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Reducing the Stress of Broiler Chickens with The Use of Pre-Slaughter Holding

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***Abstract*: Poultry meat quality depends on many factors. It is determined by the marketability of the carcass, its quality and, especially, the biological value of the meat produced. The physiological state of broiler chickens immediately before slaughtering is one of the most important prerequisites for obtaining high-quality and safe poultry products.**

***The stress factors that affect the poultry organism during growing have a negative impact on the state of its health, which causes negative consequences during slaughtering.**

***In the process of poultry slaughtering at a poultry farm, chickens are transferred to boxes immediately after they are caught and loaded. This technology has its drawbacks, in particular, a high level of stress and injury to broiler chickens. Chickens are affected by transportation stress due to overcrowded conditions in the cage during transportation. Broiler chickens are injured during loading and unloading. The stressed state of broiler chickens affects the functioning of all systems and organs, which is manifested in changes in the morphological composition of the blood, deteriorated immune function, and shifted biochemical parameters.**

Holding broiler chickens before slaughtering in special holding traps gives an opportunity to compensate for these shortcomings of the process. This contributes to improving the quality of the ready product due to the normalization of the physiological functions of systems in the organism and reducing the degree of stress to the chickens.

***Index Terms*: broiler chickens, pre-slaughter holding, stress factors, interior characteristics, technological stress, biochemical status, slaughtering.**

I. INTRODUCTION

In the period of globalization, values, as well as consumer requirements, are changing fast. The interest in the problems of food production, processing hygiene, the content of harmful admixtures and genetically modified ingredients, the origin of the products and diseases spreading through food have greatly increased. Consumers want a safe and healthy product, which can be cooked quickly. Food safety has become the order of the day, and consumers hold the vendor accountable for it [1].

Poultry meat production is a complex process that involves a series of sequential stages dependent on each other – from keeping the parent flock to slaughtering and poultry meat processing. Many researchers agree that if chickens that arrive at the processing plant are infected with pathogenic microorganisms, there is a high probability of cross-contamination of other chickens during the remaining stages. If chickens receive food that contains chemical pollutants, there is a high probability that these pollutants will be found in the ready products. There are several factors that are present at all stages of production and affect the biological safety of poultry meat. Monitoring and preventive activities for each of these factors can protect poultry against disease and ensure the biological safety of poultry meat [1-7].

Poultry slaughtering and processing are the final steps in obtaining the finished product. To obtain safe products, it is extremely important to ensure compliance with the hygienic requirements in the process of primary poultry processing from pre-slaughter holding to chilling the finished product and delivery to the consumers. Observing the time and conditions of pre-slaughter holding is an important requirement in terms of microbial safety of poultry meat: it determines fecal contamination of carcasses and, therefore, their microbial contamination. In the period of pre-slaughter holding, pH of the crop increases, the poultry starts looking for food, pecking away at its remains with particles of the bedding and droppings. With that, poultry may swallow additional Salmonella and other pathogens that find acceptable conditions for reproduction in the crop. Therefore, the contents of a damaged crop may infect the finished product with pathogens. This may be avoided by cleaning the crop during the period of fasting. At the final stage of breeding, antibacterial agents are usually removed from the poultry feed. During this period, conditionally pathogenic and pathogenic microflora may become activated in the intestines, which results in its accumulation in the intestinal contents, and often in diseases of chickens [1, 8, 9, 10].This has a negative effect on the microbial safety of the finished product. The results have shown that one of the measures for preventing this influence may be the use of probiotic cultures and organic acids with food in this period. The technological stress experienced by poultry before slaughtering in the period of catching, loading and transportation results in a prolonged excitation, and thereby slows down the bleeding process, which significantly affects carcasses quality.

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As a result, glycogen content in muscular tissues, which is required for maintaining normal acidity (pH) of meat, dramatically reduces.

If the cut meat is dark, it indicates poultry stress, injury, disease, or fatigue before slaughtering [10].

During poultry transportation for slaughtering, the effects of heat stress are also manifested due to crowded conditions. Even short-term heat stress causes changes in the acid-base balance in the blood, and disruption of muscle cells integrity. These changes result in increased losses of meat juice after deboning and to the appearance of blood spots, which affects meat quality [4, 11-14]. Thus, the pre-slaughter factors that affect meat yield and its quality may be classified as long-term and short-term. Long-term factors affect chickens during growth and development: the keeping conditions, the diet, and various diseases. Short-term factors are primarily related to what happens to the chickens during the last 24 hours before slaughtering. The research was aimed at identifying changes in the morphological and biochemical blood composition of broiler chickens, depending on the technology of poultry slaughtering under the influence of pre-slaughter factors.

II. MATERIALS AND METHODS

The research was performed at the OJSC Novosibirsk Poultry Factory, and the object of research was slaughter age (42 days old) broiler chickens of the poultry farm. The subject of the research was the citrated blood and blood serum obtained from chickens slaughtered with the use of the conventional technology – group one, with pre-slaughter holding for 24 minutes – group two, and for 48 minutes – group three. In each group, 20 broiler chickens were studied. The chickens were held in a special holding trap without natural and artificial lighting, followed by individual slaughtering. The morphological composition of chicken blood was determined using the methods generally adopted in hematology, including building leukograms. Hemoglobin content in the blood was determined using a GS-3 hematinometer. The morphological and biochemical status of blood was studied at the Department of Physiology and Biochemistry of Man and Animals of the Novosibirsk State Agrarian University with the use of a PCE-90VET biochemical analyzer. All digital data were statistically processed with the use of standard computer programs.

III. RESULTS

The final stage of the technological process of poultry meat production includes fasting for eight hours in the poultry house, capturing and delivery to the slaughterhouse, unloading, transportation to the place of hanging, hanging on the conveyor line, stunning, slaughtering, scalding, feathers removal, evisceration, chilling and further processing. The technology of poultry transportation for slaughter. During the industrial slaughtering, chickens are moved to the premises for unloading from the poultry house automatically with a transverse conveyor. From the transverse conveyor, chickens are placed into boxes 18 chickens in each (Figure 1).

Fig. 1. Unloading chickens from the poultry house

Boxes placed on a roll table are removed from the conveyor and are manually placed into containers 15 in each. Containers mounted on the roll table are moved along the premises for unloading chickens, with two doorways. Into the first doorway, containers with empty boxes are supplied, and from the second doorway, containers with chickens are unloaded with the use of an AUSA forklift. Six containers with boxes are placed on the platform of the GAZ-30104A vehicle for their subsequent transportation to the slaughterhouse (Figure 2). Six vehicles are involved in the transportation of chickens, and in a single round, a vehicle transports 1,620 broiler chickens (Figure 3). Increasing the amount of meat production also entails the necessity of upgrading all interrelated technological processes: unloading from the poultry house, loading onto vehicles, and transportation. Over a work shift, 75,000 broiler chickens are to be quickly and carefully caught and loaded.

Fig. 2. High-speed loading of containers with poultry

The disadvantages of the existing methods of the pre-slaughter technologies include the following: high degree of stress to the chickens before slaughter; injuries, broken limbs, scrapes, especially during unloading from boxes; weight loss; deterioration of raw meat qualitative characteristics due to abrupt changes in the metabolic processes that occur under the influence of stress forming hormones.

Fig. 3. Transportation of broiler chickens for slaughtering

To reduce the effect of short-term stress factors, a new slaughter technology has been developed, tested and implemented, which envisages creating a trap for 81,000 chickens. This will allow ensuring uniform supply of poultry to the conveyor without any downtime. In contrast to the adopted technology, when poultry is supplied to the slaughterhouse on a conveyor belt using the method of tipping boxes, we introduced into the technology a 24 to 48 minutes period of holding (rest).

The trap consists of three gravity transporters 16 m long each: two transporters (No. 1 and No. 2) – for the containers with live poultry, and one (No. 3) – for returning the containers with empty boxes. Each conveyor can simultaneously accommodate 16 containers. The containers are unloaded from vehicles platforms with a forklift, which puts them on gravity conveyors No. 1 and No. 2. From the containers, boxes are moved on a chain conveyor, which, in turn, moves them to the hanging area. From the boxes, chickens are removed individually, thus avoiding the stress factor and the possibility of personal injury: concussion, fractures of extremities, the formation of bruises (Figure 4).

This technology of accumulation pursues the following objectives: avoids the technological (transportation) stress in the chickens; empties the intestines, which greatly facilitates subsequent evisceration, etc.

A. Result Analysis

The ultimate goal of the research was performing a comparative assessment of the interior properties of broiler chickens with the use of pre-slaughter holding in holding traps without it.

Comparing the morphological parameters of blood and hemoglobin (Table 1), it is easy to see the clear superiority of the broiler chickens that were held before slaughtering in a special holding trap in terms of leukocytes concentration (21.6 ± 0.7 – 25.6 ± 0.7 vs. 12.8 ± 0.4 × 109/l in the conventional technology), and in terms of hemoglobin synthesis (77.0 ± 0.3 vs 59.0 ± 0.2 g/l). In terms of all other characteristics listed in Table 2, no significant difference was found.

One should pay special attention to the quantitative changes in the analyzed parameters of the broiler chickens noted at the time of slaughtering (in the slaughtering machine), compared to the characteristics of the chickens in group one.

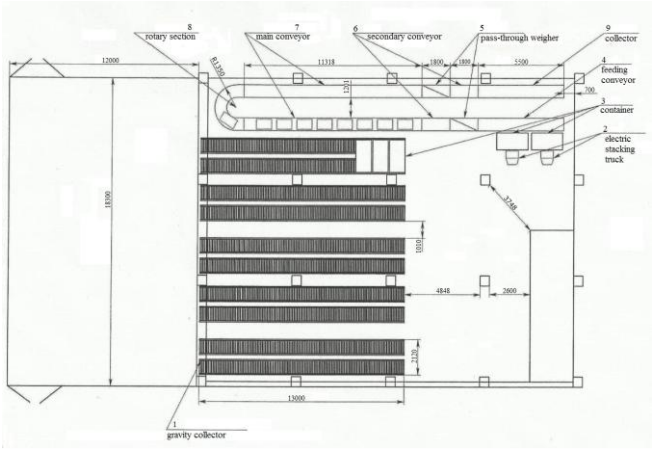

Fig. 4. A diagram of a gravity holding trap for 8,100 chickens

Table 1 shows that from the moment of taking blood samples from the chickens delivered to the slaughterhouse in the state of stress, a veracious decrease in erythropoiesis occurred with the simultaneous increase in leukopoiesis; eosinophilia (most likely as a result of sensitization caused by the technological stress and dust) and lymphocytopenia were noted. Next, the values of serum proteins in the blood were compared.

Table 2 shows that the concentration of serum protein in the chickens was the highest in the group with the conventional technology of supplying chickens for slaughtering. However, this figure decreased sharply at the slaughtering machine, reaching 30.4 ± 1.9 g/l, due to albumins and α1-globulins.

It should be noted that at the slaughtering machine (at the time of slaughtering) concentration of total serum protein in the chickens decreased significantly, including the almost two times drop in the synthesis of albumin. The concentration of α-globulins was slightly lower, and that of β-globulins and immunoglobulins G2 was significantly lower (Table 2).

What happens to the immune system of broiler chickens after 24 and 48 minutes of being held in a trap? Table 2 shows that the values of serum protein in the chickens in these groups were relatively stable, in terms of both total protein, and albumins, β-globulins, and immunoglobulins of class G1.

However, differences were noted in the levels of certain serum proteins of broiler chickens in the two compared groups. Thus, in terms of the level of α2-globulins synthesis, the advantage was with the chickens kept in the trap for 48 minutes (4.1 ± 0.3 vs. 3.3 ± 0.2 g/l), and in terms of the content of γG1- and γG2-globulins, the advantage was with the chickens kept in the trap for 24 min.

Table 1. The morphological characteristics of broiler chickens blood composition

Groups	No. of samples	Erythrocytes, $\times 10^{12}$/l	Leukocytes, $\times 10^{9}$/l	Hemoglobin, g/l	Basophilic cells, %	Eosinophils, %	Pseudoeosinophils, %	Monocytes, %	Lymphocytes, %
1st	20	3.6±0.2	12.8±0.4	5.9±0.2	2.0±0.4	1.6±0.3	21.3±0.6	2.5±0.5	72.6±1.7
2d	20	4.1±0.2	21.6±0.7***	7.7±0.3***	2.3±0.3	2.7±0.5	23.3±0.9	2.3±0.6	69.3±1.6
3d	20	2.6±0.1***	25.6±0.7***	7.6±0.4	4.0±0.6**	2.7±0.5	21.5±0.3	2.7±0.7	69.7±1.6*
4th	20	2.3±0.1	17.2±0.6***	5.1±0.1***	2.7±0.4	3.0±0.5	24.1±1.0	2.1±0.4	68.1±1.0

*P<0.01
**P<0.05
***P<0.001

Table 2. Characteristics of the immune system of broiler chickens, g/l

Groups	Total protein	Alb	$\alpha_1$gl	$\alpha_2$gl	βgl	γglG$_1$	γglG$_2$
1st	47.9±0.8	19.0±2.1	8.5±0.4	4.3±0.3	6.1±0.6	5.1±0.5	4.9±0.4
2d	40.9±1.8*	14.8±1.5	4.2±1.1***	3.3±0.2*	7.0±0.6	4.9±0.2	6.7±0.9
3d	40.3±1.9	15.8±0.9	5.8±1.0	4.1 ±0.3**	7.3±0.4	4.2±0.3	3.1±0.4***
4th	30.4±1.9***	10.4±0.9***	4.8±0.9	3.6±0.5	4.2±0.2**	4.4±0.5	3.0±0.3

*P<0.01
**P<0.05
***P<0.001

Of no less scientific and practical interest are the biochemical parameters of blood (Table 3). Over a very short period, significant changes were observed in the metabolism of broilers from groups one and four. In particular, a significant decrease was observed in the concentration of triglycerides, cholesterol, glucose, asparagine aminotransferase, as well as in the concentration of chlorides with a simultaneous increase of three times in the concentration of uric acid.

Next, we compared the biochemical status of broiler chickens from groups two and three (Table 3), both among themselves and their counterparts from group one. It has been found that there is no significant difference between the studied characteristics of broiler chickens after pre-slaughter holding for 24 and 48 min. However, more triglycerides were found in the chickens in group one that has been sent to slaughtering according to the technology adopted at the poultry farm.

Thus, the pre-slaughter holding of broiler chickens in a special holding trap for 24-48 min had a positive effect on the organism of the chickens, as evidenced by relatively stable indicators of biochemical status (absence of sudden changes), activation of erythropoiesis and leucopoiesis, and synthesis of hemoglobin and serum proteins.

Over a short period, a group of metabolic processes occurs between broiler chickens delivery from the poultry house and slaughtering, which are characterized by a significant reduction of most immunomorphological and biochemical parameters, except for eosinophils and the absolute content of leukocytes. The latter may be the result of physical allergization of the organism under the influence of the adopted technology and, most likely, in response to increasing the amount of dust when chickens are caught.

From the point of view of chickens' physiology, after pre-slaughter holding for a certain period, broilers can empty the intestines, thereby improving the evisceration technology.

Table 3. Biochemical parameters of the blood of broiler chickens

Groups	Triglycerides, mmol/l	Total cholesterol,	Glucose, mmol/l	Uric acid, mmol/l	Urea, mmol/l	AST, un/l	ALT, un/l	Chlorides, mmol/l
1st	0.9±0.1	3.3±0.1	10.4±0.4	399.8±56.8	0.9±0.1	219.3±10.1	17.9±1.0	105.5±1.4
2d	0.48±0.1*	2.5±0.2*	10.1±0.1	306.51 ±94.1	0.9±0.1	246.5±23.5	14.5±1.4	108.5±7.1
3d	0.6±0.1	2.5±0.2	9.3±1.1	413.04±61.3	0.8 ±0.1	254.4±21.9	13.4±2.1	114.5±8.2
4th	0.7±0.1	2.1±0.1	6.5±0.4***	1215.4	1.0±0.1	182.8±12.8*	20.8±0.8*	75.8±4.3***

*P<0.01
**P<0.05
***P<0.001

Avoiding simultaneous unloading ща boxes with chickens by tilting and switching to the technology of individual supplying chickens for slaughtering significantly relieves the stress and prevents injuries, including fractures and dislocations of extremities.

The materials for this study are protected by patent No. 2541643 "Method of slaughtering chickens" issued on 20.02.2015.

IV. CONCLUSIONS

The final stage (slaughtering) largely determines the quality of raw materials and products. In this sense, slaughtering and processing poultry ultimately determine the quality of the finished product. Observing the hygienic norms in primary poultry processing is extremely important. Thus, observing the time and conditions of pre-slaughter holding is an important requirement for the microbial safety of poultry meat.

The technological stress experienced by poultry before slaughtering (catching and transportation) results in a prolonged excitation, which consequently slows down the process of bleeding. As a result, the glycogen content in the muscular tissues dramatically reduces.

Comparative studies of the interior characteristics of broiler chickens during the laughter period have shown the mechanism of short-term response of the chickens to various conditions of the pre-slaughter holding. Holding in an isolated case for 48 minutes had the most beneficial effect. This fact was confirmed by an almost two times decrease in the level of eosinophils, a significant increase in the concentration of leukocytes, including lymphocytes, serum protein, liver enzymes (ALT, AST), and glucose and chloride.

The research has shown that the most beneficial effect of the pre-slaughter holding of broiler chickens for 48 minutes is the result of excluding the technological stress caused by the crowded conditions during delivery and unloading of chickens at a slaughterhouse.

In this context, we envisaged the introduction of poultry pre-slaughter holding for 24-48 minutes into the technology. This ensures emptying of the intestines, reduces the effect of stress factors, which greatly facilitates subsequent evisceration.

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