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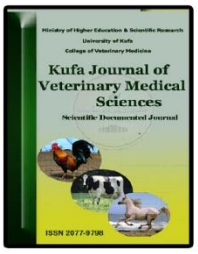

Evaluation of Toxicom on Broilers Fed Mycotoxin Contaminated Ration and Vaccinated Against Gumboro

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Abstract

The aim of this study was to evaluate the possible protective effect of preparation which synthesized in Vitebsk State Academy of Veterinary Medicine adsorbent (Toxicom) 5g\kg diet against the toxic effects of mixed mycotoxins in growing broiler chickens. Total 75 chicks, one week age, were divided into 5 treated groups,15 birds for each. The first group (G1) fed a contaminated ration with mycotoxin and supplemented with toxicom 5g/kg of diet and vaccinated with gumboro vaccine at 15 and 22 days of age. The second group (G2) was fed a ration contaminated with mycotoxin and vaccinated with gumboro vaccine at 15 and 22 days of age and not supplemented with toxicom. The third group (G3) was fed intact broiler ration and vaccinated with gumboro vaccine at 15 and 22 days of age. The fourth group (G4) was only fed a contaminated ration with mycotoxins. The fifth group (G5) was fed intact broiler ration as a control group. The diet was naturally contaminated with many mycotoxins and analyzed by ELISA and the level of mycotoxins were as follows : Aflatoxin B1 0.001 mg/kg, Dezoxivalenol 1.24 mg/kg, Zearalenon 0.068 mg/kg, Ochratoxin 0.005 mg/kg, T2 toxin 0.09 mg/kg, Fuminisen B1 0.2 mg/kg. The antibody titers for Infectious Bursal Disease vaccine (IBDv) was conducted by ELISA. It was concluded that this preparation which synthesized in Vitebsk State Academy of Veterinary Medicine is protect chickens body weight and decrease the effect of mycotoxins in comparison with the other groups and recommended for using as adsorbent in Republic of Belarus.

Key Words: Broiler, Gumboro, Mycotoxins, Adsorbents, Toxicom, ELISA, Body Weight.

تقييم التوكسيكوم على دجاج اللحم المغذى بعليقة تحتوي السموم الفطرية والملقحة بلقاح الكمبورو

الاعرجي ،فرقان ,غروموف ،ايكور ، كورشاكينا ،داريا

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الخلاصة:

ان الهدف من هذه الدراسة هو تقييم التأثير الوقائي المحتمل لاستخدام (توكسيكوم) المادة المحضرة في اكاديمية فيتبسك الحكومية للطب البيطري وبجرعة 5 غم/ كغم علف ضد السموم الفطرية المختلطة في علائق فروج اللحم. استخدم في التجربة 75 فرخا بعمر اسبوع واحد قسمت الى خمس مجاميع . المجموعة الاولى اعطيت العليقة الملوثة بالسموم الفطرية مع مادة التوكسيكوم بجرعة 5 غم/ كغم علف ولقحت بلفاح الكمبورو بعمر 15 و22 يوما، تم تغذية المجموعة الثانية العليقة الملوثة بالسموم الفطرية ولقحت ايضا بعمر 15 و 22 يوما، المجموعة الثالثة اعطيت العلف السليم الخالي من السموم الفطرية ولقحت ايضا بعمر 15 و22 يوما، اما المجموعة الرابعة فقد اعطيت العلف الملوث ولم تلقح وقد تركت المجموعة الخامسة كمجموعة سيطرة.تم تحليل نسبة التلوث في العلف بواسطة تقنية الاليزا وكانت نسب السموم الفطرية كالاتي : الافلاتوكسين 0.001ملغم/ كغم ،الديزوكسيفالينول 1.24 ملغم/ كغم ،الزيرالينون0.068 ملغم/ كغم ، الاوكراتوكسين 0.005 ملغم/ كغم ،ت 2 0.09 ملغم/ كغم والفومينيسين ب1 0.2 ملغم/ كغم. تم قياس الاجسام المناعية للكمبورو بواسطة تقنية الاليزا . تم الاستنتاج بان المادة المستحضرة في اكاديمية فيتبسك الحكومية للطب البيطري تحمي الدجاج من فقدان الوزن وتقلل تاثير السموم الفطرية مقارنة بباقي المجاميع وقد تمت التوصية باستخدامها كمادة مضادة للسموم في جمهورية بيلاروسيا.

الكلمات المفتاحية: دجاج اللحم، الكمبورو، السموم الفطرية، الممتزات، التوكسيكوم ، الاليزا ، وزن الجسم.

Introduction

Molds are filamentous fungi that occur in many feedstuffs including grains (1) and forages (2). Molds can infect animals, especially during stressful periods when they are immune suppressed, causing a disease referred to as a mycosis. Molds also produce mycotoxins, which can cause a mycotoxicosis or toxic response in animals exposed primarily by consuming mycotoxin-contaminated feeds. Surveys reveal sufficiently high occurrences and concentrations of mycotoxins to suggest that they are a constant concern (3).

Mycotoxins are chemical substances produced by several fungi, particularly by many species of *Aspergillus*, *Fusarium*, *Penicillium* and *Alternaria*. They comprise a group of several hundreds of chemically different toxic compounds. The most common mycotoxins are aflatoxins, ochratoxin A, trichothecenes, zearalenone, andfumonisins (4). The Food and Agriculture Organization (FAO) and other researchers have estimated that worldwide about 25% of crops are affected annually with mycotoxins (5). The acute mycotoxicosis outbreaks in modern poultry production system are rare, however, chronic and low level mycotoxin contamination through naturally contaminated grains often causes reduced production efficiency and increases susceptibility to many immune related infectious diseases(6). Mycotoxins may also occur in conjugated form, either soluble (masked mycotoxins) or incorporated into associated with attached to macromolecules (bound mycotoxins). These conjugated mycotoxins can emerge after metabolization by living plants, fungi and mammals or after food processing (5).Mycotoxins are unavoidable because they are naturally occurring compounds. They contaminate crops before harvest or invade feedstuffs of laying hen during processing, transport or storage (6). Chronic and low level mycotoxin contamination through naturally contaminated grains often causes reduced production efficiency and increases susceptibility to many immune related infectious diseases(7).

Many strategies have been tested to avoid mycotoxicosis (7), which can be divided into pre- and

post-harvest technologies and into biological, chemical, and physical methods. The best procedure to prevent the effect of mycotoxins is the minimizing of the mycotoxin production itself (8), e.g. by harvesting the grain at maturity and low moisture and storing it at cool and dry conditions which is difficult to perform in countries with a warm and humid climate. Furthermore, the growth of fungi and therefore the production of mycotoxins is limited by the use of propionic acid or ammonium isobutyrate. Feed additives like antioxidants, sulphur-containing amino acids, vitamins, and trace elements can be useful as detoxicants (9).

Main drawbacks of chemical detoxication are the ineffectiveness against other mycotoxins and the possible deterioration of the animals' health by excessive residual ammonia in the feed. The physical methods are focused on the removal of mycotoxins by different adsorbents added to mycotoxin-contaminated diets (10) with the hope of being effective in the gastro-intestinal tract more in a prophylactic rather than in a therapeutic manner. Certain bacteria, particularly strains of lactic acid bacteria, propionibacteria and bifidobacteria, appear to have the capacity to bind mycotoxins, including aflatoxin and some Fusarium produced mycotoxins (11, 12). Activated charcoal may be important in binding zearalenone and/or deoxynivalenol (13, 14). In an *in vitro* gastrointestinal model, activated carbon reduced availability of deoxynivalenol and nivalenol (15).

The addition of mycotoxin binders to contaminated diets has been considered the most promising dietary approach to reduce effects of mycotoxins. The theory is that the binder decontaminates mycotoxins in the feed by binding them strongly enough to prevent toxic interactions with the consuming animal and to prevent mycotoxin absorption across the digestive tract. Therefore, this approach is seen as prevention rather than therapy (16). Even though food is often contaminated with more than one mycotoxin, most studies are limited to the toxicity of a single mycotoxin.

The aim of this study is to evaluate the effect of mixed mycotoxin in chicken body weight and blood parameters and evaluate the effect of using toxicom in keeping chicken performance normal.

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Materials And Methods

This experiment was conducted to determine the effect of dietary supplementation of Toxicom (lignin derivative, synthesized in Republic of Belarus) on detoxification of mycotoxin in broilers ration. The chicks were reared from 7 to 42 days in the condition of epizootology department and pathanatomy and histology department, Vitebsk state academy of Veterinary Medicine, Republic of Belarus. A total of (75) chicks, one week age were used. Birds were fed starter diet during the third week of age (beginning date of experiment; 22.6% crude protein and 2870.4 kcal/kg of diet) and finisher diet (20.5% crude protein and 2920 kcal/kg of diet) until the marketing age (42 days of age). Chicks were randomly divided into 5 treated groups, 15 birds for each. Chicks were randomly divided into 5 treated groups, 15 birds for each. The first group (G1) fed a contaminated ration with mycotoxin and supplemented with toxicom 5g/kg of diet and vaccinated with gumboro vaccine on 15^{th} and 22^{nd} days of age. The second group (G2)

was fed a ration contaminated with mycotoxin and vaccinated with gumboro vaccine on 15^{th} and 22^{nd} days of age but not supplemented with toxicom. The third group (G3) was fed a commercial intact broiler ration and vaccinated with gumboro vaccine on 15^{th} and 22^{nd} days of age. The fourth group (G4) was only fed a contaminated ration with mycotoxins. The fifth group (G5) was fed a commercial broiler ration as a control group. The strain of vaccine was interfield 2512 that produced in Russian Federation, the vaccine was supplemented manually intra crop for every chick with one dose. The diet was naturally contaminated with many mycotoxins and analyzed by ELISA in cmolovichi laboratory .The final level of mycotoxins were as follows : Aflatoxin B1 0.001 mg/kg, Dezoxivalenol 1.24 mg/kg, Zearalenon 0.068 mg/kg, Ochratoxin 0.005 mg/kg , T2 toxin 0.09 mg/kg, Fuminisen B1 0.2 mg/kg. Five birds of each group were sacrificed to collect the blood and measured lysozyme activity of serum method that modified by Dorofeichuk Tselinograd Agricultural Institute (LASB) (17) and bactericidal activity of serum BASB - (18). Body weight was performed on an electronic balance "Scout Pro SPU 202" company "Ohaus Corporation" (USA). The titers of antibodies for infectious bursal disease vaccine were measured by ELISA, using the production system IDEXX laboratories Inc. in Scientific-Research Institute of Applied Veterinary Medicine and Biotechnology, Vitebsk State Academy of Veterinary Medicine. All data are analyzed by statistical program for study variation statistics, based on the significance ($P<0.05$). (Microsoft Excel 2003).

Results

After seven days of the first IBD vaccine, the body weight of birds in (G2) significantly ($P<0.05$) differ from the control, but the (G1) is not affected in comparison with the control ($P>0.05$).The differences in ratio of (LASB%) and (BASB) and titers of antibodies against IBD vaccine were very clear but not significant among all groups as in Table (1).

Table (1): The values after (7) days after first IBD vaccine

	Body Weight/ g	LASB.%	BASB.%	Titer of Antibodies against IBD vaccine
Group 1	510.00 ± 53.37 $P_{1-2}>0.05$ $P_{1-3}>0.05$ $P_{1-4}>0.05$ $P_{1-5}>0.05$	5.25 ± 1.97 $P_{1-2}>0.05$ $P_{1-3}>0.05$ $P_{1-4}>0.05$ $P_{1-5}>0.05$	29.74 ± 6.17 $P_{1-2}>0.05$ $P_{1-3}>0.05$ $P_{1-4}>0.05$ $P_{1-5}>0.05$	198.25±32.02 $P_{1-2}>0.05$ $P_{1-3}>0.05$ $P_{1-4}>0.05$ $P_{1-5}>0.05$
Group2	480.00 ± 44.94 $P_{2-3}>0.05$ $P_{2-4}>0.05$ **$P_{2-5}<0.01$**	6.25 ± 1.40 $P_{2-3}>0.05$ $P_{2-4}>0.05$ $P_{2-5}>0.05$	33.64 ± 7.58 $P_{2-3}>0.05$ $P_{2-4}>0.05$ $P_{2-5}>0.05$	201.25±40.73 $P_{2-3}>0.05$ $P_{2-4}>0.05$ $P_{2-5}>0.05$

Group3	527.50 ± 53.37 P_{3-4}>0.05 P_{3-5}>0.05	7.50 ± 0.84 P_{3-4}>0.05 P_{3-5}>0.05	34.27 ± 8.43 P_{3-4}>0.05 P_{3-5}>0.05	183.75±49.74 P_{3-4}>0.05 P_{3-5}>0.05
Group 4	515.00 ± 42.14 **P_{4-5}<0.05**	6.75 ± 1.69 P_{4-5}>0.05	28.21 ± 6.55 P_{4-5}>0.05	223.75±80.06 P_{4-5}>0.05
Group 5	635.00 ± 22.47	6.75 ± 1.40	32.52 ± 8.33	160.00±37.64

The values represents Mean±SE

The effect of mycotoxins with or without vaccine was very clear after 7 days of second IBD vaccine in (G2) and (G4) which recorded decrease in bodyweight (P<0.05) in comparison with control group. But, the weight of toxicom group (G1) is not affected in comparison with the control (P>0.05). All differences of (LASB %) and (BASB%) were very clear but not significant among all groups. At the same time, titers of antibodies against IBD vaccine was significantly (P<0.05) increase in (G1), (G2) and (G3) in comparison with the control as in Table (2).

Table (2): The values after (7) days after second IBD vaccine

	Body Weight/ g	LASB.%	BASB.%	Titer of Antibodies against IBD vaccine
Group 1	750.00 ± 70.23 P_{1-2}>0.05 P_{1-3}>0.05 P_{1-4}>0.05 P_{1-5}>0.05	5.50 ± 0.84 P_{1-2}>0.05 P_{1-3}>0.05 P_{1-4}>0.05 P_{1-5}>0.05	33.92 ± 7.43 P_{1-2}>0.05 P_{1-3}>0.05 P_{1-4}>0.05 P_{1-5}>0.05	5966.25±1407.31 P_{1-2}>0.05 P_{1-3}>0.05 **P_{1-4}<0.01** **P_{1-5}<0.01**
Group2	720.00 ± 19.66 P_{2-3}>0.05 **P_{2-4}<0.05** **P_{2-5}<0.05**	4.00 ± 0.56 P_{2-3}>0.05 P_{2-4}>0.05 P_{2-5}>0.05	31.74 ± 9.96 P_{2-3}>0.05 P_{2-4}>0.05 P_{2-5}>0.05	4480.25±1781.19 P_{2-3}>0.05 **P_{2-4}<0.05** **P_{2-5}<0.05**
Group3	795.00 ± 70.23 P_{3-4}>0.05 **P_{3-5}<0.05**	5.25 ± 0.56 P_{3-4}>0.05 P_{3-5}>0.05	28.99 ± 8.55 P_{3-4}>0.05 P_{3-5}>0.05	5580.50±1391.30 **P_{3-4}<0.01** **P_{3-5}<0.01**
Group 4	775.00 ± 14.05 **P_{4-5}<0.05**	6.00 ± 1.12 P_{4-5}>0.05	32.73 ± 8.24 P_{4-5}>0.05	234.50±17.17 P_{4-5}>0.05
Group 5	1000.00 ± 84.27	6.75 ± 0.84	30.36 ± 5.90	247.25±78.09

The values represents Mean±SE

Table (3) shows the values after 14 days of second IBD vaccine. The effect of mycotoxins in body weight of (G2) and (G4) was very obvious. These groups recorded decrease in bodyweight (P<0.05) in comparison with control group. However, at the same time the weight of toxicom group (G1) is not affected in comparison with the control (P>0.05). All differences of (LASB%) and (BASB%) were very clear but not significant among all

groups. The titers of antibodies against IBD vaccine was significantly (P<0.05) increase in (G1), (G2) and (G3) in comparison with the control as shown in Table (3).

Table (3): The values after (14) days after second IBD vaccine

	Body Weight/ g	LASB.%	BASB.%	Titer of Antibodies against IBD vaccine
Group 1	1145.00 ± 70.23 **P_{1-2}<0.05** P_{1-3}>0.05 P_{1-4}>0.05 P_{1-5}>0.05	7.00 ± 1.12 P_{1-2}>0.05 P_{1-3}>0.05 P_{1-4}>0.05 P_{1-5}>0.05	26.91 ± 4.78 P_{1-2}>0.05 P_{1-3}>0.05 P_{1-4}>0.05 P_{1-5}>0.05	6628.50±558.71 P_{1-2}>0.05 P_{1-3}>0.05 **P_{1-4}<0.001** **P_{1-5}<0.001**
Group2	947.05 ± 53.37 P_{2-3}>0.05 P_{2-4}>0.05 **P_{2-5}<0.001**	9.25 ± 2.25 P_{2-3}>0.05 P_{2-4}>0.05 P_{2-5}>0.05	29.32 ± 5.83 P_{2-3}>0.05 P_{2-4}>0.05 P_{2-5}>0.05	4646.00±1342.14 P_{2-3}>0.05 **P_{2-4}<0.05** **P_{2-5}<0.05**
Group3	1197.50 ± 50.56 P_{3-4}>0.05 P_{3-5}>0.05	7.75 ± 1.12 P_{3-4}>0.05 P_{3-5}>0.05	23.47 ± 3.18 P_{3-4}>0.05 P_{3-5}>0.05	5613.75±1252.53 **P_{3-4}<0.01** **P_{3-5}<0.01**
Group 4	1007.50 ± 106.74 **P_{4-5}<0.05**	9.75 ± 1.69 P_{4-5}>0.05	25.37 ± 4.63 P_{4-5}>0.05	188.25±37.64 P_{4-5}>0.05
Group 5	1295.00 ± 22.47	8.75 ± 1.97	29.66 ± 5.52	160.50±45.79

The values represents Mean±SE

Discussion

The influence of mycotoxin in body weight is very clear in (G4) that recorded weight less than the control. These results agree with (19, 20, 21) who reported that the mycotoxin cause reductions in body weight, anemia, and malformed feathers and impaired performance of broilers. The body weight of chickens did not differ significantly (p>0.05) between vaccinated group (G3) and the control throughout the period of the experiment. The differences in body weight between the groups narrowed down and towards the end of the experiment were not statistically significant (p >0.05). These results agree with (22) who refer that the body weight of vaccinated group with IBD vaccine was less than the control. On the other hand, the most decrease in body weight was in vaccinated group that fed a ration with mycotoxins (G2) along the period of experiment in comparison with control group which recorded (p<0.05) in first week after first vaccination and (p<0.05) after second vaccination, that may reveal a synergistic effect of both (vaccine and mycotoxin) which causes very clear effect in performance and weight gain. These results agreed with (23) who refers that the use of live vaccines can result in vaccination reactions and decrease body weight especially if the

birds are stressed. Furthermore, many researchers cleared that mycotoxins and stress factors result in decrease body weight (18). The results of this experiment clearly demonstrated that mycotoxicosis in broiler chickens can be influenced by supplementation the toxicom to the contaminated diet. Supplementing of toxicom with a dose 5g/kg ration essentially negated the effects of mycotoxins. Inactivation of mycotoxins by adsorbents has been proved by many searches (24, 25). The use of mycotoxin binders, or adsorbents may have the greatest application for routine avoidance of this constant exposure to low levels of multiple mycotoxins. The use of adsorbents to prevent effects of mycotoxins has been actively researched for over 25 years. A number of binder products have been shown effective and their use offers one of the greatest potentials for preventing animal toxicity (25). The differences between (LASB%) and (BASB) and titers of antibodies against IBD vaccine were very clear but not significant among all groups. and that may be because of big differences value of all groups, but, on the other hand the titer of antibodies for toxicom group was higher than (G2) with (14.8%) after 7 days after second IBD vaccine and (19.8%) after 14 days after second IBD vaccine .that was a good result that indicate the toxicom negated the effect of mycotoxins.

Conclusion

The results of this experiment clearly demonstrated that mycotoxicosis cause loss of body weight in broiler chickens and decreasing the immunity of chickens for different vaccines .furthermore. mycotoxicosis can be influenced by supplementation the toxicom to the contaminated diet. Supplementing of toxicom with a dose 5g/kg ration essentially negated the effects of mycotoxins.

References

1) Russell. L. D.F. Cox. G. Larsen. K. Bodwell. and C.E Nelson. 1991. Incidence of molds and mycotoxins in commercial animal feed mills in seven Midwestern states. 1988-89. J. Anim. Sci. 69:5-12.
2) Lacey. J. 1991. Natural occurrence of mycotoxins in growing and conserved forage crops. Pages 363-397. In: Mycotoxins and Animal Foods (Smith. J.E.. and R.E. Henderson. eds.). CRC Press. Boca Raton. FL.
3) Whitlow. L.W. W.M. Hagler. Jr.. and B.A. Hopkins. 1998. Mycotoxin occurrence in farmer submitted samples of North Carolina feedstuffs: 1989-1997. J. Dairy Sci. 81(Abstr.):1189.
4) Sweeney. M.J. Dobson. A.D.W.. 1998. Review: mycotoxin production by Aspergillus. Fusarium and Penicillium species. Int. J. Food Microbiol. 43. 141–158.
5) Fink-Gremmels J.. 1999. Mycotoxins: Their implications for human and animalhealth. Vet. Quart. 21. 115-120.
6) Raju. M. V. L. N. and G. Devegowda. 2002. Esterifiedglucomannan in broiler chicken diets-contaminated with aflatoxin. ochratoxin and T2 toxin: Evaluation of its bingding ability (*in vitro*) and efficacy as immunomodulator. Asian-

Aust.J. Anim. Sci. 15(7):1051-1056.

7) Karlovsky. P.. 1999. Biological detoxification of fungal toxinsand its use in plant breeding. feed and food production.Nat. Toxins 7. 1–23.
8) Coker. R.D.. 1998. The chemical detoxification of aflatoxincontaminatedanimal feed. Nat. Toxicants Food 284–298.
9) Nahm. K.H.. 1995. Possibilities for preventing mycotoxicosisin domestic fowl.WorldPoult. Sci. J. 51. 177–185.
10) Ramos. A.J.. Fink-Gremmels. J.. Hernandez. E.. 1996a. Preventionof toxic effects of mycotoxins by means of nonnutritiveadsorbent compounds. J. Food Prot. 59. 631–641.
11) El-Nezami. H.S.. A. Chrevatidis. S. Auriola. S. Salminen. and H. Mykkänen.2002a.Removal of common Fusarium toxins in vitro by strains of Lactobacillus and Propionibacterium.FoodAddit. Contam.. 19:680-686.
12) El-Nezami. H.S.. N. Polychronaki. S. Salminen. and H. Mykkänen. 2002b. Binding rather than metabolism may explain the interaction of two food grade Lactobacillus strains with zearalenone and its derivative a-zearalenol. Appl. Environ. Microbiol. 68:3545-3549.
13) Döll. S.. S. Dänicke. H. Valenta. G. Flachowsky. 2004. In vitro studies on the evaluation of mycotoxin detoxifying agents for their efficacy on deoxynivalenol and zearalenone. Arch. Anim. Nutr. 58:311-324.
14) Bueno. D.J.. L. di Marco. G. Oliver. A. Bardón. 2005. *In vitro* binding of zearalenone to different adsorbents. J. Food Prot. 68:613-615.
15) Avantaggiato. G.. R. Havenaar. and A. Visconti. 2004. Evaluation of the intestinal absorption of deoxynivalenol and nivalenol by an *in vitro* gastrointestinal model. and the binding efficacy of activated carbon and other adsorbent materials. Food and Chem. Toxicol. 42:817-824.
16) Galvano. F.. A. Piva. A. Ritieni. and G. Galvano. 2001. Dietary strategies to counteract the effects of mycotoxins: A review. J Food Prot. 64:120-131.
17) Матусевич. В.Ф. Способы определения естественной резистентности организма животных / В.Ф. Матусевич и др. // Сб. науч. тр. Целиноградского СХИ: Естественная резистентность сельскохозяйственных животных.- Целиноград. 1971.- Т.8.- Вып.10.- С.8-19.
18) Смирнова. О.В. Определение бактерицидной активности сыворотки крови методом нефелометрии / О.В. Смирнова. Т.А. Кузьмина // ЖМЭИ. 1966. № 4.- С.28-29.
19) Galvano. F.. A. Piva. A. Ritieni. and G. Galvano. 2001. Dietary strategies to counteract the effects of mycotoxins: A review. J Food Prot. 64:120-131.
20) Болотников. И.А. Гематология птиц / И.А. Болотников. Ю.В. Соловьев.

– Ленинград : Наука. 1980. – 115 с.

21) Диагностика и патоморфологические изменения в крови и органах иммуннойсистемы птиц при инфекционной анемии : рекомендации / И.Н. Громов [и др.] // Витебск : Копицентр-АС-принт. 2013. – 58 с.
22) Chi. M. S.. C. J. Mirocha. H. J. Kurtz. G. A. Weaver. F. Bates. T. Robison. and W. Shimoda. 1980. Effect of dietary zearalenone on growing broiler chicks. Poult.sci.,59:531—536.
23) Kubena. L. F.. S. P. Swanson. R. B. Harvey. O. J. Fletcher. L.D. Rowe. and T. D. Phillips. 1985. Effects of feeding deoxynivalenol (vomitoxin)-contaminated wheat to growing chicks. Poult.sci.,64:1649—1655.
24) Huff. W. E.. L. F. Kubena. R. B. Harvey. D. E. Corrier. and H.H. Mollenhauer. 1986. Progression of aflatoxicosis in broiler chickens. *Poult.sci.*,65:1891—1899.
25) Lanza. G. M.. K. W. Washburn. and R. D. Wyatt. 1980.Strain variation in hematological response of broilers to dietary aflatoxin. Poult.sci., 59:2686—2691.