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КИАО ЮИНЬГУИНЬ[1,2], А. КИСЕЛЕВ[1], ЛЮ ШАНГШОНГ[2]

МЕХАНИЗМ ДЕЙСТВИЯ РАСТИТЕЛЬНОГО ЭФИРНОГО МАСЛА И ЕГО ПРИМЕНЕНИЕ В ПТИЦЕВОДСТВЕ

[1]Sumy National Agricultural University of Ukraine, Sumy, Ukraine
[2]Henan Institute of Science and Technology of China, Luoyang, China

Растительные эфирные масла, извлечённые из растений в природе, обладают широким спектром биологических функций, таких как стимулирование роста животных, повышение иммунитета организма, антиоксидантная способность, улучшение кишечной флоры и т. д., и могут быть использованы в качестве хороших кормовых добавок. Данные функции вызвали интерес у специалистов. В данной статье приводятся понятие, функция и механизм действия растительных эфирных масел, а также рассматривается их применение в птицеводстве.

Ключевые слова: растительное эфирное масло, принцип действия, птица.

QIAO YINGYING[1,2], OLEKSANDR KYSELOV[1], LIU CHANGZHONG[2]

MECHANISM OF PLANT ESSENTIAL OIL AND ITS APPLICATION IN CHICKEN PRODUCTION

[1]Сумский национальный аграрный университет Украины, Сумы, Украина
[2]Хэнаньский институт науки и техники Китая, Лоян, Китай

Plant essential oils extracted from natural plants have a wide range of biological activities, such as promoting animal growth, improving body immunity, antioxidant capacity, improving intestinal flora, etc., and can be used as good feed additives. The role has aroused people's attention. This paper introduces the concept, function and mechanism of plant essential oils, and reviews the application of plant essential oils in chicken production.

Key words: plant essential oil, mechanism of action, chicken.

In recent years, the abuse of antibiotic feed additives has caused many adverse consequences, such as antibiotic residues in livestock products, increased resistance to pathogenic bacteria, reduced disease resistance of livestock and poultry, and environmental pollution of soil and water resources. Therefore, it is urgent to find antibiotic substitutes that can ensure the interests of farmers and the health of livestock and poultry, as well as the sustainable development of people and the environment. Plant essential oils have a wide range of applications in feed additives, and are considered to be a potential alternative to natural plant antibiotics and pharmaceutical growth promoters. This article reviews the concept, mechanism and application of plant essential oils in chicken production, and provides some theoretical basis for plant essential oils to become new feed additives.

1. Overview of plant essential oils

Plant essential oil is the core of plant extracts and belongs to secondary metabolites of plant origin. After being synthesized by plant organs, it is stored in glands, oil compartments, and secretory cells. Because of its relatively low molecular weight, it can be extracted from plants by distillation, liposuction, impregnation, extraction, soaking and compression [1]. Common plant essential oils include oregano oil, clove oil, tea tree oil, cinnamon oil, thyme oil and the like. According to its main components, it can be divided into four categories: terpenoids-compounds, aromatic-compounds, aliphatic-compounds and Nitrogen and sulfur compounds. Common terpene-compounds in plant essential oils are anisol ($C_8H_{12}O_2$), menthol ($C_{10}H_{18}O$), acacianes ($C_{15}H_{24}$), basilene ($C_{10}H_{16}$), patchoule ($C_{12}H_{16}O_4$), myrcene ($C_{10}H_{16}$), etc.; aromatic compounds mainly include phenols, aldehydes, ketones, esters, terpenoid derivatives and phenylpropanoid derivatives; aliphatic compounds are relatively small in plant essential oils, such as isovaleraldehyde ($C_5H_{10}O$), isovaleric acid ($C_5HC_{10}O_2$), ethyl acetate ($C_4H_8O_2$), and the like. Nitrogen and sulfur compounds are more common in spice plants, such as allicin ($C_6H_{10}S_3$) in garlic essential oils, trisulfide compounds in onion essential oils, etc. [2]. Early research found that plant essential oils have antibacterial, bactericidal, antiseptic, and insect-resistant effects, and are mainly used in products such as fruit and vegetable preservation, skin care products and pesticides [3-4]. Because of its strong pharmacological activity and safety and stability, a series of studies have also been done in the animal husbandry industry. For example, plant essential oils can improve poultry production performance to a certain extent, reduce the rate of diarrhea, maintain the balance of the gastrointestinal flora, and improve immunity. Pigs and ruminants also have corresponding effects [1, 5-8].

2. The role and mechanism of plant essential oils

2.1 Antibacterial effect of plant essential oils

Terpenoids are the most common and most abundant ingredients in essential oils, and they have antibacterial, anti-inflammatory, anti-tumor, anti-tumor, and anti-oxidant effects. Terpenoids can be divided into monoterpenes, sesquiterpenes, and diterpenes. Monoterpenes and sesquiterpene compounds often have strong antibacterial effects [2]. However, Jin Lizhi's research showed that the main antibacterial activity of plant extracts is phenols, and plant extracts such as sage, thyme, yarrow and oregano have strong antibacterial effects [9]. Aromatic compounds and terpenoids have the same antibacterial effect as well as analgesic and anesthetic effects. For example, trans-cinnam aldehyde has a strong antibacterial and antiviral ability, and eugenol has an antibacterial effect. In addition, it also has antioxidation, tumor suppression, anesthesia and other effects. Plant essential oils have an inhibitory effect on most Gram-negative and positive bacteria.

Its antibacterial effect has three main forms: First, it changes the structure and shape of the germ cell. Once the bacterial cell wall, cell membrane, and nucleus are destroyed, the germ cell will Will disintegrate death. Thyme essential oil can cause significant changes in the protein structure of the outer membrane of bacteria, and this change may affect the ability of bacteria to invade, thus exerting antibacterial effects. The second is to induce the mycelia to dissolve, change the morphological structure of the mycelium and cause the death of the pathogen. Essential oils of plants such as clove, thyme, oregano, perilla, geranium, lavender, rosemary, laurel, cumin, purple magnolia, etc., have the morphological structure of the corresponding germ cells or mycelia or act on conidia, so they are all Has a certain antibacterial effect. Eugenol can also inhibit the growth of Candida albicans mycelium, affect the integrity of mycelium, and thus exert antibacterial effects. The third is to block the germ cell's ability to multiply. By reducing or inhibiting the production and germination of conidia, or destroying its fertilization, it reduces or blocks the possibility that the offspring will continue to harm. FtsZ is a structural protein existing in bacterial cells. Studies have found that H2 and H3 in cinnamaldehyde can bind to G295 and V208 in FtsZ and inhibit the division of bacterial cells [10-12]. Studies by Wang Gaiqin and others have shown that Plant essential oils such as carvacrol, eugenol, thymol, and cinnamaldehyde have good antibacterial effects on harmful bacteria in the digestive tract of common animals such as Escherichia coli, Salmonella, and Staphylococcus aureus [13]. Yuan Yuan and other studies have shown that cinnamon oil and eugenol can completely inhibit the growth of Aspergillus flavus, and eugenol and citral can significantly inhibit the growth of Fusarium graminearum [14]. Mao Hongxia's research shows that the essential oil mixture stimulates the growth of lactobacillus, inhibits the proliferation of Escherichia coli and Staphylococcus aureus, and can improve intestinal morphology and improve intestinal function [15]. The domestic research on the antibacterial mechanism of plant essential oils is still mainly at the cellular level, so it is of great significance to gradually study at the molecular level.

2.2 Antioxidant effect of plant essential oils

Excessive free radicals in the body can damage biological membranes through lipid peroxidation and cause oxidative damage to biological macromolecular substances such as proteins and nucleic acids. Plant essential oils can remove free radicals from the body, increase antioxidant enzyme activity, and enhance the body's antioxidant capacity. There are two antioxidant pathways of plant essential oils. One is to achieve antioxidant effects by removing a series of free radicals such as DPPHH_2O_2, hydroxyl ions, superoxide, and superoxide anion. The second is to reduce lipid peroxidation by increasing the reducing ability, such as inhibiting oxidase activity, antilinoleic acid oxidation, chelating metal ions and reducing iron ions, etc. [2].

The antioxidant pathway of plant essential oils can be a combination of the above two pathways. Studies by Chen Huiliang and others have shown that adding oregano oil to dairy diets can significantly increase serum superoxide dismutase (SOD) and glutathione peroxidase (GSH-Px) activities and significantly reduce serum malondialdehyde (MDA) content ($P<0.05$).The main active ingredients in oregano oil are phenolic substances, including thymol, nerolidol, and paracetamol. The phenolic hydroxyl group can provide hydrogen and electrons, directly remove free radicals in the body, and protect other biologically active substances. Oxidized. Serum SOD and GSH-Px are endogenous antioxidant enzymes. SOD mainly catalyzes the disproportionation of superoxide anions, GSH-Px mainly catalyzes the decomposition of peroxides in the body, and the degree of their activity in serum reflects the body Overall antioxidant capacity [16]. Serum MDA is a product formed by oxidation of body lipids. The lower its content, the lower the degree of oxidation of body lipids [17]. Studies by Hashemipour et al. Have shown that the addition of thymol and carvacrol to broiler diets significantly increased the activity of SOD and GSH-Px in serum, leg muscles, and liver ($P<0.05$) [18]. Placha et al. Showed that adding $0.5g \cdot kg^{-1}$ of thyme essential oil to the diet of one-day-old Rose 308 broiler chickens and feeding it for 5 weeks significantly reduced the concentration of MDA in the duodenal mucosa and kidney tissue ($P<0.05$) [19]. Fang Rejun and other studies have shown that adding appropriate amounts of plant essential oil extracts to the diet of weaned piglets can significantly increase the activity of GSH-Px and SOD, thereby improving the body's antioxidant function [20].

2.3 Immune regulation of plant essential oils

Plant essential oils can protect receptors by reducing the proliferation of inflammatory cells. Its anti-inflammatory process is achieved through antioxidant pathways without affecting its ability to secrete cytokines IL-4 and IL-10. This indicates that plant essential oils have Strong immune regulation. In addition, the immunomodulatory effect of plant essential oils may be related to its ability to promote the production of Interleukin, Tumor-necrosis-factor-α (TNF-α), and Interferon-γ (INF-γ).Studies have reported that the addition of allicin to broiler diets can significantly increase Newcastle disease antibody levels and increase organ indices of the spleen and bursa. Enhance the reactivity of basophils in subcutaneous tissue [21]. Liu Meng research shows that adding 0.01% of plant essential oil premix to the piglet diet, the main ingredients of which are thymol 15% and cinnamon 5%, which significantly increase the white blood cell phagocytosis rate, lgM, 1gA, complement The content of C3 and C4 ($P<0.01$), and significantly increased the content of total protein and IgG ($P<0.05$), thereby enhancing the immunity of piglets [22].Wang Qiuhai's research shows that adding 10% oregano oil premix $100mg \cdot kg^{-1}$ to the basic diet can promote

the proliferation and maturation of broiler lymphocytes and improve cellular immunity [23]. Studies by Zhu Xiaolei and others show that thyme essential oil can significantly increase the percentage of blood ANAE positive lymphocytes, Newcastle disease antibody levels, and serum IgM, IgA, and IgG levels in broiler chickens, and thyme essential oil can significantly increase the immune organ index of twisted chicken, and can be used as a growth promoter P <0.05) [24-25].

It can be seen that plant essential oils can increase immune organ index, promote immune cell function and release of immune factors to enhance the body's immunity. The intestine is the body's largest immune organ. Studies have found that plant essential oils can promote the intestinal health of animals, regulate the intestinal microbial balance, and indirectly enhance the body's immune capacity [26].

3. Application of plant essential oils in chicken production

Plant essential oils have a wide range of biological activities, with antibacterial, anti-inflammatory, antitumor, antiviral, antipyretic and analgesic effects, expectorant and cough improvement, and gastrointestinal function improvement [27]. At present, there are many reports on the application of plant essential oils in poultry. Wei Lei et al. Have worked on 12 essential oils (basil oil, garlic oil, mountain seed oil, blue eucalyptus oil, benzoin oil, lemon grass oil, clove oil, thyme oil, oregano oil, cinnamaldehyde, carvacrol and thyme Phenol), the results showed that the main components of these 12 plant essential oils and their inhibitory effects on 3 common chicken-borne pathogens (chicken E. coli, salmonella pneumoniae and staphylococcus aureus), and thymol Synergistic effect with carvacrol on chicken Escherichia coli, chicken salmonella and chicken Staphylococcus aureus [28], Jin Lizhi's research showed that the antibacterial effects of the extracts of yarrow and oregano on these three pathogenic bacteria were the strongest [9]. Star anise, as an aromatic Chinese herbal medicine, has the effects of inducing appetite, stimulating gastric secretion, and intestinal peristalsis, thereby inducing animals to eat and improving animal growth performance [29]. The height of villus and crypt depth in the intestine are the main indicators reflecting the digestive and absorption function of the small intestine. The height of villus affects the absorption area of the small intestine. The higher the height of villus, the larger the absorption area, which is conducive to the absorption of nutrients; the depth of crypts affects the secretion of digestive juices. The shallower the crypt, the stronger the secretory ability; the chondrocyte ratio comprehensively reflects the functional status of the small intestine, and the chorionic gland ratio is increased, indicating that the digestive absorption capacity of the small intestine is enhanced and the intestinal mucosal structure is improved. Research by Reisinger et al. Showed that the addition of anise, oregano, and citrus fruit essential oils in the diet significantly increased the crypt depth of the ileum and the height of

the villi of the jejunum [26]. Hong et al. Found that adding star anise and oregano oil to the diet significantly increased the height of the duodenum of broilers [30]. The Amad study found that diets were supplemented with 0, 150, 750, and 1500 mg/kg. The mixture of thyme and star anise essential oil can significantly improve feed conversion rate of broilers at 22 to 42 days of age and apparent digestibility of ileal nutrients in broilers at 1 to 42 days of age [31]. The results of research by Ali et al. Showed that adding 0.25% thyme essential oil to the basic diet of laying hens could increase fertilization rate and hatchability of breeding eggs by 1.77% and 4.96% [32]. Waldenstedt and other studies have shown that oregano extract can not only promote the growth of broiler chickens, but also can be used in combination with anticoccidial vaccine to control the occurrence of coccidiosis, thereby effectively promoting the performance of broiler chickens. It can promote the growth of broiler chickens and can be used with anti-coccidial vaccine to control the occurrence of coccidiosis and reduce the harm of coccidia, and less colonization of Clostridium perfringens in the intestine [33]. The results of research by Shi Donghui and others show that the addition of 200 and 150g / t yarrow extract to the diet can improve the weight gain and feed conversion rate of broilers, and can reduce the mortality of broilers [34]. Chen Yueming and Wang Shuiming reported that adding 20 ~ 200 mg / kg of hydrangea extract to diets can significantly increase the daily weight gain and feed intake of broilers, and improve feed compensation [35].The results of Weber et al. Showed that adding 300mg / kg thymol, eugenol, piperine, and benzoic acid to the diet can significantly improve the performance of broilers under different feeding conditions [36]. The results of Herandez et al. Found that adding 5000ug / ml of labiata sage, thyme, and rosemary mixed oils to the diet can significantly increase the average daily weight gain of 14 to 21-day-old broilers, and can significantly increase the entire intestinal segment and Nutrient utilization of the ileum [37]. Lambert et al. Found that adding 0.5% rosemary or thyme leaves to the diet can increase the weight and weight of broilers, and improve feed compensation at the same time [38]. Ke Qiyun's research shows that plant essential oils can inhibit chicken coccidia, and at the same time have certain immune enhancement and growth promotion effects [39]. The above studies have proved that plant essential oils can improve the production performance of livestock and poultry, and provide a guarantee for the efficient production of safe and healthy livestock products by the livestock and poultry breeding industry.

Summary. In recent years, research on the application of plant essential oils in chicken production has continued to deepen. Existing experiments have proven that plant essential oils can promote the growth and development of pigs and chickens, enhance immunity, improve hens 'reproductive performance, reduce chickens' stress response, and have antibacterial and

antibacterial properties Viral properties can also be used to treat diseases such as chicken diarrhea. However, due to the inadequate production technology of plant essential oil products, the composition and its content are unstable, the number of animal experiments to verify the scale is not large, the mechanism is not clear, and other reasons, which have limited the widespread application of plant essential oils. It is believed that with the continuous deepening of research and the continuous improvement of production technology, the application of plant essential oils in livestock and poultry production will be greatly promoted.

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И. В ЯНОЧКИН, С. В. СМЯТКИНА, М. Н. КИРПИЧЕНКО

ВЫПАС ЛОШАДЕЙ НА МНОГОЛЕТНИХ ЕСТЕСТВЕННЫХ И КУЛЬТУРНЫХ ПАСТБИЩАХ С РАЗЛИЧНЫМ УРОВНЕМ ЗАГРЯЗНЕНИЯ ТРАВОСТОЕВ ^{137}CS

Государственное природоохранное научно-исследовательское учреждение «Полесский государственный радиационно-экологический заповедник», г. Хойники, Республика Беларусь

Статья посвящена нормированию сроков пастьбы в зависимости от уровней содержания ^{137}Cs в пастбищном травостое многолетних естественных и культурных пастбищ. Установлено, что использование загонного метода пастьбы лошадей на культурном пастбище с плотностью радиоактивного загрязнения почвы цезием 20-30 Ки/км^2 при удельной активности ^{137}Cs в травостое 200 Бк/кг обеспечивает содержание этого элемента в мышечной ткани животных старше 3 лет в течение трех месяцев 318 Бк/кг, молодняка в возрасте 12 месяцев – 165 Бк/кг. Это даёт возможность получать конину, соответствующую РДУ-99.

Ключевые слова: лошади, пастбище, травостои, ^{137}Cs.

I. V YANOCHKIN, S. V. SMYATKINA, M. N. KIRPICHENKO

GRAZING HORSES ON PERENNIAL NATURAL AND CULTURAL PASTURES WITH VARIOUS LEVELS OF POLLUTION OF GRASS STANDS WITH ^{137}Cs

State Environmental Research Institution Polesye State Radiation and Ecological Reserve, Khoiniki, Republic of Belarus

The paper dwells on rationing grazing terms depending on ^{137}Cs levels in the pasture grass stand of perennial natural and cultural pastures. It has been determined that pen