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REVIEW

STUDIES ON THE EFFECT OF PHYTOADDITIVES ON GROWTH PERFORMANCE AND MEAT QUALITY IN BROILER CHICKENS

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Abstract: Poultry meat is one of the most appreciated animal-derived food products, both for its nutritional value and for its specific sensory properties. For a long time, the preservation of the health of birds and the improvement of growth indicators were achieved through the administration of antibiotics, a technique highly contested due to their residue in finished products. Against the backdrop of these issues, various plant-based products (phytoadditives) have emerged, credited with multiple roles, from improving immunity and digestion efficiency to reducing the action of predominant pathogens and even mitigating the environmental impact of animal farming. The purpose of this study is to create a centralized overview of the effects generated by the available phytogenic additives, for their inclusion in specific bird diets with the aim of improving the quantitative and qualitative aspects of meat production.

Keywords: *additives, birds, food products, phyto additives*

INTRODUCTION

Over the past decade, phytoadditives have attracted the attention of the poultry sector for their potential role as alternatives to antibiotic-based growth promoters. The yield of applications of phytoadditives in broiler nutrition depends mainly on the composition and level of inclusion of phytoadditives in the feed, the general composition of the diet but also on the genetics of the birds.

Providing a substantial amount of protein through meat and eggs, surpassing any source of animal meat, the poultry sector is becoming of significant importance, making it a highly active and continuously advancing demand for animal products (meat, eggs, milk, fish) largely driven by population growth, urbanization and income growth. The reason for the use of feed adjuvants is to improve digestive efficiency, production efficiency by reducing the prevailing pathogens and by decreasing the impact of farm animals on the environment. However, by circumventing antibiotic growth promoters in animal nutrition, health problems can increase, and growth performance can be reduced [1].

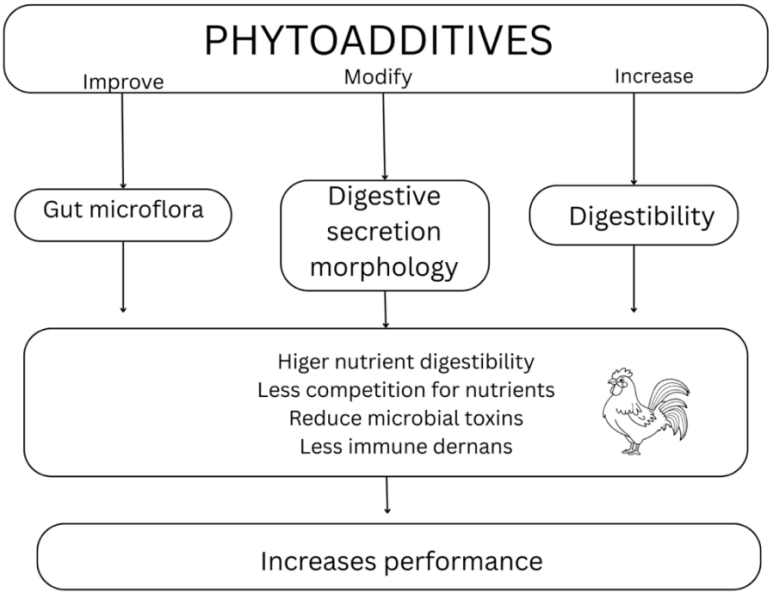


Figure 1. *Mechanism of operation of phytoadditives on growth and health performance in chicken broiler*

In the European Union, the demand for poultry meat has exceeded that for beef or lamb which makes poultry meat one of the most valued food products nowadays, this is due to the selected taste, superior quality and easy availability at a cheap price compared to red meat or fish, and the nutritional content leaves it without competition in the food market [2].

Over the years, antibiotics have been widely administered in poultry farming as a growth promoter to improve their performance. In the food industry, in recent times there has been a widespread application of phytoadditives on a large scale in several fields (textile industry, dairy and fish industry, pharmacology, poultry sector) with almost all major classes of natural pigments being used in at least one sector of the food industry. The aim of this research is to provide an overview of the additives available for inclusion in farm

animal diets and, at the same time, to include the latest results from literature. The use of herbs in poultry diets has been reported as a stimulant of endogenous antioxidants, facilitating nutrient metabolism and improving meat quality by reducing cholesterol content as we can see in Figure 1 [3].

MATERIAL AND METHODS

To carry out this review, scientific articles, specialized books and official reports published between 2000 and 2025 were consulted, available in databases such as Google Scholar, Scopus and on the websites of recognized institutions (EFSA, USDA, ISO). The keywords used in the search included: "phytoadditives", "food products", "birds performance", "additives".
The selection of papers was based on their relevance to the proposed theme, taking into account both experimental studies and synthesis articles. Only materials that directly analyzed the importance of phytoadditives and their effect on chickens (health effects, effects on meat and egg quality, on general welfare) as well as food safety aspects were included. The extracted information was then grouped and synthesized according to the categories of factors presented in the text, in order to provide a clearer and more accessible picture of the main conclusions in the literature.

THE IMPORTANCE OF PHYTOADDITIVES

Phytoadditives, also known as secondary plant, phytobiotic or botanical metabolites, are auxiliary extracts derived from plants and include a wide range of substances such as herbs, essential oils and spices, which have been reported to exhibit growth-promoting and therapeutic properties [4]. Products obtained from plants are wreck-free, compared to synthetic antibiotics, and are considered safe to be introduced as ingredients in the food industry, also in the diet of animals as an ideal promoter of growth. The use of feed phytoadditives to improve growth efficiency, disease prevention, egg production and improve feed efficiency is a strategy to improve the efficiency of the poultry industry, Figure 2. Herbs and plant extracts administered as feed additives contain a biodiversity of different bioactive elements such as glycosides, allicin, phenols, piperine, mucilage, capsaicin [5]. According to economic and technical indicators, the use of phytoadditives will continue to increase both from the perspective of growth promoters and from the point of view of antibiotic substitutes [6]. The market for feed phytoadditives is constantly growing, plant substances represent an alternative to the use of antibiotics as growth promoters [7]. The use of phytoadditives in chicken feed can influence the proper functioning of the digestive system, stimulating appetite, altering the intestinal flora and improving the palatability of the feed.

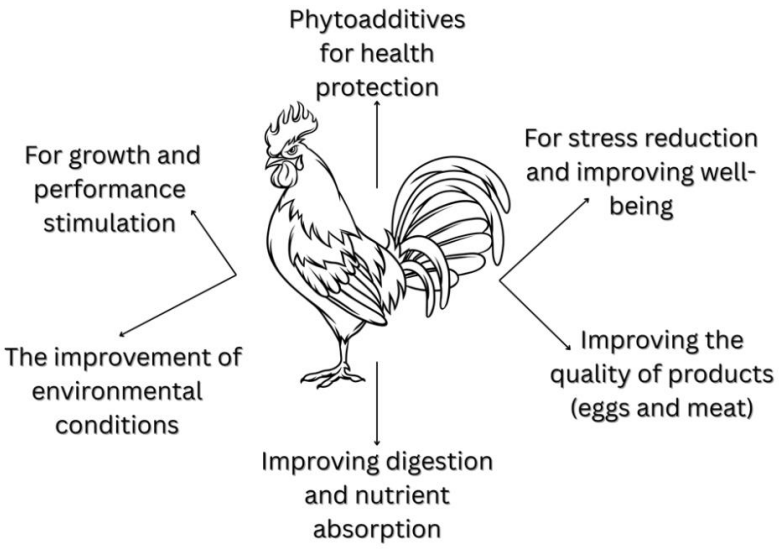


Figure 2. *Role of phytoadditives in the poultry industry*

Depending on the amount of plant extracts used, they are divided into two categories, phytoadditives with a bactericidal effect or phytoadditives with bacteriostatic effect [8]. Phytoadditives have several roles in animal nutrition, as we can see in Figure 2, the consumption of phytoadditives leads to health protection, stimulation of performance, improvement of meat and egg quality and last but not least helps digestion and absorption of nutrients [9].

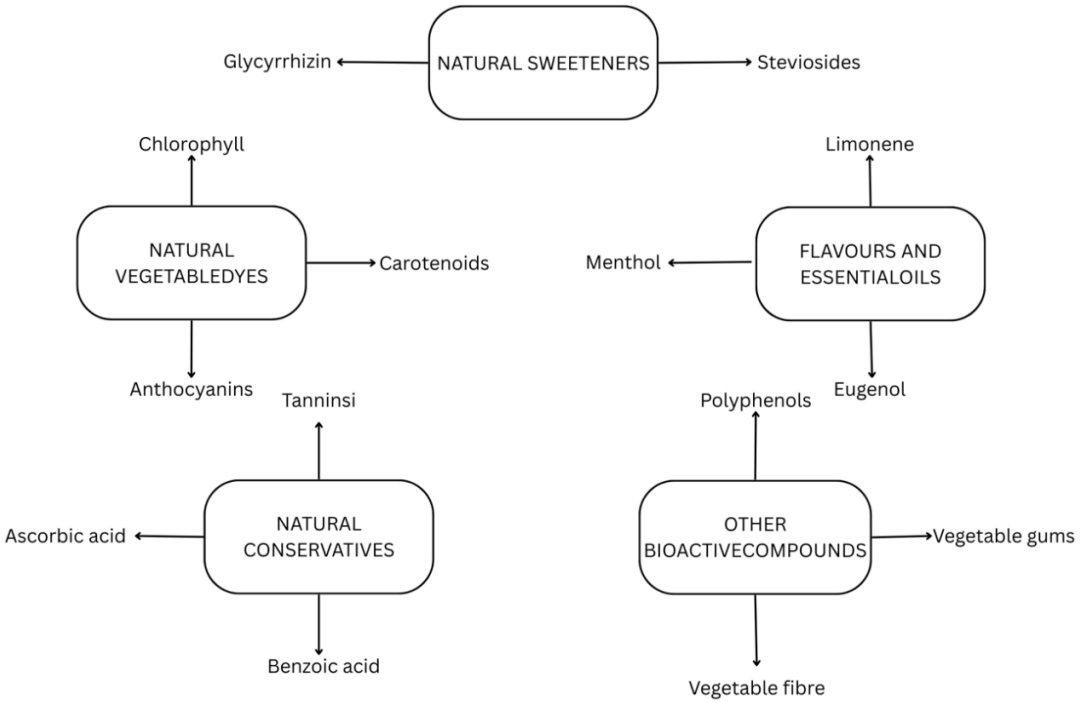


Figure 3. *Chemical composition of phytoadditives used in the livestock sector*

Herbs have gained popularity due to their multiple health benefits; these benefits are due to the chemical composition that we can find in Figure 3. The main sources of antioxidant chemicals in plants are polyphenolic flavonoids, they can be easily used in the diet of broilers to improve production [10]. It has been shown that adding phytobiotics and phytogenics to chicken nutrition can improve broiler performance [11]. They help strengthen the immune system and play an important role against environmental stressors [12]. The inclusion of grape seeds in the diet of broilers lowers blood glucose levels and triglycerides as well as the amount of cholesterol in the egg by up to 16 % [13 – 14]. The use of grape seed flour in the feed of laying hens leads to an increase in antioxidant capacity and an improvement in the amount of polyphenols and flavonoids in the egg [15]. Taking mulberry leaves in amounts of 5 % improves the quality of the meat by reducing cholesterol [16]. To improve the digestive health of broilers, oregano and rosehips are given and report that birds supplemented with plant extract have a longer intestine length [17 – 18]. Supplementing the diet with plant extract has been found to lead to reduced oxidation of intestinal lipids, resulting in better absorption of gut nutrients and increased activity of antioxidant enzymes, leading to improved immune response in birds [18].

PHYTOADDITIVES FOR GROWTH PERFORMANCE AND MEAT QUALITY

The use of herbs and spices as natural adjuvants in poultry nutrition has expanded due to their ability to improve growth without the use of synthetic antibiotics, in Figure 4 we can see alternative phytoadditive from herbs, spices, and aromatic plants. Says that the administration of 0.5 % black seeds, 0.5 % African nutmeg and 0.5 % black pepper in the diet of broilers improved carcass quality parameters, reduced abdominal fat and had no harmful effects on internal organs [19]. At the same time, the results of research reported on the use of ground black cumin in the feed of chickens, and their result showed that the chickens had a significant decrease in the percentage of weight gain compared to the control group [20]. Alfalfa is a feed that contains vitamins, minerals, and functional bioactive components, it has been established that adding 3 % to 9 % alfalfa flour to the chickens' diet significantly improved carcass parts and says that adding grape seed paste influences meat quality by increasing unsaturated fatty acids [21 – 22]. According to the administration of thyme essential oil to broilers could improve immune activity, growth performance but also protect against the negative effects of heat stress [23]. Several studies have shown that adding probiotics to the diet of broilers and turkeys leads to improved performance but says that the performance and immune response of chickens fed organic feed additives were equivalent to or even better than those of antibiotic-based growth promoters, except for diatomaceous earth [24 – 25]. It states that the addition of 3 % garlic powder improved overall performance in chicken broiler, garlic also lowers cholesterol and triglycerides has a hypotensive effect and is a powerful antioxidant and anticancer, [26 – 28]. Studies conducted by (Bölükbaşi, *et al*.) revealed that chickens fed 0.1 % and 0.5 % thyme resulted in higher egg production rates (Table 1) and lower levels of *Escherichia coli* in feces [29]. The addition of basil to the diet of broilers significantly reduced mortality, increased weight gain and improved feed conversion ratio [30]. Turmenic has been used for medicinal purposes for over 4000 years, they have antioxidant, anti-inflammatory and antihepatotoxic activities. Recent study by indicates that the use of turmeric in the diets of chickens improved the absorption of nutrients and

antioxidants, and the administration of mixtures of eucalyptus oil and peppermint in the diet of chickens reduced infection with Newcastle disease [31]. Ginger is a medicinal plant frequently used in traditional medicine; it can be used as a substitute for chemical growth promoters. Including 2 % ginger in chicken feed improves the digestibility and overall well-being of chickens [32]. Conducted a study demonstrating that ginger powder given in the diet of broiler (Table 2) chickens increased their body weight by 1 %. Ginger can be used to replace chemical growth promoters, supplementing with 2 % ginger in the feed of broilers suffering from heat stress has improved immunity and blood biochemical parameters [33].

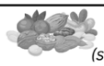
Phytoadditive	Part of plants	Major Component and Potency
Lemon basil (Ocimum x citriodorum)	 (leaves)	Caffeic acid, flavonoid, antioxidant and antimicrobial activity
Celery (Apium graveolens)	 (leaves)	Natural antioxidants (vitamins, flavonoids,unsaturated fatty acids)
Cinnamon (Cinnamomum verum)	 (Aromatic plants)	Cinnamic acid and cinnamaldehyde antioxidant activity
Nutmeg (Myristica fragrans)	 (seeds)	Essential oils
Candlenut (Aleurites moluccanus)	 (seeds)	Polyphenols content
Ginger (Zingiber officinale)	 (Aromatic plants)	Flavonoid, phenolic compound, antioxidant activity
Garlic (Allium sativum)	 (Aromatic plants)	Natural antioxidants (vitamins, flavonoids,unsaturated fatty acids)
Black pepper (Piper negru)	 (seeds)	Antioxidant activity, antimicrobial activity

Figure 4. *Several alternative Phytoadditive from herbs, spices, and aromatic plants*

Also, taking ginger essential oil and ginger root powder have antioxidant effects on chicken broiler, alleviate damage caused by lipid peroxidation, and act as a growth promoter [34, 35]. Dill is considered an essential antioxidant in digestive disorders that lower blood cholesterol, affect glucose levels, and increase HDL, reports that adding dill leaves to chicken feed does not influence carcass characteristics and growth rate, but improves the intestinal health of chickens [36]. However, they reported that birds fed 3 % dill powder experienced an increase in performance and an increase in blood cells [37]. Chicory is frequently used as a nutritious feed for animals due to its therapeutic value, the production of bioactive substances and polyphenols. According to chicory, it helps strengthen intestinal microbial integrity, it also improves the absorption of minerals in the gastrointestinal tract [38]. Reported that supplementing feed with more than 250 $mg \cdot kg^{-1}$ to broiler with chicory extract, increased performance and reduced blood lipids, and adding 3 $g \cdot kg^{-1}$ resulted in weight gain, reduced feed intake, and decreased mortality [39, 40]. Research done by demonstrates that feeding broilers a diet supplemented with

200 mg mint positively influenced the increase in the digestibility of crude proteins [41]. Worldwide, the highest consumption is recorded for chicken eggs, whose chemical composition depends, among other things, on the growth system and the quality of the feed [42]. The welfare and performance of laying hens depend on several factors and the interaction between them, but especially on the rearing system and the feed fed [43]. The egg is a complete food that plays an essential role in daily nutrition, [44]. The addition of marigold leaves and pumpkin pulp to the feed of laying hens leads to an improvement in the organoleptic quality of eggs, yolk size and feed conversion rate, [45]. Chicory and artichoke roots are administered to laying hens as rich sources of iron, inulin, and manganese, reported that the inclusion of dried and fermented ginger in chick nutrition acted as a growth promoter and improved egg production in laying hens [35, 45]. Diets with ginger and turmeric powder can be administered at the level of inclusion in the diet of chickens in proportions of 3 %. Egg quality is determined by internal factors such as egg white weight, yolk and white index, or air cell size thus, they reported that diets with the addition of 1.5 % ginger powder had increased performance in terms of eggs per day and their mass, and ginger powder improved yolk color and internal qualities of the egg [46, 47]. Cinnamon (*Cinnamomum Zeylanicum* L.) is considered a good antioxidant, due to the content of active phenolic compounds, a report revealed that supplementing chickens with cinnamon helped maintain hemostasis and reported that adding cinnamon to the chickens' diet resulted in large weight gain [48, 49]. For centuries, different parts of moringa have been used in traditional medicine, one of the most important benefits brought by it is to stop the development of mycotoxin fungi [50]. It contains phytogenic compounds, carvacrol, rosmarinus acid and thymol, which have antioxidant, antibacterial properties and are crucial for improving feed quality [51]. A study revealed that the addition of 3 % of moringa flour increased the growth performance and physiological parameters of the broilers, as well as helping them survive in hot conditions [52]. A few years later, he incorporated 0.75 % moringa powder under heat stress, and the results showed a decrease in cholesterol and triglyceride levels [53]. The administration of 5 % moringa leaves in the feed of chickens led to improved performance, lowered cholesterol [54]. According to adding an extract of chicory ethyl acetate to the diet of broilers increased performance and reduced blood lipids [39]. Oregano powder and oil have a positive effect on the intestinal microflora of chickens under heat stress, these effects are due to the properties of the oil to destroy the cell membranes of pathogenic organisms, on the other hand state that the administration of willow bark extract in the nutrition of chickens improves the intestinal microbial flora and reduces the number of Staphylococci and Enterobacteriaceae [55, 56]. The administration of curcumin in broiler diets for 42 days showed a significant increase in body weight and demonstrates that supplementing the diet with curcumin for 20 days has no beneficial effect on broiler chickens due to the short period of supplementation [57-58]. According to, the use of polyphenol-rich olive leaf extracts failed to improve digestibility coefficients in broilers, however it says that the use of essential oils such as carvacrol mixtures increases the digestibility of crude proteins, fats, cysteine, and phosphorus [59, 60]. According to studies conducted by the administration of green tea and pomegranate in broiler nutrition led to modulation of the intestinal microbiota [61, 62].

Table 1. *Phytoadditives and their effect on egg production*

Phytoadives	Major components	Dose [mg·kg^{-1}]	Effect	References
Oregano	-carvacrol -thymol	150-100	-increases egg production -increases egg weight	[63]
Mint	-menthol -izomentol -cineole	100-500	-increases egg production -increases egg weight	[64]
Peppermint essential oil	-menthol	1000	-increases egg production	[65]
Thyme essential oil	-thymol	1000	-increases egg weight	[65]
Green tea	-polyohenols	200	- increases egg production	[66]
Caraway	- chimenic alcohol -chimine	500	- increases egg production	[67]
Black Cumin	-exogenous amino acids -proteins -volatile oil -fixed oil	20-100	-reducing cholesterol in the egg	[68]
Hot pepper	- ascorbic acid -carotenoids -vitamin A -vitamin E -vitamin C	100-150	-improves the color of the yolk	[69]
Ginger	-curcumin -gingerol -phenolic compounds	100-150	- increases egg production	[35]
Dill	-limonene -carvone -cimene	100-200	-increases egg production -improves the form index and yolk index	[70]
Common chicory	-polyphenols -fructo-oligosaccharides -inulin		-improvement of production parameters	[70]
Moringa	-carvacrol - phytogenic compounds -thymol -rosmarinus acid	150-200	-increases egg production -improves the form index and yolk index	[71]

Table 2. *Phytoadditives and their effect on broiler health*

Phytoadives	Major components	Dose [mg·kg^{-1}]	Effect	References
Grape seed extract	- polyphenols	100-200	-increases body weight	[72]
Oregano	-carvacrol -thymol	100	-improves growth performance	[73]
Black pepper	-phenolic acid -flavonoids	1000	-antioxidant activity -antimicrobial activity	[74]
Eucalyptus	-cymen -cineole -cumin	100-200	-improves growth performance	[75]
Turmeric	-curcumin	1000	- antioxidant capacity	[76, 77]

Game	-phenols -flavonoids -amino acids -vitamin -mineral	20-40	- antioxidant capacity -improves growth performance	[78]
Black Cumin	- exogenous amino acids -proteins - volatile oil -fixed oil	60-100	-hepatoprotection -Kidney protector -anticancerogenic -improves the characteristics of the case	[79, 80]
Hot pepper	-ascorbic acid -carotenoids -vitamin A -vitamin E -vitamin C	100-200	-antioxidant capacity -Improves growth performance -weight gain -improves the color of the meat	[81, 82]
Moring	-carvacrol - phytogenic compounds -thymol -rosmarinus acid	150-200	-improved digestion -improves absorption - antioxidant capacity - antibacterial capacity	[71]
Ginger	-curcumin -gingerol - phenolic compounds	100-150	-antioxidant properties -antibacterial properties	[33]
Dill	-limonene -carvone -cimena	100-200	-antioxidant properties -improved digestion -fat absorption -reduces the absorption of bile salts	[37]
Common chicory	- polyphenols -inulin	300-500	-strengthening the integrity of the microbiota	[83]

According to studies conducted by black cumin seeds and extracts may protect chickens against oxidative stress and improve the health of brain and spinal cord tissues [84]. Reports that supplementing the broilers' feed with black cumin meal by 10 - 20 % or 0.5 - 1 % oil under heat stress, improves the growth performance of birds [85]. In contrast, feed supplementation with the same phytoadditive in laying hens had no negative or positive effects on laying performance, egg quality or serum parameters. Studies conducted demonstrate that feeding broilers black cumin seeds in amounts greater than 6 $g \cdot kg^{-1}$ had a negative impact on growth performance, body weight, and feed efficiency [70]. Hot pepper comes from tropical America and dates back thousands of years, it is one of the important spices used in the human and animal diet. It has an antimicrobial, antidiabetic, immunomodulatory effect due to its capsaicin content [86]. It has been shown that the administration of hot pepper fruits in the feed of chickens helps increase appetite, improves deposition parameters and darkens the color of the yolk [69]. The inclusion of 0.50 - 0.74 % and 1 % of red-hot pepper in the nutrition of broilers improved performance, weight gain and improved bird viability [69, 87, 88].

A growing number of researchers have demonstrated that taking phytoadditives in chicken feed improved health, increased immunity, and defended hosts against microbial infections [89]. Evolved the properties of dandelion, mustard, sunflower, and turmeric, studies have shown that all extractions inhibited tumor cell growth and boosted innate immunity in birds [90]. The antioxidant and anti-inflammatory properties of wormwood

have been researched by, they report that the administration of wormwood in the diet of chicken broiler alleviates the negative impact of heat stress, but at the same time improves antioxidant activity by destroying free radicals and producing flavonoid and phenolic compounds [78, 91]. The potential use of natural plant extracts in mycotoxin detoxification has received much attention [92]. The researcher report that aronia is rich in various biologically active substances- anthocyanins, flavonoids and phenolic acids, proteins, vitamins, organic acids, carbohydrates, polysaccharides, fibers and mineral elements which have positive effects on birds [93].

THE ROLE OF PHYTOADDITIVES IN STRESS ALLEVIATION IN CHICKEN BROILER

As Figure 5 makes evident, stress in hens can be a serious issue. It can be environmental, physiological, pathological, climatic, social, or nutritional. A major issue affecting the worldwide chicken business is oxidative stress, which is made worse by climate change. This is a significant barrier to long-distance transportation and intensive broiler production [94]. One of the main problems facing the poultry industry is high temperatures, particularly in developing nations where birds are reared in open-sided shelters. The issue of heat stress in chicken production has gotten worse due to the major concern of climate change. Birds prefer temperatures between 18 and 25 degrees Celsius; temperatures above or below these ranges cause heat stress. They are more susceptible to severe temperatures than other animals because they lack sweat glands and have dense feathers that keep heat from escaping [95]. Finding workable methods to lessen the impacts of heat stress on avian species is crucial for both ensuring the health of birds and increasing output as much as possible. As a result, there is now more interest in using phytoadditives in chicken feed. Numerous studies show that the bioactive ingredients in phytoadditives help birds that are experiencing heat stress [52, 55, 96].

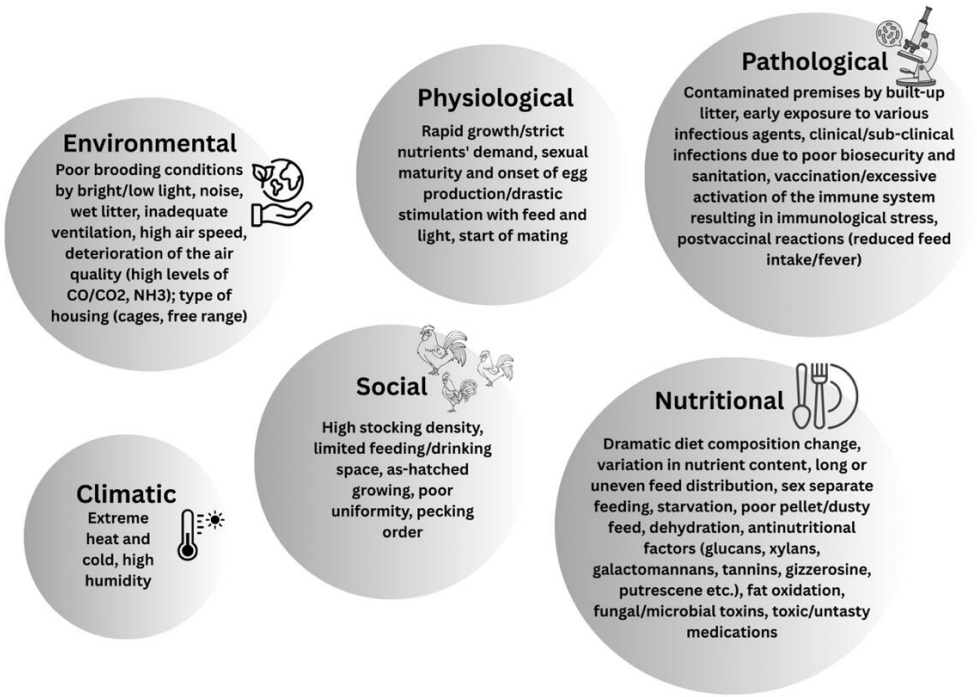


Figure 5. *Types of stress encountered in the poultry sector*

Heat stress during broiler breeding influences metabolic rate, behavior, and feed intake and weight gain [31]. Oxidative stress lowers growth performance, degrades meat quality, and increases mortality in broilers, according to his findings [95]. Because they have a major effect on reducing oxidative stress, dietary antioxidants are well-known for their numerous health advantages. Dietary strategies can help preserve or enhance birds' health and lessen the effects of heat stress on them. It is well known that the usage of synthetic antioxidants in the poultry industry can be replaced by medicinal plants and their constituents [96, 97].

CONCLUSIONS

Phytoadditives, which are present in plants, spices, essential oils, and oleoresins, can be utilized as organic, non-antibiotic growth enhancers. Studies have shown that phytoadditives can improve the health of the chicken industry by acting as a natural supply of antioxidants, lowering the need for drugs and heat stress relievers, and improving the quality of meat and eggs. Feed phytoadditives fall into several categories, such as enzymes, phenolic compounds, and nutritional additions. Each of these groups has unique purposes, such as enhancing the color of meat, enhancing the digestion of nutrients, bolstering the immune system, and fostering the balance of the gut microbiota. In addition to improving gut function, phytoadditives also improve the quality and safety of meat in storage, lower emissions in poultry farms, and improve the overall performance of birds (feed intake, feed conversion ratio, nutrient digestibility, body weight gain, carcass characteristics, and egg production). As producers look for sustainable methods to meet consumer demands for healthier meat and eggs and regulatory pressure to use less

antibiotics in livestock production, their significance in the poultry business has increased. It is important to remember that doses need to be given carefully because high dosages may contain antinutritional elements that could impair broiler performance.

REFERENCES

1. Liu, Y., Espinosa, C.D., Abelilla, J.J., Casas, G.A., Lagos, L.V., Lee, S.A., Kwon, W.B., Mathai, J.K., Navarro, D.M.D.L., Jaworski, N.W., Stein, H.H.: Non-antibiotic feed additives in diets for pigs: A review, *Animal Nutrition*, **2018**, **4** (2), 113-125;
2. Curea, C.D., Usturoi, M.G., Custură, I., Radu-Rusu, R.M., Rațu, R.N., Prisăcaru, M., Usturoi, A.: Efficiency of growing of chicken broilers under conditions of compliance with EU rules of welfare, *Scientific Papers. Series D. Animal Science*, **2023**, **LXVI** (1), 273-278;
3. Oloruntola, O.D., Ayodele, S.O., Oloruntola, D.A.: Effect of pawpaw (Carica papaya) leaf meal and dietary enzymes on broiler performance, digestibility, carcass and blood composition, *Revue d'élevage et de médecine vétérinaire des pays tropicaux*, **2018**, **71** (3), 121-129;
4. Bravo, D., Pirgozliev, V., Rose, S.P.: A mixture of carvacrol, cinnamaldehyde, and capsicum oleoresin improves energy utilization and growth performance of broiler chickens fed maize-based diet, *Journal of Animal Science, American Society of Animal Science*, **2014**, **92** (4), 1531-1536;
5. Al-Yasiry, A.R.M., Kiczorowska, B.: Frankincense - therapeutic properties in: Advances in Hygiene & Experimental Medicine/Postępy Higieny i Medycyny Doświadczalnej, *Polish Academy of Sciences*, **2016**, 70;
6. Gavris, T., Arabela, U., Saracila, M.: Use of phyto-additives in poultry nutrition in: *Scientific Papers Animal Science and Biotechnologies*, **2019**, **52** (1), 13;
7. FrAnKIČ, T., Voljč, M., Salobir, J., Rezar, V.: Use of herbs and spices and their extracts in animal nutrition, *Acta Agriculturae Slovenica*, **2009**, **94** (2), 95-102;
8. Tosi, E.A., Ré, E., Ortega, M.E., Cazzoli, A.F.: Food preservative based on propolis: Bacteriostatic activity of propolis polyphenols and flavonoids upon *Escherichia coli*, *Food Chemistry*, **2007**, **104** (3), 1025-1029;
9. Mandey, J.S., Sompie, F.N.: Phytogenic feed additives as an alternative to antibiotic growth promoters in poultry nutrition, *Advanced Studies in the 21st Century Animal Nutrition*, **2021**, Chapter 1;
10. Singh, C.B., Jilani, M.H.: Backyard poultry farming in Garhwal Himalayas in: *Indian Journal of Poultry Science*, **2005**, **40** (2), 195-198;
11. Oni, A.I., Adeleye, O.O., Adebowale, T.O., Oke, O.E.: The role of phytogenic feed additives in stress mitigation in broiler chickens, *Journal of Animal Physiology and Animal Nutrition*, **2024**, **108** (1), 81-98;
12. Song, Z.H., Cheng, K., Zheng, X.C., Ahmad, H., Zhang, L.L., Wang, T.: Effects of dietary supplementation with enzymatically treated Artemisia annua on growth performance, intestinal morphology, digestive enzyme activities, immunity, and antioxidant capacity of heat-stressed broilers, *Poultry Science*, **2018**, **97** (2), 430-437;
13. Vlaicu, P.A., Panaite, T.D., Olteanu, M., Ropota, M., Criste, V., Vasile, G., Grosu, I.: Production parameters, carcass development and blood parameters of the broiler chicks fed diets which include rapeseed, flax, grape and buckthorn meals in: *Scientific Papers Animal Science and Biotechnologies*, **2017**, **50** (1), 37-37;
14. Olteanu, M., Criste, R.D., Panaite, T.D., Ropota, M., Mitoi, M., Vlaicu, P.A., Șoica, C.: Quality of the eggs obtained from hens fed diet formulations rich in polyunsaturated fatty acids and with grape seeds meal as antioxidant, *Archiva Zootechnica*, **2017**, **20** (1), 37-37;
15. Olteanu, M., Criste, R.D., Panaite, T.D., Bunduc, V., Panaite, C.V., Ropota, M., Mitoi, M.: Study on the efficiency of grape seed meals used as antioxidants in layer diets enriched with polyunsaturated fatty acids compared with vitamin E, *Revista Brasileira de Ciencia Avicola*, **2016**, **18** (4), 655-662;
16. Margareta, O., Criste, D.C., Cornescu, M.G., Ropota, M., Panaite, T., Vlaicu, I.: Effect of dietary mulberry (Morus alba) leaves on performance parameters and quality of breast meat of broilers, *The Indian Journal of Animal Sciences*, **2015**, **85** (3), 291-295;

17. Criste, R.D., Panaite, T.D., Tabuc, C., Sărăcilă, M., Șoica, C., Olteanu, M.: Effect of oregano and rosehip supplements on broiler (14-35 days) performance, carcass and internal organs development and gut health, *AgroLife Scientific Journal*, **2017**, **6** (1);
18. Fascina, V.B., Pasquali, G.A.M., Carvalho, F.B., Muro, E.M., Vercese, F., Aoyagi, M.M., Pezzato, A.C., Gonzales, E., Sartori, J.R.: Effects of phytogenic additives and organic acids, alone or in combination, on the performance, intestinal quality and immune responses of broiler chickens, *Revista Brasileira de Ciência Avícola*, **2017**, **19** (3), 497-508;
19. Idowu, A.O., Ojebiyi, O.O., Ademola, S.G., Olakojo, A.O.: Effect of black seeds, African nutmeg and Negro pepper on carcass characteristics and organoleptic properties of broiler chickens, *Brazilian Journal of Science*, **2025**, **4** (3), 40-48;
20. Abbas, T.E., Ahmed, M.E.: Effect of supplementation of Nigella sativa seeds to the broiler chicks diet on the performance and carcass quality in: *International Journal of Agriculture Sciences*, **2010**, **2** (2), 9-13;
21. Zheng, M., Mao, P., Tian, X., Guo, Q., Meng, L.: Effects of dietary supplementation of alfalfa meal on growth performance, carcass characteristics, meat and egg quality, and intestinal microbiota in Beijing-you chicken, *Poultry Science*, **2019**, **98** (5), 2250-2259;
22. Turcu, R.P., Olteanu, M., Criste, R.D., Panaite, T.D., Ropota, M., Vlaicu, P.A., Șoica, C.: Use of flaxseed meal and grape seed meal (2% and 3%) as natural antioxidants in broiler diets, *Revista Mexicana de Ciencias Pecuarias*, **2018**;
23. Olfati, A., Mojtahedin, A.: Dietary inclusion of thyme essential oil alleviative effects of heat stress on growth performance and immune system of broiler chicks, *Banats Journal of Biotechnology*, **2018**, **1** (9), 60-71;
24. Tellez, G., Vicente, J.L., Aviña, L., Torres-Rodriguez, A., Hargis, B.: Effect of a Lactobacillus spp. -based probiotic culture product on broiler chicks performance under commercial conditions, *International Journal of Poultry Science*, **2007**, **6** (3), 154-156;
25. El-Husseiny, O.M., Abdel-Latif, K.O.: The influence of biological feed additives on broiler performance, *International Journal of Poultry Science*, **2008**, **7** (9), 862-871;
26. Hayajneh, F.M.F.: Natural feed additives for broiler chickens, *South African Journal of Animal Science*, **2019**, **49** (5), 869-875;
27. Elagib, H.A., El-Amin, W.I.A., Malik, H.E.: Effect of dietary garlic (Allium sativum) supplementation as feed additive on broiler performance and blood profile, *Poultry Science Journal*, **2015**, **94** (1), 1-6;
28. Gabor, E.F., Șara, A., Barbu, A.: The effects of some phytoadditives on growth, health and meat quality on different species of fish, *Animal Science and Biotechnologies Journal*, **2010**, **43** (1), 1-7;
29. Bölükbaşi, Ş.C., Erhan, M.K.: Effect of dietary thyme (Thymus vulgaris) on laying hens performance and Escherichia coli (E. coli) concentration in feces, *International Journal of Natural & Engineering Sciences*, **2007**, **2** (1), 1-5;
30. Jahejo, A.R., Rajput, N., Tian, W.-X., Naeem, M., Kalhoro, D.H., Kaka, A., Niu, S., Jia, F.-J.: Immunomodulatory and growth promoting effects of basil (Ocimum basilicum) and ascorbic acid in heat stressed broiler chickens, *Pakistan Journal of Zoology*, **2019**, **51** (3), 801-807;
31. Kpomasse, C.C., Oso, O.M., Lawal, K.O., Oke, O.E.: Juvenile growth, thermotolerance and gut histomorphology of broiler chickens fed Curcuma longa under hot-humid environments, *Heliyon*, **2023**, **9** (2), e13060;
32. Rehman, H.F., Zaneb, H., Masood, S., Yousaf, M.S., Ashraf, S., Khan, I., Rehman, H.: Effect of Moringa oleifera leaf powder supplementation on pectoral muscle quality and morphometric characteristics of tibia bone in broiler chickens, *Brazilian Journal of Poultry Science*, **2018**, **20** (04), 817-824;
33. Rehman, Z., Chand, N., Khan, R.U., Naz, S., Alhidary, I.A.: Serum biochemical profile of two broiler strains supplemented with vitamin E, raw ginger (Zingiber officinale) and L-carnitine under high ambient temperatures, *South African Journal of Animal Science*, **2018**, **48,** 935-942;
34. Zhang, G.F., Yang, Z.B., Wang, Y., Yang, W.R., Jiang, S.Z., Gai, G.S.: Effects of ginger root (Zingiber officinale) processed to different particle sizes on growth performance, antioxidant status, and serum metabolites of broiler chickens, *Poultry Science*, **2009**, **88** (10), 2159-2166;
35. Incharoen, T., Yamauchi, K., Thongwittaya, N.: Intestinal villus histological alterations in broilers fed dietary dried fermented ginger: Intestinal histology and dried fermented ginger in diets, *Journal of Animal Physiology and Animal Nutrition*, **2010**, **94** (5), e130-7;

36. Vispute, M.M., Sharma, D., Mandal, A.B., Rokade, J.J., Tyagi, P.K., Yadav, A.S.: Effect of dietary supplementation of hemp (Cannabis sativa) and dill seed (Anethum graveolens) on performance, serum biochemicals and gut health of broiler chickens, *Journal of Animal Physiology and Animal Nutrition*, **2019**, **103** (2), 525-533;
37. Jangali, A., Hedayati, M., Khalaji, S., Manafi, M.: Oxidative stress and effects of dill (Anethum graveolens dhi) powder on the performance and health status of broilers, *South African Journal of Animal Science*, **2022**, **51** (6), 700-714;
38. Fathi, M., Hosayni, M., Alizadeh, S., Zandi, R., Rahmati, S., Saeidian, S., Fard, M.S., Rezaee, V., Zarrinkavyani, K., Mardani, P.: Effects of chicory (*Cichorium intybus* L.) distillation wastewater on antioxidant status, immune response, cecal microbial population, growth performance and meat quality in broiler chickens, *Livestock Science*, **2024**, 105442;
39. Taraz, Z., Shargh, M.S., Samadi, F., Ebrahimi, P., Zerehdaran, S.: Effect of Chicory plant (*Cichorium intybus* L.) extract on performance and blood parameters in broilers exposed to heat stress, *Journal of Poultry Science*, **2015**, **52** (3), 188-196;
40. Abo Ghanima, M.M., Aljahdali, N., Abuljadayel, D.A., Shafi, M.E., Qadhi, A., Abd El-Hack, M.E., Mohamed, L.A.: Effects of dietary supplementation of Amla, Chicory and Leek extracts on growth performance, immunity and blood biochemical parameters of broilers, *Italian Journal of Animal Science*, **2023**, **22** (1), 24-34;
41. Khodambashi, N., Samie, A., Rahmani, H., Ruiz-Feria, C.A.: The effect of peppermint essential oil and fructooligosaccharides, as alternatives to virginiamycin, on growth performance, digestibility, gut morphology and immune response of male broilers, *Animal Feed Science and Technology*, **2012**, **175**, 57-64;
42. Usturoi, M.G., Rațu, R.N., Radu-Rusu, R.M., Ivancia, M., Usturoi, A.: Fatty acid profile in eggs and eggs products, *Scientific Papers. Series D. Animal Science*, **2021**, **LXIV,** 2;
43. Usturoi, A., Usturoi, M.G., Avarvarei, B.V., Pânzaru, C., Simeanu, C., Usturoi, M.I., Simeanu, D.: Research regarding correlation between the assured health state for laying hens and their productivity, *Agriculture*, **2022**, **13** (1), 86;
44. Nistor, L.I., Albu, A., Nistor, A.C., Usturoi, M.G.: Aspects of eggs quality provided from free range and conventional systems, *The Journal of Microbiology, Biotechnology and Food Sciences*, **2015**, **5** (2), 186;
45. Panaite, T.D., Varzaru, I., Criste, R.D., Papuc, C., Cornescu, G.M., Ropota, M., Predescu, C.: Effect of the dietary fenugreek (Trigonella foenum-graecum), used as antioxidant in layer diets, on the nutritional quality of the eggs, *Archiva Zootechnica*, **2015**, **18** (2), 45-52;
46. Gavril, R.N.R., Usturoi, M.G., Usturoi, A.: Table eggs quality, according to the storage period, *Current Opinion in Biotechnology*, **2013**, **24**, S83;
47. Kujero, G.O., Adeyemi, O.A., Njoku, C.P., Sogunle, O., Mark, S., Abayom, R., Oke, O.E.: Reproductive and physiological responses and egg quality traits of Isa Brown chickens fed diets supplemented with Zingiber officinale (Ginger) or Curcuma longa (turmeric) powder under the tropical hot environments of Nigeria, *Archives of Veterinary Science*, **2024**, **2**, 29;
48. Kanani, P.B., Daneshyar, M., Najafi, R.: Effects of cinnamon (*Cinnamomum zeylanicum*) and turmeric (*Curcuma longa*) powders on performance, enzyme activity, and blood parameters of broiler chickens under heat stress, *Poultry Science Journal*, **2016**, **4** (1), 47-53;
49. Sadeghi, A.A., Moghaddam, M.: The effects of turmeric, cinnamon, ginger, and garlic powder nutrition on antioxidant enzymes' status and hormones involved in energy metabolism of broilers during heat stress*, Iranian Journal of Applied Animal Science*, **2018**, **8** (1), 125-130;
50. Soliman, K.M., Badeaa, R.I.: Effect of oil extracted from some medicinal plants on different mycotoxigenic fungi, *Food and Chemical Toxicology*, **2002**, **40** (11),1669-1675;
51. Burits, M., Bucar, F.: Antioxidant activity of Nigella sativa essential oil, *Phytotherapy Research*, **2000**, **14** (5), 323-328;
52. Hassan, R.I., Raheem, G.S.A.: Effect of feeding benzoic acid on performance of broiler chickens, *Journal of Advanced Veterinary Research*, **2016**, **6** (4), 118-122;
53. El-Wahab, A., Kriewitz, A., Hankel, J.P., Chuppava, J., Ratert, B., Taube, C., Kamphues: The effects of feed particle size and floor type on the growth performance, GIT development, and pododermatitis in broiler chickens, *Animals*, **2020**, **10** (8);
54. Wahab, O.A.F.A., Sobhy, H.M., Badr, A.M., Ghazalah, A.A.: Effect of Moringa oleifera seeds powder on performance and immunity of broiler chicks, *Agriculture and Food*, **2020**, **5** (4), 896-910;

55. Turcu, R.P., Tabuc, C., Vlaicu, P.A., Panaite, T.D., Buleandra, M., Saracila, M.: Effect of the dietary oregano (*Origanum vulgare* L.) powder and oil on the balance of the intestinal microflora of broilers reared under heat stress (32 °C), *Scientific Papers. Series D. Animal Science*, **2018**, **61**, 217-222;
56. Saracila, M., Criste, R.D., Panaite, T.D., Vlaicu, P.A., Tabuc, C., Turcu, R.P., Olteanu, M.: Artemisia annua as phytogenic feed additive in the diet of broilers (14-35 days) reared under heat stress (32 °C), *Revista Brasileira de Ciencia Avicola*, **2018**, **20** (4), 825-832;
57. Rajput, N., Muhammad, N., Yan, R., Zhong, X., Wang, T.: Effect of dietary supplementation of curcumin on growth performance, intestinal morphology and nutrients utilization of broiler chicks, *The Journal of Poultry Science*, **2013**, **50** (1), 44-52;
58. Yadav, S., Teng, P.-Y., Souza Dos Santos, T., Gould, R.L., Craig, S.W., Lorraine Fuller, A., Pazdro, R., Kim, W.K.: The effects of different doses of curcumin compound on growth performance, antioxidant status, and gut health of broiler chickens challenged with Eimeria species, *Poultry Science*, **2020**, **99** (11), 5936-5945;
59. Leskovec, J., Levart, A., Žgur, S., Jordan, D., Pirman, T., Salobir, J., Rezar, V.: Effects of olive leaf and marigold extracts on the utilization of nutrients and on bone mineralization using two different oil sources in broilers, *The Journal of Poultry Science*, **2018**, **55** (1), 17-27;
60. Pirgozliev, V., Bravo, D., Mirza, M.W., Rose, S.P.: Growth performance and endogenous losses of broilers fed wheat-based diets with and without essential oils and xylanase supplementation, *Poultry Science*, **2015**, **94** (6), 1227-1232;
61. Chen, Y., Ni, J., Li, H.: Effect of green tea and mulberry leaf powders on the gut microbiota of chicken, *BMC Veterinary Research*, **2019**, **15** (1), 77;
62. Khan, S.H.: The use of green tea (Camellia sinensis) as a phytogenic substance in poultry diets, *Onderstepoort Journal of Veterinary Research*, **2014**, **81** (1), 1-8;
63. Peng, Q.Y., Li, J.D., Li, Z., Duan, Z.Y., Wu, Y.P.: Effects of dietary supplementation with oregano essential oil on growth performance, carcass traits and jejunal morphology in broiler chickens, *Animal Feed Science and Technology*, **2016**, **214**, 148-153;
64. Dilawar, M.A., Mun, H.S., Rathnayake, D., Yang, E.J., Seo, Y.S., Park, H.S., Yang, C.J.: Egg quality parameters, production performance and immunity of laying hens supplemented with plant extracts, *Animals*, **2021**, **11** (4), 975;
65. Akbari, M., Torki, M., Kaviani, K.: Single and combined effects of peppermint and thyme essential oils on productive performance, egg quality traits, and blood parameters of laying hens reared under cold stress condition (6.8±3 °C), *International Journal of Biometeorology*, **2016**, **60**, 447-454;
66. Wang, X.-C., Wang, X.-H., Wang, J., Wang, H., Zhang, H.-J., Wu, S.-G., Qi, G.-H.: Dietary tea polyphenol supplementation improved egg production performance, albumen quality, and magnum morphology of Hy-Line Brown hens during the late laying period, *Journal of Animal Science*, **2018**, **96** (1), 225-235;
67. Saleh, A.A., Kirrella, A.A., Dawood, M.A.O., Ebeid, T.A.: Effect of dietary inclusion of cumin seed oil on the performance, egg quality, immune response and ovarian development in laying hens under high ambient temperature, *Journal of Animal Physiology and Animal Nutrition*, **2019**, **103** (6), 1810-1817;
68. Azeem, T., Zaib-Ur-Rehman, U.S., Asif, M., Arif, M., Rahman, A.: Effect of Nigella Sativa on poultry health and production: a review, *Science Letters*, **2014**, **2** (2), 76-82;
69. Özer, A., Zik, B., Erdost, H., Özfiliz, N.: Histological investigations on the effects of feeding with a diet containing red hot pepper on the reproductive system organs of the cock, *Turkish Journal of Veterinary & Animal Sciences*, **2006**, **30** (1), 7-15;
70. Torki, M., Sedgh-Gooya, S., Mohammadi, H.: Effects of adding essential oils of rosemary, dill and chicory extract to diets on performance, egg quality and some blood parameters of laying hens subjected to heat stress, *Journal of Applied Animal Research*, **2018**, **46** (1), 1118-1126;
71. Rehman, S., Durrani, F.R., Ch, N., Khan, R.U., Rehman, U.R.F.: Comparative efficacy of different schedules of administration of medicinal plants infusion on hematology and serum biochemistry of broiler chicks, *Research Opinions in Animal and Veterinary Sciences*, **2011**, **1**, 8-14;
72. Ao, X., Kim, I.H.: Effects of grape seed extract on performance, immunity, antioxidant capacity, and meat quality in Pekin ducks, *Poultry Science*, **2020**, **99** (4), 2078-2086;
73. Ding, X., Wu, X., Zhang, K., Bai, S., Wang, J., Peng, H., Xuan, Y., Su, Z., Zeng, Q.: Dietary supplement of essential oil from oregano affects growth performance, nutrient utilization, intestinal

morphology and antioxidant ability in Pekin ducks, *Journal of Animal Physiology and Animal Nutrition*, **2020**, **104** (4), 1067-1074;
74. Oso, A.O., Suganthi, R.U., Reddy, G.B.M., Malik, P.K., Thirumalaisamy, G., Awachat, V.B., Selvaraju, S., Arangasamy, A., Bhatta, R.: Effect of dietary supplementation with phytogenic blend on growth performance, apparent ileal digestibility of nutrients, intestinal morphology, and cecal microflora of broiler chickens, *Poultry Science*, **2019**, **98** (10), 4755-4766;
75. Fathi, M.M., Al-Homidan, I., Ebeid, T.A., Abou-Emera, O.K., Mostafa, M.M.: Dietary supplementation of Eucalyptus leaves enhances eggshell quality and immune response in two varieties of Japanese quails under tropical condition, *Poultry Science*, **2020**, **99** (2), 879-885;
76. Zhang, J.F., Bai, K.W., Su, W.P., Wang, A.A., Zhang, L.L., Huang, K.H., Wang, T.: Curcumin attenuates heat-stress-induced oxidant damage by simultaneous activation of GSH-related antioxidant enzymes and Nrf2-mediated phase II detoxifying enzyme systems in broiler chickens, *Poultry Science*, **2018**, **97** (4), 1209-1219;
77. Nm, J., Joseph, A., Maliakel, B., Im, K.: Dietary addition of a standardized extract of turmeric (TurmaFEED TM) improves growth performance and carcass quality of broilers, *Journal of Animal Science and Technology*, **2018**, **60**, 1-9;
78. Brisibe, E.A., Umoren, U.E., Brisibe, F., Magalhães, P.M., Ferreira, J.F.S., Luthria, D., Wu, X., Prior, R.L.: Nutritional characterisation and antioxidant capacity of different tissues of *Artemisia annua* L., *Food Chemistry*, **2009**, **115** (4), 1240-1246;
79. Shewita, R.S., Taha, A.E.: Effect of dietary supplementation of different levels of black seed (*Nigella sativa* L.) on growth performance, immunological, hematological and carcass parameters of broiler chicks, *World Academy of Science, Engineering and Technology*, **2011**, **77**, 788-794;
80. Oke, O.E., Uyanga, V.A., Iyasere, O.S., Oke, F.O., Majekodunmi, B.C., Logunleko, M.O., Abiona, J.A., Nwosu, E.U., Abioja, M.O., Daramola, J.O., Onagbesan, O.M.: Environmental stress and livestock productivity in hot-humid tropics: Alleviation and future perspectives, *Journal of Thermal Biology*, **2021**, **100** (103077), 103077;
81. Munglang, N.N., Vidyarthi, V.K.: Hot red pepper powder supplementation diet of broiler chicken-a review, *Livestock Research International*, **2019**, **7** (3), 159-167;
82. Alafifi, S.F.: The productive performance, intestinal bacteria and histomorphology of broiler chicks fed diets containing hot red pepper, *Egyptian Poultry Science Journal*, **2020**, **40** (2), 345-357;
83. Azorín-Ortuño, M., Urbán, C., Cerón, J.J., Tecles, F., Allende, A., Tomás-Barberán, F.A., Espín, J.C.: Effect of low inulin doses with different polymerisation degree on lipid metabolism, mineral absorption, and intestinal microbiota in rats with fat-supplemented diet, *Food Chemistry*, **2009**, **113** (4), 1058-1065;
84. Farah, N., Benghuzzi, H., Tucci, M., Cason, Z.: The effects of isolated antioxidants from black seed on the cellular metabolism of A549 cells, *Biomedical Sciences Instrumentation*, **2005**, **41**, 211-216;
85. Mohammed, A.A., Suwaiegh, S.B.: Effects of Nigella sativa on mammals'health & production, *Advances in Animal and Veterinary Sciences*, **2016**, **4** (11), 630-636;
86. Madala, N., Nutakki, M.K.: Hot pepper-history, health and dietary benefits & production, *International Journal of Current Microbiology and Applied Sciences*, **2020**, **9** (4), 2532-2538;
87. Al-Kassie, G.A., Al-Nasrawi, M.A., Ajeena, S.J.: The effects of using hot red pepper as a diet supplement on some performance traits in broiler, *Pakistan Journal of Nutrition*, **2011**, **10** (9), 842-845;
88. Lokaewmanee, K., Yamauchi, K., Okuda, N.: Effects of dietary red pepper on egg yolk colour and histological intestinal morphology in laying hens, *Journal of Animal Physiology and Animal Nutrition*, **2013**, **97** (5), 986-995;
89. Lillehoj, H., Liu, Y., Calsamiglia, S., Fernandez-Miyakawa, M.E., Chi, F., Cravens, R.L., Oh, S., Gay, C.G.: Phytochemicals as antibiotic alternatives to promote growth and enhance host health, *Veterinary Research*, **2018**, **49** (1), 76;
90. Lee, S.-H., Lillehoj, H.S., Chun, H.-K., Tuo, W., Park, H.-J., Cho, S.-M., Lee, Y.-M., Lillehoj, E.P.: In vitro treatment of chicken peripheral blood lymphocytes, macrophages, and tumor cells with extracts of Korean medicinal plants, *Nutrition Research*, **2007**, **27** (6), 362-366;
91. Wan, X., Ahmad, H., Zhang, L., Wang, Z., Wang, T.: Dietary enzymatically treated *Artemisia annua* L. improves meat quality, antioxidant capacity and energy status of breast muscle in heat-stressed broilers, *Journal of the Science of Food and Agriculture*, **2018**, **98** (10), 3715-3721;

92. Mihalcea, A., Amariei, S.: Study on the importance of aflatoxins; degradation method; mycotoxins prevalent in corn, *Journal Scientific Study & Research*, *Chemistry&Chemical Engineering, Biotechnology, Food Industry*, **2021**, **22** (3), 365-381;
93. Taneva, I.: Phytochemical analysis and antioxidant activity of two aronia species grown in Bulgaria, *Journal Scientific Study & Research*, *Chemistry&Chemical Engineering, Biotechnology, Food Industry*, **2023**, **24** (4), 337-345**;**
94. Guo, K., Ge, J., Zhang, C., Lv, M. W., Zhang, Q., Talukder, M., Li, J.L.: Cadmium induced cardiac inflammation in chicken (Gallus gallus) via modulating cytochrome P450 systems and Nrf2 mediated antioxidant defense, *Chemosphere*, **2020**, **249**, 125858;
95. Uyanga, V.A., Oke, E.O., Amevor, F.K., Zhao, J., Wang, X., Jiao, H., Onagbesan, O.M., Lin, H.: Functional roles of taurine, L-theanine, L-citrulline, and betaine during heat stress in poultry, *Journal of Animal Science and Biotechnology*, **2022**, **13** (1), 23;
96. Oladokun, S., Dridi, S., Adewole, D.: An evaluation of the thermoregulatory potential of in ovo delivered bioactive substances (probiotic, folic acid, and essential oil) in broiler chickens, *Poultry Science*, **2023**, **102** (5), 102602;
97. Estévez, M.: Oxidative damage to poultry: from farm to fork, *Poultry Science*, **2015**, **94** (6), 1368-1378;
98. Wang, J.X., Peng, K.M.: Developmental morphology of the small intestine of African ostrich chicks, *Poultry Science*, **2008**, **87** (12), 2629-2635;
99. Incharoen, T., Yamauchi, K.: Production performance, egg quality and intestinal histology in laying hens fed dietary dried fermented ginger, *International Journal of Poultry Science*, **2009**, **8** (11), 1078-1085.