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FOOD SAFETY THROUGH THE LENS OF PHYTOBIOTICS

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review paper

Summary

In the field of food safety, natural plant compounds are becoming increasingly central to scientific research, and phytobiotics stand out in particular for their numerous functional properties. Phytobiotics comprise various botanical extracts and essential oils. Their importance primarily stems from their bioactive compounds. Their utilization, especially in livestock production, revealed a sequence of positive effects, including reducing pathogenic microorganisms, improving gut microbiota, and decreasing the need for anti-inflammatory drugs and antibiotics. Thus, directly and indirectly contributing to the safety of animal-derived products. Phytobiotics are emerging as an alternative to the traditional additives due to growing concerns for food safety and the need to reduce antimicrobial resistance. Their effectiveness depends on the form and type of plant material, concentration of active ingredients, method of application, and possible interaction with other food components. Simultaneously, a deficit of standardization guidelines, possible presence of contaminants, and limited regulatory clarity are challenges in their wide usage. This review provides an overview of phytobiotics and their impact on animal health, their potential in improving food safety, and the risks associated with improper use. By analyzing the available literature, emphasis is put on the need for additional research, regulatory guidelines, and ensuring quality control.

Keywords: phytobiotics, animal nutrition, food safety

Introduction

Today's intensive meat, milk, and egg production is faced with enormous challenges, such as maintaining animal health, ensuring food safety as well, and protecting consumers from harmful substances and pathogens. One of the major challenges is antimicrobial resistance which is associated with long and non-selective use of antibiotics in animal husbandry, not only for curing illness, but for growth promoters as well. The aforementioned led to the adoption of legal regulations connected to a ban on the use of antibiotics as growth promoters. One of the first countries to prohibit such use of antibiotics was the Netherlands. This resulted in a 51% drop in antibiotics sales (Lykhach and Lykhach, 2023). The ban has been running since 2006 in the European Union (Hashemi et Davodi, 2010; Akyildiz et Denli 2016). Solution is also sought to minimize the use of veterinary antibiotics (Steiner et Syed, 2015). Farmers, veterinarians, researchers, healthcare professionals, and consumers are increasingly concerned about foodborne diseases and their consequences on human health. This is aggravated by the growing resistance of microorganisms to antibiotics and excessive consumption of medical antibiotics (Friedman, 2007). It is the growing concern that has prompted research for alternatives with similar positive effects but without negative side effects (Grashorn 2010, Pandey et al., 2023).

Phytobiotics are defined as products from plants and have positive effects on gastrointestinal microflora, performance, and ultimately on the quality of animal products (Arpášová et al., 2013; Alem et al., 2024). Regarding the rapid utilization of phytobiotics in livestock production and their potential in the sustainability of the food chain, it is crucial to know and accept the mechanisms of their activity, advantages, and limitations in the feed of domestic animals, as well as regulatory requirements. Therefore, this paper aims to present and analyze the role and dynamics of applying phytobiotics in the food of domestic animals, with an emphasis on their effects on healthiness and quality of animal products and potential risks for food safety and consumer health. This paper provides an overview and highlights the importance of a balanced approach to applying phytobiotics in order to gain safe animal-based products.

The role and classification of phytobiotics

Phytobiotics or phytogenic food additives describe a group of bioactive substances of plant origin that are added to the feed of domestic animals to improve growth, health status, production efficiency, and quality of animal-based products (Friedman, 2007; Arpášová et al., 2013). They are natural compounds and can be made from spices, fruits, medical herbs, and parts of plants (Oni et al., 2024). Their primary function is not nutritional, but rather physiological and functional (Abdelli et al., 2021) as they

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are often implemented in animal feeding as alternatives to antibiotics as growth rate promoters (Kiczorowska et al., 2017).

Leaves, roots, flowers, as well as whole plants, are used to produce phytobiotic products. Products may contain dried forms of whole plants or their parts or extracts of valuable ingredients (Grashorn, 2010). Although there aren't any final criteria of classification, based on the origin and characteristics of the processing of phytobiotics, they can be arranged in four categories: spices, herbs, essential oils, and oleoresin (Senčić et al., 2021; Pandey et al., 2023). They can be used in various forms, such as solid, granular, or liquid form. Solid form is usually added to premixes or complete feed, while the liquid form is added usually to drinking water or milk substitute, or can be added by spraying onto hydrothermally processed food (pelletized or extruded food) (Steiner et Syed, 2015). Abdelli et al. (2021) in their research emphasize many spices and herbs, such as thyme, rosemary, oregano, cinnamon, marjoram, yarrow, ginger, garlic, green tea, black cumin, as well as essential oils such as thymol, garlic, anise, cinnamaldehyde, rosemary, citrus, clove, and ginger, used in poultry production. It is worth noting that combinations of different groups are often used to achieve a synergistic effect and increase the stability of formulations during storage and final food processing (Zeng et al., 2015). This is confirmed by the research Alem et al. (2024), in which the authors affirm the synergistic antibacterial effect of plants, for example, against bacteria such as *Staphylococcus spp*., *Streptococcus spp*., *Salmonella spp*., and *E. coli.*

Bioactive components of phytobiotics

Bioactive compounds of phytobiotics include terpenoids, flavonoids, alkaloids, phenols, glycosides, and glucosinolates (Demir et al., 2005; Ivanova et al., 2024). How many bioactive substances and their chemical composition in phytobiotics depend on various factors such as geographical location, part of the plant, and season of harvesting (Huyghebaert et al., 2011; Kiczorowska et al., 2017; Pandey et al., 2023; Alem et al., 2024). With that, herbal extracts also depend on the moisture content of the material, drying method, storage condition, and the production method (Liu et al., 2016; Dilbato Dinbiso et al., 2022). The largest group of secondary plant metabolites is terpenoids. Terpenes of some plants show immunosuppressive, bacteriostatic, and bactericidal properties (Rogošić et al., 2013). Saponins play a role in immune regulation, antitumor activities, and lowering cholesterol, while flavonoid glycosides have a role as antioxidants and anti-inflammatory reducers (Ivanova et al., 2024). Alkaloids have various effects as antimicrobial, anticancer, antiviral, diuretic, analgesic, anticholinergic, antitumor, sympathomimetic, antihypertensive, and antiulcerative (Ivanova et al., 2024). Phenol compounds, such as flavonoids, have a role in antioxidative, cardioprotective, antibacterial, cardio-protective, and anti-inflammatory activities (Jarial et al., 2018; Ivanova et al., 2024). Phytoncides are compounds those plants release to protect themselves from microorganisms or as a repellent effect for herbivores. In addition, it is confirmed that phytoncides show antimicrobial, antibacterial, antifungal properties, and anti-inflammatory and analgesic properties. Therefore, it has the potential to be used as a preserving agent in the food industry (Memon et al., 2021; Ivanova et al., 2024).

Effects of phytobiotics application on animal health and productivity

Beneficial effects of phytogenic compounds come from their bioactive molecules (Yitbarek, 2015), which have a part in antioxidative, antimicrobial, anticoccidial, anthelmintic, and anti-inflammatory response (Gregačević et al., 2014; Alem et al., 2024). They are powerful positive agents of the immune and digestive systems of animals (Akyildiz et Denli, 2016). With that, they improve the digestibility and maintain and stabilize beneficial microflora in the intestine (Placha et al., 2022). They stimulate the microbes in the rumen, additionally the entire digestive tract, and improve the palatability of food (Alem et al.,2024). Furthermore, they affect growth rate, reduce the number of new diseases, advance parameters of reproduction, and have a positive effect on feed efficiency, profitability, and gas emissions when they are used in poultry feeding (Yitbarek, 2015). Besides that, they reduced microbiological load and improved sensory evaluation, leading to better quality of carcass meat (Grashorn, 2010). Furthermore, the usage of phytobiotics as an alternative to antimicrobial medicine can lead to health protection and the improvement of animal productivity, but also to solving the problem of food safety by removing the cumulative effects of antibiotics in animal products (Ryazanov et al., 2021). With that, plant extracts in our meals help reduce oxidative rancidity and maintain the nutritional quality of the animal products (Alem et al., 2024).

Overview of previous research on the influence of phytobiotics on animal welfare, productivity, and the quality of animal products

In the research Al-Beitawi and El-Ghousei (2008), the effect of different quantities of smashed and non-smashed black cumin seeds *(Nigella sativa)* in feed was studied. Results showed that chicks fed with 1.5% smashed cumin seeds had better body weight, body mass gain, and feed conversion ratio. Furthermore, feeding containing 3.0%

cumin seeds (smashed and non-smashed) lowers the concentration of cholesterol and triglycerides in the blood plasma of chicks. Cisse et al. (2025) researched the influence of the citrus extract on animal growth, welfare, and gut microbiota of broiler chicks. Results show improvement in the final body weight and carcass quality of the broiler chickens. In addition, the appearance of foot dermatitis and intestinal health improved. In the research, Giannenas et al. (2005) included 210-day-old chickens. It was confirmed that the inclusion of ground oregano into the diet can reduce the adverse effects of *E. tenella* infection. The authors concluded that oregano could be included in complete broiler feed mixtures as another method to substitute ionophore antibiotics against *E. tenella*. Gumowski et al. (2025) in their research concluded that phytobiotics formulations offer a viable alternative to traditional commercial chemical products that promote the growth rate of poultry, with a positive effect on the performance of the broiler, the health of the gastrointestinal tract, and meat characteristics. The research by Demir et al. (2005) was conducted on broilers. They compared five herbal feed additives (oregano, Du-Sacch, saponin, garlic, thyme) and antibiotics and their effects on growth rate. Results showed that antibiotics can be substituted with natural herbal additives as growth promoters in broilers. Prakatur et al. (2021) conducted research in which they determined the influence of chamomile and nettle on the meat quality of broilers. Results indicated that listed natural supplements effectively affect the pigmentation of the chicken's skin, and this is precisely what makes these products visually more alluring to consumers, which definitely also influences their choices when purchasing such products. Klarić et al. (2019) researched the impact of chamomile and nettle supplementation on biochemical and production parameters of broilers. The conducted research confirmed that nettle and chamomile can be used as ingredients in feed for fattening chicks because positive effects on researched indicators were observed.

Research was carried out to examine the influence of oregano essential oil on the color and oxidative stability of chicken breast meat (raw and cooked). The oregano lowered the protein and lipid oxidation and has a positive effect on the color of raw and cooked meat. The authors believe that oregano essential oil at a concentration of 100-400 ppm have a potential to take the place of synthetic antioxidants in the meat of chicken (Al-Hijazeen et al., 2016). The aim of Iwiński et al. (2023) research was to evaluate consequence of different doses of phytocide mixtures on production and meat quality. Besides that, they studied the possibility of residues and toxic effects on broilers. It was established that the use of phytobiotic supplements does not influence the pathological changes of organs and does not relate to the appearance of residues in tissues.

Duarte and Kim (2022) studied the influence of phytobiotics on growth and intestinal health in pigs. They came to the conclusion that phytobiotics, similar to antibiotic drugs, improve the growth rate from the weaning phase to the fattening phase by acting as inflammatory and oxidative reducers. Furthermore, phytobiotics have positive effects on immune response and consequently the morphology of the jejunum. However, they found that the combined application of phytobiotics with antibiotics suppresses the effects. Lykhach and Lykhach (2023) researched the effects of liquid and dry forms of phytobiotics („Liptosa Expert ") on the growth rate of crossbred young pigs. The use of phytobiotics during the period of birth, rearing, and fattening can be an effective method of substituting antibiotics and growth stimulators, which leads to increased survival rate of piglets during the weaning period, live weights during the fattening period, and the development of beneficial microflora in the pig's intestine. The aim of the research by Katsoulos et al. (2017) was to determine the efficiency of the essential oil of oregano in stopping neonatal diarrhea in young calves (<15 days old) in field conditions. Results throughout the research, loose bowel frequency, duration, and severity were significantly reduced in the experimental group. They concluded that applying the essential oil of oregano to calves during the first 10 days of life reduces the intensity of inherently acquired diarrhea and has a prophylactic effect against neonatal diarrhea. Luo et al. (2024) researched the influence of different doses of oregano essential oil on stimulating the growth of the gastrointestinal tract and improving the immune system in calves. Results indicated that adding oregano oil had a positive effect on weight and average daily growth, as well as rising serum concentration of IgA and IgM, and remarkably increased the number and diversity of rumen microbiota. The goal of the study by Neofytou et al. (2020) was to calculate the effect of ensiled olive scones included in diets on milk production (yield, composition) from cows. By including the olive scones in the diet of cows over a period of 4 weeks, milk composition (lipid profile of milk and Halloumi cheese) was improved without any negative effect on milk production or cows. Winkler et al. (2015) conducted research on 27 dairy cows with the hypothesis that supplementation with an herbal product (95% of green tea and 5% of turmeric extract) reduces inflammation agents and endoplasmic reticulum stress in the liver in early lactation of cows. Although there were small effects related to the occurrence of endoplasmic reticulum stress and inflammation, the authors believe that polyphenol supplementation could be beneficial for improving milk production (yield) and as a prophylactic method for fatty liver disease in dairy cattle. Piran Filho et al. (2021) conducted research with the aim of evaluating the influence of mixed commercial phytobiotics

(„Digestarom“) on the amount of food consumed by animals, feeding behavior, nutrient digestibility, growth rate, and carcass components of bulls. Results show that the phytogenic supplement has a positive influence on feed intake and carcass components without any influence on metabolic disturbances.

A review that included scientific papers published between 2000 and 2020 shows that supplementation of phytogenic additives in the feed of pigs, rabbits, and ruminants advanced product quality in terms of organoleptic properties and fatty acid profile. Furthermore, advanced oxidative stability and storage life (Tsiplakou et al., 2021).

Safety and risks of using phytobiotics

Phytobiotics cannot replace the negative effects of nutrition or nutritional imbalances in meals (Arpášová et al., 2013). They are recognizable by minimal residue levels, absence of resistance growth, and lack of negative impacts (Pandey et al., 2023). Most herbal extracts tested in poultry experiments showed positive effects on productivity and had no adverse impacts on animal welfare as well as animal products (Akyildiz et Denli, 2016). Despite this, the pathway of phytobiotics is indistinct because of the broad spectrum of bioactive matter inclusion in herbal products (Pandey et al., 2023; Alem et al., 2024). Besides that, the slow therapeutic effect and unstable chemical composition make it impossible to accurately calculate the required dose (Pashtetsky et al., 2020). Therefore, special attention should be paid to dose and purity, because in higher concentrations they can have anti-nutritive properties (Almeida et al., 2021). Moreover, production of herbal extracts grapples with many obstacles, including low-volume production, inchoate extraction techniques, indeterminate dosing guidelines (for species, weight, age), expansive costs, and unpredictable effects (Pashtetsky et al., 2020). It is worth emphasizing that supplementation of phytogenic additives in poultry feed in terms of their efficiency and safety is still lacking (Hashemi et Davoodi, 2010; Huyghebaert et al., 2011). Dose adjustment of phytobiotics, better control of their extract production and application, or implementation are core for further research (Obianwuna et al., 2024).

Regulation of the safe use of phytobiotics

Food safety includes measures that ensure that food is safe for the end consumer. It is achieved through legal provisions and private regulation (Knežević et al., 2013). In the EU and our country (Republic of Croatia), the key regulation is Regulation (EZ) no. 1831/2003 on additives in feed. According to this regulation, each additive must be approved by the European Food Safety Authority (EFSA) as well. In our country, the consumption of phytobiotics is additionally regulated by the Food Act (NN 18/2023), which lays down general principles of safety in the „farm to fork “chain. When phytobiotics are used for therapeutic purposes, the provisions of the Veterinary Medicinal Products Act must also be respected.

In the Republic of Croatia, food safety supervision is carried out by various competent institutions, ensuring a comprehensive approach. Different ministries and agencies have specific duties according to manufacturing method and production, and step in the supply chain, which contributes to more efficient risk management (Ministries of Health and Agriculture, Forestry and Fisheries, Croatian Institute for Standardisation) (Knežević et al., 2013).

An important part of the responsible use of phytobiotics is including food safety management procedures and a preventive food safety system known as the HACCP system (Hazard Analysis and Critical Control Points). The implementation of the HACCP system is monitored by sanitary and veterinary inspectors who, in addition to regular inspections of facilities, also monitor hygiene conditions, product labeling, documentation, as well as the presence of biological, chemical, and physical hazards, and ensure traceability throughout the food chain.

Conclusion

Today, phytobiotics have taken up a main position in agriculture, the food production industry, and veterinary medicine, especially in livestock farming. Their bioactive compounds, with many known positive effects, such as antimicrobial, antioxidant, and inflammatory reducers, boost the health of animals and their products. Although they have numerous positive effects, their function and impact depend on many things, such as the form of plant material, the concentration of active ingredients, and the method of application. Improper use or inadequate quality control may increase the risk of contamination or variability in product quality. So, it is necessary to improve regulatory guidelines and the precise determination of doses. Besides that, it is necessary to conduct further research on their long-term effects on animals. To conclude, phytobiotics can improve microbiological stability, product quality, and food safety, but at the same time can be a source of contamination. Therefore, their use needs to be viewed through a prism of an integrated food safety approach, which includes interdisciplinary collaboration among numerous scientists and experts and careful monitoring of each.

References

Abdelli, N., Solà-Oriol, D., Pérez, J. F. (2021): Phytogenic feed additives in poultry: Achievements, prospective and challenges, *Animals* 11(12), 3471.

Akyıldız, S., Denli M. (2016): Application of plant extracts as feed additives in poultry nutrition, *Animal Science* 59 (2393), 2260.

AL-Beitawi, N., El-Ghousei, S. S. (2008): Effect of Feeding Different Levels of Nigella sativa Seeds (Black Cumin) on Performance, Blood Constituents and Carcass Characteristics of Broiler Chicks*, International Journal of Poultry Science* 7(7), 715–721.

Alem, W. T. (2024): Effect of herbal extracts in animal nutrition as feed additives, *In Heliyon* 10(3), 24973.

Al-Hijazeen, M., Lee, E.J., Mendonica, A., Ahn, D.U. (2016): Effect of oregano essential oil (Origanum vulgare subsp. Hirtum) on the Storage Stability and Quality Parameters of Ground chicken breast meat, *Antioxidants* 5(2), 1–11.

Almeida, A.K., Hegarty, R.S., Cowie, A. (2021): Meta-analysis quantifying the potential of dietary additives and rumen modifiers for methane mitigation in ruminant production systems, *Animal Nutrition* 7(4), 1219–1230.

Anonimno (2013): Zakon o hrani (NN 81/13). Retrieved August 31, 2025, from https://narodne-novine.nn.hr/clanci/sluzbeni/2013/18

Arpášová, H., Kačániová, M., Gálik, B. (2013): The Effect of Oregano Essential Oil and Pollen on Egg Production and Egg Yolk Qualitative Parameters, *Animal Science Biotechnology* 46(1), 12–16.

Cisse, S., Matuszewski, A., Bień, D., Ciborowska, P., Zalewska, A., Urban, J., Michalczuk, M., Mendel, M., Latek, U., Polak, J., Sobczak-Filipiak, M., Konieczka, P., Benarbia, M. E. A. (2025): Effects of Standardized Natural Citrus Extract on Growth, Gut Health, Carcass Quality, and Welfare of Broiler Chickens*, Animals* 15(2), 1–16.

Demir, E., Sarica, Ş., Özcan, M. A., Suicmez, M. (2005): The use of natural feed additives as alternative to an antibiotic growth promoter in broiler diets, *European Poultry Science* 69(3), 110–116.

Dilbato Dinbiso, T., Deressa, F. B., Legesse, D. T., Gebisa, E. S., Diko, A. C., Fulasa, T. T. (2022): Antimicrobial Activity of Selected Ethnoveterinary Medicinal Plants of Southern Region, Ethiopia, *Infection and Drug Resistance* 15, 6225–6235.

Duarte, M. E., Kim, S. W. (2022): Phytobiotics from oregano extracts enhance the intestinal health and growth performance of pigs, *Antioxidants* 11(10), 2066.

Friedman, M. (2007): Overview of antibacterial, antitoxin, antiviral, and antifungal activities of tea flavonoids and teas, *Molecular Nutrition and Food Research* 51(1), 116–134.

Giannenas, I. A., Florou-Paneri, P., Botsoglou, N. A., Christaki, E., Spais, A. B. (2005): Effect of supplementing feed with oregano and/or α-tocopheryl acetate on growth of broiler chickens and oxidative stability of meat, *Journal of Animal and Feed Sciences* 14(3), 521–535.

Grashorn, M. A. (2010): Use of phytobiotics in broiler nutrition-an alternative to infeed antibiotics?, *Journal of Animal and Feed Sciences* 19, 338–347.

Gregačević, L., Klarić, I., Domaćinović, M., Galović, D., Ronta, M. (2014): Fitogeni aditivi u hranidbi domaćih životinja, *Krmiva* 56, 117–123.

Gumowski, M., Ceccopieri, C., Madej, J. P., Leicht, K., Korzeniowska, M., Lipińska, A., Sierżant, K., Konkol, D., Różański, H., Asghar, M. U., Korczyński, M. (2025): The use of phytobiotics in the form of complexed organometallic phytoncides and micronized herbs in the nutrition of Ross 308 broiler chickens: Effects on growth performance, meat quality, and immune response, *Animal Feed Science and Technology* 326, 116391.

Hashemi, S. R., Davoodi, H. (2010): Phytogenies as new class of feed additive in poultry industry, *Journal of Animal and Veterinary Advances* 9(17), 2295–2304.

Hashemi, S. R., Davoodi, H. (2011): Herbal plants and their derivatives as growth and health promoters in animal nutrition, *Veterinary Research Communications* 35(3), 169–180.

Huyghebaert, G., Ducatelle, R., Immerseel, F. van. (2011): An update on alternatives to antimicrobial growth promoters for broilers, *Veterinary Journal* 187(2), 182–188.

Ivanova, S., Sukhikh, S., Popov, A., Shishko, O., Nikonov, I., Kapitonova, E., Krol, O., Larina, V., Noskova, S., Babich, O. (2024): Medicinal plants: A source of phytobiotics for the feed additives, *Journal of Agriculture and Food Research* 16, 101172.

Iwiński, H., Chodkowska, K. A., Drabik, K., Batkowska, J., Karwowska, M., Kuropka, P., Szumowski, A., Szumny, A., Różański, H. (2023): The Impact of a Phytobiotic Mixture on Broiler Chicken Health and Meat Safety, *Animals* 13(13), 1–16.

Jarial, R., Thakur, S., Sakinah, M., Zularisam, A. W., Sharad, A., Kanwar, S. S., Singh, L. (2018). Potent anticancer, antioxidant and antibacterial activities of isolated flavonoids from Asplenium nidus, *Journal of King Saud University - Science* 30(2), 185–192.

Katsoulos, P. D., Karatzia, M. A., Dovas, C. I., Filioussis, G., Papadopoulos, E., Kiossis, E., Arsenopoulos, K., Papadopoulos, T., Boscos, C., Karatzias, H. (2017): Evaluation of the in-field efficacy of oregano essential oil administration on the control of neonatal diarrhea syndrome in calves, *Veterinary Science* 115, 478–483.

Kiczorowska, B., Samolińska, W., Al-Yasiry, A. R. M., Kiczorowski, P., Winiarska-Mieczan, A. (2017): The natural feed additives as immunostimulants in monogastric animal nutrition–a review, *Annals of animal science* 17(3), 605–625.

Klarić, I., Domaćinović, M., Đidara M., Samac D., Ronta M., (2019): Utjecaj dodatka koprive i kamilice u hranidbi tovnih pilića na proizvodne te biokemijske pokazatelje tovnih pilića. Zbornik radova 54. i 14. međunarodnog simpozija agronoma. Zagreb. Agronomski fakultet Sveučilišta u Zagrebu, 490–495.

Knežević, N., Đugum, J., Frece, J. (2013): Sigurnost hrane u Hrvatskoj – pozadina i izazovi, *Meso* 15(3), 193–197.

Liu, W., Yin, D., Li, N., Hou, X., Wang, D., Li, D., Liu, J. (2016): Influence of environmental factors on the active substance production and antioxidant activity in Potentilla fruticosa L. and its quality assessment, *Scientific Reports* 6(1), 28591.

Luo, Z., Liu, T., Cairang, D., Cheng, S., Hu, J., Shi, B., Zhu, H., Chen, H., Zhang, T., Yi, X. (2024): Oregano Essential Oil as a Natural Plant Additive Affects Growth Performance and Serum Antibody Levels by Regulating the Rumen Microbiota of Calves, *Animals* 14(6), 820.

Lykhach, V., Lykhach, A. (2023): Increase of performance parameters of pigs with the use of phytobiotics., Conferința "Gestionarea fondului genetic animalier – probleme, soluţii, perspective" Maximovca, Moldova, 20-23 septembre 2023, 166–172.

Memon, A., Kim, B. Y., Kim, S. E., Pyao, Y., Lee, Y. G., Kang, S. C., Lee, W. K. (2021): Anti-inflammatory effect of phytoncide in an animal model of gastrointestinal inflammation, *Molecules* 26(7), 1–17.

Neofytou, M. C., Miltiadou, D., Sfakianaki, E., Constantinou, C., Symeou, S., Sparaggis, D., Hager-Theodorides, A. L., Tzamaloukas, O. (2020): The use of ensiled olive cake in the diets of Friesian cows increases beneficial fatty acids in milk and Halloumi cheese and alters the expression of SREBF1 in adipose tissue, *Journal of Dairy Science* 103(10), 8998–9011.

Obianwuna, U. E., Chang, X., Oleforuh-Okoleh, V. U., Onu, P. N., Zhang, H., Qiu, K., Wu, S. (2024): Phytobiotics in poultry: revolutionizing broiler chicken nutrition with plant-derived gut health enhancers, *Journal of Animal Science and Biotechnology* 15(1), 1–33.

Oni, A. I., Adeleye, O. O., Adebowale, T. O., Oke, O. E. (2024): The role of phytogenic feed additives in stress mitigation in broiler chickens*, Journal of Animal Physiology and Animal Nutrition* 108(1), 81–98.

Pandey, S., Kim, E. S., Cho, J. H., Song, M., Doo, H., Kim, S., Keum, G. B., Kwak, J., Ryu, S., Choi, Y., Kang, J., Choe, J., Kim, H. B. (2023): Cutting-edge knowledge on the roles of phytobiotics and their proposed modes of action in swine, *Frontiers in Veterinary Science* 10:1265689.

Pashtetsky, V., Ostapchuk, P., Kuevda, T., Zubochenko, D., Yemelianov, S., Uppe, V. (2020): Use of phytobiotics in animal husbandry and poultry, *E3S Web of Conferences* 215, 1–9.

Piran Filho, F. A., Turner, T. D., Mueller, I., Daniel, J. L. P. (2021): Influence of Phytogenic Feed Additive on Performance of Feedlot Cattle, *Frontiers in Animal Science* 2, 767034.

Placha, I., Gai, F., Pogány Simonová, M. (2022): Natural feed additives in animal nutrition-Their potential as functional feed, *Frontiers in Veterinary Science* 9, 1062724.

Prakatur, I., Domaćinović, M., Pavić Vulinović, M., Samac, D., Ronta, M., Đidara, M., Pastuović, Lj. (2021): The influence of chamomile and nettle addition in broiler feed mixtures on meat quality, *Krmiva* 63(2), 43–51.

Rogošić, J., Šarić, T., Tupan, I., Šikić, Z. (2013): Uloga i značenje sekundarnih biljnih metabolita u ishrani biljojeda, *Stočarstvo* 67(2), 51–68.

Ryazanov, V. A., Kurilkina, M. Y., Duskaev, G. K., Gabidulin, V. M. (2021): Phytobiotics as an alternative to antibiotics in animal husbandry (review), *Animal Husbandry and Fodder Production* 104(4), 108–123.

Senčić, Đ., Antunović, Z., Samac, D. (2021): Biopoticajni učinak fitobiotika u proizvodnji pilećeg mesa, *Meso* 23(1), 67–73.

Steiner, T., Syed, B. (2015): Phytogenic Feed Additives in Animal Nutrition, Springer Netherlands, 403–423.

Tsiplakou, E., Pitino, R., Manuelian, C. L., Simoni, M., Mitsiopoulou, C., de Marchi, M., Righi, F. (2021): Plant feed additives as natural alternatives to the use of synthetic antioxidant vitamins in livestock animal products yield, quality, and oxidative status: A review, *Antioxidants* 10 (5), 1–12.

Winkler, A., Gessner, D. K., Koch, C., Romberg, F. J., Dusel, G., Herzog, E., Most, E., Eder, K. (2015): Effects of a plant product consisting of green tea and curcuma extract on milk production and the expression of hepatic genes involved in endoplasmic stress response and inflammation in dairy cows, *Animal Nutrition* 69(6), 425–441.

Yitbarek, M. (2015): Phytogenics as feed additives in poultry production: A review, *Journal Extensive Res*. 3, 49–60.

Zeng, Z., Zhang, S., Wang, H., Piao, X. (2015): Essential oil and aromatic plants as feed additives in non-ruminant nutrition: A review, *Journal of Animal Science and Biotechnology* 6(1), 1–10.