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# Effect of complex phytobiotics on morphochemical characteristics of Cobb 500 cross mail broiler chicks

**Vladimir E. Nikitchenko, Dmitry V. Nikitchenko, Vadim G. Plyuschikov, Ivan G. Seregin, Alexander A. Nikishov, Ekaterina O. Rystsova***

*Peoples' Friendship University of Russia, 117198, Moscow, Russia*
**Corresponding author:* rystsova-eo@rudn.ru

## Abstract

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The dynamics of live weight, the morphological composition of Cobb 500 cross broiler chickens was studied at 1, 21, 28, 33, 38 and 42 days of age. It was determined that the gain in live weight and carcass weight of male broiler chickens increased progressively up to the 33 day of age, and then they started decreasing. The average daily live weight gain of the chickens in the experimental groups (over the entire brooding period) exceeded the similar parameters of the control groups by 5.58%. The broiler males in the experimental groups were bigger than the males in the control groups by 3.98% ($P < 0.05$) in the live weight and by 4.42% ($P < 0.05$) in carcass weight at the age of 33 days, by 5.12% and 5.51% ($P < 0.05$) at the age of 38 days and by 5.50% and 5.92% ($P < 0.05$) at the age of 42 days, and by 4.65%, 5.00% and 6.03% ($P < 0.05$) in muscle mass accordingly. The results of chemical studies proved that with age the muscles of male chickens became dehydrated. However, the water content in the muscles was 0.5-1% higher than in the muscles of the broilers of other crosses.

*Keywords:* broiler; male chickens; fat tissue; bone tissue; diameter; muscle fiber

## Introduction

To satisfy people with high quality products, it is necessary to improve continuously the genetics of the existing forms of crosses and create new ones with better viability, resistance to stress factors under production conditions, feed conversion and efficiency. Worldwide broiler industry is based on the use of high-productive meat crosses with a very high genetic potential: the average daily live weight gain reaches 60-65 g, feed utilization – 1.34-1.45 kg with poultry stock viability being 96-98%. The daily average consumption of poultry meat by people in Russia is 32.4 kg (Afanasyev et al., 2017). The most popular meat crosses in Russia are "Cobb 500" – 33%, "Ross-308" – 32%, "Hubbard" – 30%, the others account for 5% (Gonotsky et al., 2016; GOST 31962, 2012).

Nowadays production of high-quality meat semi-finished products is one of the crucial tasks in the meat industry.

In 2016, the production of semi-prepared food amounted to 3016.89 thousand t, that exceeded the indicators of 2015 by 103.3%, sausage products – 2410.55 thousand t, or 98.6% of the level of 2015. This is due to the fact that consumers refuse to consume ready-made meat products, preferring to buy meat in natural and semi-prepared forms. The main factor resulting in increased production of semi-finished products is the growth of household income. At the same time there is a rise in supply of chilled products, which are retaking market share from the frozen ones due to the shift in consumer preferences (Amelina&Nikitchenko, 2012; Egorov et al.,2017). If recently the price has played a key role in decision making, now, when choosing frozen meat semi-prepared food a customer pays attention to quality-price ratio, giving preference to a better product (World tendencies in Russian poultry industry, 2017). Use of various herbal supplements when growing broilers makes it possible to reduce significantly their caloric content.

To fulfill the genetic potential of broilers, mainly used are the high-quality derivatives of soybean and sunflower – oil cake, mill cake, as the most valuable and cheap feed.

To increase the productivity the antibiotic growth promoters are added to broiler feed, but since they are prohibited, the probiotics, prebiotics, organic acids, enzymes, beneficial microflora growth promoters, sorbents, etc. start to be used (Gonotsky et al., 2016).

Moreover, new phytobiotics have been added to broiler feed in recent years, but the morphological composition of broiler carcasses and individual anatomical parts is not sufficiently covered.

In our investigations phytobioticsIntebio (by BIOTROF JSC, Russia) are used instead of antibiotics.

The goal of researchis to study the influence of phytobioticsIntebio on the meat productivity of Cobb 500 cross broilers.

The task of research was to study the dynamics of live weight and morphological composition of carcasses in 5 age groups of males, and in slaughter ages: (33-, 38- and 42-day) also the ratio of tissues by anatomical parts of carcasses as an indicator of product quality.

The studies were carried out in the Center for Genetics and Selection "Zagorskoye EPH" VNITIP.

## Materials and Methods

The experiment was conducted using two groups of Cobb 500 cross males formed by the method of analogues at one day of age, control and experimental. The chickens were kept in Big Dutchmann battery cages 35 heads per each from one day to 42 days of age until they become heavy broilers.

The broilers of the control group were fed dry crumbled mixed feed with nutrients and biologically active substances (Seregin et al., 2013), but instead of 25% of soybean meal, 15% was replaced with hulled lupine (mechanically destroyed outer shell) containing up to 42% protein (main diet) (GOST 31962-2012).

The experimental group, in addition to the main diet, was supplemented with phytobioticsIntebio in an amount of 500 g/t. PhytobioticIntebio is a mixture of natural essential oils, which has antimicrobial activity, antioxidant action and anti-inflammatory effect (instead of the feed antibiotic). The temperature, light and humidity regimes, drinking and feeding space were in accordance with the recommendations of VNITIP.

The dynamics of live weight and morphology of broiler carcasses were investigated at: 1, 21, 28, 33, 38 and 42 days of age, anatomical cutting of carcasses – in 3 age groups: 33-, 38- and 42-day, taking into account the requests of consumers, namely, carcasses of different weights from 1.5 to 2.1 kg, which are sold both in carcasses and in anatomical parts.

As the male chickens reached the age of 1-, 21- and 28 days, 4 heads in each age group were slaughtered in the research laboratory of Veterinary Medicine Department of the Agrarian and Technological Institute. At 33-, 38- and 42 days of age the males were slaughtered on a small conveyor line of the slaughterhouse of the Center for Genetics and Selection "Zagorskoye EPH" according to the adopted poultry slaughtering technology.

Before they were sent to the slaughter, the males were not fed for 6 hours to ensure preslaughter hunger. Each bird was weighed on a torsion balance with an accuracy of 1 g in the morning before slaughter. The neck was cut off from the carcass at the level of the shoulder joints by means of automatic device designed for neck separation. The legs were cut off on the conveyor exactly along the ankle joint (Technological instruction for poultry processing at poultry processing plants).

The carcasses were placed in a refrigerator (0 … + 4°C) for 24 hours. Then the carcasses were weighed and anatomically dissected in the research laboratory. The muscles, bones, fat and other tissues (skin with the remains of fat, remains of the lungs and kidneys) were isolated and weighed on electric balance VLKT-500M (GOST 241-04-80) with an accuracy of 0.1 g (Afanasyev et al., 2017).

The material for microscopic study was m. superficialis pectoralis. Sampling, material preparation and obtaining histological sections were carried out according to the procedure described in (Sapozhnikov&Dorosevich, 2000).

Microscopic study of samples was performed by means of Olimpus BX51 microscope at x10, x40 magnifications. The images were digitized using ColorView camera. The diameter of muscle fibers was measured on the cross sections of muscles using «VideoTesT-Morphology 5.2» program.

The material for studying the chemical composition was m. superficialis pectoralis too, as it was for histological study.

Immediately after preparation, the muscles were placed in polyethylene bags and put to refrigerating chamber, where the air temperature was maintained within the range of 0 ... +4°C. After 24 hours, the muscles were carefully cleaned against fasciae and fat and minced twice. The water content was determined in the medium sample of minced meat by drying the samples in a drying chamber at a temperature of 105°C until a constant weight was obtained (GOST 9793-74), fat was extracted with ether in the Soxhlet extractor (GOST 23042-86), total nitrogen – by the Kjeldahl method (GOST 29128-91). The amount of water, fat and protein was calculated on a percentage basis as a ratio to the wet weight of the sample.

The digital material was processed on computers by standard statistical processing programs (Nikishov, 2014). The results of the studies are summarized in tables.

## Results and Discussion

The livestock viability for the growing period was 100% feed conversion ratio (per 1 kg of gain) was 1.56. The average daily live weight gain for the chicken males from one-day to 21-day of age in the control group was 45.45 g, in the experimental one – 46.40 g, from 21 to 33 days of age – 85.92 and 91.25 g, from 33 to 42 days of age – 80.22 and 88.67 g, for the entire growth period – 64.46 and 68.27 g. The increase in the average daily weight gain is observed up to the 33-day of age, then they decrease. The ratio of live weight increase for 42-day-old chicken males compared with the one-day-old males was 67.85 in the control group and 71.83 in the experimental group.

With live weight of males, when carcasses reach a weight of 1.5 kg (most often sold in the trade network), the slaughter yield was 72.56-72.89%, for 42-day-old ones – 72.93-73.25%.

The data in Table 1 show that the carcass contains muscular tissue most of all, its weight by the 42 day of age of the males of the control group increased 165.49 times as compared with the weight of the one-day-old chickens, 176.10 times – in the experimental group, of which 119.09 and 124.91 times up to the 33-day of age, accordingly.

The average daily muscle gain of males for the entire growth period was 30.98 and 32.98g.

Muscles are the most valuable tissue, as it contains the most complete protein and essential amino acids. The number of muscles in the carcasses of 33-day-old control chickens is 942 g, the experimental – 988 g, of which 303 and 315 g fall to the share of bones, and the ratio is 3.11 and 3.14: 1, while for 42-day-old males – it is 1309 and 337 g, 1393 and 357 g, or 3.88 and 3.90: 1, accordingly.

Fat deposits are an important indicator of carcass quality. Most of the fat is deposited: in the abdominal cavity (abdominal fat), under the skin, between the muscles and inside the muscles. In comparison with other species of animals the birds have the most fusible, aromatic fat that determines the juiciness of meat. Animal fats carry some fat-soluble vitamins; therefore, their insufficient amount in the feed leads to vitamin deficiency disease. With age and intensive feeding, excess fat is formed, so this process of fat accumulation in the carcass can be regulated by killing the bird at the most suitable age. The nutritional value of fats owes to the fact that they are carriers of large energy reserves.

**Table 1. Live weight and morphological composition of broiler carcasses**

| Indicators | Age, days | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 21 | 28 | 33 | 38 | 42 |
| Control group | | | | | | |
| Live weight, g | 40.5 ± 0.5 | 995 ± 11.7 | 1590 ± 19.6 | 2026 ± 25.4 | 2446 ± 30.7 | 2748 ± 38.6 |
| Full-drawn carcass weight, g | 15.84 ± 0.2 | 665 ± 7.9 | 1128 ± 14.3 | 1470 ± 17.1 | 1782 ± 20.8 | 2004 ± 20.6 |
| Slaughter yield | | 66.83 | 70.63 | 72.56 | 72.85 | 72.93 |
| Relative weight, % of full-drawn carcass weight | | | | | | |
| Muscles | 49.96 | 57.74 | 62.46 | 64.09 | 65.09 | 65.30 |
| Fat | – | 0.60 | 0.81 | 1.36 | 2.12 | 2.81 |
| Other tissues (skin with fat remains, remains of lungs, kidneys) | 16.59 | 14.29 | 13.26 | 13.95 | 14.81 | 15.10 |
| Bones | 33.45 | 27.37 | 23.48 | 20.60 | 17.98 | 16.80 |
| Experimental group | | | | | | |
| Live weight, g | 40.5 ± 0.5 | 1015 ± 13.0 | 1638 ± 21.9* | 2110 ± 22.3* | 2578 ± 37.3* | 2908± 40.6* |
| Full-drawn carcass weight, g | 15.84 ± 0.2 | 680 ± 8.1 | 1170 ± 14.5 | 1538 ± 19.0* | 1886 ± 25.5* | 2130 ± 28.9* |
| Slaughter yield, % | | 66.83 | 70.63 | 72.56 | 72.85 | 72.93 |
| Relative weight, % of carcass weight | | | | | | |
| Muscles | 49.96 | 57.79 | 62.56 | 64.24 | 65.27 | 65.40 |
| Fat | – | 0.74 | 0.94 | 1.50 | 2.17 | 2.91 |
| Other tissues (skin with fat remains, remains of lungs, kidneys) | 16.35 | 14.41 | 13.08 | 13.78 | 14.69 | 14.93 |
| Bones | 33.45 | 27.06 | 23.42 | 20.48 | 17.89 | 16.76 |

* – the difference is statistically significant at $P < 0.05$

According to the research findings accumulation of fat in broiler chicken is insignificant. Only the carcasses of 33-day-old broilers of the control group have fat content of 20 g, the experimental – 23 g, or 1.36% and 1.50% accordingly, 42-day-old males – 56-62 g, or 2.79-2.91%. Such meat is low-calorie and is considered dietary.

The analysis of data on the growth of other tissues (skin with some fat, remains of lungs and kidneys) found out that the absolute weight of them in the 33-42-day-old broilers in the control group is 205-302 g, or 13.95-15.07%, in the experimental group – 212-318 g, or 13.78-14.93%. The relative weight of them increases from 33 to 42 days of age because accumulation of subcutaneous fat increases, and a part of it remains on the skin when the carcasses are dissected.

The growth of bones is of the most interest from the perspective of meat production. The task of breeders is to get carcasses with the minimum content of bones (inedible parts), maximum number of muscles and moderate amount of fat. The data in Table prove that the absolute weight of bones in the carcasses of 42-day-old males in the control group increases 64.07 times in comparison with their weight at a one-day age, in the experimental groups – 67.87 times, while the muscle weight – 165.49-176.10 times. But with age, the relative weight of bones decreases by 16.37-16.43%, and the muscle weight, on the contrary, increases by 15.34 and 15.44%.

**Anatomical cutting of carcasses**

It should be noted that anatomical cutting of broiler carcasses belonging to control groups was not carried out, since their carcass weight is almost similar to that in experimental group (Table 2). The difference between the carcasses of 33-day-old broilers of experimental and control groups is 68 g, 38-day-old ones – 104 g and 42-day-old ones – 126 g, and it is not reasonable to split this difference more.

According to the Technical Regulations, bird's carcasses can be divided into parts (natural semi-products) – from two to nine parts. According to Rosptitsesoyuz, 41% of the total volume of poultry meat produced in 2014 (3,675 million tons) were sold as carcasses, the rest – as natural semi- products, of which more than 55% in each group were sold in cooled state. The remaining 19% are deep processing prod-

**Table 2. Anatomical cutting of Cobb 500 cross male carcasses**

| Age, days | 33 | | | 38 | | | 42 | | |
|---|---|---|---|---|---|---|---|---|---|
| Full-drawn carcass weight, g | 1538±19.0 | | | 1886±25.5 | | | 2130±28.9 | | |
| Absolute weight of carcass parts and ratio to the weight of full-drawn carcass and to carcass parts | Weight of carcass part, g | % of full-drawn carcass weight | % of carcass part weight | Weight of carcass part, g | % of full-drawn carcass weight | % of carcass part weight | Weight of carcass part, g | % of full-drawn carcass weight | % of carcass part weight |
| Breast | 546 | 35.50 | 100 | 677 | 35.90 | 100 | 769 | 36.10 | 100 |
| Muscles | 444 | 28.89 | 81.32 | 558 | 29.59 | 82.42 | 638. | 29.97 | 82.96 |
| Skin with fat remains | 45 | 2.89 | 8.24 | 58 | 3.08 | 8.57 | 66 | 3.09 | 8.58 |
| Bones | 57 | 3.71 | 10.44 | 61 | 3.23 | 9.01 | 65 | 3.03 | 8.45 |
| Thigh | 262 | 17.04 | 100 | 319 | 16.91 | 100 | 355 | 16.67 | 100 |
| Muscles | 193 | 12.55 | 73.66 | 239 | 12.67 | 74.92 | 268 | 12.59 | 75.49 |
| Skin with fat remains | 30 | 1.95 | 11.48 | 38 | 2.01 | 11.91 | 44 | 2.08 | 12.39 |
| Bones | 39 | 2.54 | 14.89 | 42 | 2.23 | 13.17 | 43 | 2.02 | 12.11 |
| Shin | 219 | 14.24 | 100 | 263 | 13.94 | 100 | 297 | 13.94 | 100 |
| Muscles | 143 | 9.30 | 65.30 | 177 | 9.39 | 67.30 | 199 | 9.35 | 67.00 |
| Skin with fat remains | 25 | 1.63 | 11.42 | 33 | 1.75 | 12.55 | 39 | 1.83 | 13.13 |
| Bones | 51 | 3.32 | 23.29 | 53 | 2.81 | 20.15 | 59 | 2.75 | 19.87 |
| Wing | 172 | 11.18 | 100 | 205 | 10.87 | 100 | 225 | 10.56 | 100 |
| Muscles | 78 | 5.07 | 45.35 | 96 | 5,09. | 46.83 | 108 | 5.05 | 48.00 |
| Skin with fat remains | 32 | 2.08 | 18.60 | 41 | 2.17 | 20.00 | 47 | 2.21 | 20.89 |
| Bones | 62 | 4.03 | 36.05 | 68 | 3.61 | 33.17 | 70 | 3.29 | 31.11 |
| Skeleton | 316 | 20.55 | 100 | 381 | 20.20 | 100 | 422 | 19.81 | 100 |
| Muscles | 130 | 8.45 | 41.14 | 160 | 8.48 | 41.99 | 180 | 8.45 | 42.65 |
| Skin with fat remains | 81 | 5.27 | 25.63 | 108 | 5.73 | 28.35 | 122 | 5.72 | 28.91 |
| Bones | 105 | 6.83 | 33.23 | 113 | 5.99 | 29.66 | 120 | 5.64 | 28.44 |
| Abdominal fat | 23 | 1.50 | – | 41 | 2.17 | – | 62 | 2.91 | – |

ucts: chopped semi-products, deboned meat (minced meat), specialty meats, preserves and others ready for use.

With such an assortment, the poultry industry successfully competes with other animal products, moreover, at an affordable price.

Nowadays the most popular products are natural semi-prepared bird carcasses, both with and without bones: breast, thigh, shin, wing, etc. The remaining parts of carcass, with worse food characteristics, are supplied for industrial processing.

The data obtained (Table 2) proves that breast gives the largest yield in the carcass (relative weight to carcass weight ratio in percentage terms) -35.50% (33- day-old males) and 36.10% (42-day-old males). It is followed by skeleton (20.55-19.81%), then thigh (17.04-16.67%), shin (14.24-13.94%), wing (11.18-10, 56%). Most of the muscle tissue is contained in the breast 28.99-29.97%, then in the thigh – 12.55-12.59%, and shin – 9.30-9.35%. The number of inedible tissues (bones) is contained in the skeleton – 6.83-5.64%, then in the wing – 4.03-3.29%, the shin – 3.32 -2.75%, the breast – 3.71-3, 03%.

The yield of other tissues (skin with the fat remains, remains of lungs, kidneys) increases with the age of the bird, especially in the skeleton – from 13.78 to 14.93%, where the subcutaneous fat and the residual remains of organs are stored most of all.

Thus, it can be concluded that the anatomical parts of carcasses differ in quality due to the different ratio of muscle tissue and bones in them, and their sales depend not only on the carcass morphology, but also on the consumer demand for certain anatomical parts.

**Histological examination of muscles**

Histological examination was performed on m. superficialis pectoralis. The results of studies are summarized in Table 3.

After analyzing the diameter of muscle fibers in broilers up to 42 days of age, it is evident that, in comparison with one-day-old males, the diameter of muscle fibers m. superficialispetoralis increased by 47.34 μm. Fibers have different sizes, and no dependence of the diameter range on the age of broilers is determined.

By day 42 of age the diameter of the muscle fibers of the boiler males increased 6.67 times as compared with the one-day-old ones, while the muscle weight of the carcass – 176.10 times. This suggests that the weight of muscle tissue increases not only due to the longer diameter of muscle fibers, but also due to more length of muscle fibers.

The diameter of muscle fibers increases most of all during the first 28 days of broiler life, 1.31 μm per day on average, further their growth reduces to 1.05 μm (28-33-day of age), and 0.69-0.46 μm (38-42-day of age).

**Chemical studies of muscles**

One of the qualitative indicators of poultry meat is the chemical composition of muscles, so to evaluate the food it is important to know it.

The chemical study was carried out on m. superficialis pectoralis, and the data obtained are summarized in Table 4.

The data in Table 4 prove that the amount of water in the muscles of broiler males decreases with the age. The water ratio in the muscles of one-day-old chickens is 81.42%, while that in 42-day-old chickens is 77.34%. Especially intensive decrease of water content in muscles is observed during the first 28 days of broiler life – by 2.59%, from 28 to 42 days – 1.49%.

The ratio of intramuscular fat increases from 0.53% to 1.45% with the age of broilers, and protein – from 16.90% to 20.21%, that results in water ratio reduction.

Based on the data obtained it can be concluded that chemically the meat of 33-42-day-old broiler chicken contains high amount of water, it is watery and has not reached the commercial quality (taste, smell) yet. The same is confirmed by other authors (Fisinin, 2017).

Moreover, it should be noted that meat has faint, slightly sour smell; the texture in the cooked form is dry. As a result, when storing and thawing the carcasses the meat processing plants suffer double and more losses in weight that exceeds the regulated values. After heat treatment, the yield of finished product decreases, the organoleptic parameters of the finished product deteriorate – taste, aroma, color, texture. As a result, the processing plant has to use food supplements and ingredients, dyes, flavors, stabilizers, acidity regulators, herbal and animal proteins, etc., which means additional costs. To cope with these deficiencies in some countries broilers are grown up to 50 days, and in Japan – up to 56 days in order to obtain “mature meat”.

Thus, it can be concluded that the live weight and carcass weight gains for the males before the 33-day of age increase, and then start decreasing. The average daily live weight gains

**Table 3. Diameter of broiler muscle fibers, μm**

| Age, days | 1 | 21 | 28 | 33 | 38 | 42 |
|---|---|---|---|---|---|---|
| Control group | 8.36 ±2.27 | 30.41 ±3.12 | 44.87 ±4.25 | 48.56 ±5.28 | 51.49 ±5.74 | 53.26 ±6.05 |
| Experimental group | 8.34±0.21 | 31.08 ±3.08 | 45.13 ±4.34 | 50.38 ±5.75 | 53.85 ±6.03 | 55.69 ±6.72 |

**Table 4. Chemical composition of M. superficialis pectoralis in Cobb 500 cross broilers, % Numerator is the control group, denominator is the experimental one**

| Age, days/ indicators | Water | Fat | Protein | Ash |
|---|---|---|---|---|
| 1 | 81.40 | 0.54 | 16.94 | 1.12 |
| | 81.39 | 0.53 | 16.91 | 1.15 |
| 21 | 79.80 | 0.75 | 18.27 | 1.16 |
| | 79.84 | 0.71 | 18.25 | 1.17 |
| 28 | 78.80 | 1.08 | 19.14 | 0.98 |
| | 78.83 | 1.05 | 19.12 | 1.13 |
| 33 | 78.26 | 1.16 | 19.60 | 1.01 |
| | 78.25 | 1.14 | 19.63 | 1.12 |
| 38 | 77.58 | 1.30 | 20.06 | 1.05 |
| | 78.62 | 1.32 | 20.03 | 1.03 |
| 42 | 77.38 | 1.46 | 20.14 | 1.04 |
| | 77.34 | 1.45 | 20.21 | 1.02 |

in the experimental groups (over the entire growth period) exceeded those in the control groups by 5.58%. The broiler males in the experimental groups were bigger than the males in the control groups by 3.98% ($P < 0.05$) in the live weight and by 4.42% ($P < 0.05$) in carcass weight at the age of 33 days, by 5.12% and 5.51% ($P < 0,05$) at the age of 38 days and by 5.50% and 5.92% ($P < 0.05$) at the age of 42 days, and by 4.65%, 5.00% and 6.03% in muscle mass accordingly.

As for the diameter of muscle fibers it can be noted that with each studied age period of boiler males the diameter of muscle fiber tends to be larger in the experimental groups by 0.67-2.43μm, but the figures are not reliable.

The results of chemical studies proved that with age the muscles of male chickens became dehydrated. However, the water content in the muscles is 0.5-1% higher than in the muscles of the broilers of other crosses, for example, «Smena 8». The indicators of the chemical composition of muscles among the age groups of boiler males both in the control and in the experimental groups are statistically significant.

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