IOSR Journal Of Pharmacy and Biological Sciences (IOSR-JPBS)
e-ISSN:2278-3008, p-ISSN:2319-7676. Volume 20, Issue 4 Ser. 2 (July. – August. 2025), PP 01-07
www.Iosrjournals.Org

The Preventive Effect Of Berberine Combination Therapy On Inflammation In Chicks

Zhao Lina[1234], Liu Dingkuo[134], Li Liuan[2]*
(1. Dingzheng Emerging Biotechnology (Tianjin) Co., Ltd.; 2. College Of Animal Science And Veterinary Medicine, Tianjin Agricultural University; 3. Tianjin Enterprise Technology Center; 4. Tianjin Key Laboratory Of Biological Feed Additives For Enterprises.)

Abstract:
Berberine (BBR), a primary alkaloid found in the rhizomes of Coptis chinensis, exhibits anti-inflammatory, antioxidant, immunomodulatory, gut microbiota-regulating, and intestinal mucosa-protective effects. Studies demonstrate that BBR inhibits inflammatory progression through multiple pathways, including inducing apoptosis in inflammatory cells, modulating the gut microbiome, and arresting cell cycle progression. Furthermore, BBR synergistically enhances drug sensitivity and mitigates drug resistance by regulating key signaling pathways such as phosphatidylinositol 3-kinase/protein kinase B (PI3K/Akt), mitogen-activated protein kinase (MAPK), and nuclear factor-kappa B (NF-κB). Its antioxidant and immunomodulatory functions further expand its potential in anti-inflammatory applications.This study aims to evaluate the impact of BBR on the anti-inflammatory capacity of chicks by constructing an inflammatory animal model. The trial utilized 126 one-day-old specific pathogen-free (SPF) chicks. Research indicates that supplementing the diet of layer chicks with a BBR-containing Chinese herbal compound additive can enhance their antioxidant capacity, improve serum biochemical parameters, and boost immune indicators.Concurrently, the challenges and potential strategies for the clinical translation of BBR's antitumor effects are discussed, providing a theoretical basis for its development as an antibiotic-alternative Chinese medicine.

Keywords: *Berberine，Antioxidant，Immune Indicators，Serum Biochemistry*

Date of Submission: 13-07-2025 Date of Acceptance: 23-07-2025

The intestine is a vital organ in animals[1], with primary functions including digestion, absorption, and excretion. Its complex structure[2] comprises the duodenum, jejunum, ileum, and colon. The liver performs synthesis, metabolism, detoxification, and immune functions[3]. Hepatocytes (70–80% of liver cells) and bile duct cells constitute the parenchyma, while the remaining 20–30% are immune-related cells, making the liver a key indicator of metabolic and immune responses[4].

In intensive farming systems, pathogens or repeated vaccinations often induce immune stress in layer chicks, leading to reduced productivity and economic losses. Previous studies suggest that declined antioxidant capacity[5], exacerbated inflammation, and hepatic metabolic disorders may underlie this growth impairment[6]. Modern pharmacological research confirms BBR's anti-inflammatory, hepatoprotective, antimicrobial, and antioxidant properties[7]. This study established an inflammation model using dextran sulfate sodium (DSS) in drinking water to evaluate BBR's effects on liver injury, inflammatory response, and oxidative stress in chicks. The findings may offer therapeutic strategies for chick inflammation and support BBR's application in immune stress management.

Therefore, this experiment selected 126 one-day-old specific pathogen-free (SPF) chicks purchased from Kaifeng Xingda (Henan) Industrial Co., Ltd. The chicks were evenly divided into 7 treatment groups based on their initial body weight. Each treatment group had 6 replicates, with 3 chicks per replicate. The experimental groups included: negative control (MS) group, blank control (Con) group, BBR + Surfactant A treatment group, BBR + Surfactant B treatment group, BBR high-dose group, BBR medium-dose group, and BBR low-dose group. The experimental period lasted 21 days, during which the chicks had free access to feed and water, and were provided with 24-hour artificial lighting. The environmental temperature was maintained at 35°C for the first 7 days and gradually decreased to 22°C by the 4th week. The diet was formulated according to NRC (Table 1) requirements and provided as powdered feed.

I. Materials And Methods:

Ethical Approval

The animal study protocol was approved by the Tianjin Institute of Animal Husbandry and Veterinary Medicine (Ethics No. SYXK-2017-0005).

Experimental Design

126 one-day-old SPF chicks (purchased from Kaifeng Xingda (Henan) Industrial Co., Ltd.) were randomly divided into 7 groups (6 replicates/group, 3 chicks/replicate) based on initial body weight:Negative control (MS) group，Blank control (Con) group，BBR + Surfactant A group，BBR + Surfactant B group，High-dose BBR group，Medium-dose BBR group，Low-dose BBR group.

Husbandry

The chickens were caged according to the conventional feeding and management methods for laying hens, and routine vaccinations were performed. Artificial light control: 24 h of light in the first 3 days, 23 h of light on the 4th to 7th days, and 20 h of light on the 8th to 21st days. Artificial temperature control: maintained at 33~35℃ in the first 3 days, then reduced by 1℃ every day. From the second week, the temperature was maintained at 28~30℃, and the relative humidity was controlled at 65%~70%. The experimental site was naturally ventilated throughout the whole process, and the chickens were free to eat and drink. Feed was fed in a feed pan in the first week, and from the second week onwards, feed was fed in a feed trough, and the water line was raised by 1 cm every 3 days. The diet was prepared according to the needs of NRC (Table 1) and provided in the form of powdered feed.

Ingredient	%	Nutrient Level	Value
Corn	54.14	Metabolizable Energy	12.90 MJ/kg
Soybean meal	16.67	Crude Protein	20.20%
Limestone	1.54	Calcium	1.05%
Wheat bran	9.13	Available Phosphorus	0.380%
Expanded soybean	9.43	Lysine	1.128%
Corn gluten meal	3.35	Methionine	0.487%
Fish meal	2.98	Methionine + Cysteine	0.847%

Note: Premix provided per kg of diet: VA 8000 IU, VE 100 mg, VK3 3 mg, VB2 12.5 mg, VB6 9 mg, VB12 0.03 mg, pantothenic acid 18 mg, niacin 60 mg, folic acid 1.5 mg, biotin 0.225 mg, Fe 80 mg, Cu 9 mg, I 0.9 mg, Se 0.3 mg, Mn 12.55 mg, Zn 25.2 mg.

Sample Collection

On day 21, blood was collected from the wing vein (5 chicks/replicate). Serum was separated by centrifugation (1,800×g, 10 min) and stored at −20°C for biochemical/antioxidant assays. Jejunal segments were fixed in 4% paraformaldehyde for histology; mucosa samples were flash-frozen in liquid nitrogen for RNA analysis.

Assays

Nutritional composition of diet

The crude protein content in the feed was determined using a Kjeldahl nitrogen analyzer according to GB/T 6432—2018. Calcium content was measured in accordance with GB/T 6436—2018, while total phosphorus content was analyzed as per GB/T 6437—2018. After determining phytic acid phosphorus content in the feed using the ferric chloride precipitation method, the total phosphorus content minus this value yields non-phytic

acid phosphorus content. Zinc content in the feed was measured using an ICP-9000 full-spectrum inductively coupled plasma spectrometer in compliance with GB/T 13885—2017.

Measurement of inflammation-related indicators

The content of IL-6, IL-10 and TNF-α in serum was determined by ELISA kit according to the instructions.

Measurement of liver function related indicators

The kit was used to measure serum and liver serum levels of aspartate aminotransferase (AST), alanine aminotransferase (ALT), total superoxide dismutase (T-SOD) and malondialdehyde (MDA). The specific operation was carried out according to the instructions.

Determination of antioxidant enzymes

The contents of T-AOC, CAT and T-SOD in liver were measured by using the kit. The specific operation was carried out according to the instructions.

Data statistical analysis

The experimental data were analyzed by SPSS 20.0 statistical analysis software for one-way ANOVA, and linear and quadratic curve tests were performed between additive dosage and various indicators. For indicators with significant inter-group differences, Duncan's method was used for multiple comparisons. Data were expressed as "average value ± standard deviation", and $P < 0.05$ indicated significant differences.

II. Results And Analysis

Effects of berberine on antioxidant indexes in serum of egg hens

As shown in Figure 1, both the treatment group and model group exhibited significant differences with a downward trend in IL-6 levels, with the TMP+M group demonstrating superior efficacy. Figure 2 reveals comparable differences between the two groups showing an upward trend in IL-10 levels, where the TMP+M and DVD+M groups demonstrated better outcomes. Figure 3 indicates consistent differences with decreasing SOD levels in both groups, with the TMP+M group achieving more favorable results.

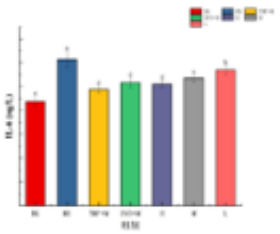

图 1

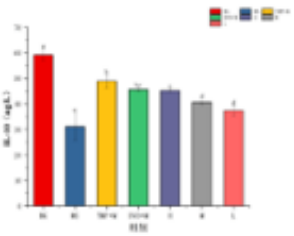

图 2

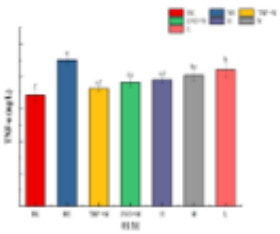

图 3

Effect of berberine on biochemical indexes in serum of egg hens

As shown in Figure 4, both the treatment group and the model group exhibited significant differences, with ALB levels showing an upward trend. The TMP+M and DVD+M groups demonstrated better efficacy. Figure 5 reveals that both treatment groups and the model group showed significant differences, with GLB levels showing a downward trend. The L group showed no significant effect, while the TMP+M, DVD+M, H, and M groups demonstrated better outcomes. Figure 6 indicates that both treatment groups and the model group showed significant differences, with A/G levels showing an X-shaped downward trend. The L group showed no significant effect, whereas the TMP+M, DVD+M, H, and M groups demonstrated superior perf.

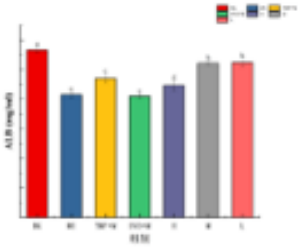

图 4

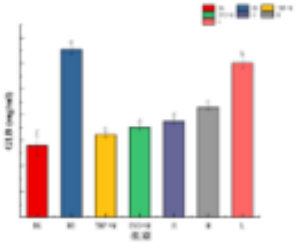

图 5

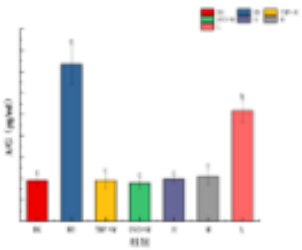

图 6

Effects of berberine on immune indicators in egg hens

As shown in Figure 7, the drug administration group showed significantly different results compared to the model group, with A IgA levels demonstrating a downward trend. The L group exhibited no significant effect, while the TMP+M group demonstrated better efficacy. Figure 8 reveals that both the drug administration group and model group showed significant differences, with G IgA levels also showing a downward trend. The M and L groups showed no notable effects, whereas the TMP+M and DVD+M groups demonstrated superior outcomes. Figure 9 indicates that the drug administration group and model group maintained significant differences, with M IgA levels showing a downward trend. The H, M, and L groups showed no significant effects, while the TMP+M and DVD+M groups demonstrated better performance.

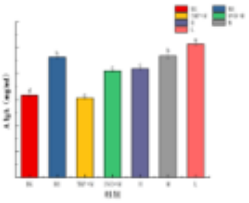

图 7

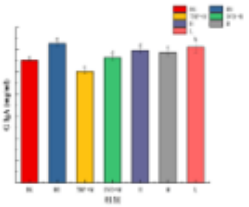

图 8

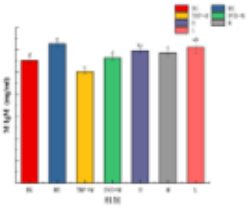

图 9

Effect of berberine on antioxidant indexes in serum of egg hens

As shown in Figure 10, both the drug administration group and the model group exhibited significant differences, with MDA levels showing a downward trend. The TMP+M and DVD+M groups demonstrated superior efficacy. Figure 11 reveals that both groups showed marked differences, with T-AOC levels increasing significantly. The TMP+M and DVD+M groups again demonstrated better performance. Figure 12 indicates that both groups showed significant differences, with SOD levels rising markedly. The TMP+M and DVD+M groups maintained superior efficacy.

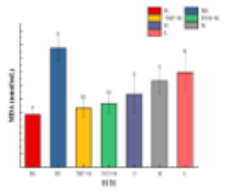

图 10

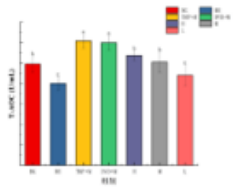

图 11

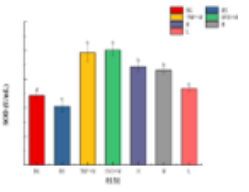

图 12

III. Discuss

Effect of berberine on biochemical indexes of serum in egg hens

Glutamine (GLB), also known as immunoglobulin [8], possesses biological functions that prevent bacterial invasion and enhance immune function; Glutamine (GLU) serves as a vital energy source for the immune system and organism [9]; while elevated serum triglyceride (TG) levels can suppress various immune functions [10]. The dynamic changes in biochemical indicators of broiler serum reflect the metabolic status of chicks [11], inflammatory responses, and hepatic and renal functions, making them crucial health assessment metrics [12]. Serum proteins such as trypsinogen (TP) and albumin (ALB) correlate with protein synthesis and animal growth [13], whereas liver enzymes ALT, AST, and ALP serve as key indicators of liver damage severity [14]. Triglycerides (TG) and total cholesterol (TC) reflect lipid metabolism and blood lipid profiles [15]. In this study, the serum ALB content in the experimental group was higher than that in the control group, while AST levels were lower. Notably, the TMP+M group showed significantly higher TP content compared to the control group, with ALT, TC, and TG levels all being substantially reduced. These findings indicate that berberine compound supplementation in feed improves serum biochemical parameters of broiler chicks, thereby promoting their growth.

Effect of berberine on antioxidant indexes in serum of egg hens

In intensive egg-laying chicken farming, high production performance is often accompanied by increased free radical levels in the body [16], making the enhancement of antioxidant capacity a key industry focus [17]. SOD serves as the first line of defense against free radicals in animals [18], rapidly converting superoxide anion (O2-) into molecular oxygen and hydrogen peroxide. CAT acts as the second line of defense [19], converting hydrogen peroxide into water and oxygen. T-AOC is a comprehensive indicator for assessing the functional status of the body's antioxidant system [20]. A healthy immune system is crucial for maintaining wellness, with immune factors acting as signaling pathways [21]. IL-1β synergistically stimulates T-cell activation, promotes B-cell proliferation, and enhances antibody secretion [22]. IL-2 secreted by Th1 cells activates helper cells, while IL-6 from Th2 cells assists B-cell differentiation [23]. TNF-α participates in biological processes including cell proliferation, differentiation, and apoptosis [24]. Oxidative stress is prevalent in high-density egg-laying chicken farming, where excessive oxidative responses can reduce production performance and decrease economic returns [25]. Li Shengjie's study [26] demonstrated that adding BBR to feed significantly improves SOD activity and T-AOC levels in post-laying hens' serum. Song Mingzhu et al. [27] found that incorporating Coptis chinensis extract into feed markedly enhances T-AOC, SOD, and GSH-Px activities in quail serum. Studies have shown that berberine has a good antioxidant capacity [28]. In this study, the combined addition of BBR could significantly improve the activity of T-SOD and the content of GSH in serum, and the effect was significantly better than that of medium dose BBR added alone.

Effects of berberine on immune indicators in egg hens

Cytokines are small-molecule proteins synthesized and secreted by immune cells and certain non-immune cells in response to specific stimuli[29]. These molecules exhibit broad biological activities, particularly demonstrating remarkable regulatory functions in immune responses[30]. IL-6, a multifunctional cytokine secreted by Th2 cells, plays a crucial role in immune function by producing immunoglobulins, stimulating B cell proliferation, and supporting hematopoiesis, pathogen defense, immune regulation, and acute stress responses[31].

IV. Conclusion

The results showed that the addition of berberine compound herbal additives to the diet of egg hens could improve the antioxidant capacity, serum biochemical indexes and immune indexes .

References

[1] Liang Y ,Zhu F ,Li J , Et Al.P-Phenylenediamine Antioxidants And Their Quinone Derivatives: A Review Of Their Environmental Occurrence, Accessibility, Potential Toxicity, And Human Exposure.[J].The Science Of The Total Environment,2024,948174449.
[2] C.HIGHNAM K .Integrated Biology[J].Nature,1965,207(4992):5-6.
[3] Bojić G M ,Aranđelović J ,Škrbić R , Et Al.Peripheral GABAA Receptors - Physiological Relevance And Therapeutic Implications.[J].Pharmacology & Therapeutics,2024,266108759.
[4] Hao Yanrong. The Effect And Mechanism Of Ginkgo Biloba Extract (Egb761) On The Process Of Aflatoxin B1-Induced Hepatocellular Carcinoma In Rats [D]. Guangxi Medical University, 2008.
[5] Yao Y ,Jia Y ,Yu Y , Et Al.Preserving Pungency And Color: Thermal/Storage Stability Of Bioactive Compounds In Chili Oil And Shelf-Life Extension Strategies[J].Food Bioscience,2025,71107212-107212.
[6] Yu J ,Zhu H ,Yu X , Et Al.Calcitriol/Vitamin D Receptor Ameliorates Fructose-Induced Enteritis-Hepatitis Axis Dysregulation In Mice.[J].The Journal Of Nutritional Biochemistry,2025,110017.
[7] Street E M ,Casadei F ,Bari D R E , Et Al.The Role Of Nutraceuticals And Probiotics In Addition To Lifestyle Intervention In The Management Of Childhood Obesity—Part 1: Metabolic Changes[J].Nutrients,2025,17(10):1630-1630.

[8] Casale B T ,Arnau G M A ,Bernstein A J , Et Al.A Plain Language Summary Of A Review About Omalizumab For People With Chronic Spontaneous Urticaria.[J].Immunotherapy,2025,17(4):1-7.

[9] Stabilization Of Oral Lecithin Immunoglobulin Using Regulatory Factor Control Mechanisms [D]. Huazhong Agricultural University, 2024.DOI:10.27158/D.Cnki.Ghznu.2024.000114.

[10] Nan D ,Yao W ,Huang L , Et Al.Glutamine And Cancer: Metabolism, Immune Microenvironment, And Therapeutic Targets[J].Cell Communication And Signaling,2025,23(1):45-45.

[11] Zhao H ,Comer L ,Akram Z M , Et Al.Recent Advances In The Application Of Microbiota Transplantation In Chickens[J].Journal Of Animal Science And Biotechnology,2025,16(1):91-91.

[12] Zhu Qingxiu, He Guizhen, Lü Yingzi, Et Al. Clinical Study On The Treatment Of Chronic Kidney Disease Stage 4-5 With Renkang Suppository Combined With Compound A-Ketoate Tablets [J/OL]. Journal Of Jilin Medical University, 1-4[2025-07-17].Https://Doi.Org/10.13845/J.Cnki.Issn1673-2995.20250520.0

[13] Duan Pingping. Barbary Wolfberry Effects Of Branches And Leaves On The Production Performance, Gastrointestinal Tissue Morphology And Microbial Flora Of Hu Sheep [D]. Tarim University, 2024.DOI:10.27708/D.Cnki.Gtlmd.2024.000420.

[14] Sun Xiaojuan. The Role Of Aquaporin AQP9 In The Mechanism Of Liver Injury In Septicemia In Mice [D]. Nanjing University Of Chinese Medicine, 2025.DOI:10.27253/D.Cnki.Gnjzu.2025.000110.

[15] Sha Yue. Effects Of Mountain Orchid Extract On Fatty Liver Disease Induced By High-Fat Diet [D]. Changchun Normal University, 2025.DOI:10.27709/D.Cnki.Gccsf.2025.000519.

[16] Wang Xingmei. Effects Of Chinese Herbal Preparations On Production Performance And Egg Quality Of Laying Hens [J]. China Animal Husbandry, 2025(09):50-51.

[17] Hou Zhigang. Construction Of Rapeseed Oil Enzyme-Membrane Combined Degumming System And Its Effects On The Quality And Flavor Of Concentrated Rapeseed Oil [D]. Hefei University Of Technology, 2023.DOI:10.27101/D.Cnki.Ghfgu.2023.000177.

[18] Kadian P J ,Kaushik L M ,Singh D A .Antioxidant And Anticancer Activity Of Tamarix Indica Aerial Extracts Against DMBA/Croton Oil-Induced Skin Carcinogenesis In Mice.[J].Asian Pacific Journal Of Cancer Prevention : APJCP,2025,26(2):701-711.

[19] Ma Huailiang. Drought Tolerance Mechanism Of Black Fungus Fruiting Bodies Cultivated With Crop Straw [D]. Northeast Agricultural University, 2015.

[20] He Fulin. Research On The Immune And Related Toxic Effects Of Induced Love In Earthworms And Their Mechanism [D]. Shandong University, 2024.DOI:10.27272/D.Cnki.Gshdu.2024.000614.

[21] Gianoli S ,Tang J ,Odegard C K , Et Al.Harnessing Adiponectin For Sepsis: Current Knowledge, Clinical Insights And Future Therapies.[J].Critical Care (London, England),2025,29(1):300.

[22] Toumi R ,Guenette S ,Chiu E , Et Al.Developing Novel Cell Therapy Strategies To Convert Macrophage Programming And Induce Synergistic, Multicellular Immunity Against AML[J].Blood,2024,144(S1):2056-2056.

[23] Yang Xinhong, Application Of Fine Lymphocyte Typing In Multiple Myeloma. Affiliated Hospital Of Chengde Medical College, Hebei Provinc

[24] Kumar S ,Ranga A .Role Of Mirnas In Breast Cancer Development And Progression: Current Research.[J].Biofactors (Oxford, England),2024,51(1):E2146-E2146.

[25] Gan Yi. Study On The Characteristics Of Lactic Acid Bacteria And The Effect Of Fermented Hawthorn Liquid On Lipid Metabolism In Rats [D]. Southwest University, 2019.DOI:10.27684/D.Cnki.Gxndx.2019.000094.

[26] Deng Chao. Effects Of Chili Meal On Production Performance, Antioxidant Function And Intestinal Function Of Laying Hens In The Late Stage Of Egg Production [D]. Sichuan Agricultural

[27] Deng Chao. Effects Of Chili Meal On Production Performance, Antioxidant Function And Intestinal Function Of Laying Hens In The Late Stage Of Egg Production [D]. Sichuan Agricultural

[28] Jiang Q S ,Dai P S ,Wang Y , Et Al.Design And Properties Of Cyclodextrin Grafted Chitosan/Sodium Alginate Dual-Network Hydrogel Based On Physical Cross-Linking.[J].International Journal Of Biological Macromolecules,2025,319(P1):145434.

[29] Chen Lei. Expression And Biological Significance Of Co-Stimulatory Molecules In Graves' Disease [D]. Soochow University, 2004.

[30] Yuan C ,Ji X ,Zhang Y , Et Al.Important Role Of Bacillus Subtilis As A Probiotic And Vaccine Carrier In Animal Health Maintenance.[J].World Journal Of Microbiology & Biotechnology,2024,40(9):268.

[31] Du L ,Zhang H ,Zhao Z , Et Al.Injectable Scaffolds With A Hierarchically Porous Structure And Augmented Paracrine Activity For Minimally Invasive Precision Medicine.[J].Materials Horizons,2025,