 2.76 abc	100 ± 0.00 a	93.7 ± 3.03 abcde
Juglans regia	100 ± 0.00 a	97.6 ± 2.42 a	100 ± 0.00 a	99.2 ± 0.80 ab
Lycium europeum	45.9 ± 8.54 hi	62.2 ± 6.37 defg	45.1 ± 4. 35 e	51.1 ± 4.33 h
Micromeria nervosa	40.0 ± 8.87 hi	70.9 ± 10.47 bcdef	89.0 ± 6.35 ab	66.6 ± 8.33 cdefgh
Parietaria diffusa	71.5 ± 5.03 def	52.0 ± 11.72 fgh	84.3 ± 0.06 bc	69.3 ± 5.96 bcdefgh
Paronychia argentea	72.9 ± 4.16 cdef	76.7 ± 3.97 abcde	89.0 ± 2.77 ab	79.5 ± 3.04 abcdefgh
Phagnalon rupestre	83.3 ± 1.04 abcde	63.8 ± 7.74 defg	81.2 ± 10.83 bc	76.1 ± 4.94 abcdefgh
Pistacia lentiscus	94.2 ± 4.38 ab	94.0 ± 3.66 ab	100 ± 0.00 a	96.1 ± 1.92 abc
Plumbago europaea	87.1 ± 6.79 abcd	88.4 ± 10.04 abc	100 ± 0.00 a	91.8 ± 4.05 abcdef
Ruscus aculeatus	83.6 ± 5.09 abcde	86.3 ± 7.36 abcd	100 ± 0.00 a	89.9 ± 3.62 abcdef
Ruta calapensis	94.8 ± 2.75 ab	61.7 ± 12.64 defg	64.3 ± 9.77 d	73.6 ± 7.07 abcdefgh
Retema raetam	66.0 ± 12.34 f	63.6 ± 9.19 defg	100 ± 0.00 a	76.5 ± 7.36 abcdefgh
Solanum nigrum	8.0 ± 2.82 j	61.5 ± 10.13 defg	81.2 ± 10.83 bc	50.2 ± 11.78 h
Salvia fruticosa	82.1 ± 3.05 bcde	62.5 ± 9.93 defg	100 ± 0.00 a	81.5 ± 6.18 abcdefg
Ziziphus spina-christi	40.2 ± 1.84 hi	68.7 ± 8.04 cdef	84.3 ± 9.04 bc	64.4 ± 7.35 efgh
Griseofulvin (reference antibiotic)***	100 ± 0.00 a	100 ± 0.00 a	100 ± 0.00 a	100 ± 0.00 a

*Means of three replicate plates for each of three isolates for each species.
**Values followed by the same letter were not significantly different based on Duncan's multiple-range test ($P < 0.05$).
***Concentration of reference antibiotic (MIC) was $0.6\ \mu g\ ml^{-1}$ for *M. canis*; $2.5\ \mu g\ ml^{-1}$ for *T. mentagrophytes*; and $0.6\ \mu g\ ml^{-1}$ for *T. violaceum*.

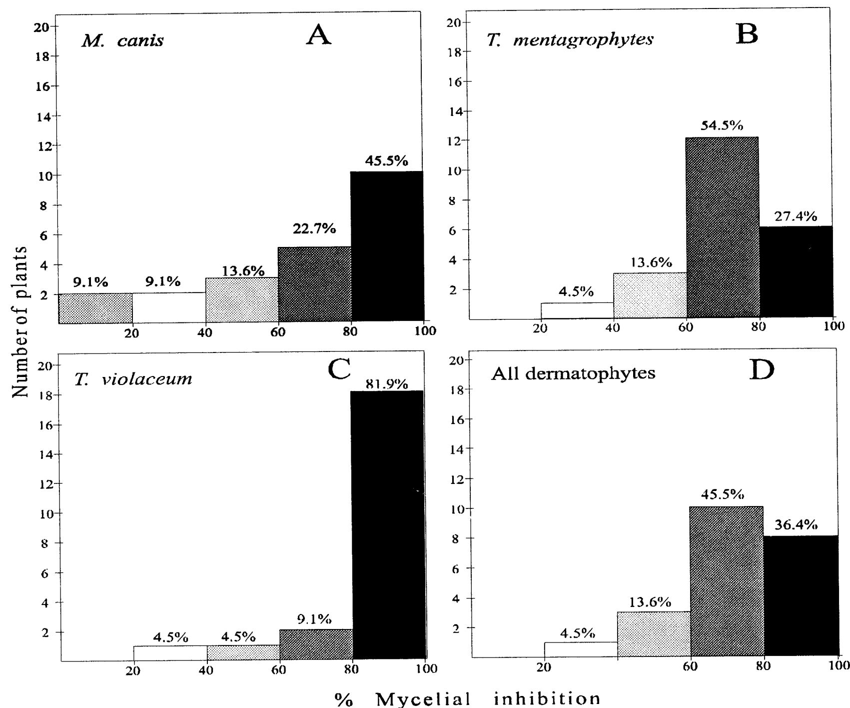

Figure 1. Antifungal activity of 22 medicinal plants against three dermatophytes: (A) *M. canis* (B) *T. mentagrophytes* (C) *T. violaceum* (D) all three dermatophytes. Figures above bars indicate percentage of total number of plants.

plants are presented in Table 2 and Fig. 1. The MIC values of extracts that were highly or moderately active (80–100% inhibition) against test dermatophytes are listed in Table 3. Aqueous extract of the different plant species reduced colony growth of the three test dermatophytes compared with the control treatment (Table 2). However, the inhibitory effect against the three fungi varied (about 36 to 100% inhibition) significantly between plants ($F = 12.5$, DF = 22,184; $P < 0.05$). Extracts of *Capparis spinosa* and *Juglans regia* completely prevented growth of *M. canis* and *T. violaceum*. In addition, extracts of *Anagallis arvensis*, *Inula viscosa*, *Pistacia lentiscus*, *Plumbago europea*, *Ruscus aculeatus*, *Retema raetam* and *Salvia fruticosa* prevented the growth of *T. violaceum*.

Antimycotic activity of extracts of nine, nine and 13 plants were comparable with that of reference antibiotic (griseofulvin $< 1–2.5\ \mu g\ ml^{-1}$) (difference not significant at $P < 0.05$) against *M. canis, T. mentagrophytes* and *T. violaceum*, respectively. The remaining plants gave significantly lower antidermatophytic activity than that of the reference.

Extracts of *A. arvensis, C. spinosa, J. regia, P. lentiscus,* and *Ruta chalapensis* were the most active (90%–100% inhibition) against *M. canis*, whereas extracts of *Solanum nigrum*, and *Eryngium creticum* were the least active (<20%).

Extracts of *I. viscosa, J. regia*, and *P. lentiscus* were also most active (90–100% inhibition) against *T. mentagrophytes*; whereas extracts of *Anchusa strigosa* and *Asphodelus microcarpus* were the least active (<40%).

Extracts of *A. lutea*, *A. arvensis*, *C. spinosa*, *Clematis cirrhosa*, *I. viscosa*, *J. regia*, *P. lentiscus*, *P. europea*, *R. aculeatus*, *R. raetam*, and *S. fruticosa* were the most active (90%–100% inhibition) against *T. violaceum*. Extracts of *E. creticum* and *L. europaeum* were on the other hand, least active (<40%).

Isolates within each dermatophyte species did not differ significantly ($P < 0.05$) with regard to their susceptibility to plant extracts. However, the three test dermatophyte species differed significantly ($F = 10.28$; DF = 8,198; $P < 0.05$) in their susceptibility to antimycotic activity of plant extracts with the most susceptible fungus, *T. violaceum*, being completely inhibited by 11 of 22 (50%) of the extracts, followed by *M. canis*, and *T. mentagrophytes* which were completely inhibited by five of 22 (23%) and three of 22 (14%) of the extracts, respectively.

The MIC values of plant extracts that showed high to moderate (80–100% inhibition) antimycotic activity against one or more of the test dermatophytes varied between $0.6\ \mu g\ ml^{-1}$ (*J. regia*) to $35\ \mu g\ ml^{-1}$ (*R. aculeatus*); Griseofulvin (reference antibiotic) gave MIC values between 0.6 and $2.5\ \mu g\ ml^{-1}$.

Table 3. Minimum inhibitory concentration (MIC) for active plant extracts and griseofulvin against three dermatophytes

Plant scientific name (Family)	Minimum inhibitory concentration (MIC) ($\mu g\ ml^{-1}$)		
	M. canis	*T. mentagrophytes*	*T. violaceum*
Asphodelus microcarpus	n.d.	n.d.	25
Asphodelus luteus	25	30	18
Anagallis arvensis	16	25	15
Capparis spinosa	15	25	5
Clematis cirrhosa	n.d.	35	17
Inula viscosa	18	20	5
Juglans regia	3	5	0.6
Micromeria nervosa	35	35	17
Parietaria diffusa	30	35	20
Paromychia argentea	20	25	20
Phagnalon rupestre	23	30	21
Pistacia lentiscus	22	21	5
Plumbago europaea	20	19	15
Ruscus aculeatus	35	29	15
Ruta calapensis	17	25	20
Retema raetam	30	30	15
Solanum nigrum	n.d.	n.d.	21
Salvia fruticosa	30	40	15
Ziziphus spina-christi	30	25	20
Griseofulvin	0.6	2.5	0.6

n.d., nondetermined.

Discussion

The fungitoxic effects of aqueous extracts of most plant species tested in the present work indicate the importance of many plant species as a natural source of antimycotic substances (Table 1) (major active constituents present are indicated [14–60]). Antifungal activity of medicinal plants, e.g. *Juglans* sp. and *Solanum* sp. extracts, against some dermatophytes including *M. canis* and *T. mentagrophytes* have also been reported by other workers [61, 62]. In the present work 41% (9/22) of the extracts (15 $\mu g\ ml^{-1}$) completely inhibited growth of one or more of test dermatophytes. In fact, 27 to 81% (6/22–18/22) of the extracts showed high antimycotic activity (80–100% inhibition) against one or more of the test dermatophytes (Fig. 1) and 9 to 55% (2/22–12/22) of the extracts showed moderate (60–80% inhibition) activity. Among the 22 plant species tested *in vitro* five were most active against *M. canis*; were most active against *T. mentagrophytes* and three were most active against *T. violaceum*. The present results are therefore consistent with those of Caceres *et al.* [62] who showed that from 44 aqueous plant extracts, 22 (50%) inhibited the growth of one or more of dermatophytes including *M. canis* and *T. mentagrophytes*. None of these plants, however, are identical with those tested in the present study. Guerin & Reveillere [63] demonstrated that in 41 extracts of medicinal plants 12 (29.3%) species have antidermatophyte activity. Also Al-Abed *et al.* [64] showed that from 40 weeds from Jordan, aqueous extracts of *I. viscosa* and *A. arvensis* were most active against the phytopathogenic fungi *Fusarium oxysporum* and *Helminthosporium sativum*.

The results also show that the aqueous extracts of different plants significantly varied in their antifungal potential. These differences may be attributed to differences in nature and/or concentration of chemical inhibitors in the different plant species and in their relative solubility in water [65, 66].

It is interesting to note that some of the aqueous plant extracts (*A. arvensis, I. viscosa, P. lentiscus*, and *R. aculeatus*) that were found in the present work to be highly active (>90% inhibition) against dermatophytes, were also found by Ali-Shtayeh *et al.* [9] to be active against *Candida albicans*. On the other hand, many of the plant species (e.g. *E. creticum* 36%, *J. regia* 99%) that showed low to high (36–99% inhibition) antifungal activity against dermatophytes in this study, were found by Yaghmour [7] to be inactive against *C. albicans*. This indicates that anticandidal compounds are less frequently encountered in aqueous extracts of test plants than antidermatophytic compounds and also indicates differences in the mode of action of these compounds.

As to the use of herbal medicine in the treatment of skin diseases suggestive of dermatophyte infection, a few studies, cited in the introduction, have been conducted in Israel and the Palestinian area where 47 plants have been used for the treatment of skin infections. Owing to the cultural and natural richness of this area, more work will be required to describe adequately the popular use of medicinal plants with an important role in the treatment of dermatomucosal diseases.

The present study indicates that the majority of the plants tested are an important source of antifungal compounds that may provide renewable sources of useful antifungal drugs against dermatophytic infections in humans. Among plant species tested, *J. regia, P. lentiscus, C. spinosa, I. viscosa*, and *A. arvensis* were shown to have high antidermatophytic activity. The MIC values (Table 3) for some of these plants, e.g. *J. regia*, were comparable with those of griseofulvin. This obviously justifies the use of many of these plants in traditional medicine to cure dermatophyte infections. However, further work is needed on the most active plants to develope new and more potent antifungal drugs from natural sources.

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