Pielęgniarstwo Neurologiczne i Neurochirurgiczne
THE JOURNAL OF NEUROLOGICAL AND NEUROSURGICAL NURSING

eISSN 2299-0321 ISSN 2084-8021 www.jnnn.pl **Review**

DOI: 10.15225/PNN.2020.9.4.6

Activity of Plant Essential Oils Against *Demodex folliculorum* and *Demodex brevis*

Aktywność roślinnych olejków eterycznych wobec *Demodex folliculorum* i *Demodex brevis*

Joanna Wróblewska, **Jarosław Nuszkiewicz**, **Marcin Wróblewski**, **Alina Woźniak**

Department of Medical Biology and Biochemistry, Faculty of Medicine,
Ludwik Rydygier Collegium Medicum in Bydgoszcz, Nicolaus Copernicus University in Toruń, Poland

Abstract

Infestation with *Demodex* spp. is an increasingly common dermatological and ophthalmic problem. Preparations for daily cleaning of eyes and the surrounding area (gels, soaked wipes) contain mainly tea tree oil or terpinen-4-ol. To date, the use of other essential oils supporting the fight against demodicosis is limited due to insufficient number of clinical trials. The aim of this review is to present the most commonly used medicinal plants and their active ingredients used in the treatment of infestation with *Demodex folliculorum* and *Demodex brevis*, with particular emphasis on tea tree oil. PubMed, Embase and Google Scholar databases were searched for the selection of scientific literature. **(JNNN 2020;9(4):160–165)**
Key Words: *Demodex brevis*, *Demodex folliculorum*, essential oil, parasitic disease, tea tree oil

Streszczenie

Zarażenie pajęczakiem z rodzaju *Demodex* stanowi coraz częstszy problem dermatologiczny i okulistyczny. Preparaty przeznaczone do codziennego oczyszczania oczu i ich okolic (żele, nasączone chusteczki) zawierają przede wszystkim, olejek eteryczny z drzewa herbacianego lub terpinen-4-ol. Do tej pory stosowanie innych olejków eterycznych wspomagających walkę z nużycą jest ograniczone, co wynika to z niewystarczającej liczby badań klinicznych. Celem tego artykułu przeglądowego jest przedstawienie roślin leczniczych, i ich składników aktywnych, które działają skutecznie na *Demodex folliculorum* oraz *Demodex brevis*. Selekcję piśmiennictwa oparto na bazach: PubMed, Embase i Google Scholar. **(PNN 2020;9(4):160–165)**
Słowa kluczowe: *Demodex brevis*, *Demodex folliculorum*, olejki eteryczne, choroby pasożytnicze, olejek drzewa herbacianego

Introduction

Demodex spp. are small arthropods, arachnids of the mite order, which live in the hair follicles and sebaceous glands of humans and animals. *Demodex* spp. was discovered by Henle in 1841 and then classified by Simón in 1842 [1]. Of the more than 100 species, only two are found in humans: *Demodex folliculorum* and *Demodex brevis*. Rabensteiner and Nicholls et al. [2,3] indicate in their studies that approximately 40% of patients with ocular discomfort were also infested with *Demodex* spp. In these photophobic mites, the life cycle lasts about a dozen days and consists of five life stages. The nourishment of all developmental stages of *Demodex* mites are epidermal cells and sebum components, therefore they live in the skin areas particularly rich in sebaceous glands, i.e. the base of the nostrils, hair follicle, the area around the mouth and eyes, cheeks, forehead and chin. They are also found in the external auditory canal and nasolabial furrow [4]. *Demodex folliculorum* and *D. brevis* are found in both women and men and the number of *Demodex* spp. increases with age [5]. These mites are transmitted through direct contact (contact with the skin of an infected person or animal) and indirect contact (towels, cosmetics, dust). The medical significance of demodicosis remains debatable,

because in some people the presence of these mites does not cause any clinical symptoms. *Demodex* spp. are an etiological factor of demodicosis, a skin disease occurring both in humans and animals [6]. *Demodex* spp. may have a direct role in pityriasis folliculorum, perioral/periorbital dermatitis-like demodicosis, rosacea, seborrheic dermatitis, pustular eruption, blepharitis and the dermotosis, which persists and shows a resistance to classical therapies. A ophthalmological study indicated that *Demodex* mites may be a potential cause of recurrent and refractory chalazia. Generally the *Demodex* mites are the most frequently encountered parasites in patients with blepharitis. *Demodex* blepharitis can be divided anatomically into anterior and posterior blepharitis. The former refers to infestation of eyelashes and follicles by *D. folliculorum*, clustering to the root of the lashes, whereas the latter involves infestation of the meibomian gland preferentially by *D. brevis* [7]. They cause inflammation or allergic reactions, mainly of the facial skin, caused by direct damage, mechanical blockage of the Meibomian glands as a result of contact with the parasite's faecesand damage to the skin barrier of the follicles by the mite's claws and mouthpiece [8]. Local symptoms may also be related to irritation caused by one of the building blocks of *Demodex* spp. — chitin. The chitin exoskeleton activates the cells of the immune response, including keratinocytes, which are capable of producing immunomodulatory cytokines. The level of tear cytokines increases, especially interleukin 1β (IL-1β) and interleukin 17 (IL-17), which may cause inflammation of the eyelid margin and the surface of the eye [9]. Therefore, the ocular form of demodicosis is manifested by eyelid margin inflammation and conjunctivitis [10]. *Demodex* spp. may participate in the pathogenesis of the floppy eyelid syndrome (FES) [10]. There have also been reports of corneal lesions in patients with blepharitis caused by *Demodex* spp. [10]. The presence of *Demodex* spp. may also be a factor predisposing to the development of basal cell carcinoma of the eyelid skin [10]. *Demodex* spp. is characterized by high resistance to antibacterial, anti-inflammatory and combined preparations used in ophthalmology [8]. There is currently no standard treatment for ocular demodicosis, and there is no Food and Drug Administration (FDA) approved treatment regimen. Recommended for local treatment include: ointment based on metronidazole, to be used twice a day for several months [10]. Moreover, good therapeutic effects are observed after the use of erythromycin ointment or a 10% methylocrotonotoluidine solution [6]. Ivermectin, which fights both internal and external parasites, is often used in combination with metronidazole, may be useful in treating *Demodex* spp. infestation [10]. Infectoscab (5% permethrin) can be used to cure demodicosis presence on the skin, and its effect is comparable to that of an ointment containing metronidazole [10]. In recent years, attempts have been made to use a number of different drugs in the therapy of demodicosis, including: ointments containing mercury oxide (such as Ophtergine, Oxyde De Mercure Chauvin, Pommade Maurice), sulfacetamide, choline esterase inhibitors, sulfur ointment, crotamiton, permethrin. Unfortunately, in the case of none of the above preparations, the effectiveness was not proven, but numerous side effects were observed [6,10]. Systemic treatment consists in administering orally tetracycline, doxycycline or minocycline, which disrupt bacterial energy processes and inhibit protein synthesis [6].

The aim of this review is to present the most commonly used medicinal plants and their active ingredients used in the treatment of infestation with *Demodex folliculorum* and *Demodex brevis*, with particular emphasis on tea tree oil.

Essential Oils and Demodicosis

Washing the face with soap and water does not reduce the intensity of the invasion, therefore it is recommended to use additional preparations for facial skin hygiene containing essential oils or their active compounds, e.g. terpenes, which show acaricidal activity [6,8]. Washing and cleaning preparations in the form of soaps, shampoos, or specially produced wipes for daily care are recommended, in conjunction with possible warming and massage of the eyelids [8,11]. Cleansing treatments combining the methods used in ophthalmic and cosmetic offices and daily hygiene at home significantly increase the effectiveness of the therapy. Tea Tree Oil (TTO) is obtained from the *Melaleuca alternifolia* plant, a shrub belonging to the *Myrtaceae* family. The versatile use of TTO makes it suitable for both skin care and the alleviation of various skin problems. The biologically active components of the oil include: terpinen-4-ol (T4O), γ-terpinene, α-terpinene and monoterpenes such as 1,8-cineole, *p*-cymene, terpinolene, α-pinene. T4O and 1,8-cineol are inhibitors of the neurotransmitter acetylcholinesterase, which also show acaricidal activity [9]. The healing properties of the oil are used in the treatment of changes in the ocular form of demodicosis (chronic blepharitis, conjunctivitis, marginal keratitis, meibomian gland dysfunction) [9]. Studies conducted *in vitro* and *in vivo* by Gao et al. [12] confirmed the therapeutic properties of TTO. The survival time of *Demodex folliculorum* depends on the concentration of the oil used. Study showed that the parasiticidal effect of the oil can be observed by applying a weekly eyelid peeling with 50% TTO and once a day shampoo contained TTO. What is particularly important, by performing these two cosmetic procedures at the same

time, mites that occur deep in the skin are also kill. Other studies conducted by Gao et al. [13] tested the effect of ointments containing 5% TTO in patients with demodicosis. Researchers have shown that daily eyelid massage with the use of this ointment significantly reduces eyelid itching and eradication of *Demodex*. Liu et al. [7] and Maher [14] confirmed the potential of using tea tree extract in the treatment of demodicosis. TTO is very effective in a group of patients with lid margin disease in relieving symptoms and improving tear film stability [14]. After applying the oil, the effect of cleaning the hair follicles of the lash roots by forcing the mites to go outside is observed [7]. The antiparasitic activity of TTO is related to its lipolytic activity, which causes drying of mites and their eggs [9]. 50% TTO causes direct death of parasites, and the ointment containing 5% of the oil inhibits the multiplication of demodicosis. For the treatment to be effective, it is necessary to completely cover the base of the eyelashes with a TTO-based preparation [6]. In addition, this oil also has antibacterial, antifungal and anti-inflammatory properties [9,14]. Various cosmetic products, i.e. shampoos, foams, sprays, gels, ointments, may contain TTO of different concentrations (1%, 2%, 4%, 5%, 7.5%, 10%, 50%) [4,11]. Attention is also paid to the correct performance of the hygiene procedure. Proper use of wipes includes washing eyelashes, forehead, eyebrows and cheek skin [8]. TTO, especially in higher concentrations, can cause contact dermatitis, allergy and eye irritation, especially in patients with sensitive skin. In the case of using preparations containing higher concentrations of oil, it is recommended that the hygienic procedure be performed in a doctor's or cosmetic office. Complications are related to the skin reaction to the organic compounds found in the oil, including α-terpinene, terpene oxide — ascaridol, *p*-cymene, terpinolene and 1,2,4-trihydroxymethane [15,16]. Prolonged storage of TTO increases the content of some chemical compounds, e.g. *p*-cymene [16]. For home use, commercially available tea tree oil could be diluted with macadamia or walnut oil. Diluting the oil reduces the risk of a burning sensation and lowers its toxicity, while maintaining parasiticidal properties [8]. Due to the side effects that may occur after the use of tea tree oil, auxiliary substances with activity against mites are sought. Tighe et al. [16] examined the effect of active compounds contained in the oil, such as T4O, α-terpineol, 1,8-cineol, sabinene, limonene, terpinolene, α-terpinene, viridifloren, γ-terpinene, *p*-cymene, ledene, aromadendren and α-pinene for the survival of *Demodex* spp. T4O has proven to be the most effective parasiticide. It was observed that 1% of T4O was the only one of the biologically active TTO compounds to show anti-*Demodex* activity. T4O has anti-inflammatory and immunomodulatory properties [16]. T4O reduces the production of pro-inflammatory cytokines such as IL-1β and IL-17 [9]. In the available literature, in the therapy aimed at effectively reducing the number of demodic mites, preparations containing 38% T4O were used, as well as tissues containing 2.5 or 4% T4O [17,18]. The use of 2% T4O does not irritate the eyes and skin, and in addition, this compound in such a low concentration still shows activity against bacteria, fungi, amoebas and parasites living on the eyelids [19]. There are Cliradex (Bio-Tissue) wipes available on the market, recommended for regular cleaning of the edges of the eyelids and eyelashes, in the case of mild or moderate demodecosis, containing 4 or 10% T4O, and preparations containing 50% T4O [15,17]. Cheung et al. [20] in an *in vitro* study compared the anti-demodicosis effect of four agents used for cleaning the eyelids: Cliradex (Bio-Tissue), Blephadex, Oust Demodex and SteriLid (Theratears). Clidarex as the only one of the above-mentioned preparations showed antiparasitic activity comparable to the activity of 50% of TTO. So far, there is no information in the available literature about the resistance of mites to TTO or T4O [9]. 100% caraway oil (*Oleum carvi*) and 100% dill weed oil (*Oleum anethi*) have been used to reduce the *Demodex* mite population [21]. Sędzikowska et al. [22,23] determined the survival time of *Demodex* spp. in oils of: tea tree, sea buckthorn, aloe, sage, mint, camphor, eucalyptus, lavender and fennel. Scientists have hypothesized that it is most likely terpenes, which are found in essential oils, that reduce the viability of parasites. It should be emphasized that not each of the above-mentioned essential oils was active against *Demodex* spp. According to the research described, it was found that apart from TTO, chia (*Spanish hispanica*) and mint (*Mentha piperita*) oils are effective substances in the treatment of demodicosis. The scientific literature also indicates that sea buckthorn oil (*Hippophae rhamnoides*) supports the treatment of *Demodex folliculorum* infestation [24]. Sędzikowska et al. [23] observed also that the mites survived longer in 1% sage oil with paraffin (135 hours) than in 1% sage oil with triglycerides (80 hours). The authors suggested that the ointment for patients with demodicosis should contain appropriate auxiliary substances. Sage (*Salvia L.*) is known as an herb used in eye diseases, so it can be useful instad of tea tree oil as a hygiene aid in the treatment of demodicosis. It is recommended to use a lotion based on essential oils of chia and aloe vera extract to rinse the eyelids twice a day, and the gel in the evening for two weeks. The treatment should be repeated after 14 days. Studies described by Krajewska et al. [25] have shown that these preparations reduce the *Demodex* spp. population, alleviate subjective and objective symptoms of eyelid margin inflammation and are well tolerated by patients. Liu et al. [26] investigated the effect of clove oil (*Oleum Caryophyllorum*), orange fruit (*Oleum*

Aurantii), ginger oil (*Oleum Zingiberis*), cinnamon bark (*Oleum Cinnamomi*), medicinal alpine rhizome (*Rhizoma Alpiniae officinarum*) and prickly pear peel (*Oleum Opuntia*) on the survival rate of *Demodex* spp. The authors showed that all six types of volatile oils killed *D. folliculorum* and *D. brevis* within 30 minutes *in vitro*. In addition, the mite survival rate in the oils was lower than that of cosmetic product Xin Fumanling Shandong Jiankang Pharmaceutical Co., Ltd. (Jinan, China). This cream is recommended for removing *Demodex* spp. and reducing inflammation, it also stops itching and improves the condition of the skin. Its purpose is to prevent the spread of demodicosis and the emergence of clinical symptoms of demodicosis. Its composition includes Bai Bu stemony root (*Radix stemonae*), *Cnidiummonnieri* seeds, bristle turnip (*Agrimonia pilosa*) and chinese carnation (*Dianthus chinensis*). Assessment of the skin irritation potential of oils is of great importance to the pharmaceutical and cosmetic industry, so researchers also performed an *in vivo* skin irritation assessment in rabbits. Based on the results of the irritation test, it was found that the oils obtained from wild Manujurian ginger, cinnamon bark, prickly pear peel and clove did not irritate intact skin. Summing up, the authors concluded that the most effective and safe in the fight against *Demodex* spp. is clove essential oil. A preparation for the treatment of demodecosis containing a composition of three essential oils: rocket seeds (*Eruca sativa*), alpine medicinal (*Alpinia officinarum*) and ginger (*Zingiber officinale*) were patented by Bermejo et al. [27]. Cetiol V (decyl oleate) was used to dilute the oils. Cetiol V has moisturizing properties, facilitates the penetration and introduction of oils into the epidermis. The percentages of the oils exhibiting anticidal activity were: 0.25–12.5% for arugula oil, 0.25–12.5% for alpine oil, and 0.25–1% for ginger oil. Additionally, researchers have shown that the above concentrations of oils do not irritate the eyes. The most frequently mentioned preparations with anti-mite effect include plant extracts obtained from the root of the angelica (*Archangelicae radix*), yarrow herb (*Millefoliiherba*), willow bark (*Salicis cortex*), aloe (*Aloë L.*), calamus (*Acorus calamus*), and celandine herb (*Chelidonium maius*) [6]. Extract from the leaves of persimmon (*Diospyros kaki*), japanese knotweed (*Polygonum Cuspidatum*) and japanese chestnut (*Castanea crenata*) allows to reduce excess sebum from the skin, which may facilitate the removal of *Demodex* spp. [28]. The acaricidal activity is also shown by mugwort argyi (*Artemisia argyi*), wintersweet (*Chimonanthus praecox*) and korean mint (*Agastache rugosa*) [18]. Essential oils obtained from various plant materials are widely used for therapeutic purposes and can be considered potential therapeutic and prophylactic agents. According to the latest research, the substances contained in some essential oils of plant origin are effective in the treatment of demodicosis (Table 1). Therefore, the use of substances contained in essential oils should be the subject of further research not only *in vitro*, but also *in vivo*. It is worth adding that the effectiveness of preparations of plant origin that do not contain essential oils is also assessed. As an example, studies involving the antiparasitic evaluation of manuka honey produced from the pollen of the flowers of the manuka shrub (Leptospermum scoparium). Its main active ingredient is methylglyoxal (MGO). Frame et al. [29] compared the anti-degenerative effect of MGO in combination with alpha-cyclodextrin (a natural mixture of cyclic glucose oligomers made from starch) in relation to the effect of 50% TTO in an *in vitro* study. Scientists concluded that MGO in complex with alpha-cyclodextrin exhibits comparable acaricidal activity to 50% of TTO. Topical application of the eye cream with MGO microemulsion alleviates the symptoms of the eye surface, ensures the stability of the tear film and the appropriate thickness of the lipid layer. This cream can be used to treat blepharitis [30].

Table 1. Volatile oils showing significant anti-*Demodex* activity

References	Natural essential oil	Plant (raw material)	Selected additional the biological properties
[27,31]	Galangal oil	*Alpinia officinarum* (horizontal rhizome)	Antimicrobial activity, antifungal activity, antiviral activity, anti-inflammatory activity, antiallergic activity.
[27,32]	Ginger oil	*Zingiber officinale* (rhizome)	Antimicrobial activity, antifungal activity, anti-inflammatory activity, analgesic.
[22,33]	Peppermint oil	*Mentha piperita* (leaves)	Antimicrobial activity, antiviral activity, anti-inflammatory activity, antiallergic activity.
[27,34]	Rocket oil	*Eruca sativa Mill* (leaves and young stems)	Treatment of acne on the face (antimicrobial activity), antifungal activity, anti-inflammatory activity, analgesic.
[22,35]	Salvia oil	*Salvia hispanica* (stem and leaves)	Antimicrobial activity, antifungal activity, antiviral activity, anti-inflammatory activity, antiseptic.
[14,16]	Tea tree oil	*Melaleuca alternifolia* (leaves and terminal branches)	Antimicrobial activity, antifungal activity, anti-inflammatory activity.

Conclusions

It should be emphasized that a key role in the treatment of demodicosis is played by diligent and constant eyelid hygiene. The basic element in the prevention of *Demodex* spp. invasion is the use of ophthalmic liquids, gels, or wipes soaked in the active substance. Preparations recommended for daily eyelid and face hygiene are still sought, which do not cause side effects, and also have a moisturizing, soothing and cleansing effect on the skin and can be recommended as a makeup remover. Without proper hygiene, inflammation can spread to the conjunctiva, causing a condition known as blepharitis and conjunctivitis. Demodicosis is a chronic disease that requires not only long-term therapy, but also basic hygiene rules, like using high temperature for washing and drying bedding, avoiding oily cleaning agents, and periodic exfoliation of the epidermis. For the most popular products for its effectivess against Demodex spp. are TTO and some of its components.

Implications for Nursing Practice

The nursing team should also know the individual medicinal plants and their active ingredients that are effective against many diseases. However, there are too few clinical trials on medicinal plants. Thus, medical staff should conduct more study on this topic.

References

[1] Moris García V., Valenzuela Vargas G., Marín Cornuy M., Aguila Torres P. Ocular demodicosis: A review. *Arch Soc Esp Oftalmol*. 2019;94(7):316–322.

[2] Rabensteiner D.F., Aminfar H., Boldin I. Demodex Mite Infestation and its Associations with Tear Film and Ocular Surface Parameters in Patients with Ocular Discomfort. *Am J Ophthalmol*. 2019;204:7–12.

[3] Nicholls S.G., Oakley C.L., Tan A., Vote B.J. Demodex species in human ocular disease: new clinicopathological aspects. *Int Ophthalmol*. 2017;37(1):303–312.

[4] Karakurt Y., Zeytun E. Evaluation of the Efficacy of Tea Tree Oil On the Density of Demodex Mites (Acari: Demodicidae) and Ocular Symptoms In Patients With Demodectic Blepharitis. *J Parasitol*. 2018;104(5):473–478.

[5] Zhong J., Tan Y., Li S. et al. The Prevalence of *Demodex folliculorum* and *Demodex brevis* in Cylindrical Dandruff Patients. *J Ophthalmol*. 2019;2019:8949683.

[6] Kaźmierczak A., Wcisło-Dziadecka D., Grabarek B., Jasik K. Demodicosis or real aspect of demodex mites. *Pol J Cosmetol*. 2017;20(2):133–137.

[7] Liu J., Sheha H., Tseng S.C. Pathogenic role of Demodex mites in blepharitis. *Curr Opin Allergy Clin Immunol*. 2010;10(5):505–510.

[8] Lacey N., Russell-Hallinan A., Powell F.C. Study of Demodex mites: Challenges and Solutions. *J Eur Acad Dermatol Venereol*. 2016;30(5):764–775.

[9] Lam N.S.K., Long X.X., Griffin R.C., Chen M.K., Doery J.C. Can the tea tree oil (Australian native plant: Melaleuca alternifolia Cheel) be an alternative treatment for human demodicosis on skin? *Parasitology*. 2018; 145(12):1510–1520.

[10] Sędzikowska A. Demodicosis — pathophysiology, treatment and therapeutic efficacy of metronidazole ointment and mercury oxide ointment. *Ophtha Therapy*. 2014;1(2):108–113.

[11] Bitton E., Ngo W., Dupont P. Eyelid hygiene products: A scoping review. *Cont Lens Anterior Eye*. 2019;42(6):591–597.

[12] Gao Y.Y., Di Pascuale M.A., Li W. et al. In vitro and in vivo killing of ocular Demodex by tea tree oil. *Br J Ophthalmol*. 2005;89(11):1468–1473.

[13] Gao Y.Y., Xu D.L., Huang L.J., Wang R., Tseng S.C. Treatment of ocular itching associated with ocular demodicosis by 5% tea tree oil ointment. *Cornea*. 2012; 31(1):14–17.

[14] Maher T.N. The use of tea tree oil in treating blepharitis and meibomian gland dysfunction. *Oman J Ophthalmol*. 2018;11(1):11–15.

[15] Messaoud R., El Fekih L., Mahmoud A. et al. Improvement in ocular symptoms and signs in patients with *Demodex* anterior blepharitis using a novel terpinen-4-ol (2.5%) and hyaluronic acid (0.2%) cleansing wipe. *Clin Ophthalmol*. 2019;13:1043–1054.

[16] Tighe S., Gao Y.Y., Tseng S.C. Terpinen-4-ol is the Most Active Ingredient of Tea Tree Oil to Kill *Demodex* Mites. *Transl Vis Sci Technol*. 2013;2(7):2.

[17] Kabat A.G. In vitro demodicidal activity of commercial lid hygiene products. *Clin Ophthalmol*. 2019;13:1493–1497.

[18] Yi-Ning P., Ying Z., Ru-Juan Z. et al. Effects of five Chinese herbs on human demodicid mites *in vitro*. *Zhongguo Xue Xi Chong Bing Fang Zhi Za Zhi*. 2018; 31(3):301–304.

[19] Su C.W., Tighe S., Sheha H., Cheng A.M.S., Tseng S.C.G. Safety and efficacy of 4-terpineol against microorganisms associated with blepharitis and common ocular diseases. *BMJ Open Ophthalmol*. 2018;3(1):e000094.

[20] Cheung I.M.Y., Xue A.L., Kim A., Ammundsen K., Wang M.T.M. Craig J.P. In vitro anti-demodectic effects and terpinen-4-ol content of commercial eyelid cleansers. *Cont Lens Anterior Eye*. 2018;41(6):513–517.

[21] Lacey N., Russell-Hallinan A., Powell F.C. Study of Demodex mites: Challenges and Solutions. *J Eur Acad Dermatol Venereol*. 2016;30(5):764–775.

[22] Sędzikowska A., Osęka M., Grytner-Zięcina B., Roman B., Jaremko E. Effect of Metronidazol, Mercury Oxide and Essentials Oils on the *in vitro* Survivability of Demodex Mites. *Okulistyka*. 2014;4:64–66.

[23] Sędzikowska A., Osęka M., Roman B., Jaremko E. Impact of Salvia and Peppermint Oil on the *In Vitro* Survival of *Demodex* Mites. *J Bacteriol Parasitol*. 2015;6(3):1–2.

[24] Bal L.M., Meda V., Naik S.N., Satya S. Sea buckthorn berries: A potential source of valuable nutrients for

nutraceuticals and cosmoceuticals. *Food Res Int*. 2011;44(7):1718–1727.
[25] Krajewska M., Wasyluk J., Osęka M., Sędzikowska A., Roman B., Jaremko E. Evaluation of Demoxoft Lipogel and Demoxoft Liquid efficacy and safety in patients with Demodex blepharitis. *Invest Ophthalmol Vis Sci*. 2014; 55(13):9–11.
[26] Liu J.X., Sun Y.H., Li C.P. Volatile oils of Chinese crude medicines exhibit antiparasitic activity against human *Demodex* with no adverse effects *in vivo*. *Exp Ther Med*. 2015;9(4):1304–1308.
[27] Egea Bermejo E., Garavito De Egea G., Abello Llanos R. et al. Compositions for Treating Infections Caused by the Mite *Demodex Spp*. WIPO IP PORTAL. Publication Number WO/2016/108070.
[28] Kashif M., Akhtar N., Mustafa R. An overview of dermatological and cosmeceutical benefits of *Diospyros kaki* and its phytoconstituents. *Rev Bras Farmacogn*. 2017;27(5):650–662.
[29] Frame K., Cheung I.M.Y., Wang M.T.M., Turnbull P.R., Watters G.A., Craig J.P. Comparing the in vitro effects of MGO™ Manuka honey and tea tree oil on ocular Demodex viability. *Cont Lens Anterior Eye*. 2018;41(6): 527–530.
[30] Craig J.P., Cruzat A., Cheung I.M.Y., Watters G.A., Wang M.T.M. Randomized masked trial of the clinical efficacy of MGO Manuka Honey microemulsion eye cream for the treatment of blepharitis. *Ocul Surf*. 2020;18(1):170–177.
[31] Subramanian P., Nishan M. Biological Activities of Greater galangal, *Alpinia galanga* — A Review. *Res Rev J Bot Sci*. 2015;(Phytopathology/Genes & Diseases-S1): 15–19.
[32] Mahboubi M. *Zingiber officinale* Rosc. essential oil, a review on its composition and bioactivity. *Clin Phytoscience*. 2019;5(6):1–12.
[33] Trevisan S.C.C., Menezes A.P.P., Barbalho S.M., Guiguer É.L. Properties of Mentha Piperita: a Brief Review. *World J Pharm Med Res*. 2017;3(1):309–313.
[34] Marwat S.K., Rehman F., Khan A.A. Phytochemistry and Pharmacological Values of Rocket (*Eruca sativa* Miller) — A Review. *Int J Hortic*. 2016;6(21):1–7.
[35] Yadav A., Joshi A., Kothari S.L., Kachhwaha S., Purohit S. Medicinal, Nutritional and Industrial Applications of *Salvia* species: A Revisit. *Int J Pharm Sci Rev Res*. 2017; 43(2):27–37.

Corresponding Author:
Jarosław Nuszkiewicz
Department of Medical Biology and Biochemistry,
Faculty of Medicine,
The Ludwik Rydygier Collegium Medicum in Bydgoszcz,
The Nicolaus Copernicus University in Toruń, Poland
Łukasiewicza 1 street, 85-821 Bydgoszcz, Poland
e-mail: jnuszkiewicz@cm.umk.pl

Conflict of Interest: None
Funding: None
Author Contributions: Joanna Wróblewska[A–C, E, F, H], Jarosław Nuszkiewicz[B, C, E, F, H, J], Marcin Wróblewski[A, B, E, F, H], Alina Woźniak[A, C, G, H]
(A — Concept and design of research, B — Collection and/or compilation of data, C — Analysis and interpretation of data, E — Writing an article, F — Search of the literature, G — Critical article analysis, H — Approval of the final version of the article, J — Translation)
Received: 28.10.2020
Accepted: 1.12.2020