Available online at www.agrifarming.org

DOI: http://dx.doi.org/10.18782/2582-7146.197

ISSN: 2582 – 7146

Curr. Rese. Agri. Far. (2023) *4*(3), 15-22

Review Article

Current Research in Agriculture and Farming

Peer-Reviewed, Refereed, Open Access Journal

Thymol Essential Oil as an Alternative to Antibiotics and Naturally Occurring Growth Promoter with their Significant Impacts on GIT of Broiler -A Review

Ahmad Safi*, Hafiz Muhammad Talha Ahsan, Muhammad Imtiaz, Talal Yaqoob

Department of Animal Science, College of Agriculture, University of Sargodha, Sargodha 40100, Pakistan

*Corresponding Author E-mail: ahmadsafi98344@gmail.com

Received: 16.03.2023 | Revised: 29.04.2023 | Accepted: 14.05.2023

ABSTRACT

Background: *Thymol (2-isopropyl-5-methylphenol) is a component of different essential oils and phenolic compounds that are derived from plants belonging to the Lamiaceae family and Monarda genera, and other plants that belong to the Apiaceae, Ranunculaceae and Verbenaceae families.* ***Objectives:*** *The increasing demand for organic meat free of antibiotic residues has derived the focus on naturally occurring plants that can be used in feed as an alternative to antibiotics. The problem with the antibiotics was that they started causing alterations in human health and bacteria became more resistant to antibiotics. In that aspect role of the thymus in poultry performance has been focused to study.* ***Methods:*** *Different articles were collected from Google Scholar database by searching keywords related to thymol and phytogenes. After collecting several articles, they were analyzed.* ***Results:*** *A review of different previous research has shown that thymol possesses many positive properties related to poultry health, naturally occurring antibacterial and antioxidant. It also modulates the immune response and regulates the gut microbial population.* ***Conclusion:*** *With the increasing demand for organic meat and its by-products thymol can be used as a green alternative to improve the performance of poultry chicken without producing any harmful effects.*

Keywords: *Thymol, Poultry production, Essential oil, Antioxidant, Growth Promoter.*

INTRODUCTION

In the past, antibiotics have been used to increase growth rate, greater feed conversion ratio, and decreased mortality but they were banned because of increased antibiotic resistance in poultry and residues of antibiotics in its meat when consumed. When consumed by human beings, poultry meat supplemented with antibiotics developed bacteria resistant to that particular class of antibiotics (Zeng et al., 2015).

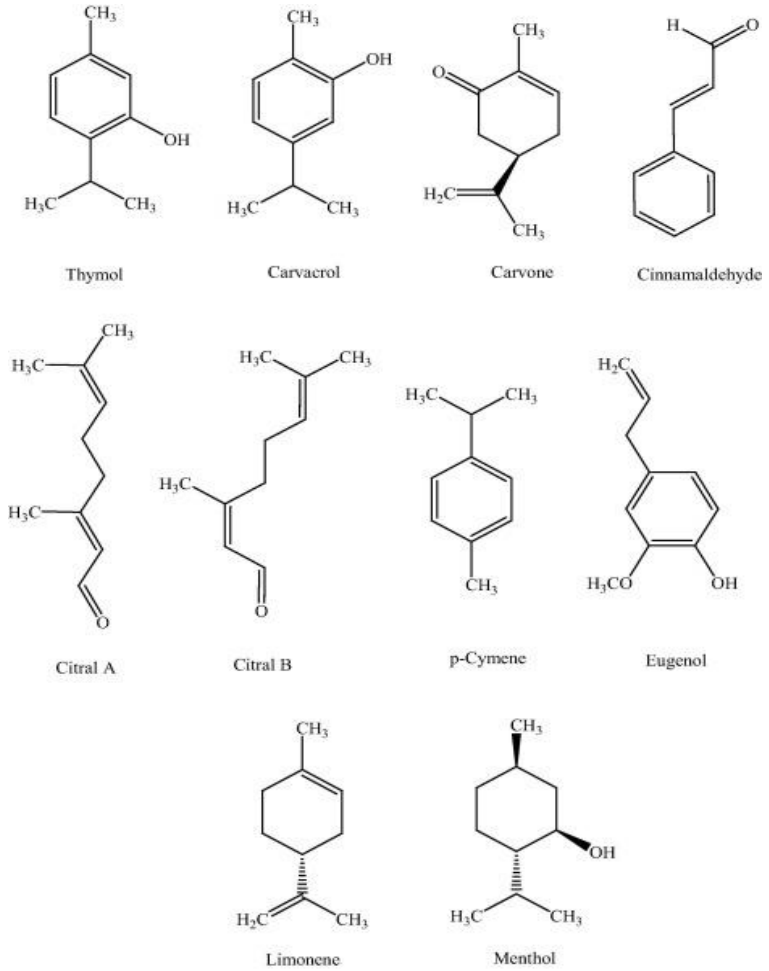
Cite this article: Safi, A., Ahsan, H. M. T., Imtiaz, M., & Yaqoob, T. (2023). Thymol Essential Oil as an Alternative to Antibiotics and Naturally Occurring Growth Promoter with Their Significant Impacts on GIT of Broiler -A Review, *Curr. Rese. Agri. Far. 4*(3), 15-22. doi: http://dx.doi.org/10.18782/2582-7146.197

Following the ban on antibiotics in the feed had driven nutritionists and feed manufacturers to make feed free of antibiotics by using alternatives such as prebiotics, probiotics, and organic acids. But in recent years, there has been an increased interest regarding the use of herbs or plant extracts as natural antioxidants for poultry production because of their action against oxidative stress (Altop et al., 2018). Phytobiotics are plant-derived bioactive compounds also referred to as phytogenic or phytochemicals. Till now more than 8000 Phytobiotics have been found in different parts of different fruits, vegetables nuts, herbs, and grains (Yadav et al., 2016). When these compounds are supplemented in commercial animal diets they showed positive responses in the sense of production, performance, and better feed conversion rates (Gholami-Ahangaran et al., 2021). Essential oils and different photogenic products got their attention because of non-toxic elements, higher availability in nature, and an ideal feed ingredient. Plant-derived compounds having antimicrobial activity include thymol, carvacrol, terpenes, and their precursors (Gholami-Ahangaran et al., 2020).

1.1 Thymol and its importance

Plant-origin-based products have variables composition of compounds because of different environmental factors and processing techniques and Gholami-Ahangaran et al. (2019) written that components of thymol essential oils are thymol and carvacrol, the percentage of both of these components can vary from as low as 3% to as high as 60% depending upon its processing techniques and environmental factors. Skoufos et al. (2020) described that the composition of thymol and carvacrol, making up to 80% of thymol essential oils sometimes can be found only in trace amounts because of greater variability. Factors like which plant part is used, the harvesting season of the plant, and geographical region affect the chemical composition and active contents of essential oils (Gholami-Ahangaran et al., 2022). Plant additives have been showing combined effects as anti-inflammatory, antioxidative, and metabolic regulators for the past two decades. Kikusato (2021) wrote that improved meat and egg quality with increased growth rate in poultry production has been seen when supplemented in feed. Because of properties like antioxidants phytochemicals are being supplemented in the diets of poultry during heat stress (Gholami-Ahangaran et al., 2022). Furthermore, increased digestive enzyme activity and greater absorption capacity are seen when birds are fed with phytochemicals.

For decades, thyme has used been as a traditional medicine because of its various properties like anti-inflammatory, antioxidant, antibacterial and, antifungal. The Thymol constituent of thyme is a naturally occurring antioxidant that scavenges the free radicles produced by enhancing enzymatic activity. Thymus vulgaris, Thymus ciliates, Thymus zygis, thymbra capitate, Thymus pectinatus, and Carum copticum are the plants that contain thymol abundantly (Nagoor Meeran et al., 2017). Some medicinal plants like Origanum compactum, Monarda fistulosa, and T. glandulosus contain thymol while some wildflowers and bee balms of Monarda didyma are natural sources of thymol molecules (El-Hack & Alagawany, 2015).



Structure and chemical composition of Thymol, Carvacrol, Carone, Cinnamaldehyde, Citral A, Citral B, p-Cymene, Eugenol, Limonene, Menthol (Marchese et al., 2016)

In this review article, I have focused on the chemical composition and its bioavailability, antibacterial and antifungal effects of thymol and their possible mechanism underlying its overall effect on growth performance, feed utilization, antioxidant and inflammatory effect. These things are also discussed that why phytoadditives are need of today. In this review, earlier material is on the usefulness of thymol for poultry.

1.2 Biological activity of thymol and its mode of action

The biological activity and mechanism of action of thymol comprises producing desired effect on improving and increasing digestive enzyme activity, feed nutrient bioavailability, and feed utilization, also possessing antioxidant and anti-inflammatory activity (Alavinezhad & Boskabady, 2014). Thymol is a biocide with strong antimicrobial activity. Nostro et al. (2004) described that the use of thymol could reduce bacterial resistance to penicillin and other drugs. The antibacterial activity of phytogenic compounds is linked with their hydrophobicity which disrupts the permeability of cell membrane causing severe effects even death of the cell. Phenolic components of different essential oils like thymol have strongest antibacterial properties, it ruptures the outer membrane of gram-negative bacteria and releases lipopolysaccharides increasing the permeability of the cytoplasmic membrane to ATP and altering the cytoplasmic membrane (Xu et al., 2008).

1.2.1 Growth performance

Windisch et al. (2008) stated that aromatic medicinal plant extract enhances the growth and performance of poultry by increasing the flavor and palatability. Supplementation of thyme essential oil in the feed at 1000mg/kg increased body weight gain by decreasing feed

intake by nearly 10% (Cross et al., 2007). Some researchers reported that there were inconsistent results that can be due to diet formulation, experimental design, dosage, and concentration of active substances, which is why the same essential oil can have different effects because of different environmental and physical factors. Burt (2004) stated that thymol content in oregano essential oil can vary greatly from as low as 5 to as high as 85%.

1.2.2 Feed utilization

The feed conversion ratio is affected greatly by usage of essential oil in the feed because they help microorganisms' population stability and increase nutrient absorption (Gholami-Ahangaran et al., 2022). Furthermore, essential oils enhance digestion by activating enzymes, with improved feed conversion ratio by inactivating insulin sites in the liver (Lee et al., 2003; & Zhu et al., 2021). Supplementation of oregano essential oil at the rate of 1% increased FCR by 1 similarly addition of 600 mg kg^{-1} of oregano essential oil in the feed decreased feed intake and improved feed conversion ratio (Roofchaee et al., 2011). *O. vulgare* L. contained components like 4-terpineol that inhibited aflatoxins, making its use in the feed industry to control aflatoxins in corn and soybean grains (Esper et al., 2014). Another study showed that supplementation of oregano essential oil at the rate of 250 mg kg^{-1} with vitamin C (200mg kg^{-1}) increased body weight and FCR when compared to the feed without these supplementations (Ghazi et al., 2015). Jiang et al. (2007) noted that the amount and activity of pancreatic amylase, maltase, and trypsin increased in poultry when they received different dosages and blends of essential oils.

1.2.3 Thymol as antioxidant

Cells generate free radicles and reactive oxygen intermediates during metabolism. However, whenever these free radicles are accumulated in excessive amounts they start damaging the tissue and disrupt the normal functioning of cells. Luna et al. (2010) reported that inhibition of oxidation of lipids has been seen with essential oil addition in the feed other than synthetic antioxidants such as butylated hydroxytoluene (BHT). Vitamin E and ascorbic acid. Placha et al. (2014) concluded that poultry fed with essential oil having thymol in it showed reduced oxidation by the indication of lower malondialdehyde levels in duodenal mucosa. Supplementation of oregano essential extract (thymol 31% and carvacrol 10%) at the rate of 100 mg kg^{-1} increased the thymol and carvacrol content up to 55.2% and 64.8% respectively (Ramos et al., 2017). Herbal extract having antioxidants when ingested and absorbed, protect the meat from lipid oxidation. The bioavailability mechanism of phenolic compounds influences the determination of antioxidant health benefits.

1.2.4 Immunomodulatory effect

Stimulation of the immune system by using herbal extracts in feed decreases the chances of infectious disease manifestation in the animal (Dhama et al., 2015). Different factors are responsible for immunodeficiency like abuse of antibiotics, failure of vaccination programs, and immune-suppressive disease (Gholami-Ahangaran et al., 2013). Thymol-rich herbs act as antioxidants and extend the activity of vitamin C to improve the immune system (de Cássia et al., 2013). Another study showed that feeding birds with a diet supplemented with phytogenic such as thymol can significantly reduce the risk of disease and boost the immune system (Lillehoj et al., 2011). Including essential oils with thymol and carvacrol improves broiler chickens' humoral and cellular immune responses and increases the ability to deal with infectious disease-causing organisms (Perez-Roses et al., 2015). Most of the phytochemicals inhibit the immune response by targeting the pathogen pattern and eliminating it (Furness et al., 2013).

1.3 Antibacterial and antifungal activities of thymol

Bacteria and fungi are considered mainstream species that affect poultary chicken production. Many species can be controlled by using essential oils and thier related natural oil

products such as thymol and carvacrol. The thymol activity was tested using different methods, but the dish diffusion method was relatively more relable and continuous.

Table: Antimicrobial activity of Thymol and Carvacrol determined by ager dish diffusion method as decribed by Botelho et al. (2007)

Sample	Thymol (50mg/mL)	Carvacrol (50mg/mL)
Incubation zone of Streptococcus mutans (mm)	7.8	8.0
Inhibition Zone of Streptococcus mitis (mm)	15	13
Inhibition Zone of Streptococcus salivarius (mm)	7.7	7.5
Inhibition Zone of Streptococcus sanguis (mm)	16	15

CONCLUSION

This review highlights the importance of plant additives and their use in the diets of poultry chickens. Thymol works as a natural growth promoter by working fully on feed utilization, microbial infection, immunity, and oxidative stress. Thymol prevents adherence of pathogenic loads to the mucosa because of its antimicrobial properties. With the addition of thymol in the feed of birds, greater enzymatic activity and absorption have been seen. Normal gut functioning and overall performance like body weight gain, feed conversion ratio, and nutrient digestibility have been seen to improve much when thymol was supplemented in feed. In general, there are many positive effects of thymol but there is still a lack of precise knowledge about its mode of action, so further research is required to fully know its modes of action.

Acknowledgement:

This creative scientific literature, an acknowledgement, is an expression of gratitude for assistance in creating original work.

Funding:

No Funding for this paper

Conflict of Interest:

There is no conflict of interest between authors.

Author's Contribution:

All authors are contributed equally, and equal response is observed from all authors.

REFERENCES

Abd El-Hack, M. E., & Alagawany, M. (2015). Performance, egg quality, blood profile, immune function, and antioxidant enzyme activities in laying hens fed diets with thyme powder. *Journal of Animal and Feed Science*, *24*(2), 127-133. https://doi.org/10.22358/JAFS%2F65638%2F2015

Alavinezhad, A., & Boskabady, M. H. (2014). Antiinflammatory, antioxidant, and immunological effects of Carum copticum L. and some of its constituents. *Phytotherapy Research*, *28*(12), 1739-1748. https://doi.org/10.1002/ptr.5200

Altop, A., Erener, G., Duru, M. E., & Işık, K. (2018). Effects of essential oils from Liquidambar orientalis Mill. leaves on growth performance, carcass and some organ traits, some blood metabolites and intestinal microbiota in broilers. *British Poultry Science*, *59*, 121-127. https://doi.org/10.1080/00071668.2017.1400657

Botelho, M. A., Nogueira, N. A. P., Bastos, G. M., Fonseca, S. G. C., Lemos, T. L. G., Matos, F. J. A., & Brito, G. A. C. (2007). Antimicrobial activity of the essential oil from Lippia sidoides, carvacrol and thymol against oral pathogens. *Brazilian Journal of Medical and Biological Research*, *40*, 349-356. https://doi.org/10.1590/s0100-879x2007000300010

Burt S. (2004). Essential oils: their antibacterial properties and potential applications in foods--a review. *International Journal of Food*

Microbiology, *94*(3), 223–253. https://doi.org/10.1016/j.ijfoodmicro.2004.03.022

Cross, D. E., McDevitt, R. M., Hillman, K., & Acamovic, T. (2007). The effect of herbs and their associated essential oils on performance, dietary digestibility and gut microflora in chickens from 7 to 28 days of age. *British Poultry Science*, *48*(4), 496–506. https://doi.org/10.1080/00071660701463221

de Cássia da Silveira E Sá, R., Andrade, L. N., Dos Reis Barreto de Oliveira, R., & de Sousa, D. P. (2014). A review on anti-inflammatory activity of phenylpropanoids found in essential oils. *Molecules (Basel, Switzerland)*, *19*(2), 1459–1480. https://doi.org/10.3390/molecules19021459.

Dhama, K., Latheef, S. K., Mani, S., Samad, H. A., Karthik, K., Tiwari, R., & Tufarelli, V. (2015). Multiple Beneficial Applications and Modes of Action of Herbs in Poultry Health and Production-A Review. *International Journal of Pharmacology*, *11*, 152-176. https://doi.org/10.3923/IJP.2015.152.176

Esper, R. H., Gonçalez, E., Marques, M. O. M., Felicio, R. C. & Felicio, J. D. (2014) Potential of essential oils for protection of grains contaminated by aflatoxin produced by Aspergillus flavus. *Frontier in Microbiology*, *5*, 269. https://doi.org/10.3389/fmicb.2014.00269

Furness, J. B., Rivera, L. R., Cho, H. J., Bravo, D. M., & Callaghan, B. (2013). The gut as a sensory organ. Nature reviews. *Gastroenterology and Hepatology*, *10*(12), 729–740. https://doi.org/10.1038/nrgastro.2013.180

Ghazi, S., Amjadian, T., & Norouzi, S. (2015). Single and combined effects of vitamin C and oregano essential oil in diet, on growth performance, and blood parameters of broiler chicks reared under heat stress condition. *International Journal of Biometeorology*, *59*(8), 1019–1024. https://doi.org/10.1007/s00484-014-0915-4

Gholami-Ahangaran, M., Ahmadi-Dastgerdi, A., & Karimi-Dehkordi, M. (2020). Thymol and carvacrol; as antibiotic alternative in green healthy poultry production. *Plant Biotechnology Persa*, *2*(1), 22-25. https://doi.org/10.29252/pbp.2.1.22

Gholami-Ahangaran, M., Fathi-Hafshejani, E., & Seyed-Hosseini, R. (2013). Seromolecular study of chicken infectious anemia in chickens, ostriches, and turkeys in Iran. *The Journal of Applied Poultry Research*, *22*, 404-409. "https://doi.org/10.3382/JAPR.2012-00567"

Gholami-Ahangaran, M., Peimani, N., & Ahmadi-Dastgerdi, A. (2019). The effect of thyme (thymus daenensis) supplement on growth and hygienic parameters of broilers meat. *Iraqi Journal of Veterinary Sciences*, *33*(1), 87–92. https://doi.org/10.33899/ijvs.2019.125526.1048

Gholami-Ahangaran, M., Ahmadi-Dastgerdi, A., Azizi, S., Basiratpour, A., Zokaei, M., & Derakhshan, M. (2022). Thymol and carvacrol supplementation in poultry health and performance. *Veterinary Medicine and Science*, *8*(1), 267–288. https://doi.org/10.1002/vms3.663

Gholami-Ahangaran, M., Karimi-Dehkordi, M., Akbari Javar, A., Haj Salehi, M., & Ostadpoor, M. (2021). A systematic review on the effect of Ginger (Zingiber officinale) on improvement of biological and fertility indices of

sperm in laboratory animals, poultry and humans. *Veterinary Medicine and Science, 7*, 1959-1969. https://doi.org/10.1002/vms3.538

Jiang, I. S., Ko, Y. H., Kang, S. Y., & Lee, C. Y. (2007). Effect of a commercial essential oil on growth performance, digestive enzyme activity and intestinal microflora population in broiler chickens. *Animal Feed Science and Technology, 134*(3-4), 304-315. https://doi.org/10.1016/j.anifeedsci.2006.06.009

Kikusato M. (2021). Phytobiotics to improve health and production of broiler chickens: functions beyond the antioxidant activity. *Animal Bioscience, 34*(3), 345–353. https://doi.org/10.5713/ab.20.0842.

Lee, K. W., Everts, H., Kapperst, H., Yeom, K. H., & Beynen, A. C. (2003). Dietary carvacrol lowers body weight gain but improves feed conversion in female broiler chickens. *Journal of Applied Poultry Research, 12*(4), 394-399. https://doi.org/10.1093/japr/12.4.394

Lillehoj, H. S., Kim, D. K., Bravo, D. M., & Lee, S. H. (2011). Effects of dietary plant-derived phytonutrients on the genome-wide profiles and coccidiosis resistance in the broiler chickens. *BMC proceedings, 5* Suppl 4(Suppl 4), S34. https://doi.org/10.1186/1753-6561-5-S4-S34

Luna, A., Lábaque, M. C., Zygadlo, J. A., & Marin, R. H. (2010). Effects of thymol and carvacrol feed supplementation on lipid oxidation in broiler meat. *Poultry Science, 89*(2), 366–370. https://doi.org/10.3382/ps.2009-00130

Kowalczyk, A., Przychodna, M., Sopata, S., Bodalska, A., & Fecka, I. (2020). Thymol and thyme essential oil—new insights into selected therapeutic applications. *Molecules, 25*(18), 4125. https://doi.org/10.3390/molecules25184125

Marchese, A., Orhan, I. E., Daglia, M., Barbieri, R., Di Lorenzo, A., Nabavi, S. F., Gortzi, O., Izadi, M., & Nabavi, S. M. (2016). Antibacterial and antifungal activities of thymol: A brief review of the literature. *Food Chemistry, 210*, 402–414. https://doi.org/10.1016/j.foodchem.2016.04.111

Nagoor Meeran, M. F., Javed, H., Al Taee, H., Azimullah, S., & Ojha, S. K. (2017). Pharmacological Properties and Molecular Mechanisms of Thymol: Prospects for Its Therapeutic Potential and Pharmaceutical Development. *Frontiers in Pharmacology, 8*, 380. https://doi.org/10.3389/fphar.2017.00380

Nostro, A., Blanco, A. R., Cannatelli, M. A., Enea, V., Flamini, G., Morelli, I., Sudano Roccaro, A., & Alonzo, V. (2004). Susceptibility of methicillin-resistant staphylococci to oregano essential oil, carvacrol and thymol. *FEMS Microbiology Letters, 230*(2), 191–195. https://doi.org/10.1016/S0378-1097(03)00890-5

Pérez-Rosés, R., Risco, E., Vila, R., Peñalver, P., & Cañigueral, S. (2015). Effect of some essential oils on phagocytosis and complement system activity. *Journal of Agricultural and Food Chemistry, 63*(5), 1496–1504. https://doi.org/10.1021/jf504761m

Placha, I., Takacova, J., Ryzner, M., Cobanova, K., Laukova, A., Strompfova, V., Venglovska, K., & Faix, S. (2014). Effect of thyme essential oil and selenium on intestine integrity and antioxidant status of broilers. *British Poultry Science, 55*(1), 105–114. https://doi.org/10.1080/00071668.2013.873772

Ramos, F., El Guezzar, M., Greson, M., & Wiame, J. M. (1985). Mutations affecting the enzymes involved in the utilization of 4-aminobutyric acid as

nitrogen source by the yeast Saccharomyces cerevisiae. *European Journal of Biochemistry, 149*, 401-404. https://doi.org/10.1111/j.1432-1033.1985.tb08939.x

Roofchaee, A., Irani, M., Ebrahimzadeh, M. A., & Akbari, M. R. (2011). Effect of dietary oregano (Origanum vulgare L.) essential oil on growth performance, cecal microflora and serum antioxidant activity of broiler chickens. *African Journal of Biotechnology*, *10*(32), 6177-6183. https://doi.org/10.1080/1828051X.2016.1274243

Skoufos, I., Bonos, E., Anastasiou, I., Tsinas, A., & Tzora, A. (2020). Effects of phytobiotics in healthy or disease challenged animals. *Feed Aditives*, pp. 311-337. https://doi.org/10.1016/B978-0-12-814700-9.00018-2

Windisch, W., Schedle, K., Plitzner, C., & Kroismayr, A. (2008). Use of phytogenic products as feed additives for swine and poultry. *Journal of Animal Science*, *86*(14 Suppl), E140–E148. https://doi.org/10.2527/jas.2007-0459

Xu, J., Zhou, F., Ji, B. P., Pei, R. S., & Xu, N. (2008). The antibacterial mechanism of carvacrol and thymol against Escherichia coli. *Letters in Applied Microbiology*, *47*(3), 174–179. https://doi.org/10.1111/j.1472-765X.2008.02407.x

Yadav, A. S., Kolluri, G., Gopi, M., Karthik, K., Malik, Y. S., & Dhama, K. (2016). Exploring alternatives to antibiotics as health promoting agents in poultry - a review. *Journal of Experimental Biology and Agricultural Sciences*, *4*, 368–383. https://doi.org/10.18006/2016.4%283S%29.368.383

Zhu, Q., Sun, P., Zhang, B., Kong, L., Xiao, C., & Song, Z. (2021). Progress on Gut Health Maintenance and Antibiotic Alternatives in Broiler Chicken Production. *Frontier in Nutrition*, *8*, 692839. https://doi.org/10.3389/fnut.2021.692839

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), 7. https://doi.org/10.1186/s40104-015-0004-5