

Lan L, Zuo B, Ding H, et al [Anticoccidial evaluation of a traditional Chinese medicine-- Brucea javanica--in broilers.](#) Poult Sci. 2016 Apr;95(4):811-8.

The traditional Chinese medicinal plant *Brucea javanica* has received much attention for its significant antiprotozoal effects in recent years; however, little is known about its potential anticoccidial functions. In the present study, a series of experiments was conducted to investigate the prophylactic and therapeutic effects of ethanol extract from *B. javanica* on coccidiosis induced by *Eimeria tenella* in broiler chickens. Chickens infected with *E. tenella* were treated with *B. javanica* extract and compared either with broilers treated with the anticoccidial halofuginone hydrobromide (Stenorol) or with control groups that consisted of infected-unmedicated and uninfected-unmedicated broilers. The experiments revealed that the *B. javanica* extract could significantly ($P < 0.05$) reduce bloody diarrhea and lesion scores. Additionally, OPG output in these plant extract treated groups was reduced in comparison with non-treated groups ($P < 0.05$). However, there was no evidence to show that the extract could promote BWG. Histological data showed that the number of second-generation schizonts in the medicated groups was substantially less than that in the infected-unmedicated control. In summary, our work showed that *B. javanica* extract exerted considerable anticoccidial effects, supporting its use as a promising therapeutic in controlling avian coccidiosis

Diaz-Sanchez S, D'Souza D, Biswas D, Hanning I. [Botanical alternatives to antibiotics for use in organic poultry production.](#) Poult Sci. 2015 Jun;94(6):1419-30.

The development of antibiotic resistant pathogens has resulted from the use of sub-therapeutic concentrations of antibiotics delivered in poultry feed. Furthermore, there are a number of consumer concerns regarding the use of antibiotics in food animals including residue contamination of poultry products and antibiotic resistant bacterial pathogens. These issues have resulted in recommendations to reduce the use of antibiotics as growth promoters in livestock in the United States. Unlike conventional production, organic systems are not permitted to use antibiotics. Thus, both conventional and organic poultry production need alternative methods to improve growth and performance of poultry. Herbs, spices, and various other plant extracts are being evaluated as alternatives to antibiotics and some do have growth promoting effects, antimicrobial properties, and other health-related benefits. This review aims to provide an overview of herbs, spices, and plant extracts, currently defined as phytobiotics as potential feed additives.

Brown AW, Stegelmeier BL, Colegate SM Etal [The comparative toxicity of a reduced, crude comfrey \(*Symphytum officinale*\) alkaloid extract and the pure, comfrey-derived pyrrolizidine alkaloids, lycopsamine and intermedine in chicks \(*Gallus gallus domesticus*\)](#). J Appl Toxicol. 2015 Jul 14. doi: 10.1002/jat.3205. [Epub ahead of print]

Comfrey (*Symphytum officinale*), a commonly used herb, contains dehydropyrrolizidine alkaloids that, as a group of bioactive metabolites, are potentially hepatotoxic, pneumotoxic, genotoxic and carcinogenic. Consequently, regulatory agencies and international health organizations have recommended comfrey be used for external use only. However, in many locations comfrey continues to be ingested as a tisane or as a leafy vegetable. The objective of this work was to compare the toxicity of a crude, reduced comfrey alkaloid extract to purified lycopsamine and intermedine that are major constituents of *S. officinale*. Male, California White chicks were orally exposed to daily doses of 0.04, 0.13, 0.26, 0.52 and 1.04 mmol lycopsamine, intermedine or reduced comfrey extract per kg bodyweight (BW) for 10 days. After another 7 days chicks were euthanized. Based on clinical signs of poisoning, serum biochemistry, and histopathological analysis the reduced comfrey extract was more toxic than lycopsamine and intermedine. This work suggests a greater than additive effect of the individual alkaloids and/or a more potent toxicity of the acetylated derivatives in the reduced comfrey extract. It also suggests that safety recommendations based on purified compounds may underestimate the potential toxicity of comfrey.

Haselmeyer A1, Zentek J, Chizzola R. [Effects of thyme as a feed additive in broiler chickens on thymol in gut contents, blood plasma, liver and muscle](#). J Sci Food Agric. 2015 Feb;95(3):504-8.

Aromatic herbs as feed additives in animal production are encountering growing interest, but data on the fate of the aromatic compounds from the plant in the animal body are very scarce. In the present study, thyme (*Thymus vulgaris*) herb consisting of leaves and flowers without stems was used as an ingredient in the diet for broilers. The herb was fed for 35 days to five groups of broilers (0, 0.1, 0.2, 0.3, and 1% w/w in the diet). Animal performance and the concentrations of the main essential oil component from thyme, thymol, were measured in gut contents, plasma and liver and muscle tissues using solid phase microextraction and gas chromatography/mass spectrometry. There were no differences between the groups in feed intake, daily weight gain, feed conversion and slaughter weight. Thymol was detected in gut contents, plasma and liver and muscle tissues. Increased intestinal thymol

concentrations were found in the group with 1% thyme compared with the other groups ($P < 0.05$). In liver and muscle tissues the thymol levels were close to the limit of quantification. The data do not indicate a positive effect of thyme on animal performance. With high dietary levels of thyme herb, thymol concentrations increased in gut contents and plasma but were very low in edible tissues such as liver and flesh.
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Wunderlich F, Al-Quraishy S, Steinbrenner H et al. [Towards identifying novel anti-Eimeria agents: trace elements, vitamins, and plant-based natural products.](#) Parasitol Res. 2014 Oct;113(10):3547-56.

Eimeriosis, a widespread infectious disease of livestock, is caused by coccidian protozoans of the genus *Eimeria*. These obligate intracellular parasites strike the digestive tract of their hosts and give rise to enormous economic losses, particularly in poultry, ruminants including cattle, and rabbit farming. Vaccination, though a rational prophylactic measure, has not yet been as successful as initially thought. Numerous broad-spectrum anti-coccidial drugs are currently in use for treatment and prophylactic control of eimeriosis. However, increasing concerns about parasite resistance, consumer health, and environmental safety of the commercial drugs warrant efforts to search for novel agents with anti-*Eimeria* activity. This review summarizes current approaches to prevent and treat eimeriosis such as vaccination and commercial drugs, as well as recent attempts to use dietary antioxidants as novel anti-*Eimeria* agents. In particular, the trace elements selenium and zinc, the vitamins A and E, and natural products extracted from garlic, barberry, pomegranate, sweet wormwood, and other plants are discussed. Several of these novel anti-*Eimeria* agents exhibit a protective role against oxidative stress that occurs not only in the intestine of *Eimeria*-infected animals, but also in their non-parasitized tissues, in particular, in the first-pass organ liver. Currently, it appears to be promising to identify safe combinations of low-cost natural products with high anti-*Eimeria* efficacy for a potential use as feed supplementation in animal farming.

Drăgan L, Györke A, Ferreira JF, Pop IA, Dunca I, Drăgan M, Mircean V, Dan I, Cozma V. [Effects of *Artemisia annua* and *Foeniculum vulgare* on chickens highly infected with *Eimeria tenella* \(phylum Apicomplexa\).](#) Acta Vet Scand. 2014 Apr 15;56:22.

Intensive poultry production systems depend on chemoprophylaxis with anticoccidial drugs to combat infection. A floor-pen study was conducted to evaluate the anticoccidial effect of *Artemisia annua* and *Foeniculum vulgare* on *Eimeria tenella*

infection. Five experimental groups were established: negative control (untreated, unchallenged); positive control (untreated, challenged); a group medicated with 125 ppm lasalocid and challenged; a group medicated with *A. annua* leaf powder at 1.5% in feed and challenged; and a group treated with the mixed oils of *A. annua* and *Foeniculum vulgare* in equal parts, 7.5% in water and challenged. The effects of *A. annua* and oil extract of *A. annua* + *F. vulgare* on *E. tenella* infection were assessed by clinical signs, mortality, fecal oocyst output, faeces, lesion score, weight gain, and feed conversion. Clinical signs were noticed only in three chickens from the lasalocid group, six from the *A. annua* group, and nine from the *A. annua* + *F. vulgare* group, but were present in 19 infected chickens from the positive control group. Bloody diarrhea was registered in only two chickens from *A. annua* group, but in 17 chickens from the positive control group. Mortality also occurred in the positive control group (7/20). Chickens treated with *A. annua* had a significant reduction in faecal oocysts (95.6%; $P = 0.027$) and in lesion score (56.3%; $P = 0.005$) when compared to the positive control. At the end of experiment, chickens treated with *A. annua* leaf powder had the highest body weight gain (68.2 g/day), after the negative control group, and the best feed conversion (1.85) among all experimental groups. Our results suggest that *A. annua* leaf powder (Aa-p), at 1.5% of the daily diet post-infection, can be a valuable alternative for synthetic coccidiostats, such as lasalocid.

Zeng ZK, Li QY, Piao XS, Liu JD, Zhao PF, Xu X, Zhang S, Niu S. [Forsythia suspensa extract attenuates corticosterone-induced growth inhibition, oxidative injury, and immune depression in broilers](#). *Poult Sci.* 2014 Jul;93(7):1774-81.

Forsythia suspensa extract (FSE) has been demonstrated to attenuate physiological stress induced by high temperature or high stocking density. This experiment was conducted with 144 male Arbor Acre broilers (1-d-old, weighing 42.7 ± 1.7 g) to determine the effects of FSE on performance, nutrient digestibility, antioxidant activities, serum metabolites, and immune parameters for birds treated with corticosterone (CS). The birds were randomly allotted to 1 of 4 treatments in a 2×2 factorial arrangement that included FSE supplementation (0 or 100 mg/kg) and CS administration (0 or 20 mg/kg of diet for 7 consecutive days starting on d 14). The feeding program consisted of a starter diet from d 1 to 21 and a finisher diet from d 22 to 42. Corticosterone administration decreased ($P < 0.01$) ADG and impaired ($P < 0.01$) feed conversion ratio in both phases and overall, which were alleviated ($P < 0.01$) by dietary FSE supplementation in the finisher phase and overall. At d 21, CS administration caused decreases ($P < 0.05$) in the apparent digestibility of energy, relative weight of bursa and thymus, total antioxidant capacity, superoxide dismutase (SOD) activity, and antibody titers to Newcastle disease virus (NDV); however, serum malondialdehyde and uric acid were increased. All of these changes were attenuated ($P < 0.05$) by dietary FSE supplementation. At d 42, FSE supplementation improved ($P < 0.05$) the apparent digestibility of DM and CP, relative weights of bursa, SOD

activity, and antibody titers to NDV, which were impaired by CS administration. Interactions ($P < 0.05$) were noted between CS and FSE for ADG and feed conversion ratio in the finisher phase and overall, as well as total antioxidant capacity, SOD activity, uric acid, and antibody titers to NDV at d 21, as well as relative weights of thymus at d 42. In conclusion, dietary FSE supplementation enhanced nutrient digestibility and performance of broiler possibly by reducing oxidative stress and immune depression challenged by CS.

Sun Y, Niu L, Song M, Zhao X, Sun N, He J, Wu C, Jiang J, Bai Y, Guo J, Li H. [Screening compounds of Chinese medicinal herbs anti-Marek's disease virus](#). Pharm Biol. 2014 Jul;52(7):841-7.

Marek's disease (MD) seriously threatens the world poultry industry and has resulted in great economic losses. Chinese medicinal herbs are a rich source for lead compounds and drug candidates for antiviral treatments. The object of the study was to investigate the anti-MDV activity and mechanism of 20 compounds extracted from Chinese medicinal herbs. Antiviral assay, time of addition experiments, and virucidal assay were performed on chicken embryo fibroblast cells. The 50% cytotoxic concentration and 50% effective concentration were determined and, accordingly, selectivity index and inhibition ratio were calculated. Antiviral assay showed dipotassium glycyrrhizinate (DG) and sodium tanshinone IIA sulfonate (STS) exhibited significantly inhibitory activity against MDV in a dose-dependent manner. EC₅₀ of DG and STS were $893.5 \pm 36.99 \mu\text{g/mL}$ and $54.82 \pm 2.99 \mu\text{g/mL}$, and selective index (SI) were >3.36 and >9.12 , respectively. Time of addition experiment and virucidal assay demonstrated DG inhibited viral replication in the full replication cycle and inactivated MDV particles in non-time-dependent manner, but STS interfered with the early stage of MDV replication and inactivated MDV particles in a time-dependent manner. Moreover, both DG and STS promoted apoptosis of cells infected by MDV. DG and STS have great potential for developing new anti-MDV drugs for clinic application.

Varmuzova K, Matulova ME, Gerzova L, Cejkova D, Gardan-Salmon D, Panhéleux M, Robert F, Sisak F, Havlickova H, Rychlik I. [Curcuma and Scutellaria plant extracts protect chickens against inflammation and Salmonella Enteritidis infection](#). Poult Sci. 2015 Sep;94(9):2049-58.

After a ban on the use of antibiotics as growth promoters in farm animals in the European Union in 2006, an interest in alternative products with antibacterial or anti-inflammatory properties has increased. In this study, we therefore tested the effects

of extracts from *Curcuma longa* and *Scutellaria baicalensis* used as feed additives against cecal inflammation induced by heat stress or *Salmonella Enteritidis* (*S. Enteritidis*) infection in chickens. Curcuma extract alone was not enough to decrease gut inflammation induced by heat stress. However, a mixture of Curcuma and *Scutellaria* extracts used as feed additives decreased gut inflammation induced by heat or *S. Enteritidis*, decreased *S. Enteritidis* counts in the cecum but was of no negative effect on BW or humoral immune response. Using next-generation sequencing of 16S rRNA we found out that supplementation of feed with the 2 plant extracts had no effect on microbiota diversity. However, if the plant extract supplementation was provided to the chickens infected with *S. Enteritidis*, *Faecalibacterium*, and *Lactobacillus*, both bacterial genera with known positive effects on gut health were positively selected. The supplementation of chicken feed with extracts from Curcuma and *Scutellaria* thus may be used in poultry production to effectively decrease gut inflammation and increase chicken performance.

Lan L, Zuo B, Ding H, Huang Y, Chen X, Du A. [Anticoccidial evaluation of a traditional Chinese medicine--*Brucea javanica*--in broilers.](#) *Poult Sci.* 2016 Apr;95(4):811-8.

The traditional Chinese medicinal plant *Brucea javanica* has received much attention for its significant antiprotozoal effects in recent years; however, little is known about its potential anticoccidial functions. In the present study, a series of experiments was conducted to investigate the prophylactic and therapeutic effects of ethanol extract from *B. javanica* on coccidiosis induced by *Eimeria tenella* in broiler chickens. Chickens infected with *E. tenella* were treated with *B. javanica* extract and compared either with broilers treated with the anticoccidial halofuginone hydrobromide (Stenorol) or with control groups that consisted of infected-unmedicated and uninfected-unmedicated broilers. The experiments revealed that the *B. javanica* extract could significantly ($P<0.05$) reduce bloody diarrhea and lesion scores. Additionally, OPG output in these plant extract treated groups was reduced in comparison with non-treated groups ($P<0.05$). However, there was no evidence to show that the extract could promote BWG. Histological data showed that the number of second-generation schizonts in the medicated groups was substantially less than that in the infected-unmedicated control. In summary, our work showed that *B. javanica* extract exerted considerable anticoccidial effects, supporting its use as a promising therapeutic in controlling avian coccidiosis.

Gholami-Ahangaran M, Rangsz N, Azizi S. [Evaluation of turmeric \(*Curcuma longa*\) effect on biochemical and pathological parameters of liver and kidney in chicken aflatoxicosis.](#) *Pharm Biol.* 2016 May;54(5):780-7.

Aflatoxins as potent mycotoxins can influence vital parameters in chickens. Turmeric was used in decreasing toxic effect of mycotoxins on vital organs, traditionally. The study compared the protective effect of turmeric and Mycoad(TR) in broilers exposed to aflatoxin. Chickens (270) were divided into six groups. The chickens were fed a basal diet, turmeric extract (5 mg/kg diet), Mycoad(TR) (25 mg/kg diet), productive aflatoxin (3 mg/kg diet), aflatoxin plus turmeric extract (3 versus 5 mg/kg diet), and aflatoxin plus Mycoad(TR) (3 versus 25 mg/kg diet) in basal diet. At 28 d old, we determined plasma concentration of total protein, albumin, triglyceride, cholesterol, high-density lipoprotein (HDL), low-density lipoprotein (LDL), calcium, potassium, phosphorous, uric acid, aspartate transferase (AST), and alanine aminotransferase (ALT). Furthermore, liver and kidney were sampled for pathological examination. Chickens fed turmeric with aflatoxin had significant lower ALT, AST, and uric acid than chickens fed aflatoxin (11.4 ± 0.79 , 228 ± 9 , and 6 ± 0.4 versus 17.2 ± 1.7 , 283 ± 5 , and 7.7 ± 0.1) whereas, total protein, calcium, and HDL values in chickens fed aflatoxin plus turmeric increased significantly (2.66 ± 0.16 , 8.4 ± 0.2 , and 920 ± 4.1 versus 1.7 ± 0.17 , 7 ± 0.2 , and 690 ± 4.8). Pathological examination revealed severe congestion, degeneration, and necrosis in liver and kidney in chickens that received aflatoxin. The study showed that turmeric may provide protection against the toxic effects of aflatoxin on liver and kidney.

Nechita IS1, Poirel MT2, Cozma V3, Zenner L2. [The repellent and persistent toxic effects of essential oils against the poultry red mite, *Dermanyssus gallinae*](#). Vet Parasitol. 2015 Oct 24. pii: S0304-4017

The economic impact of the poultry red mite, *Dermanyssus gallinae*, the lack of new acaricides, the occurrence of resistance and tighter legislation have all led to the need to find new ways to control this pest. One promising alternative method of control focuses on employing repellent and/or toxic effects of selected plant essential oils against *D. gallinae*. Ten essential oils (basil, thyme, coriander, eucalyptus, lavender, lemon, fir tree, oregano, mint, and juniper) were tested for the persistence of toxic and repellent effects. In filter-paper toxicity bioassays against *D. gallinae*, the best results were observed for lavender (more than 97% mortality after 48 and 72 h) and thyme (84% at 72 h) at a dose of 0.12 mg/cm². In addition, two oils showed significant persistent toxic effects 15 and 30 days post application to filter papers. Thyme was the most effective (100% mortality at 72 h), followed by lavender (nearly 80% mortality after 72 h). Out of the ten oils tested for their repellent effect, thyme was the strongest, with nearly 80% of the tested area avoided by mites; oregano caused a 60% avoidance and lavender exhibited an effect close to 40%. All other oils exhibited a repellent effect of less than 30%. None of the experiments showed a repellent effect for HM (commercial alimentary oil) or negative controls. We found

that the thyme and lavender essential oils exhibited promising results when tested in vitro for toxic and repellent effects against *D. gallinae*; thus, we suggest that future experiments focus on in vivo tests using these oils in farm units.

Kim JE, Lillehoj HS, Hong YH, Kim GB, Lee SH, Lillehoj EP, Bravo DM. [Dietary Capsicum and Curcuma longa oleoresins increase intestinal microbiome and necrotic enteritis in three commercial broiler breeds](#). Res Vet Sci. 2015 Oct;102:150-8.

Three commercial broiler breeds were fed from hatch with a diet supplemented with Capsicum and Curcuma longa oleoresins, and co-infected with *Eimeria maxima* and *Clostridium perfringens* to induce necrotic enteritis (NE). Pyrotag deep sequencing of bacterial 16S rRNA showed that gut microbiota compositions were quite distinct depending on the broiler breed type. In the absence of oleoresin diet, the number of operational taxonomic units (OTUs), was decreased in infected Cobb, and increased in Ross and Hubbard, compared with the uninfected. In the absence of oleoresin diet, all chicken breeds had a decreased *Candidatus Arthromitus*, while the proportion of *Lactobacillus* was increased in Cobb, but decreased in Hubbard and Ross. Oleoresin supplementation of infected chickens increased OTUs in Cobb and Ross, but decreased OTUs in Hubbard, compared with unsupplemented/infected controls. Oleoresin supplementation of infected Cobb and Hubbard was associated with an increased percentage of gut *Lactobacillus* and decreased *Selenihalanaerobacter*, while Ross had a decreased fraction of *Lactobacillus* and increased *Selenihalanaerobacter*, *Clostridium*, *Calothrix*, and *Geitlerinema*. These results suggest that dietary Capsicum/Curcuma oleoresins reduced the negative consequences of NE on body weight and intestinal lesion, in part, through alteration of the gut microbiome in 3 commercial broiler breeds.

Alipour F, Hassanabadi A, Golian A, Nassiri-Moghaddam H. [Effect of plant extracts derived from thyme on male broiler performance](#). Poult Sci. 2015 Nov;94(11):2630-4.

The effect of dietary thyme-oil extract (TOE) supplementation on immune functions of broilers were assessed by feeding graded levels (50, 100, 200, or 400 ppm) of TOE to male broiler chicks during a 42-d feeding trial compared with negative- or positive-control diets. Dietary control treatments included a negative-control diet with no feed-additive supplementation and 2 positive-control groups supplemented with either virginiamycin or zinc bacitracin. In total, 300 1-day-old Ross × Ross male broilers were randomly assigned to 6 dietary treatments that consisted of 5 replicates of 10 birds each. On d 21 and 42, 2 birds from each replicate were killed by cervical cutting

to measure the relative weights of spleen and bursa of Fabricius. At 25 d of age, chicks were injected with 0.5 mL of 10% SRBC suspension. Broilers fed with 200 ppm of TOE had heavier weights of bursa of Fabricius than those fed other dietary treatments at d 42 of age. Furthermore, dietary inclusion of 100 ppm of TOE resulted in higher ($P < 0.05$) total immunoglobulin response in primary antibody titer against sheep erythrocytes compared with other dietary treatments. On the other hand, diet modifications had no significant effect on blood leukocyte subpopulations and heterophil-to-lymphocyte ratio. These results suggest that dietary supplementation with TOE, especially at the level of 100 ppm, can improve immunological responses of broiler chicks.

Varmuzova K, Matulova ME, Gerzova L, Cejkova D, Gardan-Salmon D, Panhéleux M, Robert F, Sisak F, Havlickova H, Rychlik I. [Curcuma and Scutellaria plant extracts protect chickens against inflammation and Salmonella Enteritidis infection.](#) Poult Sci. 2015 Sep;94(9):2049-58.

After a ban on the use of antibiotics as growth promoters in farm animals in the European Union in 2006, an interest in alternative products with antibacterial or anti-inflammatory properties has increased. In this study, we therefore tested the effects of extracts from *Curcuma longa* and *Scutellaria baicalensis* used as feed additives against cecal inflammation induced by heat stress or *Salmonella Enteritidis* (*S. Enteritidis*) infection in chickens. Curcuma extract alone was not enough to decrease gut inflammation induced by heat stress. However, a mixture of Curcuma and Scutellaria extracts used as feed additives decreased gut inflammation induced by heat or *S. Enteritidis*, decreased *S. Enteritidis* counts in the cecum but was of no negative effect on BW or humoral immune response. Using next-generation sequencing of 16S rRNA we found out that supplementation of feed with the 2 plant extracts had no effect on microbiota diversity. However, if the plant extract supplementation was provided to the chickens infected with *S. Enteritidis*, *Faecalibacterium*, and *Lactobacillus*, both bacterial genera with known positive effects on gut health were positively selected. The supplementation of chicken feed with extracts from Curcuma and Scutellaria thus may be used in poultry production to effectively decrease gut inflammation and increase chicken performance.

Varmaghany S1, Karimi Torshizi MA2, Rahimi S3, et al. [The effects of increasing levels of dietary garlic bulb on growth performance, systolic blood pressure, hematology, and ascites syndrome in broiler chickens.](#) Poult Sci. 2015 Aug;94(8):1812-20.

The effects of dietary garlic bulb were studied separately on hematological parameters, ascites incidence, and growth performance of an ascites susceptible broiler hybrid under both standard temperature conditions (STC) and cold temperature conditions (CTC). A total of 336 one-day-old male broiler chickens were allocated to 4 experimental groups with 4 replicates of 21 birds each under STC. In addition, the same grouping with another 336 birds was used for CTC. Under CTC, the birds were exposed to cold temperatures for induction of ascites. Experimental groups were defined by the inclusion of 0 (control), 5, 10 or 15 g/kg garlic bulbs in the diets under both STC and CTC. Growth performance, systolic blood pressure (as a measure of systemic arterial blood pressure), physiological and biochemical parameters, as well as ascites indices (right ventricle [RV], total ventricle [TV] weights, and RV/TV) were evaluated. Systolic blood pressure was determined using an indirect method with a sphygmomanometer, a pediatric cuff, and a Doppler device. The final body weight decreased quadratically ($P = 0.003$), with increasing garlic bulb levels in the diets under STC. The feed conversion ratio showed no significant differences among all groups under both STC and CTC. No significant differences were observed in total mortality and ascites-related mortality in all groups under STC, although total mortality (L: $P = 0.01$; Q: $P = 0.001$) and ascites-related mortality (L: $P = 0.007$; Q: $P = 0.001$) were significantly different among the diets under CTC. Under STC, the systolic blood pressure, packed cell volume, hemoglobin, RV, TV, and RV/TV did not vary significantly among the diets. However, red blood cell count and erythrocyte osmotic fragility decreased linearly ($P < 0.005$) with increasing garlic bulb levels in the diets under STC. Under CTC, the systolic blood pressure, packed cell volume, red blood cell count, and erythrocyte osmotic fragility decreased ($P < 0.05$) with increasing garlic levels. It is concluded that the inclusion of 5 g/kg garlic bulb in susceptible broiler chicken diets has a systemic anti-hypertensive effect and could decrease ascites incidence without impairing broiler chicken performance.

Diaz-Sanchez S, D'Souza D, Biswas D, Hanning I. [Botanical alternatives to antibiotics for use in organic poultry production](#). *Poult Sci.* 2015 Jun;94(6):1419-30.

The development of antibiotic resistant pathogens has resulted from the use of sub-therapeutic concentrations of antibiotics delivered in poultry feed. Furthermore, there are a number of consumer concerns regarding the use of antibiotics in food animals including residue contamination of poultry products and antibiotic resistant bacterial pathogens. These issues have resulted in recommendations to reduce the use of antibiotics as growth promoters in livestock in the United States. Unlike conventional production, organic systems are not permitted to use antibiotics. Thus, both conventional and organic poultry production need alternative methods to improve growth and performance of poultry. Herbs, spices, and various other plant extracts are being evaluated as alternatives to antibiotics and some do have growth promoting effects, antimicrobial properties, and other health-related benefits. This

review aims to provide an overview of herbs, spices, and plant extracts, currently defined as phytobiotics as potential feed additives.

Müştak HK, Torun E, Özen D, Yücel G, Akan M, Diker KS. [Effect of Lonicera japonica extract on Mycoplasma gallisepticum in naturally infected broiler flocks.](#) Br Poult Sci. 2015;56(3):299-303

In this study, the effect of chlorogenic acid extract from *Lonicera japonica* Thunb. on *Mycoplasma gallisepticum* infections and the performance of broiler flocks was investigated. 2. A total of 360 Ross-308 broiler chicks taken from *M. gallisepticum* seropositive flocks were divided equally into three groups designated as control (nothing administered), antibiotic (Tylosin tartrate given for the first 3 d and d 20-22) and test group (chlorogenic acid extract given twice a day on d 16 and 22). 3. Broiler performance analysis, serological tests (slide agglutination), molecular identification (polymerase chain reaction) and histopathological examination were performed to detect *M. gallisepticum*. 4. The results show that chlorogenic acid not only increases live body weight but is also an alternative treatment option in *M. gallisepticum*-infected broiler flocks.

Song X, Zhang Y, Yin Z, Zhao X, Liang X, He C, Yin L, Lv C, Zhao L, Ye G, Shi F, Shu G, Jia R. [Antiviral effect of sulfated Chuanmingshen violaceum polysaccharide in chickens infected with virulent Newcastle disease virus.](#) Virology. 2015 Feb;476:316-22

Newcastle disease virus (NDV) belonging to the Paramyxovirinae subfamily is one of the most devastating pathogens in poultry. Although vaccines are widely applied to control the infection, outbreaks of Newcastle disease (ND) repeatedly happen. Currently, there are no alternative control measures available for ND. In the present study, we found that sulfated *Chuanmingshen violaceum* polysaccharide (sCVPS) were potent inhibitors of NDV in specific pathogen free chickens infected with a virulent strain. With sCVPS treatment, the survival rate increased by almost 20% and virus titers in test organs, including brain, lung, spleen and thymus, were significantly decreased. The sCVPS also exhibited the ability to prevent viral transmission by reducing the amount of virus shed in saliva and feces. Higher concentrations of interferon α and γ in serum were detected in chickens treated with sCVPS, indicating that one of the antiviral mechanisms may be attributed to the property of immunoenhancement. Histopathological examination showed that sCVPS could alleviate the tissue lesions caused by NDV infection. These results suggest that sCVPS are expected to be a new alternative control measure for NDV infection and further

studies could be carried out to evaluate the antiviral activity of sCVPS against other paramyxoviruses.

Yang WC, Tien YJ, Chung CY, Chen YC, Chiou WH, Hsu SY, Liu HY, Liang CL, Chang CL. [Effect of *Bidens pilosa* on infection and drug resistance of *Eimeria* in chickens.](#) Res Vet Sci. 2015 Feb;98:74-81.

Extensive use of current anti-coccidial drugs together with drug resistance and residue has raised concerns about public health and poultry development. Here, we studied the anti-coccidial properties of *Bidens pilosa*. A phytochemical approach was developed for analysis of *B. pilosa* utilized as a feed additive. The protective effects of *B. pilosa* supplemented chicken diet were evaluated chickens infected with *Eimeria tenella*. *B. pilosa*, at doses of 0.5%, 1% and 5% of the chicken diet, significantly protected against *E. tenella* as measured by reduction in mortality, weight loss, fecal oocyst excretion and gut pathology in chickens. Finally, drug resistance of *E. tenella* to *B. pilosa* was assessed in chickens using the anti-coccidial index. This index showed that *B. pilosa* induced little, if any, drug resistance to *Eimeria* in chickens. Collectively, this work suggests that *B. pilosa* may serve as a novel, natural remedy for coccidiosis with low drug resistance in chickens.

Rusinek-Prystupa E, Tataro MR. [Effect of a plant preparation Citrosept on selected immunity indices in blood of slaughter turkey hens.](#) Ann Agric Environ Med. 2014;21(3):581-4

The objective of this study was to determine the effect of per os administration of 3 various dosages of a Citrosept preparation (a grapefruit extract) to growing turkey hens on changes in their selected haematological and immunological blood indices. An attempt was also undertaken to select the most efficient dose of the preparation with respect to the mentioned indices in turkey hens. The experiment was conducted on 180 turkey hens allocated at random to 4 groups, 45 birds in each group. Samples of their full blood were analyzed for haematological indices, such as red blood cell count (RBC), haemoglobin content (Hb), haematocrit value (Ht), and white blood cell count (WBC). Samples of blood plasma were assayed to determine the activity of lysozyme (chamber-diffusive method) and heterophils capability to reduce nitro blue tetrazolium (stimulated and spontaneous NBT test). Phagocytic activity of leucocytes against *Staphylococcus aureus* 209P strain was assessed and expressed as the percentage of phagocytic cells (% PC) and phagocytic index (PI). The administration of the grapefruit extract to turkey hens with drinking water caused a significant increase

in haemoglobin content in blood, as well as an increase in non-specific humoral immunity marker (activity of lysozyme) and non-specific cellular immunity marker (percentage of phagocytic cells; $P \leq 0.05$). The results obtained enabled the positive evaluation of the advisability of applying the Citrosept preparation in the feeding of turkey hens at the age of 6-9 weeks. Among the doses examined, the most efficient with respect to the stimulation of the non-specific humoral and cellular immunity was the dose of 0.021 ml/kg of body weight.

Zhong X, Shi Y, Chen J, Xu J, Wang L, Beier RC, Hou X, Liu F. [Polyphenol extracts from Punica granatum and Terminalia chebula are anti-inflammatory and increase the survival rate of chickens challenged with Escherichia coli.](#) Biol Pharm Bull. 2014;37(10):1575-82

Avian pathogenic Escherichia coli (APEC) causes inflammation in multiple organs of chickens called avian colibacillosis, and results in serious economic loss to the chicken industry. Polyphenolic compounds possess a wide range of physiological activities that may contribute to their beneficial effects against inflammation-related diseases. In this study, the curative effect and mechanism of action of the polyphenolic extracts from Punica granatum L. and Terminalia chebula Retz. in chickens challenged with APEC were studied. Specific-pathogen-free white Leghorn chickens (males, 21-d old) were challenged with APEC and then given oral administration of extracts of P. granatum and T. chebula. The extracts decreased the morbidity and inflammation induced by APEC. Data from quantitative real-time polymerase chain reaction and enzyme-linked immunosorbent assay showed that the extracts of P. granatum and T. chebula polyphenols (GCP) reversed the over-expression genes of the Toll-like receptor (TLR) 2, 4, and 5, down-regulated the activation of nuclear factor-kappa B signal transduction pathways, and inhibited the production of pro-inflammatory cytokines. Naturally occurring GCP may be a potential alternative medicine for the prevention or treatment of avian colibacillosis.

Parker CD, Prins C, Saliba C, Gutierrez G, Serrar M. [Effect of TEX-OE\(®\) treatment on the development of heat shock proteins in commercial broiler chicks and the impact on performance indicators in the grow-out period.](#) Br Poult Sci. 2014;55(5):592-7.

Heat shock proteins (HSPs) are highly conserved proteins, shown to protect organisms against physical and physiological stress. TEX-OE(®) is a patented total extract of the fruit of Opuntia ficus indica, which has been demonstrated to accelerate the development of HSPs in several animal species. One-day-old commercial broiler chicks

were treated with TEX-OE(®); HSP was measured by enzyme-linked immunosorbent assay (ELISA), and a large commercial field trial investigated key performance indicators (KPIs) in treated versus untreated controls chicks. TEX-OE(®) significantly increased HSP concentrations in treated chicks versus controls. Final cumulative mortality, liveweight and percentage factory-rejects were better than in controls. The accelerated HSP response may enable chicks to cope with early stressors, which is reflected in improved KPIs.

Zhai L, Wang Y, Yu J, Hu S. [Enhanced immune responses of chickens to oral vaccination against infectious bursal disease by ginseng stem-leaf saponins.](#) Poult Sci. 2014 Oct;93(10):2473-81.

Infectious bursal disease (IBD), caused by infectious bursal disease virus (IBDV), is an immunosuppressive infectious disease of global economic importance in poultry. This study was designed to evaluate the effect of oral administration of ginseng stem-leaf saponins (GSLs) on humoral and gut mucosal immunity in chickens vaccinated with live IBDV vaccine, and furthermore, to test its protective efficacy against virulent IBDV challenge following vaccination. In experiment 1, chickens were orally administered with GSLs at 5 mg/kg of BW for 7 d, and then immunized with live IBDV vaccine via the oral route. Serum was sampled on 0, 1, 2, 3, 4, and 5 wk postvaccination for detecting antibody titers by ELISA, and intestinal tissues were collected on 0, 1, 3, and 5 wk postvaccination for measurement of IgA-positive cells and intestinal intraepithelial lymphocytes by immunohistochemical and hematoxylin-eosin staining, respectively. Result showed that antibody titers, IgA-positive cells and intestinal intraepithelial lymphocytes were significantly higher in chickens drinking GSLs than the control, suggesting an enhanced effect of GSLs on humoral and gut mucosal immune responses. In experiment 2, chickens were delivered with GSLs and then vaccinated in the same way as in experiment 1. The birds were challenged with virulent IBDV at wk 3 postvaccination. Then the birds were weighed, bled, and necropsied at d 3 postchallenge and the bursae were sampled for gross and histopathological examination. Results demonstrated that GSLs provided a better protection against virulent IBDV challenge following vaccination than the control. In conclusion, oral administration of GSLs enhances both humoral and gut mucosal immune responses to IBDV and offers a better protection against virulent IBDV challenge. Considering its immunomodulatory properties to IBDV vaccine, GSLs might be a promising oral adjuvant for vaccination against infectious diseases in poultry.

Pourhossein Z, Qotbi AA, Seidavi A, Laudadio V, Centoducati G, Tufarelli V. [Effect of different levels of dietary sweet orange \(Citrus sinensis\) peel extract on humoral immune system responses in broiler chickens.](#) Anim Sci J. 2015 Jan;86(1):105-10.

This experiment was conducted to evaluate the effects of different levels of sweet orange (*Citrus sinensis*) peel extract (SOPE) on humoral immune system responses in broiler chickens. Three hundred 1-day broilers (Ross-308) were randomly allocated to treatments varying in supplemental SOPE added in the drinking water. The experimental groups consisted of three treatments fed for 42 days as follows: a control treatment without feed extract, a treatment containing 1000 ppm of SOPE and a treatment containing 1250 ppm of SOPE. All treatments were isocaloric and isonitrogenous. Broilers were vaccinated with Newcastle disease virus (NDV), avian influenza (AI), infectious bursal disease (IBD) and infectious bronchitis virus (IBV) vaccines. Antibody titer response to sheep red blood cells (SRBC) was higher in the group fed 1250 ppm of SOPE ($P < 0.05$) as well as for immunoglobulin G (IgG) and IgM. Similarly, antibody titer responses to all vaccines were constantly elevated ($P < 0.05$) by SOPE enrichment in a dose-dependent manner. Relative weights of spleen and bursa of Fabricius were unaffected by treatments. Dietary SOPE supplementation may improve the immune response and diseases resistance, indicating that it can constitute a useful additive in broiler feeding. Thus, supplying SOPE in rations may help to improve relative immune response in broiler chickens.

Sun Y, Niu L, Song M, Zhao X, Sun N, He J, Wu C, Jiang J, Bai Y, Guo J, Li H. [Screening compounds of Chinese medicinal herbs anti-Marek's disease virus](#). *Pharm Biol.* 2014 Jul;52(7):841-7.

Marek's disease (MD) seriously threatens the world poultry industry and has resulted in great economic losses. Chinese medicinal herbs are a rich source for lead compounds and drug candidates for antiviral treatments. This study was to investigate the anti-MDV activity and mechanism of 20 compounds extracted from Chinese medicinal herbs. Antiviral assay, time of addition experiments, and virucidal assay were performed on chicken embryo fibroblast cells. The 50% cytotoxic concentration and 50% effective concentration were determined and, accordingly, selectivity index and inhibition ratio were calculated. Antiviral assay showed dipotassium glycyrrhizinate (DG) and sodium tanshinone IIA sulfonate (STS) exhibited significantly inhibitory activity against MDV in a dose-dependent manner. EC₅₀ of DG and STS were $893.5 \pm 36.99 \mu\text{g/mL}$ and $54.82 \pm 2.99 \mu\text{g/mL}$, and selective index (SI) were >3.36 and >9.12 , respectively. Time of addition experiment and virucidal assay demonstrated DG inhibited viral replication in the full replication cycle and inactivated MDV particles in non-time-dependent manner, but STS interfered with the early stage of MDV replication and inactivated MDV particles in a time-dependent manner. Moreover, both DG and STS promoted apoptosis of cells infected by MDV. DG and STS have great potential for developing new anti-MDV drugs for clinic application.

Tanweer AJ, Chand N, Saddique U, Bailey CA, Khan RU. [Antiparasitic effect of wild rue \(*Peganum harmala* L.\) against experimentally induced coccidiosis in broiler chicks.](#) Parasitol Res. 2014 Aug;113(8):2951-60.

Organic farming of poultry has increased in recent years as the prophylactic use of antibiotics has come into disfavor. This study was conducted to explore the antiparasitic effect of a methanolic extract of *Peganum harmala* in broilers challenged with coccidiosis. For this purpose, 200 1-week-old broiler chicks were divided into five treatments: negative control (basal diet, Ph-0/NC), positive control (basal diet with coccidiosis challenge, Ph-0/C), and three groups challenged with coccidiosis and supplemented with *P. harmala* at the rate of 200 mg L⁻¹ (Ph-200), 250 mg L⁻¹ (Ph-250), and 300 mg L⁻¹ (Ph-300) drinking water. Each group had three replicates of ten chicks each. Challenge with standard dose of the larvae of coccidiosis and supplementation of *P. harmala* were initiated on day 14 until 35 days of age. As expected, the results revealed that weight gain, feed intake, and feed conversion ratio (FCR) were depressed significantly in Ph-0 group with significant mortality percentage. Weight gain, total body weight, and FCR increased linearly with increasing dose of *P. harmala* with the exception of feed intake. The growth and feed efficiency of Ph-0/NC was better in Ph-0/NC compared to that in Ph-0/C and comparable to that in *P. harmala*-treated birds. Similarly, mean oocysts per gram (OPG) decreased linearly ($P < 0.05$) in supplemented groups compared to that in Ph-0/C. Histological evidences showed that cecal lesion and leucocyte infiltration decreased markedly in supplemented groups of *P. harmala* specifically the Ph-300 group compared to those in Ph-0/C. From the present experiment, we concluded the anticoccidial effect of *P. harmala* in broiler chicks.

Zeng ZK, Li QY, Piao XS, Liu JD, Zhao PF, Xu X, Zhang S, Niu S. [Forsythia suspensa extract attenuates corticosterone-induced growth inhibition, oxidative injury, and immune depression in broilers.](#) Poult Sci. 2014 Jul;93(7):1774-81.

Forsythia suspensa extract (FSE) has been demonstrated to attenuate physiological stress induced by high temperature or high stocking density. This experiment was conducted with 144 male Arbor Acre broilers (1-d-old, weighing 42.7 ± 1.7 g) to determine the effects of FSE on performance, nutrient digestibility, antioxidant activities, serum metabolites, and immune parameters for birds treated with corticosterone (CS). The birds were randomly allotted to 1 of 4 treatments in a 2×2 factorial arrangement that included FSE supplementation (0 or 100 mg/kg) and CS administration (0 or 20 mg/kg of diet for 7 consecutive days starting on d 14). The

feeding program consisted of a starter diet from d 1 to 21 and a finisher diet from d 22 to 42. Corticosterone administration decreased ($P < 0.01$) ADG and impaired ($P < 0.01$) feed conversion ratio in both phases and overall, which were alleviated ($P < 0.01$) by dietary FSE supplementation in the finisher phase and overall. At d 21, CS administration caused decreases ($P < 0.05$) in the apparent digestibility of energy, relative weight of bursa and thymus, total antioxidant capacity, superoxide dismutase (SOD) activity, and antibody titers to Newcastle disease virus (NDV); however, serum malondialdehyde and uric acid were increased. All of these changes were attenuated ($P < 0.05$) by dietary FSE supplementation. At d 42, FSE supplementation improved ($P < 0.05$) the apparent digestibility of DM and CP, relative weights of bursa, SOD activity, and antibody titers to NDV, which were impaired by CS administration. Interactions ($P < 0.05$) were noted between CS and FSE for ADG and feed conversion ratio in the finisher phase and overall, as well as total antioxidant capacity, SOD activity, uric acid, and antibody titers to NDV at d 21, as well as relative weights of thymus at d 42. In conclusion, dietary FSE supplementation enhanced nutrient digestibility and performance of broiler possibly by reducing oxidative stress and immune depression challenged by CS.

Drăgan L, Györke A, Ferreira JF, Pop IA, Dunca I, Drăgan M, Mircean V, Dan I, Cozma V. [Effects of *Artemisia annua* and *Foeniculum vulgare* on chickens highly infected with *Eimeria tenella* \(phylum Apicomplexa\)](#). Acta Vet Scand. 2014 Apr 15;56:22.

Intensive poultry production systems depend on chemoprophylaxis with anticoccidial drugs to combat infection. A floor-pen study was conducted to evaluate the anticoccidial effect of *Artemisia annua* and *Foeniculum vulgare* on *Eimeria tenella* infection. Five experimental groups were established: negative control (untreated, unchallenged); positive control (untreated, challenged); a group medicated with 125 ppm lasalocid and challenged; a group medicated with *A. annua* leaf powder at 1.5% in feed and challenged; and a group treated with the mixed oils of *A. annua* and *Foeniculum vulgare* in equal parts, 7.5% in water and challenged. The effects of *A. annua* and oil extract of *A. annua* + *F. vulgare* on *E. tenella* infection were assessed by clinical signs, mortality, fecal oocyst output, faeces, lesion score, weight gain, and feed conversion. Clinical signs were noticed only in three chickens from the lasalocid group, six from the *A. annua* group, and nine from the *A. annua* + *F. vulgare* group, but were present in 19 infected chickens from the positive control group. Bloody diarrhea was registered in only two chickens from *A. annua* group, but in 17 chickens from the positive control group. Mortality also occurred in the positive control group (7/20). Chickens treated with *A. annua* had a significant reduction in faecal oocysts (95.6%; $P = 0.027$) and in lesion score (56.3%; $P = 0.005$) when compared to the positive control. At the end of experiment, chickens treated with *A. annua* leaf powder had the highest body weight gain (68.2 g/day), after the negative control group, and the best feed conversion (1.85) among all experimental groups. Our results suggest that *A.*

annua leaf powder (Aa-p), at 1.5% of the daily diet post-infection, can be a valuable alternative for synthetic coccidiostats, such as lasalocid.

Habibi R, Sadeghi G, Karimi A. [Effect of different concentrations of ginger root powder and its essential oil on growth performance, serum metabolites and antioxidant status in broiler chicks under heat stress.](#) Br Poult Sci. 2014;55(2):228-37

This study was carried out to evaluate the impact of ginger (*Zingiber officinale*) feed supplementation on growth performance, antioxidant status, carcass characteristics and blood parameters in broiler chicks under conditions of heat stress ($32 \pm 2^\circ\text{C}$ for 8 h per d). 2. A total of 336 d-old male broiler chicks (Cobb-500) were randomly assigned to one of 6 dietary groups representing: basal diet with no supplement as control, basal diet containing 100 mg/kg vitamin E as positive control, basal diets containing either 7.5 or 15 g/kg of ginger root powder, and diets containing 75 or 150 mg/kg of ginger essential oil. 3. The results indicated that at 22 d of age, the group receiving 7.5 g/kg of ginger root powder experienced significantly increased body weight (BW) and body weight gain (BWG) compared to the control group. There were no significant difference among the diet groups regarding BW, BWG, feed intake (FI) or feed conversion ratio (FCR) at 42 and 49 d of age. 4. The inclusion of powder and essential oil of ginger in broiler diets did not affect carcass characteristics and blood parameters of the chickens. However, in the group receiving 150 mg/kg ginger essential oil, the total superoxide dismutase (TSOD) activity in liver increased compared to the control group. Malondialdehyde (MDA) concentrations in liver also decreased in the groups receiving ginger powder and essential oil compared to that in the control group. There were no significant difference between experimental groups regarding glutathione peroxidase (Gpx), TSOD and catalase (CAT) enzymes in red blood cells. All dietary groups increased total antioxidant capacity (TAC) and decreased MDA concentration in serum compared to the control group. 5. The results of this study suggest that ginger powder and essential oils may be a suitable replacement for synthetic antioxidants in broiler diets. Results also suggest that ginger powder might be better than extracted essential oil for improving antioxidant status in broilers.

Bozkurt M1, Giannenas I, Küçükyılmaz K, Christaki E, Florou-Paneri P. [An update on approaches to controlling coccidia in poultry using botanical extracts.](#) Br Poult Sci. 2013;54(6):713-27.

This paper reviews the use of botanical extracts in the control of coccidial infection in poultry. 2. Some plants and their respective volatile oils and extracts have the potential to alleviate coccidiosis and reduce its severity. 3. Most plant bioactives improve some, but not all, aspects of coccidiosis with variable effectiveness against different species of *Eimeria*. 4. Difficulties in comparing research findings have arisen from the use of different experimental models, different active components and infectious dose of *Eimeria*. 5. Current knowledge of their potential anti-coccidial effects may provide guidance for the use of botanical extracts in the control of the coccidiosis.

Patil V, Asrani RK, Patil RD, Ledoux DR, Rottinghaus GE. [Pathology of ochratoxin A-induced nephrotoxicity in Japanese quail and its protection by sea buckthorn \(*Hippophae rhamnoides* L.\)](#). Avian Dis. 2013 Dec;57(4):767-79.

The present study was designed to study the protective effect of sea buckthorn (SBT) against renal damage induced by ochratoxin A (OTA) in Japanese quail. Day-old quail chicks were divided into six groups and fed a basal quail chick mash containing 2% SBT leaf powder (group SX), OTA at a dietary level of 3 ppm (group OX), 25 ppm L-beta-phenylalanine (Phe) plus 3 ppm OTA (group OP), 2% dietary level of SBT leaf powder plus 3 ppm OTA (group OS), SBT leaf extract at a level of 10%/L of drinking water plus 3 ppm OTA (group OSS), and a standard toxin-free feed (group CX, control) for 21 days. OTA at 3 ppm level in diet grossly revealed mild to moderate renal swelling in OX birds, and the severity was less in the case of OS, OSS, and OP birds. Microscopically, degenerative, necrotic, and inflammatory changes were observed in OX birds, but the changes were less severe in OS, OSS, and OP birds. Ultrastructural studies revealed remarkable and consistent changes in the proximal convoluted tubules (PCTs), with severe damage of mitochondria and endoplasmic reticulum in OX birds, whereas SBT-treated birds (groups OS, OSS) had mild changes in mitochondria. A moderate to marked increase in number of peroxisomes in the cytoplasm of PCTs was a consistent finding in the Phe- and SBT-treated groups kept on OTA in comparison to the group fed OTA alone. In conclusion, the inclusion of 2% SBT leaf powder in feed and SBT leaf extract in water provided partial protection against OTA-induced nephropathy in Japanese quail.

Almeida GF, Thamsborg SM, Madeira AM, Ferreira JF, Magalhães PM, Demattê Filho LC, Horsted K, Hermansen JE. [The effects of combining *Artemisia annua* and *Curcuma longa* ethanolic extracts in broilers challenged with infective oocysts of *Eimeria acervulina* and *E. maxima*](#). Parasitology. 2014 Mar;141(3):347-55.

Due to an increasing demand for natural products to control coccidiosis in broilers, we investigated the effects of supplementing a combination of ethanolic extracts of *Artemisia annua* and *Curcuma longa* in drinking water. Three different dosages of this herbal mixture were compared with a negative control (uninfected), a positive control (infected and untreated), chemical coccidiostats (nicarbazin+narazin and, later, salinomycin), vaccination, and a product based on oregano. Differences in performance (weight gain, feed intake, and feed conversion rate), mortality, gross intestinal lesions and oocyst excretion were investigated. Broilers given chemical coccidiostats performed better than all other groups. Broilers given the two highest dosages of the herbal mixture had intermediate lesion scores caused by *Eimeria acervulina*, which was higher than in broilers given coccidiostats, but less than in broilers given vaccination, oregano and in negative controls. There was a trend for lower mortality ($P = 0.08$) in the later stage of the growing period (23-43 days) in broilers given the highest dosage of herbal mixture compared with broilers given chemical coccidiostats. In conclusion, the delivery strategy of the herbal extracts is easy to implement at farm level, but further studies on dose levels and modes of action are needed.

Kim DK, Lillehoj HS, Lee SH, Jang SI, Lillehoj EP, Bravo D. [Dietary *Curcuma longa* enhances resistance against *Eimeria maxima* and *Eimeria tenella* infections in chickens](#). *Poult Sci.* 2013 Oct;92(10):2635-43.

The effects of dietary supplementation with an organic extract of *Curcuma longa* on systemic and local immune responses to experimental *Eimeria maxima* and *Eimeria tenella* infections were evaluated in commercial broiler chickens. Dietary supplementation with *C. longa* enhanced coccidiosis resistance as demonstrated by increased BW gains, reduced fecal oocyst shedding, and decreased gut lesions compared with infected birds fed a nonsupplemented control diet. The chickens fed *C. longa*-supplemented diet showed enhanced systemic humoral immunity, as assessed by greater levels of serum antibodies to an *Eimeria* microneme protein, MIC2, and enhanced cellular immunity, as measured by concanavalin A-induced spleen cell proliferation, compared with controls. At the intestinal level, genome-wide gene expression profiling by microarray hybridization identified 601 differentially expressed transcripts (287 upregulated, 314 downregulated) in gut lymphocytes of *C. longa*-fed chickens compared with nonsupplemented controls. Based on the known functions of the corresponding mammalian genes, the *C. longa*-induced intestinal transcriptome was mostly associated with genes mediating anti-inflammatory effects. Taken together, these results suggest that dietary *C. longa* could be used to attenuate *Eimeria*-induced, inflammation-mediated gut damage in commercial poultry production.

Bazh EK, El-Bahy NM. [In vitro and in vivo screening of anthelmintic activity of ginger and curcumin on Ascaridia galli](#). Parasitol Res. 2013 Nov;112(11):3679-86.

Intestinal helminthic infection, continue to be a cause of major concern in several parts of the world, particularly in the developing nations. The use of plant extracts to control poultry helminths is increasing in different rearing systems. The anthelmintic activity of ginger and curcumin was studied on the nematode *Ascaridia galli*. In vitro and in vivo studies were allocated. Live parasites for in vitro studies were collected from the intestine of naturally infected chickens. Some living worms were incubated at 37 °C in media containing ginger at three concentration levels (25, 50, and 100 mg/ml), and others were incubated in media containing curcumin at the same concentration levels. Another living worm group was incubated in media containing albendazole at a dose of 7.5 mg/ml. The extracts' efficacy was exhibited in a concentration-time-dependent manner mainly at 100 mg/ml and after 48 h. The in vivo study takes place on experimentally infected chickens. Group of infected chickens was treated with ginger extract at dose of 100 mg, another group was treated with curcumin extract at dose of 100 mg, and a third group was treated with albendazole at dose of 7.5 mg. In vivo study of ginger and curcumin recorded lower mortality rates than the in vitro study. It is concluded that ginger and curcumin extracts have potential anthelmintic properties against *A. galli*. Ginger in all concentrations used exhibited a higher death rate observed than curcumin. Their wormicidal effect is concentration-time dependent.

Li XT, Wang B, Li JL, Yang R, Li SC, Zhang M, Huang W, Cao L. [Effects of Dangguibuxue Tang, a Chinese herbal medicine, on growth performance and immune responses in broiler chicks](#). Biol Res. 2013;46(2):183-8.

The effects of Dangguibuxue Tang (DBT) on growth performance and immunity response in immunosuppressed broiler chicks were investigated in this study. 240 one-d-old broiler chicks (DaHeng S01) were randomly divided into 4 groups, 2.0% DBT-treatment (A), 0.5% DBT-treatment (B), cyclophosphamide-control (C), and control group (D). From 4 d to 7 d of age, chicks in group A, B and C were given cyclophosphamide (CY) at a dosage of 100mg/kg body weight (BW) daily by intraperitoneal injection to induce immunosuppression. Chicks in group D were given an equal volume of physiological saline daily by intraperitoneal injection and considered normal chicks. Groups A and B were supplemented with 2.0% or 0.5% of DBT in the drinking water from 8 d to 42 d of age. Groups C and D did not receive any additional medication. The results revealed that chicks from group B had lower feed:gain rate (FGR), lower total mortality, higher immunity organ indexes, higher levels of Newcastle disease (ND) antibody and infectious bursal disease (IBD)

antibody, higher interleukin-2 and interleukin-6 levels, and greater lymphocyte proliferative responses to concanavalin A (ConA) during the experiment than those from group C. However, no significant difference in the immunity status in the two levels of DBT-treatment was observed. These results indicate that supplementation of 0.5% of DBT can improve both cellular immunity and humoral immunity in immunosuppressed broiler chicks.

Solcan C, Gogu M, Floristean V, Oprisan B, Solcan G. [The hepatoprotective effect of sea buckthorn \(*Hippophae rhamnoides*\) berries on induced aflatoxin B1 poisoning in chickens 1](#). *Poult Sci.* 2013 Apr;92(4):966-74.

The leaves and berries of sea buckthorn (SB; *Hippophae rhamnoides*; family Elaeagnaceae) are medically claimed as having phytoantioxidant, antiinflammatory, and anticancerous properties in humans. This study evaluated the hepatoprotective activity of oil from SB berries against toxicity induced by aflatoxin B1 (AFB1) in broiler chickens. The toxicity of AFB1 led to lower total serum proteins and specifically reduced albumin ($P < 0.001$). Serum aspartate aminotransferase increased from 191.14 ± 11.56 to 218.80 ± 13.68 ($P < 0.001$). When chickens were simultaneously dosed with AFB1 and an extract of SB berries, subsequent histology of the liver showed a significant reduction of necrosis and fatty formation compared with chickens treated with AFB1 alone. Immunohistochemical results indicated that COX2, Bcl-2, and p53 were highly expressed in the liver of AFB1-treated chickens and their expression was significantly reduced by SB oil supplementation. The levels of AFB1 residues in chickens livers were significantly reduced by SB oil from 460.92 ± 6.2 ng/mL in the AFB1 group to 15.59 ± 6.1 ng/mL in the AFB1 and SB oil group. These findings suggest that SB oil has a potent hepatoprotective activity, reducing the concentration of aflatoxins in liver and diminishing their adverse effects.

Shang R, He C, Chen J, Pu X, Liu Y, Hua L, Wang L, Liang J. [Hypericum perforatum extract therapy for chickens experimentally infected with infectious bursal disease virus and its influence on immunity](#). *Can J Vet Res.* 2012 Jul;76(3):180-5.

Hypericum perforatum extract (HPE) has been proved a drug effective to many viral diseases. The purpose of this paper was to investigate the therapeutic efficacy and immuno-enhancement of HPE for chickens which were already challenged with infectious bursal disease virus (IBDV BC-6/85). Chickens infected with IBDV were treated with HPE for 5 consecutive days, the observation of immune organ indexes and pathological changes index, determination of IFN- α and detection of IBDV with

RT-PCR were employed to assess in vivo whether or not HPE had the certain therapeutic efficacy on infectious bursal disease (IBD), and if HPE was able to improve the immunologic function. The results showed that 1330 and 667.9 mg/kg body weight (BW) per day of HPE had significant therapeutic efficacy and improvement immunologic functions for chickens infected experimentally with IBDV.

Zhang DF1, Sun BB, Yue YY, Zhou QJ, Du AF. [Anticoccidial activity of traditional Chinese herbal *Dichroa febrifuga* Lour. extract against *Eimeria tenella* infection in chickens.](#) Parasitol Res. 2012 Dec;111(6):2229-33.

The study was conducted on broiler birds to evaluate the anticoccidial efficacy of an extract of Chinese traditional herb *Dichroa febrifuga* Lour. One hundred broiler birds were assigned to five equal groups. All birds in groups 1-4 were orally infected with 1.5×10^4 *Eimeria tenella* sporulated oocysts and birds in groups 1, 2 and 3 were medicated with 20, 40 mg extract/kg feed and 2 mg diclazuril/kg feed, respectively. The bloody diarrhea, oocyst counts, intestinal lesion scores, and the body weight were recorded to evaluate the anticoccidial efficacy. The results showed that *D. febrifuga* extract was effective against *Eimeria* infection; especially 20 mg *D. febrifuga* extract/kg feed can significantly increase body weight gains and reduce bloody diarrhea, lesion score, and oocyst excretion in comparison to infected-unmedicated control group.

Akhtar M, Hai A, Awais MM, Iqbal Z, Muhammad F, ul Haq A, Anwar MI. [Immunostimulatory and protective effects of *Aloe vera* against coccidiosis in industrial broiler chickens.](#) Vet Parasitol. 2012 May 25;186(3-4):170-7.

This paper reports the immunostimulatory and protective effects of *Aloe vera* extracts (aqueous and ethanolic) against coccidiosis in industrial broiler chickens. The study was divided into two experiments. Experiment-I was conducted for the evaluation of immunostimulatory activity of *A. vera* and experiment-II demonstrated the protective efficacy of *A. vera* extracts against coccidiosis in chickens. Results of the experiment-I revealed significantly higher ($p < 0.05$) lymphoproliferative responses in chickens administered with ethanolic extract of *A. vera* as compared to those administered with aqueous extract and control group. Microplate haemagglutination assay for humoral response on day 7th and 14th post primary and secondary injections of sheep red blood cells (SRBCs) revealed significantly higher ($p < 0.05$) anti SRBC antibody (total Igs, IgG and IgM) titers in chickens of experimental groups as compared to the control group. None of the extracts, however, demonstrated

significant effects on the development of lymphoid organs. Results of experiment-II revealed maximum protection (60%) in chickens administered with aqueous Aloe extract as compared to the ethanolic extract administered chickens (45%). Mean oocysts per gram of droppings in the control group was significantly higher ($p < 0.05$) as compared to the chickens in both the experimental groups. Chickens administered with aqueous Aloe extract showed a minimal mean lesion score (2.3) followed by those administered with ethanolic Aloe extract (2.6) and control chickens (3.05) for caeca, and a similar pattern was observed for intestinal lesion scoring. Further, significantly higher weight gains and antibody titers ($p < 0.05$) were observed in chickens administered with *A. vera* extracts as compared to those in the control group. It was concluded that *A. vera* may be a potential and valuable candidate to stimulate the immune responses and can be used successfully as an immunotherapeutic agent against coccidiosis in industrial broiler chickens.