Influence of botanical feed additives on cholesterol content in poultry meat and eggs

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Keywords: broiler; laying hen; botanical feed additives; meat; egg; cholesterol

Abstract

The cholesterol content in broiler meat and laying hen eggs is one of the quality indices whose level the consumer wants to have as low as possible. In this connection special local botanical feed additives were produced and their influence on cholesterol dynamics was evaluated in the body of broiler chicks of cross Hybro-G and laying hens of cross Lohmann Brown.

It was stated that botanical feed additives decreased the cholesterol level on average in broiler liver by 4%, blood by 12%, muscle mass by 5% and laying hen eggs by 5%. Simultaneously the amount of carotenoids increased by 4.3%. It can be concluded that the use of botanical feed additives in broiler and laying hen feeding improved meat and egg quality.

Introduction

The cholesterol content in broiler meat and eggs is one of the most important quality indices that the consumer wants to have as low as possible. One of the factors contributing to the decrease of the cholesterol level in meat and eggs is ingredients of feed content that are fed to the birds. Thus including natural complexes of herbs and plants of biologically active substances of different content, i.e., botanical feed additives in the poultry diet it is possible to influence metabolism of cholesterol in the poultry body and alter the cholesterol level in poultry meat and eggs. For example, garlic powder additives (3-5%) to poultry feed decreases the cholesterol content in the body. Bioactive substances of garlic powder increase the activity of the enzymes that convert cholesterol to bile acids, eventually being catabolised and excreted from the body (Esmail, 2003).

The inclusion of increased amounts of plant sterols in the diet has been shown to result in a considerable reduction in yolk cholesterol levels through their ability to compete with cholesterol during absorption and subsequent metabolism (Esmail, 2003). Halbikainen *et al. (*2000) state that plant sterol derivatives sitostanol and compestanol restrict absorption of feed cholesterol and bile acid cholesterol also in human digestive tract and reduce in that way the level of the total and LDL cholesterol in blood serum. Plant phytosterines prevent absorption of cholesterol in the gut, possibly reduce synthesis of endogenous cholesterol (Zariņš and Neimane, 2002).

In order to decrease the cholesterol level in broiler meat and laying hen eggs a special botanical feed additive was produced from local flora products. Though there is a point of view that bioactive substances of ingredients of herbs and plants grown in local ecological conditions are more effective in birds grown in the relevant region.

There are Flores Calendulae, Cortex Quercus, Folia et herba Urticae and other phytogenic ingredients in the produced botanical feed additives. Especially there is a lot of the following complexes of bioactive substances: carotenoids, sterols glycosides, complex polysaccharides, polyphenols, garlic acid, etc..

The aim of the study: to evaluate the influence of the produced botanical feed additive on poultry productivity and product quality, especially on the cholesterol content in broiler chick meat and laying hen eggs.

Materials and methods

The trial was carried out at the age of 0 to 49 days with two groups of broiler chicks of cross Hybro-G (n=200) and laying hens of cross Lohmann Brown (n=200) at the age of 21 to 45 weeks according to the scheme shown in Table 1.

Table 1 Scheme of the trial.

Group	Feeding programme
1st group – control	Basic feed
2nd group - trial	Basic feed + 1% botanical feed additives

The content of basic feed for broilers and laying hens has been balanced according to the standard of the cross. The only difference is that 1% of botanical feed additives is added to the basic feed of the second group for broilers and laying hens.

During the trial period basic indices of broiler and laying hen productivity, meat and egg quality were evaluated according to the generally accepted standard methods. Egg quality indices were determined according to the programme FUTURA – Egg Quality – Measure – software.

The cholesterol content in meat and eggs was analysed by Blur colorimetric method with spectrophotometer СФ 26 ЛОМО.

Results and discussion

Addition of the produced botanical feed additive to broiler and laying hen feed increased productivity and improved product quality.

Thus feeding broiler chicks with the feed containing botanical additive live weight at the age of 49 days was on average 2,513 g, i.e., by 69.7 g or by 2.8% higher than in the controls (Table 2).

Table 2 Productivity of broilers and laying hens.

Parameters	1st group – control	2nd group – trial	± to control
Productivity of broilers:			
Live weight at the age of 49 days, g	2443.9 ±13.19	2513.6 ±10.99	+ 69.7
Feed conversion, kg/kg	1.96	1.92	-0.04
Index of productivity	254.4	267.2	+12.8
Productivity of layers:			
Laying intensity, %	88.56	91.77	+3.21
Feed conversion, kg/kg	2.26	2.20	-0.06

Also broiler productivity index (267.2) that is calculated by means of average live weight, age in day, % of mortality, feed conversion with botanical feed additive is by 12.8 higher in comparison with control group.

Carcass quality, sensorical features of the breast and thigh meat of broilers were the best in the group with the botanical additive.

These data coincide with the results of studies by other authors who added different amounts of plant extract based on a combination of the phytogenic active substances to the feed for cross Hybro-G broilers (Jamroz *et al.*, 2002; Kamel, 2002).

During the recording period laying intensity of laying hen group with botanical feed additive was 91.77% on average, that is by 3.21% higher in comparison with the control group (Table 2).

Botanical feed additive did not influence the following egg quality mean indices: weight, Haugh unit and albumen (Table 3).

Table 3 Morphological traits of egg quality.

Group	1st group – control	2nd group – trial	± to control	% to control
Average egg weight, g	62.28± 0.20	61.78 ± 0.18	- 0.5	99.19
Haugh unit	90.3± 1.11	90.8 ±1.23	+0.5	100.55
Albumen height, mm	8.12 ±0.05	8.05 ±0.04	-0.07	99.14
Breakresist egg shell, N	45.67 ±0.08	48.50± 0.09	+2.83	106.19
Egg shell thickness µ	369.42 ±1.04	379.12 ±1.10	+9.70	102.63
Yolk colour, points	9-10	11-12	+2	-

Botanical feed additive improved egg shell strength (breakresist) by 2.83 N and shell thickness by 9.70 µ (Table 3) in comparison with the control group. When improving shell strength and thickness, the broken egg number decreased.

In comparison with the control group botanical feed additive darkened egg shell colour and intensified yolk colour by 1-2 points on the Rouche colour fan. That was provided by the high content of carotenoids in the ingredients of botanical feed additive (Flores Calendulae, Folia et herba Urticae etc.).

Botanical feed additives produced by foreign companies also improve egg quality, including egg yolk pigmentation (natural yolk ….2003; Improving egg …. 2003).

The cholesterol level was 58.65 – 85.94 mg % in muscles, 285.40% - 326.56 mg % in liver, 156.03 – 186.36 mg % in the blood and 571 – 597 mg% in egg yolk (Table 4 and Table 5) of broilers and laying hen trial groups.

Botanical feed additive decreased the cholesterol level in broiler and laying hen muscle tissues by 5.0% and 4.9%, in liver by 4%, in the blood by 5.85% and 2.57% and in egg yolk by 4.3%, respectively.

Simultaneously the total content of fat decreased in broiler and laying hen muscle tissues and liver as well as in laying hen yolk, the content of glucose and pyruvic acid decreased in the blood, but the carotenoids content in the blood and egg yolk increased.

Table 4 Chemical indices of broiler tissue mass.

Parameters	1st group – control	2nd group – trial	± to control	% to control
Cholesterol, mg %				
In muscle tissue mass	85.94 ±0.35	81.69 ±0.28	- 4.25	95.00
In liver	326.56 ±3.11	313.49 ±1.15	-13.07	96.00
In blood	186.36± 2.54	175.45± 3.25	- 10.91	94.15
Carotenoids mg%				
In blood	0.975 ±0.11	1.065± 0.14	+0.09	109.23
Glucose, mg %				
In blood	169.9 ±3.19	150.0 ±2.31	- 19.9	88.2
Pyruvic acid, mg%				
In blood	1.51±0.11	1.09 ±0.10	-0.42	72.18
Total fat, %				
In muscle tissue mass	1.62± 0.08	1.23± 0.07	-0.39	75.92
In liver	6.21 ±0.94	5.76 ±0.45	-0.45	92.75

These changes of biochemical indices could be connected with the influence of botanical feed additive on poultry body metabolism. Biosynthesis of cholesterol takes place in cytoplasm and microsomes of liver and small intestines. The liver synthesizes lipoprotein VLDL and these are converted to LDL (King, 2003). Egg cholesterol transported to the ovaries by plasma are very low density lipoprotein particles (VLDL) (Debski *et al.*, 2000).

It is possible that bioactive substances of botanical feed additives have influenced biosynthesis of cholesterol and metabolism in birds' body, thus also its amount in birds' muscle tissues, liver, blood and eggs.

Biosynthesis of cholesterol is regulated by hormones, including also pancreas hormones (King, 2003). In this regard we can assume that a botanical feed additive has contributed to the hormonal functions of pancreas which on their turn have prevented synthesis of cholesterol.

The analysed level of glucose and pyruvic acid in broiler and laying hen blood indirectly determines hormonal activity of pancreas. (Table 4, 5). If the body lacks pancreas hormone insulin, then glucose accumulates in the blood in the high amount and pyruvic acid is not oxidised.

Table 5 Changes of biochemical indices in laying hen body and eggs.

Parameters	1st group – control	2nd group – trial	± to control	% to control
Cholesterol, mg %				
In muscle tissue mass	61.67 ±1.24	58.65 ±1.30	- 3.02	95.10
In liver	296.87 ±2.18	285.40 ±2.37	-11.47	96.00
In blood	160.15± 1.44	156.03± 1.86	- 4.12	97.43
In egg yolk	597.00 ±3.45	571.00 ± 2.89	- 26.0	95.64
Carotenoids mg%				
In blood	0.76 ±0.10	0.80± 0.09	+0.04	105.26
In egg yolk	37.22 ±1.15	38.82 ±1.01	+1.60	104.3
Glucose, mg %				
In blood	188.00 ±1.94	172.28±1.88	- 15.72	91.64
Pyruvic acid, mg%				
In blood	2.35±0.29	1.84 ±0.20	-0.51	78.30
Total fat, %				
In muscle tissue mass	1.46± 0.15	1.21± 0.13	-0.25	82.88
In liver	6.11 ±0.58	5.90 ±0.96	-0.21	96.56
In egg yolk	26.36 ±1.04	24.75 ±1.19	-1.61	93.89

Botanical feed additive to broiler and laying hen feed decreased the level of glucose in the blood by 11.72% and 8.36%, respectively. It contributed to the reduction of pyruvic acid in a glucolitic and oxidative cycle. That is why the level of pyruvic acid was reduced by 0.42 mg% in the blood of the trial group broilers and by 0.51 mg% in the laying hen blood in comparison with the control version.

Decrease in the cholesterol content in broiler chick muscle tissues and laying hen eggs could be also connected with the high content of natural antioxidant complex in the content of botanical feed additive. Carotenoid in the content of botanical feed additive, especially β- carotene, polyphenoles including garlic acid is with a strong antioxidative activity (Van Dyck, 2003).

Ingredients of botanical feed additive contained about 300 mg/kg of carotenoids on average.

When adding the produced botanical feed additive to the broiler and laying hen feed, poultry feed and later also poultry body were enriched with carotenoids having an antioxidative activity.

The carotenoid content increased in the trial group of broilers and laying hens in the blood by 9.23% and 5.26% and in egg yolk by 4.3% in comparison with the control group.

Carotenoids in botanical feed additive strengthened egg yolk pigmentation, enriching its content with carotenoids, but acted as a complex of antioxidants that protect PUFA (Ferrante *et al.*, 2002) from oxidation.

Natural antioxidants stabilised polyunsaturated acids in the body (Freese *et al.*, 2000). On their turn they influenced metabolism of cholesterol in the body (King, 2003).

Thus bioactive substances of the botanical feed additive positively influenced metabolism in the poultry body, reducing cholesterol synthesis and its level in the meat and eggs.

Conclusions

Addition of the produced botanical feed additive (1%) to the broiler chick and laying hen feed in comparison to the control group:

- increased poultry productivity:
  - broiler live weight at the age of 49 days – by 2.8%;
  - laying hen laying intensity – by 3.2%.
- improved broiler meat and laying hen egg quality:
  - reduced the cholesterol content:
    - in broiler liver by 4%;
    - in broiler muscle tissue mass – by 5%;
    - in laying hen muscle tissue mass – by 4.90%;
    - in egg yolk – by 4.3%;
  - increased carotenoid content in laying hen egg yolk – by 4.3%.

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