Phytochemicals as Anthelmintic Agents in the Battling against *Ascaridia galli*: a Review

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Abstract

Ascaridia galli is the most pathogenic parasite in the poultry industry. *A. galli* causes significant impact on the country's economy. Different anthelmintic drugs were used in the past to treat this parasite. By the use of same kind of drugs, *A. galli* developed resistance and drug residue was found in the poultry products. It is necessary to deal with this problem. Plant-derived compounds are increasingly acknowledged as sustainable and efficient substitutes for synthetic anthelmintics in poultry husbandry, providing advantages such as enhanced gut health and immunity while mitigating drug resistance. Nonetheless, their inconsistent efficacy due to variations in composition and potential toxicity necessitates careful dosage optimization and residue analysis to ensure safety for human consumption of poultry products. Plant-based compounds have the potential to revolutionize poultry farming by providing natural, cost-effective solutions to *A. galli* infections and drug resistance, but further research is needed to standardize active compounds.

Keywords: Poultry, *Ascaridia galli*, Anthelmintic, Phytochemical, Effective Alternatives, Plants

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Introduction

Poultry is one of the largest industries globally, playing a crucial role in the economies of developing countries and significantly contributing to poverty alleviation (Abebe and Gugsa, 2018). Poultry products, including eggs and meat, are widely consumed worldwide, with poultry meat being the second largest source of food at a global level (FAOSTAT, 2016). Globally, poultry egg production reaches approximately 73 million tons annually, while poultry meat production stands at around 100 million tons. Broilers, backyard poultry, and layers contribute 92, 2, and 6% respectively to overall poultry meat production (Gleam, 2016). Asia dominates global poultry production, with significant growth in recent years outpacing other continents (Tucker et al., 2007; Kandeel et al., 2022). Approximately 42 billion broilers are produced annually worldwide (Jamil et al., 2022). However, the poultry industry faces significant losses due to parasitic infections (Dinka et al., 2010), which negatively impact bird health by disrupting metabolism and immunity (Khater, 1993; Abbas et al., 2015). Among these parasites, nematodes, cestodes, and *Eimeria* species are the primary culprits causing economic losses in poultry production (Puttalakshmamma et al., 2008). The roundworm *Ascaridia galli* is one of the most common nematodes in poultry. Its adult stage resides in the small intestine, where it absorbs nutrients, causing substantial damage (Zaman et al., 2020).

A. galli is the most pathogenic parasite which belongs to the phylum Nematoda. It is most common in the egg laying hens and flocks up to 64.8%. In the poultry industry, 22 to 84% infection was due to this parasite (Sharma et al., 2018). The prevalence and risk rate of *A. galli* are higher in free-range chickens than in cage hens, and this varies depending on the production system (Green et al., 2013). Globally, the free-range systems are commonly found in the Germany, Sweden, Bangladesh, Tanzania, and India, where the prevalence of ascaridiasis is 88, 77.1, 61, 32.3 and 32.97%, respectively. In contrast, the countries where cage system is common i.e. Serbia and Ghana where the infection of ascaridiasis is lower as 15.6-24 and 30%, respectively (Shohana et al., 2023). The prevalence of ascaridiasis in Pakistan varies from 24.5 to 52.17%, depending upon the different provinces and poultry systems. *A. galli* infection in Baluchistan was reported 52.17% in migratory quails which have serious threat of spreading infection in the poultry (Faizullah et al., 2022). In Punjab, there were 24.5% of government poultry farms (Bachaya et al., 2015). However, limited data is available on the prevalence of *A. galli* in Sindh province.

1. Life Cycle

Ascaridia galli is the most common in chicken, pigeons, and wild birds. It primarily affects the duodenum; part of small intestine. Where A. galli eggs hatched and larvae move freely there initially. During the first 8 to 9 days, it caused serious hemorrhages. After the 18 days, when the larvae became worms, it enters in the lumen and attached with lumen walls. The worms became mature with 28 to 30 days, when a chicken ingest the eggs (Al-Quraishi et al., 2020). There is two way of getting ascaridiasis infection in chicken either by direct ingestion of eggs or by the intermediate host i.e. earthworms and grasshoppers. The direct ingest of *A. galli* eggs harms the poultry industry by acting as a vector for other different diseases; *Salmonella enterica*, exacerbating health risks and production losses; in the organisms. This parasite causes anemia also decline the productivity of the chicken and the farmers also faced economic challenges due to this parasite. Moreover, different therapeutic controlling strategies is being in processed which help in the mitigation the effect of the *A. galli* infection (Figure 1) (Tarbiat et al., 2020).

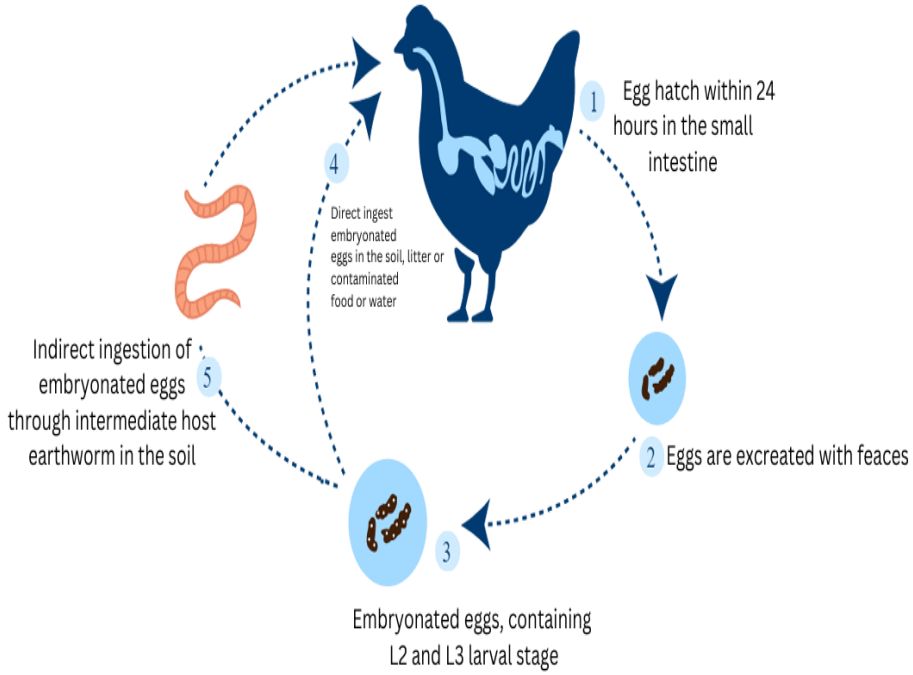

Fig. 1: Life cycle of *Ascaridia galli*

2. ControllingStrategies of *Ascaridia galli*

2.1. Anthelmintic Drugs used against *Ascaridia galli*

The control of *A. galli* is the main issue as it causes serious impact on the country economy. Globally, synthetic drugs are considered as the primary controlling method to prevent this parasitic infection in the past (Sarfaraz et al., 2024). There are different anthelmintics drugs are used to control the *A. galli* infection in poultry i.e. albendazole, benzimidazole, fenbendazole, ivermectin, levamisole, and piperazine. The most effective drug among them is the fenbendazole because of its mechanism action (Bazh and El-Bahy, 2013; Yazwinski et al., 2013; Umar et al., 2018). It bind with a protein i.e. tubulin, in nematodes. By doing this it disrupts the formation of part of cytoskeleton which is microtubules, which results in restriction of glucose uptake, due to which glycogen depletion occur, paralysis, energy system failure and which lead to the death of the parasite (Duwel, 1977; Tarbiat et al., 2017). Similarly, fenbendazole and flubendazole are the drugs which is effective at the adult stage of the *A. galli* helpful in egg shedding reduction. Which are administered orally by mixing in the water. However, some studies have shown effective treatment results against *Ascaridia dissimilis* (Hoglund and Jason, 2011; Collins et al., 2019). The use of same anthelmintics against the *A. galli* infection, it gives raises to the resistance over the time (Tarbiat et al., 2017).

2.1.1. Limitations of using Anthelmintic Drug

2.1.1.1. Development of Drug Resistance

Anthelmintic resistance is a significant challenge for the poultry industry. Despite advances in the manufacturing of anthelmintics that target nematodes, resistance remains a chronic issue. The emerging resistance to *Ascaridia galli* is mostly due to inappropriate anthelmintic dose and administration. Fenbendazole, recognized for its unique mechanism of action, is given by water and efficiently minimizes egg shedding. However, one significant disadvantage is its limited effectiveness, as certain nematodes, such as *Ascaris dissimilis*, can survive therapy. Due to this limitation, there is need to develop an alternative controlling method to deal with this raising problem of drug resistance against the *A. galli*. Infections in the chicken, as various studies have described this problem throughout the world (Abbas et al., 2025).

2.1.1.2. Presence of Drug Residue

Anthelmintic drugs like benzimidazoles (such as flubendazole and fenbendazole), imidazothiazoles (such as levamisole), tetrahydro pyrimidines (e.g., piperazine), macrocyclic lactones (such as ivermectin). Now a day two benzimidazoles drugs are used to treat the *A. galli* infection in chicken i.e. Flubendazole and levamisole. The excess use of these drugs give rise to the drug residual in the products (Patel et al., 2018; Zirintunda et al., 2022). So, it is necessary to cope this problem with effective alternative strategies.

2.2. Alternative Approach to Anthelmintic Drugs

Anthelmintic resistance in poultry causes both direct and indirect losses, offering considerable problems to the business. According to studies, rising global temperatures increase the possibility of anthelmintic resistance (Yazwinski et al., 2013). Phytochemicals are being investigated as potential alternatives to synthetic anthelmintics, especially against resistant parasite strains (Mahdi et al., 2019; Mirza et al., 2020; Aslam et al., 2021). Plants contain several phytochemical components work in ways comparable to synthetic anthelmintics to control the parasite. Like saponins thatworks similar to praziquantel (Wang et al., 2010). Phytochemicals are the agents that act as arm forced in fighting against the *A. galli* infection.

2.2.1. Phytotherapy against *Ascaridia galli*

Phytotherapy is the use of plants part or whole in controlling the *A. galli* infection in the chicken. Different phytochemicals of plants are used in different studies (Nouri et al., 2016). Resulting, these are considered in improving the feed intake of the chicken. It also stimulates the digestive enzyme and hormonal secretion and also improve stomach and intestine function (Al-Snafi, 2016; Kholif et al., 2018; Wang et al., 2018).

Sarfaraz et al. (2025) reports numerous biological activities have been demonstrated by plants, such as antibacterial (Nabavi et al., 2015; Abd El-Hack et al., 2018; Doğan et al., 2018; Zhang et al., 2018; Dorla et al., 2019), anticoccidial (Sundar et al., 2017; Abbas et al., 2019; Zhang et al., 2020), anthelmintic (Romero Benavides et al., 2017; Abo-El-Sooud, 2018; Lopez et al., 2018; Collins et al., 2019; Fayaz et al., 2019; Nghonjuyi et al., 2020; Symeonidou et al., 2020), antiviral (Goswami et al., 2016; Mahmood et al., 2018; Kushwaha et al., 2019; Andleeb et al., 2020), anti-inflammatory, and antioxidant properties (Mgbeahuruike et al., 2017; Kiran et al., 2018; Mohammadi Gheisar and Kim, 2018). The primary components responsible for the medicinal and health-promoting benefits of these plants are their secondary metabolites (SMBs), which are mostly responsible for their bioactivity (Christaki et al., 2012; Bozkurt et al., 2013).

2.3. Plants Action Mechanism as an Anthelmintic

Terpenoids (TPs) have been identified as active chemicals in different plants. TPs damage parasites' intestinal tracts by interfering with tubulin polymerization, which eventually results in starvation and death (Jain et al., 2013). Moreover, TPs cause intestinal inflammation in the host, upsetting homeostasis and making conditions unfavorable for intestinal parasites (Borba et al., 2010). *Ascaridia galli* are susceptible to the neurotoxic effects of certain TPs, including thymol and carvacrol, which interact with the tyramine receptor Ser-2 (Kaplan et al., 2014; Symeonidou et al., 2018). Another type of TP, triterpenes, can interfere with the reproductive cycle of *A. galli* by disrupting reproduction through their hormonal activities (Van Krimpen et al., 2010; Ali et al., 2011). Moreover, TPs can damage *A. galli's* membrane integrity, upsetting pH and the organic ion balance (Lambert et al., 2001). Phytochemicals are crucial for preserving gut health, enhancing nutrient uptake, and strengthening the immune system. Their cost-effectiveness and widespread availability have led to their growing inclusion in poultry feed as natural growth promoters and alternatives to antibiotics. The application of plant-based anthelmintics, despite their promise, is still restricted in developing countries, primarily due to insufficient research and a lack of awareness. Additional research is crucial to deepen our knowledge of phytochemicals and to formulate effective methods for safeguarding poultry against the economic impacts of parasitic infections (Ahmad et al., 2023).

2.4. Challenges of using Plants for Controlling *A. galli*

A significant challenge in using plants as anthelmintics lies in the standardization of their active compounds. The efficacy of plant-based treatments can vary widely depending on geographical location, season, species, subspecies, harvesting time, and the specific plant parts used. Additionally, the methods employed for processing plants can alter the composition of their phytochemicals. The choice of solvent for extracting plant materials also influences the concentration and composition of these compounds. Furthermore, some plants contain toxins that can harm poultry if used excessively. Therefore, it is essential to conduct comprehensive studies to determine the advantage and potential risks of plant-based compounds in poultry. These studies should focus on determining optimal dosages and identifying harmful levels of ingestion (Wu et al., 2004; Bozkurt et al., 2013). The study of residue isalso necessary before plants can be safely incorporated into poultry management systems. This ensures that no harmful residues are carried over into eggs and meat, safeguarding both animal health and consumer safety.

Conclusion

Ascaridia galli is the most pathogenic and prevalent nematode which cause negative impact on the global economy. Due to the development of drug resistance and residue it is necessary to move to the alternative strategy. Plants are considered as the cheap, easily available and reachable to the poor farmers. Plants based treatment helpful in poultry growth and improve the digestive function with less toxic effects. Standardization and possible toxicity issues in the actual use of plant-derived substances are made worse by elements like geographic variations, collecting practices, ways of processing, and extraction techniques. To minimize toxicity issues, maximize their use, and establish safe and efficient dosages, extensive study is required. To ensure that herbal treatments do not compromise the safety of poultry products, including meat and eggs, residue investigations are also crucial. With further investigation, plant-based solutions could provide effective and practical alternatives to synthetic anthelmintics in the management of poultry.

References

Abbas, R. Z., Qureshi, M. A., & Saeed, Z. (2025). Botanical compounds: A promising control strategy against Trypanosoma cruzi. Boletín Latinoamericano y del Caribe de Plantas Medicinales y Aromáticas, 24(3), 308-327.

Abbas, A., Abbas, R. Z., Khan, M. K., Raza, M. A., Mahmood, M. S., Saleemi, M. K., & Sindhu, Z. U. D. (2019). Anticoccidial effects of *Trachyspermum ammi* (Ajwain) in broiler chickens. *Pakistan Veterinary Journal*, *39*(2), 301-304.

Abbas, A., Iqbal, Z., Abbas, R. Z., Khan, M. K., & Khan, J. A. (2015). In-vitro anticoccidial potential of Saccharum officinarum extract against Eimeria oocysts. *Boletinlatino Americano y del Caribe de Plant as Medicinales y Aromaticas*, *14*(6), 456-461.

Abd El-Hack, M. E., Samak, D. H., Noreldin, A. E., El-Naggar, K., & Abdo, M. (2018). Probiotics and plant-derived compounds as eco-friendly agents to inhibit microbial toxins in poultry feed: a comprehensive review. *Environmental Science and Pollution Research*, *25*, 31971-31986. https://doi.org/10.1007/s11356-018-3197-2

Abd El-Hack, M. E., Samak, D. H., Noreldin, A. E., El-Naggar, K., & Abdo, M. (2018). Probiotics and plant-derived compounds as eco-friendly agents to inhibit microbial toxins in poultry feed: a comprehensive review. *Environmental Science and Pollution Research*, *25*, 31971-31986. https://doi:10.1007/s11356-018-3197-2

Abebe, E., & Gugsa, G. (2018). A review on poultry coccidiosis. *Abyssinia Journal of Science and Technology*, *3*(1), 1-12.

Abo-EL-Sooud, K. (2018). Ethnoveterinary perspectives and promising future. *International Journal of Veterinary Science and Medicine*, *6*(1), 1-7.

Ahmad, S., Humak, F., Ahmad, M., Altaf, H., Qamar, W., Hussain, A., & Mughal, M. A. S. (2023). Phytochemicals as alternative anthelmintics against poultry parasites: a review. *Agrobiological Records*. 12, 34-45. https://doi.org/10.47278/journal.abr/2023.015

Ali, N., Shah, S. W. A., Shah, I., Ahmed, G., Ghias, M., & Khan, I. (2011). Cytotoxic and anthelmintic potential of crude saponins isolated from Achillea Wilhelmsii C. Koch and Teucrium Stocksianumboiss. *BMC Complementary and Alternative Medicine*, *11*, 1-7. https://doi.org/10.1186/1472-6882-11-106

Al-Quraishi, M. A., Al-Musawi, H. S., & Al-Haboobi, Z. A. M. (2020). Pathological study of Ascaridia galli in poultry. *EurAsian Journal of BioSciences*, *14*(2), 3327-3329.

Al-Snafi, A. E. (2016). Antiparasitic effects of medicinal plants (part 1)-A review. *IOSR Journal of Pharmacy*, *6*(10), 51-66.

Andleeb, R., Ashraf, A., Muzammil, S., Naz, S., Asad, F., Ali, T., & Mahboob, S. (2020). Analysis of bioactive composites and antiviral activity of Iresineherbstii extracts against Newcastle disease virus in ovo. *Saudi Journal of Biological Sciences*, *27*(1), 335-340.

Aslam, M., Aslam, U., & Dur-e-Najaf, H. (2022). Honey: A miraculous drug. *Agrobiological Records*, *10*, 59-73. https://doi.org/10.47278/journal.abr/2022.027

Bachaya, H. A., Raza, M. A., Anjum, M. A., Khan, I. A., Abdul Aziz, A. A., Zahid Manzoor, Z. M., & Munawar, S. H. (2015). Prevalence of Ascaridia galli in white leghorn layers and Fayoumi-Rhode Island red crossbred flock at government poultry farm Dina, Punjab, Pakistan, 32(1), 11-16.

Bazh, E. K., & El-Bahy, N. M. (2013). In vitro and in vivo screening of anthelmintic activity of ginger and curcumin on Ascaridia galli. *Parasitology Research*, *112*(11), 3679-3686.

Borba, H. R., Freire, R. B., Albuquerque, A. C., Cardoso, M. E. O., Braga, I. G., Almeida, S. T. P., & Dire, G. F. (2010). Anthelmintic comparative study of Solanum lycocarpum St. Hill extracts in mice naturally infected with Aspiculuris tetraptera. *Nature and Science, 8*(4), 95-100.

Bozkurt, M., Giannenas, I., Küçükyilmaz, K., Christaki, E., & Florou-Paneri, P. (2013). An update on approaches to controlling coccidia in poultry using botanical extracts. *British Poultry Science*, *54*(6), 713-727.

Christaki, E., Bonos, E., Giannenas, I., & Florou-Paneri, P. (2012). Aromatic plants as a source of bioactive compounds. *Agriculture*, *2*(3), 228-243.

Collins, J. B., Jordan, B., Baldwin, L., Hebron, C., Paras, K., Vidyashankar, A. N., & Kaplan, R. M. (2019). Resistance to fenbendazole in Ascaridiadissimilis, an important nematode parasite of turkeys. *Poultry Science*, *98*(11), 5412-5415.

Doğan, A. N. C., Çelik, E., Kılıçle, P. A., Atalay, E., Sağlam, A. G., Doğan, A., &Otlu, S. (2018). Antibacterial Effect of Hot Peppers (Capsicum annuum, Capsicum annuum var globriusculum, Capsicum frutescens) on Some Arcobacter, Campylobacter and Helicobacter Species. *Pakistan Veterinary Journal*, *38*(3), 266-270.

Dorla, E., Grondin, I., Hue, T., Clerc, P., Dumas, S., Gauvin-Bialecki, A., & Laurent, P. (2019). Traditional uses, antimicrobial and acaricidal activities of 20 plants selected among Reunion Island's flora. *South African Journal of Botany*, *122*, 447-456. https://doi.org/10.1016/j.sajb.2018.04.014

Düwel, D. (1977). Fenbendazole. II. Biological properties and activity. *Pesticide Science*, *8*(5), 550-555.

Faizullah, Jan, S. U., Taj, K., Akbar, M., Sattar, A., & Akbar, H. (2022). Morphological and molecular evidences of Ascaridia galli in migratory quail Coturnix coturnix japonica from Baluchistan Pakistan. *Brazilian Journal of Biology*, *82*, e258647. https://doi.org/10.1590/1519-6984.258647

FAOSTAT 2016. FAO statistical database, accessed in July 2016. https://www.fao.org › faostat

Fayaz, M. R., Abbas, R. Z., Abbas, A., Khan, M. K., Raza, M. A., Israr, M., & Zaman, M. A. (2019). Potential of botanical driven essential oils against Haemonchuscontortus in small ruminants. *Boletín Latinoamericano y del Caribe de Plantas Medicinales y Aromáticas*, *18*(6), 533-543.

Gleam 2.0. (2016). Global Livestock Environmental Assessment Model. FAO, Rome. Available at http:// www.fao.org/gleam.

Goswami, D., Mukherjee, P. K., Kar, A., Ojha, D., Roy, S., & Chattopadhyay, D. (2016). Screening of ethnomedicinal plants of diverse culture for antiviral potentials, 15: 474–481. http://nopr.niscpr.res.in/handle/123456789/34290

Green, L. E., & Cornell, S. J. (2013). The Effects of Cage and Free-range Rearing on the Welfare of Laying Hens. *Animals*, 3(2), 398-415

Höglund, J., & Jansson, D. S. (2011). Infection dynamics of Ascaridia galli in non-caged laying hens. *Veterinary Parasitology*, *180*(3-4), 267-273.

Dinka, H., Chala, R., Dawo, F., Bekana, E., & Leta, S. (2010). Major constraints and health management of village poultry production in Rift Valley of Oromia, Ethiopia. *American-Eurasian Journal of Agricultural and Environmental Sciences*, *9*(5), 529-33.

Faizullah, Jan, S. U., Taj, K., Akbar, M., Sattar, A., & Akbar, H. (2022). Morphological and molecular evidences of Ascaridia galli in migratory quail Coturnix coturnix japonica from Baluchistan Pakistan. *Brazilian Journal of Biology*, 82, 258647. https://doi.org/10.1590/1519-6984.258647

Jain, P., Singh, S., Singh, S. K., Verma, S. K., Kharya, M. D., & Solanki, S. (2013). Anthelmintic potential of herbal drugs. *International journal of research and Development in Pharmacy and Life Sciences*, *2*(3), 412-427.

Jamil, M., Aleem, M. T., Shaukat, A., Khan, A., Mohsin, M., Rehman, T. U., & Li, K. (2022). Medicinal plants as an alternative to control poultry parasitic diseases. *Life*, *12*(3), 449.

Kandeel, M., Akhtar, T., Zaheer, T., Ahmad, S., Ashraf, U., & Omar, M. (2022). Anti-parasitic Applications of Nanoparticles: A Review. *Pakistan Veterinary Journal*, *42*(2), 135-140.

Kaplan, R. M., Storey, B. E., Vidyashankar, A. N., Bissinger, B. W., Mitchell, S. M., Howell, S. B., &Skrypec, D. J. (2014). Antiparasitic efficacy of a novel plant-based functional food using an Ascaris suum model in pigs. *Acta Tropica*, *139*, 15-22. https://doi.org/10.1016/j.actatropica.2014.06.008

Khater, H. F. (1993). Studies on enteric helminth parasites in domestic birds. https://agris.fao.org/search/en/providers/122598/records/6472251b77fd37171a72a516

Kholif, A. E., Gouda, G. A., Anele, U. Y., & Galyean, M. L. (2018). Extract of Moringa oleifera leaves improves feed utilization of lactating Nubian goats. *Small Ruminant Research*, *158*, 69-75. https://doi.org/10.1016/j.smallrumres.2017.10.014

Kiran, K., Saleem, F., Awan, S., Ahmad, S., Ahmad, S., Arshad Malik, M. A., & Sharif, A. (2018). Anti-Inflammatory and Anticancer Activity of Pteris cretica Whole Plant Extracts. *Pakistan Veterinary Journal*, *38*(3), 225–230.

Kushwaha, N. K., Hafrén, A., & Hofius, D. (2019). Autophagy–virus interplay in plants: from antiviral recognition to proviral manipulation. *Molecular Plant Pathology*, *20*(9), 1211-1216.

Lambert, R. J. W., Skandamis, P. N., Coote, P. J., &Nychas, G. J. (2001). A study of the minimum inhibitory concentration and mode of action of oregano essential oil, thymol and carvacrol. *Journal of Applied Microbiology*, *91*(3), 453-462.

Lopez, D., Cherigo, L., de Sedas, A., Spadafora, C., & Martinez-Luis, S. (2018). Evaluation of antiparasitic, anticancer, antimicrobial and hypoglycemic properties of organic extracts from Panamanian mangrove plants. *Asian Pacific Journal of Tropical Medicine*, *11*(1), 32-39.

Mahdi, A. A., Rashed, M. M., Al-Ansi, W., Ahmed, M. I., Obadi, M., Jiang, Q., & Wang, H. (2019). Enhancing bio-recovery of bioactive compounds extracted from Citrus medica L. Var. sarcodactylis: optimization performance of integrated of pulsed-ultrasonic/microwave technique. *Journal of Food Measurement and Characterization*, *13*, 1661-1673. https://doi.org/10.1007/s11694-019-00083-x

Mahmood, M. S., Amir, H. W., Abbas, R. Z., Bilal Aslam, B. A., & Azhar Rafique, A. R. (2018). Evaluation of antiviral activity of Azadirachta indica (Neem) bark extract against Newcastle disease virus, 38(1),25–28.

Mgbeahuruike, E. E., Yrjönen, T., Vuorela, H., & Holm, Y. (2017). Bioactive compounds from medicinal plants: Focus on Piper species. *South African Journal of Botany*, *112*, 54-69. https://doi.org/10.1016/j.sajb.2017.05.007

Mirza, Z., Soto, E. R., Hu, Y., Nguyen, T. T., Koch, D., Aroian, R. V., & Ostroff, G. R. (2020). Anthelmintic activity of yeast particle-encapsulated terpenes. *Molecules*, *25*(13), 2958.

Mohammadi Gheisar, M., & Kim, I. H. (2018). Phytobiotics in poultry and swine nutrition–a review. *Italian Journal of Animal Science*, *17*(1), 92-99.

Nabavi, S. M., Marchese, A., Izadi, M., Curti, V., Daglia, M., & Nabavi, S. F. (2015). Plants belonging to the genus Thymus as antibacterial agents: From farm to pharmacy. *Food Chemistry*, *173*, 339-347. https://doi.org/10.1016/j.foodchem.2014.10.042

Nghonjuyi, N. W., Keambou, C. T., Sofeu-Feugaing, D. D., Taiwe, G. S., Aziz, A. R. A., Lisita, F., ... & Kimbi, H. K. (2020). Mimosa pudica and Carica papaya extracts on Ascaridia galli-Experimentally infected Kabir chicks in Cameroon: Efficacy, lipid and hematological profile. *Veterinary Parasitology: Regional Studies and Reports*, *19*, 100354. https://doi.org/10.1016/j.vprsr.2019.100354

Nouri, F., Nourollahi-Fard, S. R., Foroodi, H. R., & Sharifi, H. (2016). In vitro anthelmintic effect of Tobacco (Nicotiana tabacum) extract on parasitic nematode, Marshallagiamarshalli. *Journal of Parasitic Diseases*, *40*, 643-647. https://doi.org/10.1007/s12639-014-0550-3

Patel, T., Marmulak, T., Gehring, R., Pitesky, M., Clapham, M. O., & Tell, L. A. (2018). Drug residues in poultry meat: A literature review of commonly used veterinary antibacterials and anthelmintics used in poultry. *Journal of Veterinary Pharmacology and Therapeutics*, *41*(6), 761-789.

Puttalakshmamma, G. C., Mamatha, P. R., & Rao, S. (2008). Prevalence of gastrointestinal parasites of poultry in and around Banglore. *Veterinary World*, *1*(7), 201.

Romero-Benavides, J. C., Ruano, A. L., Silva-Rivas, R., Castillo-Veintimilla, P., Vivanco-Jaramillo, S., & Bailon-Moscoso, N. (2017). Medicinal plants used as anthelmintics: Ethnomedical, pharmacological, and phytochemical studies. *European Journal of Medicinal Chemistry*, *129*, 209-217. https://doi.org/10.1016/j.ejmech.2017.02.005

Sarfaraz, M. Z., Abbas, S., Zaman, M. A., Parveen, A., Kousar, S., Bosire, E. M., Zulqarnain, M., Khalil, I., and Bibi, S., (2024). Phytotherapy against eimeriosis; as an alternative approach to synthetic drug. In: Abbas RZ, Khan AMA, Qamar W, Arshad J and Mehnaz S (eds), Complementary and Alternative Medicine: Botanicals/Homeopathy/Herbal Medicine. Unique Scientific Publishers, Faisalabad, Pakistan, pp: 150-156. https://doi.org/10.47278/book.CAM/2024.241

Sarfaraz, M. Z., Abbas, S., Zaman, M. A., Parveen, A., Kousar, S., & Zulqarnain, M. (2025). A Step Forward to Revolutionize the Eimeriosis Controlling Strategies in Cattle by Using Traditional Medication. *Available at SSRN 5062922*.https://papers.ssrn.com/sol3/papers.cfm?abstract_id=5062922

Sharma, N., Hunt, P. W., Hine, B. C., McNally, J., Sharma, N. K., Iqbal, Z., & Ruhnke, I. (2018). Effect of an artificial Ascaridia galli infection on egg production, immune response, and liver lipid reserve of free-range laying hens. *Poultry Science*, *97*(2), 494-502.

Shohana, N. N., Rony, S. A., Ali, M. H., Hossain, M. S., Labony, S. S., Dey, A. R., & Anisuzzaman. (2023). Ascaridia galli infection in chicken: Pathobiology and immunological orchestra. *Immunity, Inflammation and Disease*, *11*(9), 1001.

Sundar, S. B., Harikrishnan, T. J., Latha, B. R., Chandra, G. S., & Kumar, T. M. S. A. (2017). Anticoccidial drug resistance in chicken coccidiosis and promising solutions: A review. *Journal of Entomology and Zoology Studies*, *5*(4), 1526-1529.

Symeonidou, I., Bonos, E., Moustakidis, K., Florou-Paneri, P., Christaki, E., & Papazahariadou, M. (2018). Botanicals: a natural approach to control ascaridiosis in poultry. *Journal of the Hellenic Veterinary Medical Society*, *69*(1), 711-722.

Tarbiat, B., Jansson, D. S., Tydén, E., & Höglund, J. (2017). Evaluation of benzimidazole resistance status in Ascaridia galli. *Parasitology*, *144*(10), 1338-1345.

Tarbiat, B., Jansson, D. S., Wall, H., Tydén, E., & Höglund, J. (2020). Effect of a targeted treatment strategy against Ascaridia galli on egg production, egg quality and bird health in a laying hen farm. *Veterinary Parasitology*, *286*, 109238. https://doi.org/10.1016/j.vetpar.2020.109238

Tucker, C. A., Yazwinski, T. A., Reynolds, L., Johnson, Z., & Keating, M. (2007). Determination of the anthelmintic efficacy of albendazole in the treatment of chickens naturally infected with gastrointestinal helminths. *Journal of Applied Poultry Research*, *16*(3), 392-396.

Umar, S., Abbas, S., Irfan Khan, M., Nisa, Q. U., Younus, M., Aqil, K., & Ali Shah, M. (2018). Safety of fenbendazole in common peafowl (Pavo cristatus). *Pakistan Journal of Pharmaceutical Sciences*, *31*(1), 159–167

Van Krimpen, M. M., Binnendijk, G. P., Borgsteede, F. H. M., & Gaasenbeek, C. P. H. (2010). Anthelmintic effects of phytogenic feed additives in Ascaris suum inoculated pigs. *Veterinary Parasitology*, *168*(3-4), 269-277.

Wang, G. X., Han, J., Zhao, L. W., Jiang, D. X., Liu, Y. T., & Liu, X. L. (2010). Anthelmintic activity of steroidal saponins from Paris polyphylla. *Phytomedicine*, *17*(14), 1102-1105.

Wang, H., Li, S., Fang, S., Yang, X., & Feng, J. (2018). Betaine improves intestinal functions by enhancing digestive enzymes, ameliorating intestinal morphology, and enriching intestinal microbiota in high-salt stressed rats. *Nutrients*, *10*(7), 907.

Wu, K. M., Farrelly, J., Birnkrant, D., Chen, S., Dou, J., Atrakchi, A., & Zhang, K. (2004). Regulatory toxicology perspectives on the development of botanical drug products in the United States. *American Journal of Therapeutics*, *11*(3), 213-217.

Yazwinski, T. A., Tucker, C. A., Wray, E., Jones, L., & Clark, F. D. (2013). Observations of benzimidazole efficacies against Ascaridiadissimilis, Ascaridia galli, and Heterakisgallinarum in naturally infected poultry. *Journal of Applied Poultry Research*, *22*(1), 75-79.

Zaman, M. A., Abbas, R. Z., Qamar, W., Qamar, M. F., Mehreen, U., Shahid, Z., & Kamran, M. (2020). Role of secondary metabolites of medicinal plants against Ascaridia galli. *World's Poultry Science Journal*, *76*(3), 639-655.

Zhang, K. X., Li, X. L., Na, C., Abbas, A., Abbas, R. Z., & Zaman, M. A. (2020). Anticoccidial effects of Camellia sinensis (green tea) extract and its effect on blood and serum chemistry of broiler chickens. *Pakistan Veterinary Journal*, *40*(1), 77-80.

Zhang, Q. H., Nie, F. H., Wang, X. N., Lin, H. Y., Wang, H. C., Gooneratne, S. R., & Chen, J. J. (2018). Effect of flavonoids from Eupatorium odoratum L. on immunoglobulins and cecal microflora in broilers. *Pakistan Veterinary Journal*, *38*(3), 296-300

Zirintunda, G., Biryomumaisho, S., Kasozi, K. I., Batiha, G. E. S., Kateregga, J., Vudriko, P., & Acai-Okwee, J. (2022). Emerging anthelmintic resistance in poultry: can ethnopharmacological approaches offer a solution?. *Frontiers in Pharmacology*, *12*, 774896. https://doi.org/10.3389/fphar.2021.774896