Can the thyme oil be an alternative treatment for human demodicosis?

Serife Akkucuk
serifeakkucuk@hotmail.com

Mustafa Kemal University
Kaya OM
Mustafa Kemal University

Research Article

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Abstract

Background: Demodex mites can cause ocular demodicosis in humans. Natural products such as tea tree oil are used for ocular demodicosis, which can take a long time to treat. The aim of our study is to investigate the effects of some essential oils on in vitro mite lifespan.

Methods: Eyelashes were examined under a light microscope. Mites were determined and the killing times of mineral oil, tea tree oil, black seed oil, St. John's Wort oil, sage oil and thyme oil were recorded. The active ingredients of thyme, tea tree and sage oils were determined by GC / MS method.

Results: It was determined that 1% concentration of thyme oil has more effective killing time than 5% concentrations of tea tree oil and sage oil ($p < 0.0001$). The most important active ingredients were carvacrol in thyme oil, terpinen-4-ol in tea tree oil, and 1.8-cineol in sage oil.

Conclusion: Thyme oil was the most effective oil in killing mites. In addition, the first steps were taken that thyme oil and its products can be used in therapy.

Introduction

Demodex mites are the most common obligate ectoparasites in humans. Two species under this genus in humans have been isolated. *Demodex folliculorum* (DF) lives in the pilosebaceous glands, with two or more mites in one follicle. It can also be found in meibomian glands. However, *Demodex brevis* (DB) lives inside the meibomian glands and less frequently in the pilosebaceous glands (Murube 2015). Demodex infestation has been reported in many dermatological diseases in humans with increasing frequency (Lacey et al. 2016). Pityriasis follicleum (Forton 2012), pustular folliculitis (Vollmer 1996), blepharitis, spinulosis (Farina et al. 1998), granulomatous and papulopustular rosacea (Bonnar et al. 1993; Forton and Seys 1993; Erbagci and Ozgoztasi 1998), androgenetic alopecia and increased infestation has been found in diseases such as perioral dermatitis (Gajewska 1975; Dolenc-Voljc et al. 2005). In addition, an increase in mites is observed on the skin of patients who receive immunosuppressive therapy or whose immune system is suppressed (Dominey et al. 1989; Redondo et al. 1993; Aquilina et al. 2002; Kulac et al. 2008; Lacey et al. 2016; Kaya et al. 2019).

Although it commonly causes skin problems, it also plays a role in the etiology of ocular diseases such as blepharitis and chalazion in the eyelid. As a general rule, ocular demodicosis treatment takes several months. The use of yellow mercury ointment (mercury oxide ointment), sulfur ointment, camphor oil, crotamitone, choline esterase inhibitors, sulfacetamide, steroids, antibiotics and antimycotic drugs provides some improvements (Czepita et al. 2007). Permethrin or metronidazole is applied topically in the treatment of blepharitis associated with Demodex spp. Success has been reported with oral ivermectin. The currently recommended treatment is the application of tea tree oil (TTO) containing terpinen-4-ol (T4O) (Zorbozan et al. 2016). There are studies indicating successful treatment with TTO peeling and TTO shampoo in patients with ocular demodicosis (Kim et al. 2011; Gao et al. 2012; Cheng et al. 2015; Hirsch-Hoffmann et al. 2015). In addition, it has been reported that some patients develop allergic reactions after the use of TTO and ocular irritation occurs as a treatment complication (Sędzikowska et al. 2015). Therefore, it is important to study different vegetable oils and essential oils on mites to develop alternative therapy.

Materials And Methods

Study approval numbered 2018/154 was obtained from the Clinical Research Ethics Committee of Hatay Mustafa Kemal University Tayfur Ata Sökmen Faculty of Medicine. The study material consisted of vital Demodex mites collected from eyelashes of patients diagnosed with chronic blepharitis and chalazion. Adult parasites isolated from eyelashes found positive for *Demodex spp*. were divided into groups for in vitro study. In this study, some essential oils obtained by distillation method and some carrier oils obtained by infusion and cold pressing methods were tested. Used oils and groups were formed as follows;

In the first group (Tea tree oil - positive control group) 100% Tea Tree Oil (TTO) produced by water vapor distillation from *Melaleuca alternifolia L*. was used. In the second group (black seed oil group) 100% Black Seed Oil (BSO) produced from *Nigella sativa L*. seeds by cold press method was used. 100% St. John's Wort Oil (SJWO) produced by infusion method from *Hypericum perforatum L*. was studied in group three (St. John's Wort Oil group). In group 4 (Sage Oil group) 100% Sage Oil (SO) produced by water vapor distillation from *Salvia officinalis L*. was studied. In the 5th group (Thyme Oil group), 100% Thyme Oil (TO) produced by water vapor distillation from *Thymus serpyllum L.* was used. Negative control group (Group 6) was studied with Mineral Oil (MO) of Sigma-Aldrich (Steinheim, Germany).

All vegetable oils used in the study were produced and obtained from the manufactorer (Mecitefendi, Yesilvadi Herbal Cosmetics and Health Products Food Industry and Trade Ltd. Co., Izmir, Turkey) and had ISO9001, ISO22000, ISO22716 certifications. Four subgroups were formed with concentrations of 100%, 50%, 25% and 5% of the oils in the first five groups. Due to the positive result obtained in thyme oil, its concentration of 1% was also studied. Mineral oil was used when preparing different concentrations of essential oils. 50 parasites were examined in each group. The survival time of 1100 parasites in 22 groups were examined and recorded.

The antiparasitic effect of the essential oils to be studied was carried out in an environment where the in vitro optimum temperature for DF and DB was 16–22 ° C (Zhao et al. 2009). During this period, the parasites were kept in the humidity chambers. Flat cotton pads were placed to cover the base of the standard petri dish for the mite chamber. A moisture chamber was created by adding 9 ml of distilled water with a pipette to moisten the cotton (Lacey et al. 2016). Life times were checked at x100 and x400 magnification under light microscopy according to motion evaluation criteria. If the chelicera or legs of the mite remained motionless for one minute according to these criteria, a second observation was made after 30 minutes. If the mite was still immobile, it was considered dead (Zhao et al. 2009). The mobility of parasites at different time intervals were examined; Continuous observation for 0–60 minutes time period was performed. Between 60–180 minutes observation was made in every 5 minutes, Between 180–360 minutes observation was made in every 15 minutes, Between 360–720 minutes observation was made in every 1 hour and observation was performed in every 2 hours after 720 minutes.

Gas Chromatography / Mass Spectrometry (Gc / Ms) Analysis

The active ingredient and quantification analyzes of the essential oils *Melaleuca alternifolia L*. (tea tree) oil, *Salvia officinalis L.* (sage) oil and *Thymus serpyllum L.* (thyme) oil used in the study were carried out by the GC / MS method at the Central Research Laboratory of Cukurova University.

Statistical Analysis

Statistical analysis of obtained results was performed with the use of SPSS 22.0 for Windows (Statistical Package for Social Sciences, Chicago, IL) (SPSS Inc., Chicago, USA) and Prism 7 for Windows (Version 7.04). Mean survival time and standard deviation (SD) was calculated.

Results

Table 1 shows the effects of some essential oils and carrier oils used in the study on the survival time of *Demodex spp.*

Table 1
Effects of some essential and carrier oils on survival time of *Demodex spp.*

Oil	Number of mites (n)	Mean survival time (min ± SD)	Median survival time (min-max minute)
Mineral oil	50	13596 ± 3827	12240 (8640–21840)
%100 TTO	50	4,62 ± 2,26	4 (2–11)
%50 TTO	50	16,5 ± 7,07	16 (4–32)
%25 TTO	50	35,8 ± 13,93	35,5 (13–90)
%5 TTO	50	90,02 ± 27,19	90 (52–165)
%100 BSO	50	312,3 ± 102	300 (140–600)
%50 BSO	50	996,6 ± 550,1	960 (360–2280)
%25 BSO	50	2017 ± 623,2	2040 (480–3120)
%5 BSO	50	2299 ± 743,4	2280 (1320–4320)
%100 SJWO	50	288,6 ± 107,9	285 (105–540)
%50 SJWO	50	837,6 ± 508,8	720 (240–1920)
%25 SJWO	50	1699 ± 569,9	1560 (420–3000)
%5 SJWO	50	1944 ± 587,9	1800 (1200–4080)
%100 SO	50	7,54 ± 3,26	7 (2–15)
%50 SO	50	32,78 ± 10,49	32 (18–57)
%25 SO	50	85,58 ± 41,48	85 (25–180)
%5 SO	50	194,9 ± 47,23	195 (85–270)
%100 TO	50	2,06 ± 0,61	2 (1–3)
%50 TO	50	2,9 ± 0,95	3 (1–5)
%25 TO	50	4,98 ± 2,24	4,5 (2–11)
%5 TO	50	6,24 ± 2,27	6 (3–14)
%1 TO	50	34,18 ± 14,96	32 (15–90)

The comparison of the negative control group mineral oil and all other oil concentrations is given in Fig. 1 and a significant difference was found ($p < 0.0001$).

Different concentrations of all oil groups were compared with each other. The oil concentrations that have a similar effect on the life span of the mite and for which no statistically significant difference could be determined are given in Table 2. Except for the oil concentrations presented in Table 2, a significant difference was found between all concentrations ($p < 0.05$).

Table 2
Comparison of oil concentrations with similar effect.

Oil concentration Mean survival time (min ± SD)		P
%100 BSO 312,3 ± 102	%100 SJWO 288,6 ± 107,9	0,261
%50 BSO 996,6 ± 550,1	%50 SJWO 837,6 ± 508,8	0,129
%25 BSO 2017 ± 623,2	%5 SJWO 1944 ± 587,9	0,547
%100 TTO 4,62 ± 2,26	%25 TO 4,98 ± 2,24	0,426
%25 TTO 35,8 ± 13,93	%1 TO 34,18 ± 14,96	0,576
%25 TTO 35,8 ± 13,93	%50 SO 32,78 ± 10,49	0,223
%5 TTO 90,02 ± 27,19	%25 SO 85,58 ± 41,48	0,528
%1 TO 34,18 ± 14,96	%50 SO 32,78 ± 10,49	0,589

It was determined that the most effective oils in killing parasites were TO, TTO, SO, SJWO and BSO, respectively. It was observed that 1% concentration of thyme oil had similar killing times with 50% SO and 25% TTO. It was found statistically significant that 5% TO had a more effective killing time than all TTO and SO concentrations except 100% TTO ($p < 0.0001$). Although there was a significant difference between 100% TTO and ($p = 0.0006$), it was determined that this difference was in favor of TTO. It was determined that 1% TO had a more effective killing time than 5% concentrations of TTO and SO, and a significant difference was found ($p < 0.0001$).

The main compounds of the essential oils used on mite according to the active ingredient and quantity analysis results made by GC / MS method. 42 active ingredients were detected in *Melaleuca alternifolia*

L. (tea tree) oil (Table 3), 49 active ingredients in *Salvia officinalis L*. (sage) oil (Table 4) and 27 active ingredients in *Thymus serpyllum L.* (thyme) oil (Table 5). The most important 15 active ingredients contained in the analyzed essential oils were given in the charts.

Table 3
GC/MS analysis of *Melaleuca alternifolia L.* essential oil.

	Active Ingredient	**Concentration (%)**
1	Terpinen-4-ol	31,62
2	γ-Terpinene	15,47
3	Terpinolene	9,05
4	ρ-Cymene	4,20
5	Isoterpinolene	3,83
6	α-Terpineol	3,68
7	Leden	3,62
8	Cadina-1,4-diene	3,62
9	1,8-Cineole	2,87
10	α-Pinene	2,83
11	Aromandendrene	2,70
12	Pseudolimonen	2,02
13	α-Thujone	1,18
14	δ-Cadinene	0,87
15	Sabinene	0,19

Table 4
GC/MS analysis of *Salvia officinalis L.* essential oil.

	Active Ingredient	Concentration (%)
1	1,8-Cineole	18,95
2	Caryophyllene	12,13
3	Camphor	11,48
4	α-Thujone	9,64
5	α-Pinene	5,17
6	Thymol	4,69
7	Humulene	4,37
8	β-Pinene	4,23
9	β-Thujone	4,00
10	Camphene	3,42
11	Isoborneol	2,24
12	d-Viridiflorol	1,94
13	α-Bornyl acetate	1,93
14	β-Myrcene	1,82
15	p-Cymene	1,61

Table 5
GC/MS analysis of *Thymus serpyllum L.* essential oil.

	Active Ingredient	Concentration (%)
1	Carvacrol	59,93
2	o-Cymene	7,67
3	γ-Terpinene	5,94
4	Thymol	5,30
5	β-Bisabolene	2,47
6	Linalool	2,46
7	Caryophyllene	2,46
8	Borneol	2,04
9	Terpinolene	1,91
10	Terpinen-4-ol	1,55
11	β- Myrcene	1,37
12	α-Pinene	1,04
13	Caryophyllene oxide	0,78
14	D-Limonene	0,70
15	1,8-Cineole	0,48

Discussion

There are some herbal and essential oils whose in vivo and in vitro effects on DF and DB have been investigated (Tighe et al. 2013; Sędzikowska et al. 2015). In in vitro studies, an average of 8 mites (Gao et al. 2005), 10 mites (Zhao et al. 2009), 12 mites (Sędzikowska et al. 2015) and 30 mites (Zhao et al. 2011) were observed in each group. In our study, we observed the lifetime of 50 mites in each group. There are studies in which the life span of up to 150 minutes following the addition of different substances to the mite (Gao et al. 2005; Tighe et al. 2013), as well as studies followed until the mites die (Zhao et al. 2009; Zhao et al. 2011; Sędzikowska et al. 2015). In our study, we continued to observe the mites until they died.

Tea tree oil is the most studied essential oil for its successful effect on mite in vivo and in vitro (Gao et al. 2005; Gao et al. 2007; Kheirkhah et al. 2007; Kim et al. 2011; Gao et al. 2012; Koo et al. 2012; Gunnarsdottir et al. 2016; Karakurt and Zeytun 2018; Maher 2018). Different TTO formulations such as

7.5% TTO eyelid shampoo (Blefaroshampoo, Teka, Turkey) (Karakurt and Zeytun 2018) were effective in reducing the density of *Demodex spp*. and eliminating ocular symptoms. However, other essential oils and plants studied in vitro can be listed as follows: cumin oil, dill oil (Gao et al. 2005), sage oil and peppermint oil (Sędzikowska et al. 2015).

In an in vitro study examining the effects of tea tree oil, cumin oil, dill oil and mineral oil on Demodex lifespan, it was reported that TTO was the most effective substance on mites (Gao et al. 2005). However, the number of mites examined in the groups in the study ranged from 5–21. In our study, mite lifespans were detected as 13596 minutes (226.6 hours) in mineral oil; 4.62 ± 2.26 min in 100% TTO, 16.5 ± 7.07 min in 50% TTO, 35.8 ± 13.93 min in 25% TTO, 90.02 in 5% TTO ± 27.19 min. All other oil concentrations we used killed the mites in a significantly shorter time compared to the negative control group, mineral oil. In our study, TTO effects on mites were similar to the TTO results in Gao et al. (2005)'s study, although there is little difference. We think that this is due to the high number of mites in our study.

Black cumin, which is among the medicinal plants, has many beneficial biological effects used in acute and chronic diseases (Topcagic et al. 2017). Although black cumin seed extracts have a low antimicrobial activity, they show a slightly higher activity against gram positive bacteria compared to gram negative bacteria (Topcagic et al. 2017; Rasool et al. 2018). It is stated that BSO also has a low antibacterial effect that cannot be ignored (Vlachojannis et al. 2018). No studies were found showing the effect of black cumin on Demodex mite. In our study, the concentration and mean life span of the mite were 100% BSO 312.3 ± 102 min, 50% BSO 996.6 ± 550.1 min, 25% BSO 2017 ± 623.2 min, 5% BSO 2299 ± 743.4 min, respectively.

There are studies showing that St. John's wort has antibacterial (Çırak and Kurt 2014; Ghasemi Pirbalouti et al. 2014; Aksu and Altınterim 2015; Altan et al. 2015) and significant larvicidal activity against Culex pipiens (Rouis et al. 2013). However, no study was found showing the effect of St. John's wort on Demodex mite. In our study, the concentration and mean mite survival were as follows, respectively: 100% SJWO 288.6 ± 107.9 min, 50% SJWO 837.6 ± 508.8 min, 25% SJWO 1699 ± 569.9 min, 5% SJWO 1944 ± 587.9 min.

Black seed and St. John's Wort oils showed similar effects on mite lifespan. Although both oils killed mites in a shorter time compared to mineral oil, they took significantly longer to kill mites compared to TTO, SO and TO. The mite killing time of SJWO is slightly shorter than BSO. However, no significant difference was found between them. Similar killing times were determined with 100% BSO-100% SJWO, 50% BSO-50% SJWO, and 25% BSO-5% SJWO, and no significant difference was detected between them.

Sage is used internally and externally to resolve many complaints among the public (Yılmaz and Güvenç 2007). In vitro studies have been conducted mostly on the antibacterial effect of the plant. *Salvia officinalis* inhibits the growth of *Escherichia coli, Staphylococcus aureus, Candida albicans* (Cutillas et al. 2017), and growth and biofilm formation of *Streptococcus pyogenes* (Wijesundara and Rupasinghe 2018). There is only one study reporting that sage oil is promising for the treatment of demodicosis. In the study, the effects of SO (*Salvia hispanica*) and peppermint oil were compared. It has been found that

SO has a greater acaricidal effect compared to peppermint oil, but has a longer killing time than TTO reported in previous studies (Sędzikowska et al. 2015). In our study, the concentration and mean survival were as follows, respectively: 100% SO 7.54 ± 3.26 min, 50% SO 32.78 ± 10.49 min, 25% SO 85.58 ± 41.48 min, 5% SO 194.9 ± 47.23 min. Our results were similar to the results of Sędzikowska et al. (2015). We think that the small difference is due to the number of mites tested or the difference in sage species (the species used in our study: *Salvia officinalis*). In our study, it was determined that the killing time of TTO was shorter than that of SO. However, 50% SO-25% TTO and 25% SO-5% TTO have the same killing times and no significant difference was detected between them.

Thymus genus thyme is a medicinally important, traditionally used herb that has been the subject of many studies (Koyuncu et al. 2017). There are studies (Kang et al. 2018; Manconi et al. 2018; Gadisa et al. 2019) showing this plant’s antibacterial effect. There are also studies showing its antiparasitic effect. antiamoebic, anthelmentic effects against *Antiamoeba histolytica* (Behnia et al. 2008) and Acanthamoeba (Saoudi et al. 2017) trophozoites (Ferreira et al. 2016; Trabelsi et al. 2018), antileishmanial effects on promastigotes (Malatyalı et al. 2009; Machado et al. 2014) and acaricidal effects for *Dermanyssus gallinae* (Pritchard et al. 2016) were determined. However, no study was found showing the effect of thyme on *Demodex spp.* In our study, 25% TO – 100% TTO, 1% TO – 25% TTO and 50% SO had the same killing times and no significant difference was found between them. The mite killing time of 5% TO was found to be significantly shorter than all other oil concentrations except 100% TTO. It was determined that 1% TO had a more effective killing time than 5% concentrations of TTO and SO, and a significant difference was found.

Gas Chromatography/Mass Spectrometry is the most common method used to analyze essential oil molecules (Cutillas et al. 2017). In our study, it was determined that the most effective oils in killing mites were TO, TTO, SO, SJWO and BSO, respectively. Three essential oils (TO, TTO, SO) were analyzed by GC/MS method.

The most important compound of the essential oil of *Melaleuca alternifolia* is terpinen-4-ol. Apart from this, there are major components such as γ-terpinene, 1,8-cineol and α-terpinene (Tighe et al. 2013; Raymond et al. 2017; Karakurt and Zeytun 2018). The chemical composition of *M. alternifolia* oil, which is marketed for commercial purposes, has been defined by the International Organization of Standardization with the ISO 4730:2004 standard (Tighe et al. 2013; Raymond et al. 2017). According to this definition, the ten most important compounds of *M. alternifolia* are: terpinen-4-ol (30–48%), γ-terpinene (10–28%), α-terpinene (5–13%), α-terpineol (% 1.5-8%), ρ-cymene (0.5-8%), α-pinene (1–6%), terpinolene (1.5-5%), 1,8-cineole (< 15%), sabinene (< 3.5%) and δ-cadinene (< 3%) (Tighe et al. 2013). The active ingredients of *M. alternifolia* essential oil we used in our research were compatible with the ISO 4730:2004 standard and the most important compound was determined as terpinen-4-ol (31.62%).

Among the chemical components of *Salvia officinalis* essential oil, substances such as α-thujone, camphor, 1,8-cineole and β-thujone, caryophyllene were determined (Bayaz 2014; Başyiğit and Baydar 2017; Cutillas et al. 2017; Wijesundara and Rupasinghe 2018). In a Canadian study, it is stated that the main components of the essential oil of *S. officinalis* are α-thujone (28.5%) and camphor (16.7%) (Wijesundara and Rupasinghe 2018). In the study carried out in Spain, the active ingredients were α-thujone (22.8–41.7%), camphor (10.7–19.8%), 1,8-cineole (4.7–15.6%) and β-thujone (6.1–15.6%) (Cutillas et al. 2017). The components of essential oils obtained from medicinal sage leaves, which were cut and dried at different harvest times in Isparta, were determined by GC/MS method. In the study, the most important components that make up the essential oil composition are 1.8-cineol (11.93%-31.87%), α-thujone (15.72-26.26%), β-thujone (4.51-27.67%) and camphor (3.65%-23.02%). In general, 1.8-cineole and camphor rates were found to be lower in spring, while α-thujone and β-thujone rates were found to be higher. Although the harvest period and plant productivity affect the essential oil content, it has been reported that the most important compounds found in essential oil in each period are 1,8-cineole, α-thujone, β-thujone and camphor (Başyiğit and Baydar 2017). The results of our GC/MS analysis also support that the most important compound of sage essential oil is 1,8-cineole (18.95%), and other important active ingredients are caryophyllene, camphor and α-thujone. Considering that the essential oil content changes according to the harvest period, our results are compatible with the general literature.

Thymol and carvacrol are found in high concentrations in thyme essential oil (Tanker and İliulu 1981; Salehi et al. 2018). Other substances found in Thymus genus thyme, which are medically important, are 1,8-cineole, linalool, α-pinene, borneol, camphor, geraniol, α-citral and β-citral (Ait-Ouazzou et al. 2011; Hassan et al. 2018; Salehi et al. 2018). The essential oil components of *T. serpyllum*, which is common in our country, were first identified in 1960. The essential oil of this plant contains geraniol, terpineol, citronellol, borneol, linalool, nerolidol, citral, cineole, carvacrol, thymol, bornyl acetate, geranyl acetate, neryl acetate, linalyl acetate, terpinyl acetate, citronellal, camphene, α-pinene and limonene (Özkan et al. 2010). However, the chemical composition of *T. serpyllum* mainly depends on many genetic and ecological factors. Although the main compounds mentioned in the general literature are thymol and carvacrol, in a study conducted in Estonia, it was determined that this plant mostly contains substances such as nerolidol, linalyl acetate, and linalool (Paaver et al. 2008). As a result of various studies, thymol was detected in *T. serpyllum* at 35% in Japan, 42.6% in Pakistan, 64.6% in India and 81.5% in Armenia. *Thymus serpyllum* collected from the mountainous regions of Kayseri were dried as a whole and their essential oil was obtained by methanol extraction. It has been reported that the main volatile substances of the plant obtained by GC/MS method are terpenes. It is stated that these compounds represent more than 90% of the total volatiles. Other chemical groups such as alcohols and acids have been detected in small amounts. Thymol (1702 mg/100 g) and carvacrol (179 mg/100 g) were reported to be the most abundant compounds. In addition, important active substances such as γ-terpinene (90.4 mg/100 g), β-cymene (88.8 mg/100 g) were identified (Sonmezdag et al. 2016). Thyme to be used for medicinal purposes is expected to contain at least 20% thymol and carvacrol. These rates are high in thyme in Turkey; thymol and carvacrol increase up to 85% (Ustu and Ugurlu 2018). According to the results of GC/MS analysis of *T. serpyllum* used in our study, it was determined that the essential oil contained 59.93% carvacrol and 5.30% thymol. It is thought that the essential oil, which has a total carvacrol and thymol content of 65.23%, can be used for medical purposes. Other important active substances it contains are o-cymene, γ-terpinene, β-bisabolene, linalool, caryophyllene, borneol, α-pinene, D-limonene, 1,8-cineol, and are compatible with the general literature.

Conclusion

Treatment with herbal products emerges as an alternative treatment for the solution of some health problems, especially in developing countries due to the expensiveness of pharmaceutical products. The results of this study, which we started to answer the question of ‘whether we can find an alternative treatment?’, have been very promising. As a result of the literature review, no study could be found on the in vitro or in vivo application of BSO, SJWO and TO against Demodex infestation. In addition, it is the first time that an oil with a more acaricidal effect has been encountered against TTO used in the current treatment. In this respect, the original value of the study is high. Our next goal is to identify and compare the skin irritation and acute toxicity tests of TO, SO and TTO in experimental models, and to develop an effective, reliable and economical product in the treatment of demodicosis.

Statement And Decleration

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We declare that there is no conflict of interest in this study.

All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by Serife Akkucuk and Ozlem Makbule Kaya. The first draft of the manuscript was written by Serife Akkucuk and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

This study was performed in line with the principles of the Declaration of Helsinki. Approval was granted by the Ethics Committee of University of Hatay Mustafa Kemal (2018/154)

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Figures

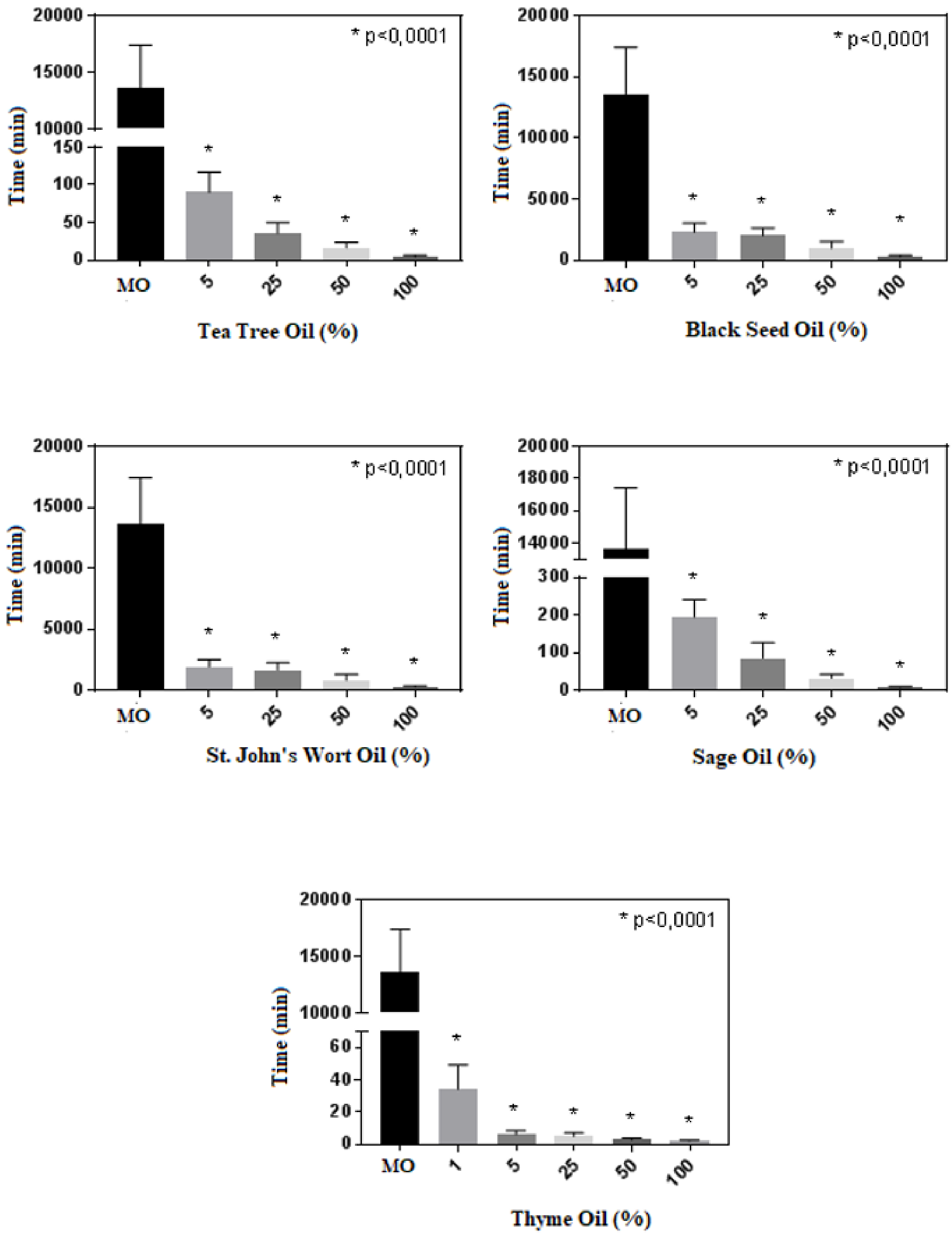

Figure 1

Comparison of the mite lifespan of mineral oil and other oils.

(Prism 7 for Windows (Version 7.04) was used to create the graph)