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REVIEW PAPER

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DIFFERENT VARIATIONS OF USING ESSENTIAL OILS IN SEVERAL ANIMAL SPECIES: TREATMENT AND SUPPLEMENTATION

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ABSTRACT

Due to the abuse of antimicrobial agents, microorganisms are increasingly showing resistance to antibiotics, which is a problem not only from a medical point of view but also from an economical perspective. Microbes acquire the ability to develop resistance to antibiotics, which puts the effectiveness of therapy in question. Therefore, there was an increased interest in substances found in plants, showing strong antimicrobial activity [Król et al. 2013, Lima et al. 2013, Różański and Drymel 2009, Grzesiak et al. 2018]. An effective natural alternative are essential oils. These natural plant extracts find their application in medicine, cosmetology, food industry [Herman and Herman 2015, Kaniewski et al. 2016] and in animal nutrition [Radkowska 2013]. In addition to the effect of better feed utilization, essential oils are also useful in the treatment and prevention in various animal species [Crowell 1999].

Key words: essential oils, veterinary medicine, animal treatment, nutrition and supplementation in animals

INTRODUCTION

Over the years, there has been significant progress in medicine and pharmacy. Most treatment methods are based on antibiotics, which is not always effective and can sometimes be harmful or cause side effects. Due to the abuse of antimicrobial agents, microorganisms are increasingly showing resistance to antibiotics, which is a problem not only from a medical point of view but also from an economical perspective. This can result in less effective treatment and go even up to morbidity and mortality due to infections. Therefore, there was an increased interest in substances found in plants, showing strong antimicrobial activity (exhibiting antibacterial properties) [Sibanda and Okoh 2007, Król et al. 2013, Lima et al. 2013, Herman and Herman 2015], which are important when it comes to animal health [Różański and Drymel 2009, Grzesiak et al. 2018]. According to Chouhan [2017], these natural compounds are available at reasonable prices and yet are very effective therapeutics used in the prevention and treatment of many diseases, including those caused by antibiotic resistant strains. A number of undesirable side effects and the frequently questionable effectiveness of conventional treatment methods have resulted in an enhanced interest in natural remedies, which include essential oils. These natural plant extracts find their application in medicine, cosmetology as well as in the food industry [Herman and Herman 2015, Kaniewski et al. 2016, Pateiro et al. 2018]. Due to the search of natural alternatives the composition and percentage content of individual components could be determined. Particular attention is paid to the impact of different oils on various micro-organisms, how they affect each other but also how they work in combination with other antimicrobial compounds and to what extent the interaction between them and the animal organism occurs. Increased chemical stability of oils and their relatively high solubility allows for the destruction of multi-drug resistant pathogens [Adaszyńska et al. 2013]. Modern science, using special methods and research techniques allowed the use of oils in the form of capsules, thanks to which controlled and sustained release is possible. This enhances their effectiveness and bioavailability [Adamiec and Kalemba 2007]. The main advantage of essential oils is their wide spectrum of activity, including insecticidal, antioxidant, antiseptic, antifungal, antiparasitic, antiviral and antibacterial [Kaloustian et al. 2008]. Due to the fact that they have an extensive composition, they can inhibit

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the deepening bacterial resistance [Benjilali et al. 1986, Burt 2004, Stefanakis et al. 2013].

There are more than 1,700 plants producing essential oils, which are located in various plant organs, such as buds, flowers, leaves, stems, roots, rhizomes, bark, fruits, onions and seeds [Kaniewski et al. 2016]. They are mainly obtained in the process of steam distillation by pressing or macerating them with fats. Methodology based on water vapor has been known since the Middle Ages and is still the most frequently used method. [Bansod and Rai 2008]. These substances can be volatile, liquid, usually soluble in fats and dyes. They are mostly transparent. They contain a mixture of highly complex substances, comprise from 20 to even 60 different components of different concentrations. Most of the essential oils contained 2–3 main components (at concentrations of about 20–70% of the total), where the rest of the components were found in trace amounts [Wolski et al. 2004]. Components of essential oils are usually chemical derivatives of terpenes and their oxidized derivatives, such as terpenoids, which are esters of aromatic and aliphatic acids as well as phenolic compounds [Król et al. 2013]. Due to their hydrophobicity, essential oils are permeable through the bacterial cell membrane, which causes the death of the bacterial cell due to the leakage of critical particles and ions [Devi et al. 2010].

The World Health Organization (WHO) has included essential oils on the list of safe substances. Some of the substances that are included in the oils have been approved for use as antibacterial additives [Stefanakis et al. 2013]. A number of studies have been conducted on the effectiveness of selected essential oils in various groups of diseases in animals. The positive effects of selected oils in supplementation and animal nutrition have also been described.

ANIMAL NUTRITION

In 2006 The European Union has prohibited the use of antibiotics in animal nutrition [Anadon 2006]. The abuse of growth stimulants in animal feeds resulted in an increased drug resistance, which negatively affected animal health [Hołdernia-Kędzia et al. 2006]. The studies conducted by Radkowska [2013] describe the action of essential oils in herbs used as feed additives in livestock nutrition (eg, marjoram and peppermint extracts). Plant mixtures stimulated the metabolism, counteracted inflammation of the gastrointestinal tract, acted anti-diarrhea, anti-inflammatory, anti-parasitic and anti-pyretic. In the nutrition and supplementation certain parts or even whole plants can be used in fresh and dried form, in the form of infusions, decoctions, extracts, macerates and just essential oils. The effects of these preparations consisted in regulating digestive processes, assist the secretion of digestive enzymes and bile [Jamroż et al. 2005]. The properties of feed are changed which led to improvement of the product. Compounds based on herbs inhibited the development of pathogenic microorganisms, stimulated the immune and reproductive systems, stimulated blood circulation, inhibited inflammation and promoted the renewal of epithelia and villi [Różański and Drymel 2009]. Studies conducted by Lee et al. [2003] and Jang et al. [2004] showed an increase activity of trypsin and amylase under the influence of essential oils, being an addition to broiler fodder. 200 mg $\cdot$ kg^{-1} carvacrol or thymol feed was added to the diet of chicken broilers. In the case of carvacrol, a significant incresing body mass could be observed, consumption and feed use were given in an controlled enviroment, but they did not notice any significant effects of thymol on the birds. In other studies, the addition of 60 mg thymol oil (per kilogram of feed), rich in carvacrol, increased growth, improved feed intake and reduced the fat in the quail [Denli et al. 2004]. Similar studies have been carried out by Bölükbaşi et al. [2008] showed that adding thymus vulgaris, sage (*Salvia sclarea*) and rosemary (*Rosmarinus officinalis*) to the feed of laying hens contributes to better feed utilization and higher egg weight. However, Florou-Paneri et al. [2005] did not notice what a positive effect the supplementation of the laying hens diet with oregano oil had on the mass of the eggs, the consumption and use of feed.

Research on the positive effects of natural feed additives has also been carried out on pigs. Peris and Asensio [2002] state that the use of a mixture containing propionic, formic and lactic acids as well as essential oils extracted, for example, from lemon and rue, gave a 10% improvement in growth of the piglets and an 8% improvement in feed utilization. Namkung et al. 2004 described the effect of herbal extracts containing essential oils from cinnamon, thyme and oregano, on the yield increase, intestinal microflora and digestive functions in newly established piglets. Animals supplemented with herbal extracts in their 3rd week of life showed an increased body weight compared to those fed with antibiotic supplement. There was a reduction of the proliferation of bacteria from the Coli group (14 days after weaning). Lan and Kim [2018] reported the effect of the diet with the addition of essential oils (EO) and betaine on the efficiency of the growth, digestibility of nutrients and serum hormone levels in pigs under conditions of heat stress. At week 12 and 18, the EO diet reduced serum cortisol and norepinephrine levels. At week 18, the EO and betaine diet reduced the concentration of epinephrine. It has been established that the addition of essential oils can be a potential feeding strategy to alleviate heat stress in pigs. Better digestibility of nutrients and relatively higher weight gains were determined. Research on the improvement of digestibility under the influence of natural feed additives has also

been carried out on dairy cattle. It has been proven that carwone (a component of essential oil) obtained from the above-ground portion of caraway carnass (*Carum carvi*) increases appetite, improves the milkiness of animals and prevents bloating and colic. In turn, the leaves of yarrow (*Achillea millefolim*, yarrow), namely azulen, proazulen, cham- azulen (components of essential oil), stimulate the digestive system, eliminating flatulence and constipation and removes toxins. Essential oils extracted from burnet (*Sanguisorba officinalis*, great burnet), increase appetite, stimulate milk production and stimulate metabolism. The oil obtained from common dandelion (*Taraxacum officinale*, common dandelion) affects metabolism regenerating the liver and increases the production of bile [Tipu et al. 2006, Kryszak 2007, Verma and Singh 2008, Frankič et al. 2009, Grela and Kowalczuk-Vasilev 2010].

Essential oils can also affect fermentation in the rumen, but also modulate the absorption of cations such as Na^+, Ca^{2+} and NH^{4+} through the rumen epithelium in cattle and sheep, through direct interaction with epithelial transport proteins. The influence of essential oils on the transport of various ions through the gastrointestinal epithelium was noticed not only in human and rat colon [Kaji et al. 2011], but also in the rumen epithelium in cattle and sheep [Rosendahl et al. 2016]. Research on this issue was also carried out by Braun et al. [2018]. The aim was to study the effect of a blend of essential oils (BTX12; PerformaNat GmbH, Berlin, Germany, patent US9693971) on the cation status and feed efficiency in dairy cows during lactation. Feeding animals with fodder with additions of essential oils increased milk yield, milk fat and protein yield as well as feed efficiency, while plasma and milk urea levels decreased. In addition, plasma calcium levels increased significantly after supplementation, confirming the hypothesis that increased absorption of cations may contribute to beneficial effects.

TREATMENT

In addition to the effect of better feed efficiency, essential oils can also be used in the treatment and prophylaxis in various animal species. Crowell [1999] in his research reports that essential oils contained in plants can inhibit the activity of the hepatic enzyme (HMG reductase – CoA), thereby regulating the amount of cholesterol synthesized, reducing its level in the blood. Bölükbaşi et al. [2008] report that chemical compounds contained in essential oils, such as citral, geraniol, cineol, borneol, menton, menthol, fenchon, fenchyl, may inhibit HMGCoA reductase activity. Bölükbaşi et al. [2007] and Yap et al. [2014] report that the 300mg / kg thymol oil feed supplement reduced cholesterol and triglyceride levels in laying hens. Also Bölükbaşi et al. [2008] found a fall in the level of cholesterol and triglycerides in the blood of laying hens fed with 200 mg $\cdot$ kg^{-1} oil of thyme, sage and rosemary. The effect of *Zataria multiflora* (ZM) essential oil on the rate of H9N2 virus replication in broiler target organs was also investigated. Groups that received oils before or after H9N2 challenge and amantadine-treated group showed reduced viral replication in the airways and gastrointestinal tract as compared to the control. The results showed that oil supplementation had a positive effect on reducing viral replication both in the gut and trachea of broiler chickens infected with H9N2 influenza, resulting in milder clinical symptoms and better results [Shayeganmehr et al. 2018].

Essential oils also have a positive effect on combating parasitic, viral, bacterial and fungal infections. The studies evaluated the effect of essential oils obtained from *Thymus vulgaris* L. (thyme thyme), Origanum vulgare L. (St. marjoram, oregano], *Origanum majeran* L. (marjoram marjoram), *Mentha piperita* L. (peppermint) and *Allium ursinum* L. (bear garlic) for *Prototheca zopfii* strains causing udder inflammation (mastitis) in cows. The tests were carried out on ten strains derived from milk samples. All strains were sensitive to essential oils from marjoram, thyme and oregano and resistant to peppermint and garlic oils. Research shows that oils can be used as natural remedies (in preventing disease in animals) for animal prevention, especially in mastitis-affected cows. Subsequent studies on the effectiveness of essential oils were also carried out on cattle. The action of lemon oil and black pepper oil was investigated to determine how it would perform as an anit-tick substitute. Lemon essential oil caused 100% mortality of the tick (females) at the highest concentration (10%). Black pepper oil inhibited egg laying by as much as 96% depending on the concentration, suggesting that it reduces the tick's fertility [Vinturelle et al. 2017]. A study conducted on Santa Ines sheep reports that the essential oil extracted from the field cache (*Aphanes arvensis* L.) has been proved effective in fighting the parasite *Haemonchus contortus*. In the in vivo test, a single dose of the oil (200 mg $\cdot$ kg^{-1} body weight) had an efficacy of about 50% on days 1, 14 and 21 [Chagas et al. 2018]. In the studies carried out by Lima et al. [2013], the bactericidal ability of rosemary oil against 18 *S. pseudintermedius* isolates recovered from dogs with bacterial skin infection has been checked. In all tested concentrations, the oil caused a decrease in the viability of the bacterial cells after 30 minutes of exposure. Thomas et al. [2016], on the other hand, analyzed the bactericidal properties of tea tree oil in relation to the pyogenic strains of staphylococci and streptococci. Reduction of pathogen progression and accelerated wound healing were noted. In addition, the toxic properties of dominant components of oils in relation to mites were also demonstrated. The bactericidal properties of the same oil were analyzed by Fitzi et al. [2002].

It was reported that the use of a ointment (for a total of 4 weeks) containing 10% tea tree oil (Bogaskin product) inhibited the development of pathogenic microorganisms (including *S. pseudintermedius*) in 82% of the dogs examined. Ebani et al. [2017] conducted studies on the effectiveness of essential oils in the fight against otitis in dogs and cats. Nine commercial oils from: Roman chamomile (*Anthemis nobilis* L.), star anise (*Illicium verum*), lavender (*Lavandula hybrida*), litsea (*Litsea cubeba* (Lour.) Pers.), basil (*Ocimum basilicum* L.), oregano (*Origanum vulgare* L. subsp. *Hirticum*), rosemary (*Rosmarinus officinalis* L.), clary sage (*Salvia sclarea* L.) and thyme (*Thymus vulgaris* L.) were used to examine antibacterial activity. The pathogens were isolated from materials derived from the ears of dogs and cats, in particular, the analyzes were carried out on *Pseudomonas aeruginosa*, *Staphylococcus aureus*, *Staphylococcus pseudointermedius*, *Aspergillus niger*, *Aspergillus fumigatus*, *Aspergillus terreus*, *Candida albicans*, *Candida tropicalis*, *Trichosporon* sp. and *Rhodotorula* sp. Oil with oregano and oil from sage showed a higher antibacterial activity than other oils. The strains *Trichosporon* sp., *C. albicans* and *A. terreus* were insensitive to most of the oils used, while other yeast and molds showed different degrees of sensitivity. Most of the pathogens were inhibited by oregano and rosemary oil. Bacteriostatic properties of oils are also used in horses. According to Anioł-Kwiatkowska [1993] chamomile, juniper, marjoram, yarrow and thyme oil can be successfully used for yeast infection, while anise and melissa caraway oil for fungal infections. Sadowska [2003] describes the effect of anise, wormwood, brambusc and garlic oil in the fight against external parasites. Another alternative action of oils is their calming effect, eg. hop, lavender, melissa oil and their stimulating effects, eg. lovage oil, bergamot oil. These characteristics of oils can have particular importance in breeding horses.

CONCLUSIONS

Examples of the presented research results suggest that essential oils can be an alternative to conventional therapeutic methods and can be successfully used as an effective substitute for growth stimulators in animal feed. The increase in interest in natural products of plant origin has influenced a better understanding of oils, which promotes their wider use in various areas of life. The multicomponent nature of these plant extracts makes it difficult or even impossible for pathogens to develop resistance, so oils can be used in cases of ineffectiveness of other treatments. Conducting research on wider use of essential oils seems to be useful in the era of advancing technology, thanks to which we can increase the availability of oils or control their release. The great interest in essential oils, influences the emergence of an ever-larger database, favoring a wider recognition and use of these natural substitutes.

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MOŻLIWOŚCI WYKORZYSTANIA OLEJKÓW ETERYCZNYCH U RÓŻNYCH GATUNKÓW ZWIERZĄT: LECZENIE I SUPLEMENTACJA

STRESZCZENIE

Ze względu na nadużywanie leków przeciwdrobnoustrojowych, mikroorganizmy coraz częściej wykazują oporność m.in. na antybiotyki, co stanowi problem z punktu widzenia ekonomicznego oraz leczniczego. Drobnoustroje wykształcają oporność na antybiotyki co stawia skuteczność terapii pod znakiem zapytania. Zauważono wzrost zainteresowania substancjami pochodzenia roślinnego, wykazującymi silne działanie przeciwdrobnoustrojowe [Król i in. 2013; Lima et al., 2013; Różański and Drymel, 2009; Grzesiak et al. 2018]. Skuteczną naturalna alternatywą są olejki eteryczne. Te naturalne ekstrakty znajdują swoje zastosowanie w medycynie, farmacji, przemyśle spożywczym [Herman and Herman 2015; Kaniewski et al. 2016] oraz jako dodatki paszowe w żywieniu zwierząt [Radkowska 2013]. Oprócz wpływu na lepsze wykorzystanie paszy olejki eteryczne sprawdzają się również w leczeniu i profilaktyce u różnych gatunków zwierząt [Crowell 1999].

Słowa kluczowe: olejki eteryczne, medycyna weterynaryjna, leczenie zwierząt, żywienie i suplementacja zwierząt