MORPHOLOGICAL CHARACTERISTICS OF THE OVARY OF LAYING HENS FED OPTIMAL FEED ADDITIVES

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Breeding egg-laying hens requires the use of appropriate feed and feed additives to supplement the animal's diet. Feed additives contain substances that are not present in the basic ration or are present in insufficient quantities to balance it in terms of certain nutrients. Without additives, it is impossible to provide a complete and balanced diet that supports the genetically inherent traits of the species [5]. There are a number of ways to improve egg production and egg quality in poultry [7, 9]. We have developed and introduced into production a mineral and energy feed additive containing 0.71% sunflower residue in combination with 400 g/t of hexavalent zinc sulfate. It is intended to balance the feed for breeding hens on the content of fat, linoleic acid, zinc and sulphur [6].

It has been proven that egg production rates of hens are closely related not only to feeding and housing conditions, but also to the development of ovarian follicles [10, 11]. The structural and functional state of reproductive organs is an extremely important marker of poultry productivity and egg quality. Studies of the morphological parameters of the ovary of hens when different additives, in particular sunflower residue and zinc sulfate, are included into the feed are important and relevant. Sunflower residue (a by-product of oil production) has a positive effect on metabolic processes and poultry performance, as it increases the calorie content and linoleic acid content of the feed. It plays a primary role in the basic metabolism, as it is a part of cell membrane phospholipids, participates in the synthesis of prostaglandins and their derivatives, and therefore has a positive effect on egg fertility and hatchability. Zinc is a functional cofactor in the metabolism of linoleic acid [1]. The physiological role of zinc is closely linked to the action of hormones, enzymes and vitamins [8]. Zinc is an important trace element as it is involved in a wide range of biological and metabolic processes, including DNA synthesis and regulation of gene expression. It acts as an activator of two types of superoxide dismutase, which is part of the body's antioxidant defence system. At relatively low and moderate concentrations, zinc plays a crucial role in cellular metabolism and cell proliferation [4, 12]. Sulphur is valuable in the supplement because it is a component of methionine, cystine, cysteine, and has antioxidant properties [7].

The aim of the study was to determine the effect of optimal feed additives of sunflower residue and zinc sulfate on the morphological parameters of the ovary of egg-laying hens.

For this purpose, on the “Borky” experimental farm (Zmiiv district, Kharkiv region) two groups of 40 birds each were formed on the basis of the Rhode Island breed of hens of line 38 of 36-week-old hens according to the principle of analogues. The first (control) group of birds received complete feed balanced according to DSTU (National Standard of Ukraine) 4120-2002. The feed of the second (experimental) group was supplemented with 0.71% residue and 400 g/t of hexavalent zinc sulfate ($ZnSO_4 \cdot 7H_2O$). The experiment lasted for 154 days.

The structure of the ovary was examined macroscopically (n=10) and on histological specimens (n=5). Macroscopically, ovarian follicles were divided into two categories: pre-hierarchical (pre-ovulatory) and hierarchical (ovulatory). Pre-hierarchical follicles included small white follicles (SWF), large white follicles (LWF), small yellow follicles (SYF) and large yellow follicles (LYF) [3]. The ovary and excised ovulatory follicles were fixed in 8% neutral formalin, embedded in paraffin, sections were prepared and stained with haematoxylin and eosin, Mallory’s fuchsin-aniline blue orange. Lipids were detected on frozen sections stained with pike perch black B according to the Lizon method [2].

According to the results of the macroscopic examination of the ovary of laying hens, the following has been found: general characteristics of its structure, size and shape that depend on the functional state and age of the bird, and are consistent with the literature [2]. The weight of the ovary in the experimental group was 64.5±4.5 g, exceeding the control group by 19.4 % ($P \leq 0.05$). Since the formation of follicles in poultry is a continuous process throughout the reproductive period, the surface of the ovary of hens of the control and experimental groups appears macroscopically tuberous. There are follicles the size of a pinhead, a millet grain and a pea. In the experimental group, the density of follicles is higher, with LWF and LYF predominating. Large yellow follicles, which become hierarchical, are suspended on a pedicle and surrounded by blood vessels. The development of ovarian follicles in hens treated with the feed additive has a priority character. These differences in the development of ovarian follicles may be the reason for the different egg production rates of hens.

Histological examination revealed that the ovary is covered with a single layer of squamous epithelium, under which loose connective tissue forms a protein membrane. The boundary between the cortical and cerebral substances is unclear. In the hens of the experimental group, the cortical and cerebral stroma has well-developed blood vessels filled with blood. The cortex contains follicles with oocytes at different stages of oogenesis. During oogenesis, complex morphological and biochemical transformations occur in the cytoplasm, nucleus and organelles of the cells [3, 10].

In the primordial follicles (SWF) of the ovary of the hens of the control and experimental groups, oocytes are spherical and surrounded by a monolayer of squamous epithelium. The cytoplasm of oocytes is uniformly basophilic and the nuclei are large, spherical, basophilic.

In the primary follicles (LWF), the height of the follicular epithelium increases to cuboidal. A theca is formed around the follicles consisting of of concentrically arranged delicate fibres of loose connective tissue with amorphous substance in between. The oocytes are larger in size than in primordial follicles, their shape is spherical, the cytoplasm is basophilic, finely cellular, the nuclei are large, weakly basophilic, indicating an activation of the synthesis processes. Some small red vacuoles are detected in the cytoplasm, confirming the presence of the carbohydrate yolk, which is an integral part of the latebra.

Secondary follicles (SYF and LYF) are larger than primary follicles. Their walls are composed of multilayered cuboidal epithelium (granulosa) and theca. The process of ovarian follicle development is combined with the differentiation of the granulosa and theca layers [3, 10]. The outer theca is composed of loose connective tissue, in which a network of blood vessels containing sudanophilic droplets is well expressed in the experimental group of hens. The interfollicular stroma contains many fibroblasts, eosinophils and diffusely scattered lymphocytes. There are isolated perivascular lymphoid formations. The oocytes in the follicles are spherical with slightly basophilic, foamy cytoplasm. The perinuclear zone of the cytoplasm of oocytes from the ovaries of hens of the experimental group is intensely basophilic, which characterises the metabolic centre of activity. The perinuclear part of the cytoplasm of individual oocytes contains fatty inclusions, which are stained with pike perch black B, confirming the formation of fatty yolk. Follicles are found in which fatty inclusions in the form of small spherical formations are located in the oocyte cytoplasm under the subcortical layer of mitochondria, also indicating the synthesis of fatty yolk. The nuclei of oocytes are large, slightly basophilic, and contain 14-15 small spherical nuclei, which is a sign of intensive endogenous protein synthesis. That is, various synthesis processes take place in the oocyte cytoplasm. There are follicles in which the zone of fatty inclusions is moved to the peripheral layer of the oocyte cytoplasm, and penetration of droplets through the follicle wall into the oocyte cytoplasm is observed, which indicates the intake of ready-made substances from the blood that are synthesised in the liver in birds [3, 8]. The volume of hepatic cells and nuclei increases, the nucleus is large and intensely coloured. The cytoplasm of hepatocytes becomes more basophilic. Lipid vacuoles occupy a significant part of the cytoplasm. In the stroma, between the liver lobes, the blood vessels are dilated and filled with blood. There is an intensive growth of oocytes due to both endogenous and exogenous yolk synthesis. Compounds coming from the environment are converted into cytoplasmic components and reserve substances [3].

In the maturing follicles, the granulosa is thinned, the theca is well developed with a large number of blood vessels, the oocyte cytoplasm is heterogeneous – basophilic with vacuoles around the nucleus and finely cellular, foamy with fatty inclusions and vacuoles at the periphery, the oocyte nuclei are large with 9-10 nuclei. The interfollicular stroma contains many fibroblasts and eosinophilic leukocytes. Blood vessels contain fat droplets. The yolk precursor vitellogenin enters the oocyte cytoplasm as part of pinocytosis vesicles. Vitellogenin is further degraded to lipovitellin and fosvitin. Pinocytic vesicles containing exogenous yolk fuse with Golgi vesicles containing endogenous yolk to form mixed yolk granules [10].

In the experimental and control groups, there are individual atretic follicles characterised by loosening of the theca, fragmentation of the cytoplasm and nucleus in oocytes, detachment of the follicular epithelium, and infiltration of these areas by eosinophils and lymphocytes. The number of atretic follicles is inversely proportional to the number of LYF.

Thus, the number of large yellow and ovulatory follicles increased in the ovary of laying hens treated with a feed additive containing 0.71% sunflower residue and 400 g/t of hexavalent zinc sulfate, in which oocytes actively synthesise carbohydrate, fat and protein yolk, accelerating follicular maturation and ovulation, improving egg production and the quality of hatching eggs.

References

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