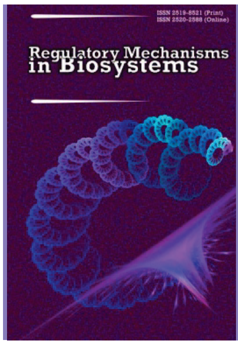

Regulatory Mechanisms in Biosystems

ISSN 2519-8521 (Print)
ISSN 2520-2588 (Online)
Regul. Mech. Biosyst.,
2024, 15(4), 912–916
doi: 10.15421/0224132

Condition of T- and B-cellular-mediated specific protection in sows and their offspring subject to essential oils

T. Y. Prudyus*, O. I. Vishchur*, D. B. Mudrak*, Y. I. Kentsalo*, T. A. Holubieva**, N. V. Gutsol***

**Intsitute of Animal Biology NAAS, Lviv, Ukraine*
***National University of Life and Environmental Sciences of Ukraine, Kyiv, Ukraine*
****Institute of Feeds and Agriculture of Podillia National Academy of Sciences, Vinnytsya, Ukraine*

Article info

Received 25.08.2024
Received in revised form 05.10.2024
Accepted 30.10.2024

Intsitute of Animal Biology, National Academy of Agrarian Sciences, V. Stus st., 38, Lviv, 79034, Ukraine.
Tel.: +38-067-322-22-58.
E-mail: tarasvet126@gmail.com, vishchur_oleg@ukr.net, daramydrak@ukr.net, kentsalo80@gmail.com

National University of Life and Environmental Sciences of Ukraine, Heroiv Oborony st., 15, Kyiv, 03041, Ukraine.
E-mail: golubev.mon@gmail.com

Institute of Feeds and Agriculture of Podillia National Academy of Sciences, Yunosti av., 16, Vinnytsya, 21100, Ukraine.
E-mail: gutsolka@i.ua

Prudyus, T. Y., Vishchur, O. I., Mudrak, D. B., Kentsalo, Y. I., Holubieva, T. A., & Gutsol, N. V. (2024). Condition of T- and B-cellular-mediated specific protection in sows and their offspring subject to essential oils. Regulatory Mechanisms in Biosystems, 15(4), 912–916. doi:10.15421/0224132

The objective of the study was identification of the activities of T- and B-cellular mechanisms of specific protection in sows and their offspring subject to essential oil from *Origanum vulgare*, cinnamaldehydum, extract from *Capsicum* sp., *Rosmarinus officinalis*, and *Thymus serpyllum* in the form of encapsulated feed supplement Aktyvno. The assessment of the activity of the cellular factors of the specific protection was conducted by enumerating T- and B-lymphocytes and assessing their functional ability in peripheral blood of swine in the reaction of spontaneous rosette-formation with ram erythrocytes. For the study, we selected Large White sows, of the English PIC genetics, and divided them into two groups (control and experimental, 10 animals in each). Experimental Group sows, for a month prior to the expected labor and until day 28 of lactation, received the Aktyvno feed supplement together with their standard diet, in the amount of 0.1 kg/t of fodder, and Control Group animals received only the standard mixed feed. The piglets born from the sows of Experimental and Control groups, starting from the age of 5 days and until weaning, received pre-starter mixed feed (PMF). During the same period, the piglets of the Experimental Group had been additionally receiving Aktyvo in the amount of 0.2 kg/t of mixed feed. To conduct the immunological studies, we collected blood of the sows from the jugular vein on days 85 and 112 of farrow and day 21 of lactation. From the piglets, blood samples were collected from the superior vena cava, when the animals were 5, 14, and 28 day-old. The numbers of T- and B-lymphocytes and their functional activities in heparin-stabilized blood were determined using the rosette formation method (E-rosette forming lymphocytes and erythrocyte-antibody-complement rosette forming lymphocytes, E-RFLs and EAC-RFLs). In the sows, intake of the tested essential oils led to increase in the number of T-lymphocytes (total and theophylline-resistant) and increase in their functional activity through redistribution of the avidity of the cells' receptor field, in particular, increase in the numbers of low-avid T- and B-lymphocytes and decline in functionally inactive T-lymphocytes. At the same time, in Experimental Group sows on day 112 of farrow and day 21 of lactation, we observed a high number of theophylline-resistant T-lymphocytes with low density of receptors and lower number of inactive Th-lymphocytes in the blood. In the piglets born from the sows of Experimental Group and Control, we observed similar changes, although they were manifested in much lower degree. At the same time, in the blood of 28 day-old Experimental Group piglets that had been consuming the Aktyvo supplement, we saw a lower number of inactive TA-RFLs and higher number of theophylline-resistant T-lymphocytes with low avidity. Therefore, secondary plant components activate the cellular mechanisms of specific protection in the sows and their offspring, which in general promotes the formation of high immune potential of their bodies. The prospects of further studies include researching the influence of secondary plant components of *O. vulgare*, *Cinnamomum* sp., *Capsium* sp., *R. officinalis*, and *T. serpyllum* on the colostral mechanisms of protection in sows.

Keywords: secondary plant components; sows; piglets; cellular immunity; T- and B- lymphocytes; functional activity of lymphocytes.

Introduction

The central problem of modern animal farming, in particular, swine rearing, is survival of offspring, especially young piglets at an early age. Solving this issue requires complex measures such as provision of optimum maintenance conditions, balanced diet of the sow herd and their offspring, reduction of the impacts of various stress factors on the body, and organization of monitoring of physiological state of the animals (Jun et al., 2023). The systemic solution of those issues serves as a basis for ensuring high immune potential of the animals and their productivity.

It was experimentally determined that farrow in swine is a specific physiological state of the body, accompanied by significant changes and intensity of metabolic processes. The last month of farrow is one of the critical physiological periods, characterized by intensified metabolic processes, endocrinous regulation, and adaptation mechanisms, which considerably affect the functioning of the immune and antioxidant protection system. Changes occurring in sows during this period are related to heightened need of nutrients (proteins, carbohydrates, lipids, vitamins, and mineral compounds), necessary for growth and development of the fetus (Khalak et al., 2016; Yang et al., 2019). Expenditures of resources by the organisms increase accordingly, as well as the rates of metabolic processes. Therefore, it is important to develop a strategy of balanced nutrition during the period of the reproductive cycle, which would ensure maximum fulfillment of the animals' needs in nutrients (Kostenko et al., 2015).

The immunological interaction between the organisms of mother and fetus is characterized by dynamic balance, during which the fetus is simultaneously under the mother's immune protection and also develops its own immunological activity, while its mother supports her own immune protection, at the same time not rejecting the trophoblast and placenta. The physiological period of pregnancy is first of all associated with immune detection of semi-hallogenic antigens of fetus and placenta with immunocompetent cells of the mother. T-lymphocytes of the mother recognize antigens of the fetus. This antigen-specific immune response to parent antigens causes proliferation and accumulation of individual clones of T-lymphocytes of the fetus (Lin et al., 2009; Fraser et al., 20016).

The mechanisms of supporting the immune homeostasis of the body, which have developed in the course of evolution, are often unable to perform their functions; this inability leads to immune pathology, mostly immune deficiency (Saliga, 2009; Liu et al., 2013). It occurs in newborn animals as a result of insufficient and incomplete nutrition of sows, malpractice in their maintenance, viral and bacterial infections, unfavorable ecological situation, and a number of anthropogenic factors, which lead to impaired metabolism in their bodies and pathology (Poroshynska et al., 2020; Islas-Fabila et al., 2024). Since it is important to retain metabolic homeostasis and increase the immune potential of animals, particularly sows during farrowing and lactation (and their offspring as well), it is practical to take into account the aforementioned peculiarities and use modern immunotropic means. Over recent years, during immune deficiencies and administration of vaccines to animals, which exert immune-suppressive action, the animals are given immune stimulators or immune modulators, made of raw material of plant, animal, and bacterial origins, and also synthetic preparations (Zamazii et al., 2013). The phytobiotic drugs based on plant extracts and essential oils not only have nutrients and food characteristics, but also displayed immunomodulating action (Allan & Bilkei, 2005; Ogawa et al., 2014; Yang et al., 2019).

Studies by many scientists have noted the use of biologically active compounds from essential oils and extracts from aroma plants (*Origanum vulgare*, *Rosmarinus* sp., *Cinnamomum* sp., *Foeniculum vulgare*, Chili peppers, *Thymus* sp., etc.) in feeding. Likewise, research has confirmed their positive effects on metabolism in lactating and farrowing sows (Sirovatko et al., 2021; Santos et al., 2023, Prudyus et al., 2024), their immunity (Vishchur et al., 2009), reproductive functions, milkiness (Allan & Bilkei, 2005; Ogawa et al., 2014; Costermans et al., 2020), and productivity parameters (Sirovatko et al., 2021; Halak et al., 2022).

Essential oils (EO) are aromatic, volatile oily fluids, which are extracted from plants (Brenes, et al., 2010). They exert antibacterial, antioxidant, and immune properties with low toxicity, low residuals, and low contamination (Zeng, et al., 2015). The primary function of these EOs is their antibacterial activity, which is mediated by their interaction with the cytoplasmic membranes of bacteria and their impact on energy metabolism (Omonijo, et al., 2018). Many authors note that plant components in the diet of animals improve the immune response and the protection of the gastrointestinal tract from the exogenous stress factors (Kim et al., 2013; Liu et al., 2013). However, the mechanisms by which phytochemical compounds act upon the host cells are yet to be identified. It is hard to determine the possible interactions among phytogenic and phytochemical compounds due to their diversity.

Thus, the complexity of immunoregulatory actions of compounds of plant-origin hinders the progress of research related to this theme. Also, the indicated compounds have not gained wide application in veterinary medicine due to the insufficient degree to which they have been studied, difficulties in use, and high cost of their individual components. At the same time, phytogenic and phytochemical compounds are still some of the most promising food supplements because of their positive effects on the regulation of the immune response, particularly, in swine. Therefore, it is essential to develop cheap and at the same time effective immunotropic means to preserve metabolic homeostasis in sows, and also enhance the vitality and boost the immune potential of their offspring. Solving those issues requires systematic studies.

The objective of the study was to determine the effect of mixture of secondary plant components of *O. vulgare*, cinnamaldehydum, *Capsium* extract, *R. officinalis*, and *Thymus serpyllum* encapsulated in a capsule of fat on the state of the cellular mechanism of specific protection in sows and their offspring.

Materials and methods

All the studied animals during the experiment were subjected to minimal stress and pain. The regions of blood collection were treated with 70% alcohol to prevent infection. The maintenance and feeding of the sows and piglets corresponded to the existing zootechnical requirements. All the procedures were performed with adherence to the requirements of the General Ethical Principles of Performance of Experiments on Animals, adopted by the 1st National Congress of Bioethics of Ukraine in 2001. This document correlates with the international standards of the protection of animal rights and wellbeing during research and includes the principles of The European Convention for the Protection of Vertebrate Animals used for Experimental and other Scientific Purposes (Strassbourg, 1986).

The scientific-research studies were carried out at one of the pig farms of Lviv Oblast on Large White sows, of PIC English genetics. According to the analogue principle, the sows (2–3 farrow and without prolonged anestrous interval) were divided into two groups, control and experimental, 10 animals in each. During farrow and lactation, the animals were held in one room under the same conditions of microclimate that was maintained using an automated ventilation system. During the preparation period, which lasted for one month, the sows were kept in individual pens with individual drinkers and feeders.

The animals were fed with the standard mixed feed (SMF), balanced in nutrients and biologically active compounds. In the following periods, the sows of both groups were also given SMF that corresponded to the period of farrow and lactation. Feeding the farrowing sows was performed using automatic feeders twice during the day providing an estimated 3.5 kg/day, and the lactating sows received the daily need in food, divided into four parts in the amount of 7 kg/day, provided in automated regime. After the preparation period, in particular, day 85 of farrow, Experimental Group sows, together with SMF, received the feed supplement Aktyvo in the amount of 0.1 kg/t of feed. On day 110 of farrow or five days before the expected labor, the sows were transferred into the labor section, where they were held in individual pens designed for labor. Experimental Group sows were fed with SMF and additionally received the feed supplement Aktyvo in the amount of 0.1 kg/t of feed. After labor, the sows of both groups were kept according to the indicated feeding scheme.

The phytogenic feed supplement Aktyvo contains a mixture of secondary plant components isolated from aroma herbs and spices, in particular essential oil from *O. vulgare*, cinnamaldehydum, extracts from *Capsicum* sp., *R. officinalis*, and *T. serpyllum*.

To conduct the immunological studies, blood was collected from the jugular vein of the sows on days 85 and 112 of farrow and day 21 of lactation. From the piglets, blood was taken from the superior vena cava at the age of 5, 14, and 28 days. The numbers of T- and B-lymphocytes and their subpopulations in heparin-stabilized blood were identified using the method of rosette formation (E-RFLs and EAC-RFLs). The presence of various markers and receptors on the surface of lymphocytes allows them to be differentiated from one another. Another distinctive feature of T-lymphocytes of animals is the presence of receptors for heterogenic erythrocytes on their surface. B-lymphocytes on the cellular membrane, besides their own immunoglobulins, bear receptors for Fc-fragment and the third component of the complement (C_3). Identification of those functional structures is the basis of methods of determining the quantities of T- and B-blood cells (Jondal et al., 1972).

In our studies, we used the methods that are the most suitable for our conditions, which we described in the reference book (Vlizlo et al., 2012). The rosettes were counted under an MC-2 microscope. We determined the activity of rosette formation according to the density of receptors: 3–5 – receptors with low density; 6–10 – receptors with the average density; rosettes in the form of 'morula' – receptors with high density. The number of T-cells with mostly suppressive activity (TPS) was counted by subtracting the number of theophylline-resistant T-cells (TPR) from the general number of T-lymphocytes. The immunoregulatory index (IRI) was estimated as the ratio of theophylline-resistant T-cells to the number of theophyline-sensitive T-cells.

The results were statistically analyzed using the single-factor dispersion analysis ANOVA, taking into account Bonferroni's Correction, and also the two-factor analysis using the Tukey Test. For this purpose, we used the StatPlus (AnalystSoft Inc., USA) software. The results are presented as mean ± SD (standard deviation). The differences between the groups were considered statistically significant at $P < 0.05$.

Results

The results of the conducted studies revealed that the general number of T- and B-lymphocytes in blood of Control Group sows significantly did not change depending on the physiological condition of the animals (Table 1). We observed no significant changes in the number of T-lymphocytes (total and active) in blood of the farrowing sows subject to the tested feed supplement. Instead, the additional feeding of the sows with the feed supplement Aktyvo caused a notable effect on the quantity of the mentioned populations of immunocompetent cells in blood of Experimental Group sows during lactation. In particular, the total number of T-lymphocytes in blood of Experimental Group sows on day 21 of lactation was higher than in Control (Table 1). At the same time, in the blood of the sows of this group, we observed a higher number of E-RFLs with low avidity and lower number of 'zero', inactive, cells. A similar pattern of changes occurring during intake of the studied feed supplement was also revealed by T-active (A-RFLs) rosette-forming lymphocytes (Table 1). However, those changes were manifested to a much lower degree, and the determined differences in the studied parameters were not reliable; only tendencies were observed.

Table 1
Number of T-lymphocytes and their populations and B-lymphocytes in blood of the examined sows (%, x ± SD, n = 5)

Parameters	Groups	Period of study		
		prior to intake	after intake	
		85 day of farrow	112 day of farrow	21 day of lactation
T-total	control	41.0 ± 2.4[a]	41.4 ± 1.9[a]	41.6 ± 1.1[a]
E-RFLs, %	experimental	42.4 ± 0.9[a]	43.6± 1.1[ab]	45.4 ± 1.1[ab]
T-active	control	23.4 ± 2.1[a]	23.8 ± 1.9[a]	24.8 ± 0.8[a]
A-RFLs, %.	experimental	24.4 ± 1.9[a]	24.2 ± 1.6[a]	26.6 ± 1.1[a]
T-helpers	control	23.2 ± 1.3[a]	23.6 ± 0.9[a]	24.2 ± 0.8[a]
(theophylline-resistant), %	experimental	24.4 ± 0.9[a]	25.8 ± 0.8[ab]	28.2 ± 1.3[ab]
B-lymphocytes	control	40.4 ± 1.1[a]	40.8 ± 0.8[a]	41.0 ± 0.7[a]
EAC-RFLs, %	experimental	41.2 ± 1.3[a]	42.8 ± 1.9[ab]	42.4 ± 1.1[ab]
T-suppressors,	control	17.6 ± 1.0[a]	17.6 ± 1.4[a]	16.8 ± 0.6[a]
(theophylline-sensitive), %	experimental	18.6 ± 0.6[a]	19.4 ± 0.7[ab]	18.4 ± 0.7[a]
T-helpers/T-suppressors (IPI)	control	1.33 ± 0.09[a]	1.38 ± 0.14[a]	1.44 ± 0.06[a]
	experimental	1.31 ± 0.02[a]	1.33 ± 0.06[a]	1.53 ± 0.03[ab]

Note: different letters within one parameter of sampling indicate significant differences according to the Tukey Test ($P < 0.05$).

Therefore, on day 21 of lactation, the general number of A-RFLs in the blood of Experimental Group sows was higher than in Control. Increase in the total number of T-active lymphocytes in the blood occurred simultaneously with increase in the number of A-RFLs with low density of receptors and decrease in inactive and average-avidity cells.

Of great importance during the study of cellular link of immunity of animals are T-helpers (theophylline-resistant) and T-suppressors (theophylline-sensitive), lymphocytes that constitute the main population of immunoregulatory cells. While studying the mentioned populations of T-lymphocytes (Table 1), we noted increase in the general number of theophylline-resistant T-lymphocytes in blood of Experimental Group sows during the periods of farrow and lactation. Those changes in the examined subpopulation of T-lymphocytes were more pronounced in the blood of the lactating sows. At the same time, the quantity of T-suppressors in the blood of Experimental Group sows had a tendency towards increase. The immunoregulatory index (IRI), which characterizes the ratio of T-helpers to T-suppressors, in Experimental Group sows also had an upward tendency on day 21 of lactation, as compared with Control Group animals (Table 1). When studying the antigen-dependent population of B-lymphocytes (EAC-RFLs), we observed changes similar to those detected when measuring T-lymphocytes in blood of the sows consuming the Aktyvo supplement (Table 1). Therefore, the general number of B-lymphocytes in the blood of Experimental Group sows in all the periods of experiment had a tendency towards increase. At the same time, in the blood of sows of this group, on day 112 of farrow and day 21 of lactation, we observed higher number of low-avid B-lymphocytes against a downward tendency in inactive EAC-RFLs. When studying the number of T- and B-lymphocytes and their regulatory populations in the blood of the piglets from sows of the control and experimental groups, we observed similar changes, though they were manifested to a much lower degree (Table 2). The differences in the general numbers of T- and B-lymphocytes in the blood of Experimental Group sows in relation to Control in all the study periods were not reliable in most cases, with only upward tendencies found.

The data presented in Table 2 show that feeding Experimental Group piglets with pre-starter mixed feed and the food supplement caused a pattern of changes similar to such observed in other populations of immunocompetent cells. In particular, in the blood of 28 day-old piglets, against the background of downward tendency in theophylline-resistant T-lymphocytes, we determined an increase in their general number, and especially in their low-avid forms. As with the populations of theophylline-sensitive T-lymphocytes and IPI, no statistically significant changes were found.

We observed only a downward tendency in the number of T-suppressors and increase in the IPI in blood of Experimental Group piglets at the age of 28 days. Nonetheless, those data indicate the activating effect of the experimental feed supplement on the condition of the T- and B-cellular mechanism of immunity of piglets. Thus, the results of our studies suggest that the supplement Aktyvo, added to the diet of the sows and piglets, more intensely influenced the condition of T- and B-cells of the specific protection in the blood of the sows rather than their piglets.

Table 2
Numbers of T-lymphocytes and their populations and B-lymphocytes in blood of the examined piglets (%, x ± SD, n = 5)

Parameters	Groups of animals	Periods of study		
		prior to intake	after intake	
		day 5 after birth	day 14 after birth	day 28 after birth
T-active	control	20.4 ± 0.9[a]	21.4 ± 1.1[a]	22.0 ± 1.6[a]
A-RFLs, %	experimental	20.2 ± 0.5[a]	21.6 ± 1.1[a]	23.6 ± 0.6[ab]
T-helpers (theophylline-resistant),	control	21.3 ± 1.1[a]	21.4 ± 2.9[a]	21.6 ± 2.2[a]
%	experimental	21.6 ± 1.5[a]	22.0 ± 2.4[a]	23.0 ± 2.2[a]
T-suppressors,	control	10.0 ± 0.7[a]	9.4 ± 0.6[a]	9.0 ± 2.1[a]
(theophylline-sensitive), %	experimental	11.3 ± 1.0[a]	9.6 ± 2.3[a]	8.0 ± 1.4[a]
T-helpers/T-suppressors (IPI)	control	2.10 ± 0.08[a]	2.29 ± 0.40[a]	2.51 ± 0.62[a]
	experimental	1.92 ± 0.12[a]	2.39 ± 0.61[a]	2.91 ± 0.32[a]

Note: see Table 1.

Discussion

Immunity of animals depends on the reactivity of their bodies and their main immunocompetent cells, T- and B-lymphocytes. T-lymphocytes and their regulatory populations are important in the formation of the specific immune response, and they provide immunobiological homeostasis and the resistance to the actions of antigenic determinants (Lin et al., 2009; Ogawa et al., 2014; Hlavova, 2017). This is especially important during the last period of farrow, when the intensity of metabolic processes increase, as well as the immunological tension in the body. The analysis of the literature data and our previous studies indicates the significance of this period, when the colostral immunity, and especially the cellular mechanism of specific protection, forms (Blavi et al., 2021; Velez et al., 2024).

Using intensive methods in pig farming against the background of a number of technological and anthropogenic factors imposes a suppressive impact on the activity of the protective systems in the organism (Prudyus et al., 2023; Mainardi et al., 2024), and especially that of sows, leading to immune deficiency (Mainardi et al., 2024). This factor has a negative effect on the offspring in post-natal period, and also their further growth and development (Lillehoj et al., 2011; Islas-Fabila et al., 2024).

Starting from the second half of farrow (days 70–100), the sows are in the state of immune deficiency, which is associated with the development of the fetus and the preparation of the body for synthesis of milk. Decline in the immune potential of sows during this time occurs through the natural mechanism of its inhibition (Blavi et al., 2021).

On the one hand, the results of our studies indicate the possibility of supporting a high immune potential of sows during the periods of farrow and lactation, especially cellular and humoral factors of the specific protection, by using the Aktyvo supplement in their diet. On the other hand, increase in the number and functional activity of the immunocompetent cells in the blood of the mother provides their transfer into milk, especially during the pre-lactation restructuring of the organism, and, thus, to newborn offspring via the known colostral mechanisms of the immunity formation. In particular, in the perinatal period, a large amount of immunocompetent cells and their stem precursors transfer from the mammary glands into colostrum, and, with no hindrance, are ingested during first 72 h of life and enter the blood flow and immunocompetent organs of the newborn. Then, they actively participate in the formation of immune reactions. Those mother cells and cellular products synthesized in them play the determining role, as mentioned above, in the protection of the newborn animals from the commonest viral diseases in this age period.

Such a stimulating effect on the activity of the studied immunocompetent cells in blood of Experimental Group sows was likely caused by the complex additive action of components of the feed plant-based supplement, its anti-inflammatory, immunomodulating, and antioxidant properties.

Specifically, the Aktyvo feed supplement contains:

– essential oil from *O. vulgare*, which exerts bactericidal properties that inhibit the growth of Gram-positive and Gram-negative bacteria and viruses, and displays a fungicidal action. Oregano has a stimulating effect on the digestive and antioxidant systems;

– essential oil of cinnamon, which stimulates the taste buds, produces anti-inflammatory properties, reduces stress, and exhibits antioxidant function;

– extract from chili pepper, which stimulates the consumption of feed, water, and salivation process, which improves digestion. In the gastrointestinal tract, it stimulates secretion of gastric juices, activates the system of fermentation, improving the breakdown and metabolism of compounds, thereby improving the productivity and conversion of mixed feed;

– essential oil from *R. officinalis*, which is an antioxidant and anti-inflammatory agent, which reduces the oxidative and inflammatory reactions, regulates the body temperature, and reduces pain during inflammatory processes;

– essential oil from *T. serpyllum*, which exerts anti-inflammatory properties, stimulates the immune system of animals, and is used in treatment of respiratory organs and the gastrointestinal tract;

– essential oil of oregano (OEO) is extracted from plants *O. vulgare* by water vapor distillation. The main nutraceutical components of those oils are carvacrol and thymol. The analysis of the literature data revealed that using essential oils from oregano in the diet has an immunostimulating effect on sows. Therefore, on day 14 of lactation, higher concentrations of T-lymphocytes were observed in the young sows after adding 250 ppm of OEO to their diet (Ariza-Nieto et al., 2011). The results of other studies indicate that using 300 ppm OEO or 300 ppm of mixture of carvacrol and thymol in the diet of poultry positively affects the growth and immune response, indicating decrease in the number of oocytes of coccidian protozoans in the excreta samples (Alp et al., 2012), and also heightened reaction of hypersensitivity, the total titer of antibodies, and the ratio of neutrophils to lymphocytes H/L (Hashemipour et al., 2013).

Many other studies also reported positive effects of essential oil from some species of *Cinnamomum*, which contain a large amount of trans-cinnamon aldehyde, on the parameters of poultry productivity (Sang-Oh et al., 2013; Shirzadegan et al., 2014), hematological profile (Najafi et al., 2014), and immune function (Al-Kassie, 2009; Sadeghi et al., 2012).

The results of our studies are coherent with the data of Ariza-Nieto et al. (2011), who reported that using oregano essential oil in the diet of sows caused increase in the number of T-lymphocytes in their offspring on day 14 of lactation. In our study, the piglets born from the sows that consumed the supplement tended to consume more milk ($P = 0.10$). On the other hand, adding 250 mg/kg of oregano essential oil to the diet of sows during farrow or lactation had no effect ($P > 0.05$) on the concentration of immunoglobulins in the blood of the piglets after consuming colostrum. At the same time, in blood of the piglets, no changes were recorded in the numbers of T-lymphocytes and their subpopulations ($P > 0.05$), and also the activity of natural cell killers.

In general, the results of our studies indicate that the feed supplement Aktyvo, utilized in the diet of sows and piglets, to a higher degree affected the condition of the T- and B-cellular mechanism of specific protection in the blood of the sows than in their offspring. Such a stimulating effect on the activity of immunocompetent cells in the blood of the animals was obviously due to the complex adaptive action of the components of studied plant-based supplement, which boosted the immune potential of sows, especially under conditions of physiological immunosuppression in the last period of farrow. At the same time, higher numbers and greater functional activities of T- and B-lymphocytes and their populations in the blood of sows likely provide their transfer into colostrum and milk, and, therefore, newborn offspring, via the known colostral mechanisms of immunity formation.

Conclusion

The results of our studies revealed that using the plant-based feed supplement Aktyvo in the diet of farrowing and lactating sows and also their piglets positively affected the condition of cellular mechanisms of specific protection of their bodies. This was evidenced by increase in the numbers of T-lymphocytes (general and theophylline-resistant) and B-lymphocytes and increase in their functional activity, which occurred through redistribution of the receptor apparatus of immunocompetent cells. In particular, the population of functionally inactive T- and B-lymphocytes declined and the number of lymphocytes with low, and in some cases average, density of receptors increased. At the same time, those changes were more expressed in the lactating sows, and also 28 day-old piglets. Such an activating effect of the herbal supplement on the immune function of the sows and their offspring can be explained by the complex additive action of the studied agents that the feed supplement contains.

The authors state that they have no conflict of interests.

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