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EFFECT OF POLYPHENOL COMPLEX FROM *VITIS VINIFERA* L. ON FEMALE DOGS IN THE POSTPARTUM PERIOD

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Summary. This paper presents the results of a study investigating the effects of the polyphenolic complex *Vitis vinifera* L. (PCV) on the antioxidant status, liver function, hormonal profile, and innate immunity of female dogs in the postpartum period. The use of PCV was found to be accompanied by a significant decrease in the intensity of lipoperoxidation processes (Thiobarbituric acid reactive substances (TBARS) content and lipid hydroperoxide levels) and an increase in the activity of the endogenous antioxidant system (blood plasma total antioxidant activity, catalase activity, superoxide dismutase activity, and reduced glutathione levels), indicating its membrane-stabilizing and antioxidant effects. Along with the normalization of free radical metabolism, there was a decrease in hepatospecific enzyme activity, reflecting reduced cytolytic damage to hepatocytes and improved liver function. The hormonal profile of the female dogs remained stable with respect to thyroid hormones and estradiol. However, there was a trend toward lower cortisol, insulin, and progesterone levels, which may be associated with reduced metabolic and inflammatory stress. Immunological studies revealed an upward trend in serum bactericidal and lysozyme activity, as well as increased neutrophil phagocytic activity and phagocytic index. This reflects the optimization of innate immunity under the influence of the complex. The obtained data indicate PCV's multifaceted physiological effects aimed at restoring antioxidant balance, protecting the liver, reducing stress-induced endocrine shifts, and strengthening the immune system in female dogs during the postpartum period.

Keywords: therapy, oxidative stress, antioxidant system, immune system, metabolism

Introduction. The postpartum period is a critical stage for female dogs. It is marked by significant hormonal and metabolic changes that are essential for maintaining their physiological state and ensuring proper growth and development of their puppies (Ottka et al., 2023; Parakhnych and Koshevoy, 2025). The postpartum period in female dogs is characterized by increased metabolic processes and hormonal fluctuations, which can lead to the formation of reactive oxygen species (ROS) and oxidative stress (Kim and Wakshlag, 2023; Wu, 2024). The antioxidant system is key during this period, as it neutralizes excess ROS arising from intensive lipolysis, lactational metabolic stress, and inflammatory processes. This prevents damage to cell membranes and supports the functional activity of the liver, endocrine organs, and immune system. These factors contribute to full recovery after childbirth (Koshevoy et al., 2024; Parakhnych and Koshevoy, 2025).

The polyphenol complex of *Vitis vinifera* L. (grape) comprises a group of compounds that play a key role in determining its biological activity and the health benefits it provides to humans and animals. These polyphenols include phenolic acids, flavonoids, stilbenes, and tannins. The concentration and ratio of these compounds depend on the variety of grape, its degree of ripeness, the growing conditions, and the technological processing methods used. Grapes and their waste products are used to produce phytopreparations with a high polyphenol content, including resveratrol, anthocyanins, and

quercetin (Darwiche et al., 2023). The biological action of polyphenols is associated with their ability to chelate metal ions, inhibit prooxidant compound activity, and modulate cellular antioxidant defenses (Chedea et al., 2022).

Resveratrol, which is primarily found in the skin of red grapes, is renowned for its antioxidant, anti-inflammatory, and cardioprotective properties. Meanwhile, anthocyanins are highly effective at neutralising free radicals (Koshevoy et al., 2024). Resveratrol activates antioxidant enzymes such as catalase and superoxide dismutase, thereby enhancing the body's natural defenses against increased free radical oxidation. Additionally, resveratrol inhibits the activity of enzymes involved in inflammatory reactions, thereby reducing the formation of toxic compounds. Consequently, it improves cardiovascular function, slows down cellular ageing, and enhances the body's overall antioxidant potential (Rauf et al., 2018; Fukuoka et al., 2023).

The use of anthocyanins in the composition of herbal preparation from *Vitis vinifera* L. can help maintain antioxidant balance, strengthen the immune system, and accelerate recovery from lactation stress (Lu et al., 2024). In addition, anthocyanins can improve microcirculation, stabilize cell membranes, and reduce the risk of developing inflammatory processes, which is important for the recovery of the bitch's body after childbirth (Mattioli et al., 2020). Quercetin is a flavonoid that neutralises free radicals and prevents oxidative damage

to cell membranes by regulating the level of reduced glutathione. This enhances the body's natural antioxidant defenses. Additionally, quercetin exhibits anti-inflammatory properties and positively impacts blood vessel health (Qi et al., 2022).

Catechins, which belong to polyphenolic compounds, directly neutralize toxic radicals, in particular hydroxyl and peroxy radicals, interrupting the chain reactions of lipid peroxidation in cell membranes; they stabilize the structure of DNA and proteins, which helps reduce inflammatory processes (Ciardullo et al., 2024). Vitamin C, or ascorbic acid, is a powerful water-soluble antioxidant that effectively neutralizes free radicals in the aqueous environment of cells, which restores oxidized forms of other antioxidants, in particular vitamin E. Vitamin C is involved in collagen synthesis and supports the normal functioning of the immune system (Gordon et al., 2020). Tannins, or proanthocyanidins, contained mainly in the skin and seeds of grapes, also have a pronounced antioxidant effect — they bind free radicals and chelate metal ions that participate in the catalysis of the formation of ROS, tannins also inhibit the activity of enzymes that stimulate oxidative processes, such as lipoxygenases, and thereby reduce the formation of free radicals at the enzymatic level (Amarowicz and Pegg, 2024).

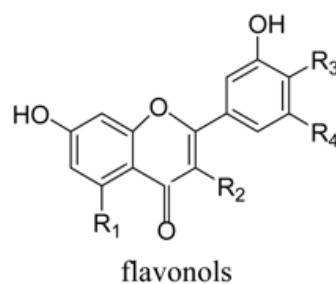
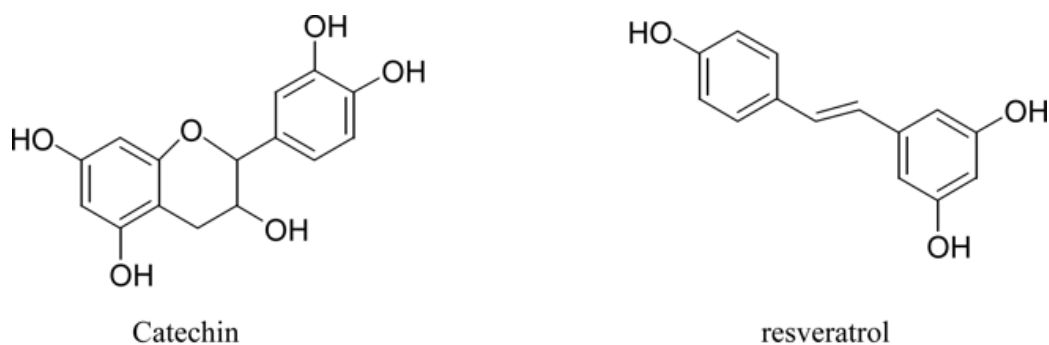
The use of a natural polyphenolic complex from *Vitis vinifera* L. can help restore antioxidant balance, reduce inflammatory reactions, and improve the general condition of the bitch after childbirth. The main components of this complex, such as resveratrol, anthocyanins, catechins, Vitamin C, and tannins, neutralize toxic radicals, enhance antioxidant protection, and affect the activity of enzymes, providing a comprehensive protective effect.

Therefore, the study **aimed** to determine the effect of a polyphenolic complex from *Vitis vinifera* L. on antioxidant status, detoxification processes, and the state of the endocrine and immune systems in female dogs in the postpartum period.

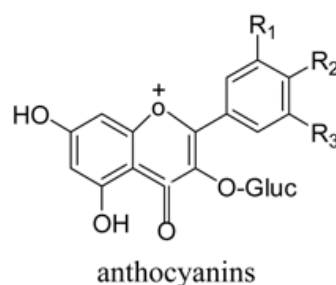
Materials and methods. The studies were conducted on 24 female dogs of different breeds, aged 3–6 years, weighing 8–12 kg, with eutocytic births according to the recommendations of Lúcio, Silva and Vannucchi (2021). All animals were divided into two groups according to the principle of analogues — control ($n = 12$), which were kept on a diet adjusted according to the needs in postpartum period, and experimental ($n = 12$), which, in addition to the main diet, received a polyphenol complex from *Vitis vinifera* L. (PCV), mainly represented by the compounds shown in Fig. 1. The method of obtaining PCV is based on the use of plant raw materials (dried and crushed grape pomace, mainly skins and seeds) and extraction technology, which allowed to minimize the degradation of thermolabile polyphenols and ensured the preservation of biologically active compounds. PCV for female dogs in the postpartum period was presented in the form of capsules, each of which contained 200 mg of active ingredient. Capsules were administered at the

rate of 20 mg of total polyphenols per kilogram of body weight once with feed to reduce possible irritation of the gastric mucosa and ensure more uniform absorption. Administration began in the early postpartum period, on the first day after delivery, and continued for 30 days, which covered the phase of maximum metabolic and inflammatory stress associated with the onset and stabilization of lactation, restoration of the uterus, and restructuring of the endocrine status until the conditional return of the female dog's body to the pre-gravid state.

During the application, clinical and laboratory monitoring of the condition of animals was carried out, including the assessment of antioxidant status indicators, activity of hepatospecific enzymes, hormonal profile, and immune reactivity parameters. Blood for research was collected once in the morning on an empty stomach. To determine the antioxidant status of female dogs, the total antioxidant activity was determined using the FRAP analysis, the principle of which is based on determining the antioxidant power of iron. Catalase activity was determined by measuring the amount of undecomposed hydrogen peroxide in the sample. Upon reacting with molybdenum salts, hydrogen peroxide forms a stable coloured complex. The intensity of this complex was measured against a control sample consisting of 2 ml of water instead of hydrogen peroxide. Determination of superoxide dismutase activity was carried out by a method based on the competitive interaction of this enzyme with nitroblue tetrazolium for superoxide anion radicals formed as a result of the reaction of the reduced form of NADH and phenazine methosulfate. The level of reduced glutathione was estimated using the Ellman's reagent method, in which the thiol groups of glutathione form a colored complex. The content of thiobarbituric acid reactive substances was determined by a method based on the binding of malondialdehyde with thiobarbituric acid to form a stable trimethine complex. The amount of lipid hydroperoxides was determined using the protein precipitation principle with a trichloroacetic acid solution and lipid extraction with ethanol. This method is based on measuring the level of the coloured product formed when the ethanol extracts of lipids interact with ammonium thiocyanate. The state of the endocrine system was determined by the level of hormones in the blood of female dogs, including cortisol, insulin, 17β -estradiol, progesterone, thyroxine, and triiodothyronine, by the immunoenzymatic method. Natural resistance was assessed by the indicators of the humoral link (bactericidal and lysozyme activity of blood serum) and the cellular link (phagocytic activity of neutrophil granulocytes and phagocytic index of blood). The functional state of the liver in bitches was investigated by the activity of four hepatospecific enzymes — alanine and aspartate aminotransferases, γ -glutamyl transpeptidase and alkaline phosphatase using a semi-automatic biochemical analyzer BioChem SA (USA). The obtained results were statistically processed using a one-factor analysis of variance (ANOVA test).



	R ₁	R ₂	R ₃	R ₄
quercetin	OH	OH	OH	-
rutin	OH	O-Rutinose	OH	-
morin	OH	OH	-	OH
myricetin	OH	OH	OH	OH
fisetin	OH	OH	OH	-



	R ₁	R ₂	R ₃
peonidin-3- <i>O</i> -glucoside	OCH ₃	OH	-
petunidin-3- <i>O</i> -glucoside	OH	OH	OCH ₃
malvidin-3- <i>O</i> -glucoside	OCH ₃	OH	OCH ₃
cyaniding-3- <i>O</i> -glucoside	OH	OH	-
delphinidin-3- <i>O</i> -glucoside	OH	OH	OH

Figure 1. Main phenolic compounds contained in *Vitis vinifera* L. and their chemical structure (according to Xia et al., 2010).

Results and discussion. The effect of the polyphenol complex from *Vitis vinifera* L. (PCV) was evaluated by changes in the dynamics of antioxidant protection, detoxification processes, and the state of the endocrine and immune systems. Distinct dynamics of changes in

the antioxidant defense system were observed in female dogs under the influence of PCV (Fig. 2, Table 1).

From the data in Fig. 2 it is seen that in experimental group of female dogs there was an increase in total antioxidant activity of blood serum, in particular on

the 7th day by 15.7% (1.03 ± 0.04 mmol/l, $P < 0.05$), on the 14th day — by 23.5% (1.21 ± 0.05 mmol/l, $P < 0.001$), and on the 30th day — by 36.8% (1.56 ± 0.07 mmol/l, $P < 0.001$) compared to the control. The antioxidant effect of PCV was demonstrated through changes in various indicators, particularly catalase activity (CAT), superoxide dismutase (SOD) levels, reduced glutathione (RG) content, thiobarbituric acid reactive substances (TBARS) levels, and lipid hydroperoxide levels.

As shown in Table 1, no significant changes in CAT activity were observed during the study, although the data of the experimental group tended to increase compared to the control group in all observation periods. At the same time, a significant increase in SOD activity was found: 34.1% on the seventh day, 30.3% on the fourteenth day, and 25.8% on the thirtieth day ($P < 0.001$). Similar changes were observed in the level of reduced glutathione (RG) in the blood of female dogs. In particular, the experimental group's RG levels exceeded the control group by 17.2% on the seventh day, 21.3% on the fourteenth day, and 19.8% on the thirtieth day ($P < 0.01$). Thus, PCV increased the activity of antioxidant defense components.

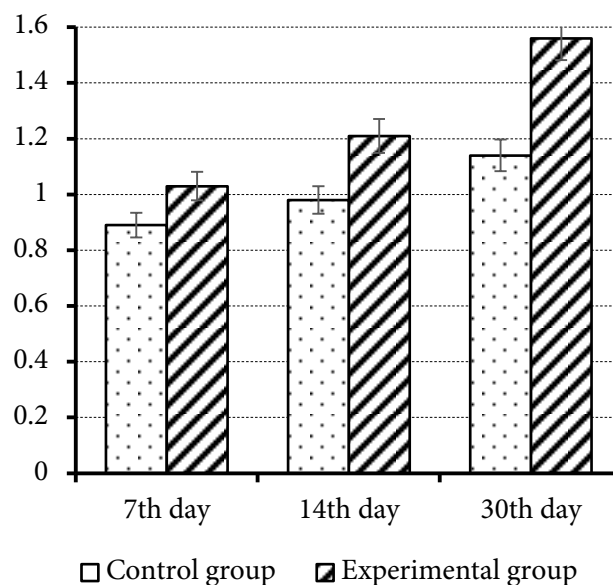


Figure 2. Total antioxidant activity in the blood serum of female dogs throughout the experiment.

Table 1 — Dynamics of antioxidant status indicators in female dogs

Indicators	Experiment day					
	7 th		14 th		30 th	
	Control group	Experimental group	Control group	Experimental group	Control group	Experimental group
CAT, un./mg prot.	210.5 ± 7.5	232.7 ± 9.3	230.8 ± 10.6	264.1 ± 12.1	270.2 ± 13.2	304.2 ± 14.1
SOD, un./ml	27.1 ± 1.1	36.4 ± 1.3 ³	30.5 ± 0.9	39.8 ± 1.4 ³	33.5 ± 1.2	42.2 ± 1.8 ³
RG, μmol/l	129.4 ± 5.1	151.6 ± 6.1 ²	160.5 ± 5.9	194.7 ± 8.4 ²	183.2 ± 7.6	219.5 ± 8.8 ²
TBA-P, μmol/l	22.4 ± 0.7	20.2 ± 0.7 ¹	21.2 ± 0.8	18.7 ± 0.6 ¹	19.3 ± 0.8	15.4 ± 0.6 ³
LHP, un./l	1.14 ± 0.05	1.06 ± 0.05	1.02 ± 0.04	0.89 ± 0.03 ¹	0.91 ± 0.03	0.74 ± 0.02 ³

Notes: ¹ — $P < 0.05$, ² — $P < 0.01$, ³ — $P < 0.001$ statistically significant changes compared to the control group.

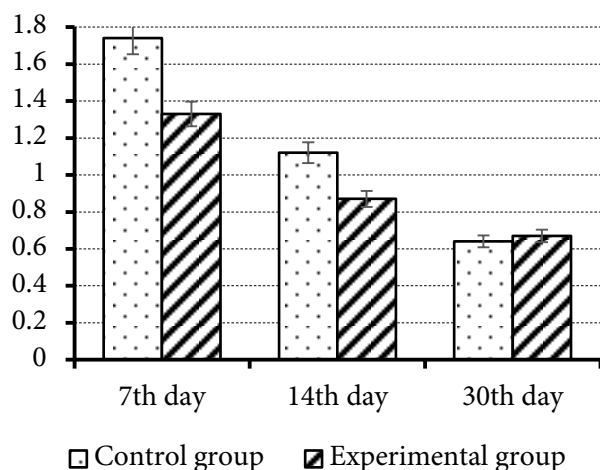
A decrease in the intensity of lipid peroxidation processes was also observed. In the experimental group, the content of TBA-P decreased significantly by 9.8% ($P < 0.05$) on the 7th day, and the content of LHP tended to decrease. Later, on 14th day of the study, the TBA-P content decreased by 11.8%, and the LHP content decreased by 12.7% ($P < 0.05$). By the end of the experiment on 30th day, the most significant decrease in lipoperoxidation markers was observed: TBA-P decreased by 20.1%, and LHP decreased by 18.7% ($P < 0.001$). This indicated PCV's complex effect on oxidative process indicators in female dogs. The positive effect of PCV on hepatospecific enzyme dynamics in the blood of female dogs was also established (Figs 3, 4).

From the data in Fig. 3, it can be seen that the activity of ALT on the 7th day of the study was lower than the control values by 23.6% (1.33 ± 0.06 μmol/sxl, $P < 0.001$), and on the 14th day — by 22.3% (0.87 ± 0.03 μmol/sxl, $P < 0.001$). The activity of AST on the 7th day tended to decrease compared to the control, and on the 14th day it was lower by 14.5% (0.71 ± 0.03 μmol/sxl, $P < 0.01$). At

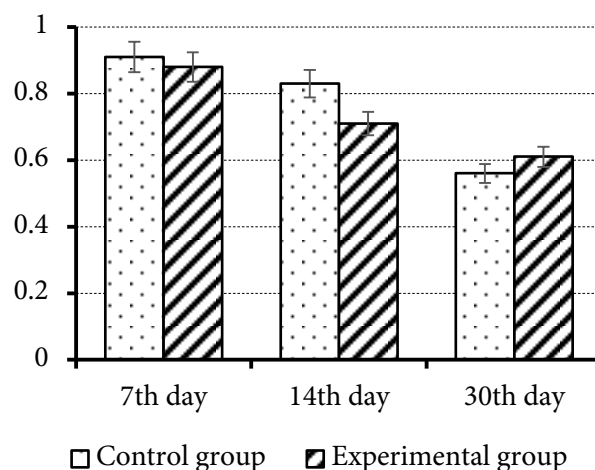
the end of the experiment, on the 30th day, the activity of both of the above enzymes did not show significant changes compared to the control; the de Ritis coefficient was 0.87 and 0.91 for animals in the control and experimental groups, respectively.

The activity of γ-glutamyl transpeptidase (Fig. 4A) on the 7th day was characterized by a tendency to decrease compared to the data in the control group; on the 14th day, it was significantly lower by 14.6% (92.1 ± 4.23 nmol/sxl, $P < 0.01$). On the contrary, on the 30th day of the experiment, the activity of this enzyme exceeded the control values by 11.2% (83.1 ± 2.59 nmol/sxl, $P < 0.01$). At the same time, the activity of alkaline phosphatase (Fig. 4B) decreased by 13.8% (0.94 ± 0.03 μmol/sxl, $P < 0.05$) on the 7th day of the study, and then had a tendency to decrease.

The hormonal background of female dogs was assessed by the dynamics of the levels of the following hormones — insulin and cortisol, estradiol (E2) and progesterone (P4), thyroxine (T4) and triiodothyronine (T3), which are summarized in Table 2.

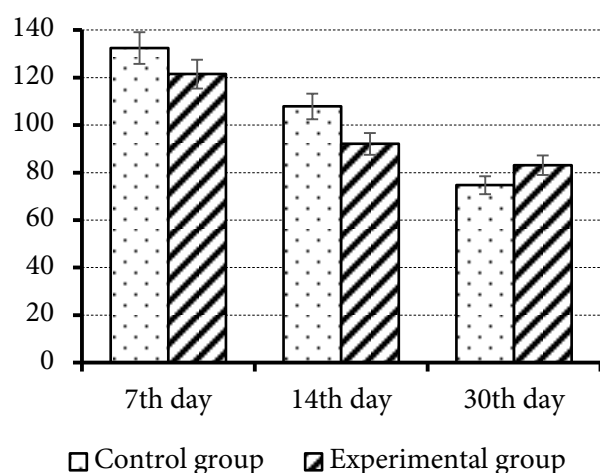


A

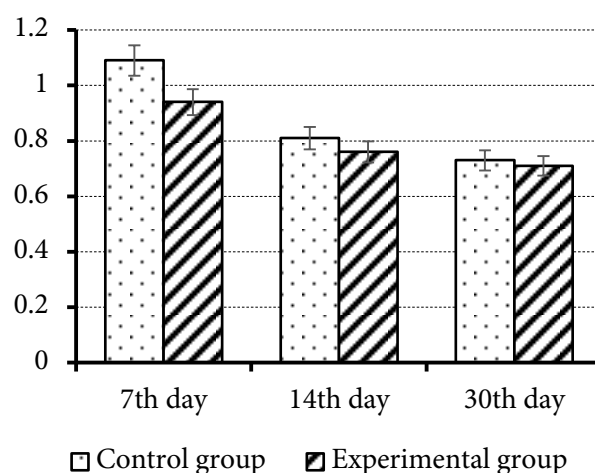


B

Figure 3. Alanine (A) and aspartate (B) aminotransferase activity in the blood of female dogs during the experiment.



A



B

Figure 4. Activity of γ -glutamyl transpeptidase (A) and alkaline phosphatase (B) in the blood of female dogs during the experiment.

The endocrine system of female dogs did not undergo significant changes under the action of PCV (Table 2). In general, the experimental group of animals experienced similar physiological adaptations during the postpartum period, and their hormonal levels were similar to those of the control group. Notably, the levels of thyroid hormones and E2 remained within physiological ranges. Conversely, the level of progesterone (P4) was highest on the 7th day of the observation period. On the 14th day, there was a tendency for it to decrease. Only at the end of the experiment was the level of this hormone significantly lower than in the control group by 21.7%. Overall, the dynamics of changes in gonadal hormone levels did not suggest a significant impact of PCV on female dogs' gonads. Insulin levels reflected the lactation load, which was more pronounced at the beginning of the experiment and decreased by the 30th day. The obtained data were within physiological limits for this species of animals. Regarding cortisol levels, it is worth

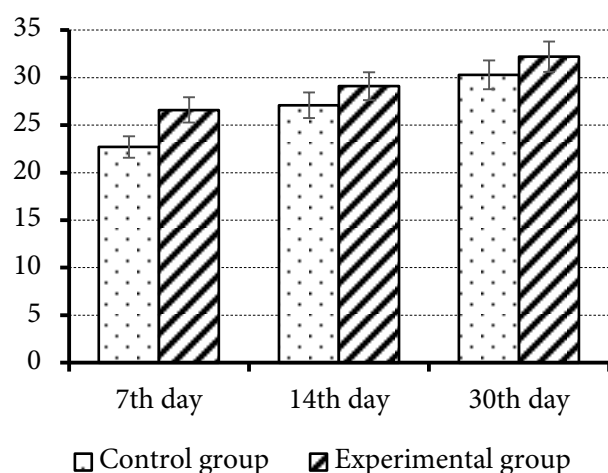
noting that they tended to decrease during PCV administration throughout the study, though no significant differences were found between the experimental and control groups.

As shown in Fig. 5, the bactericidal and lysozyme activities of the blood serum of female dogs in both groups increased during the study, reflecting the gradual restoration of immune protection after childbirth. On the 7th day of the experiment, PCV significantly increased bactericidal activity by 14.7% ($26.6 \pm 0.9\%$, $P < 0.01$). In the future, both indicators in the experimental group only showed a tendency to increase without significant fluctuation. No significant changes in neutrophil phagocytic activity (Fig. 6A) or the phagocytic index (Fig. 6B) were observed during the experiment when PCV was present. Both indicators increased gradually over the duration of the study and as the female body recovered physiologically during the postpartum period.

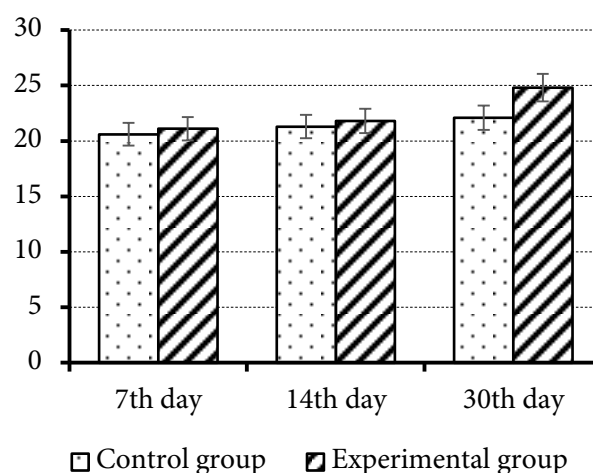
Table 2 — Hormonal changes of female dogs in the postpartum period under the effect of PCV

Indicators	Experiment day:					
	7 th		14 th		30 th	
	Control group	Experimental group	Control group	Experimental group	Control group	Experimental group
Insulin, pmol/l	134.7 ± 5.8	141.2 ± 6.1	124.4 ± 5.3	121.3 ± 4.8	119.7 ± 3.9	108.9 ± 4.3
Cortisol, nmol/l	167.4 ± 7.5	147.5 ± 6.2	152.8 ± 7.1	134.3 ± 6.4	131.1 ± 5.8	122.9 ± 4.7
E2, pmol/l	31.7 ± 1.6	29.4 ± 2.8	34.3 ± 2.3	30.9 ± 1.8	32.2 ± 1.1	34.5 ± 1.3
P4, nmol/l	0.74 ± 0.06	0.76 ± 0.03	0.51 ± 0.04	0.44 ± 0.03	0.69 ± 0.04	0.54 ± 0.05 ¹
T4, pmol/l	11.7 ± 0.3	11.4 ± 0.4	10.2 ± 0.4	9.2 ± 0.3	8.9 ± 0.2	9.1 ± 0.3
T3, nmol/l	4.5 ± 0.1	4.3 ± 0.2	4.3 ± 0.2	4.2 ± 0.1	4.3 ± 0.2	4.4 ± 0.2

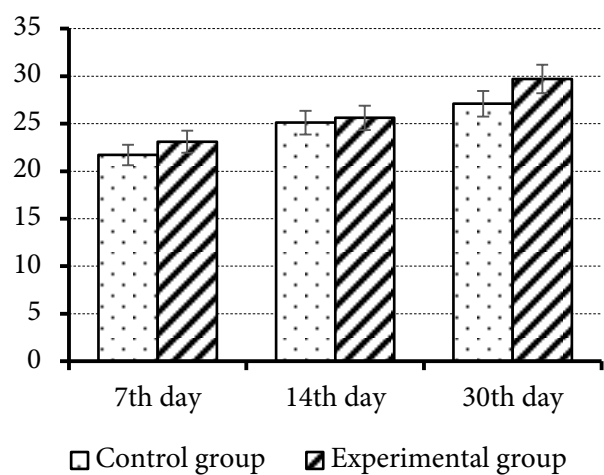
Notes: ¹ — P < 0.05 statistically significant changes compared to the control group.



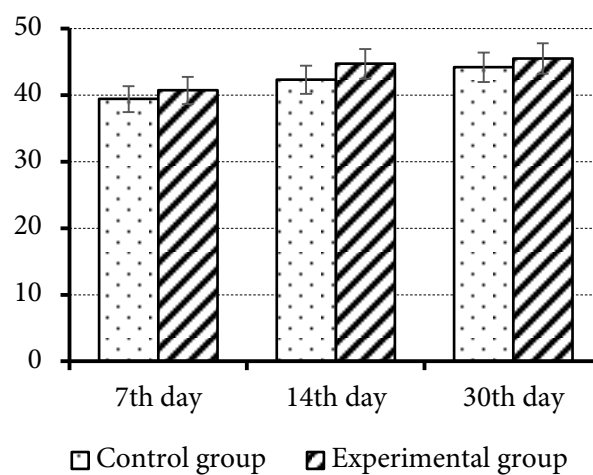
A



B

Figure 5. Bactericidal (A) and lysozyme (B) activity of blood serum of female dogs during the experiment.

A



B

Figure 6. Phagocytic activity of neutrophils (A) and phagocytic index (B) in female dogs during the experiment.

In general, the established decrease in the activity of hepatospecific enzymes in female dogs in the postpartum period under the influence of PCV reflects the multifactorial protective effect of biologically active components on liver, since this period is characterized by a pronounced metabolic restructuring, increased lipolysis, transient hyperketonemia, increased production of ROS and cytokines, which creates conditions for subclinical

damage to hepatocytes, against the background of which a moderate violation of the integrity of cell membranes leads to the release of ALT, AST and other enzymes into the systemic bloodstream (Loupit et al., 2020; Prata et al., 2025). PCV has pronounced antioxidant properties, which are realized through direct binding of free radicals, inhibition of lipoperoxidation processes, and restoration of the activity of endogenous enzymatic systems of

antioxidant defense (Tabeshpour et al., 2018; Lyu et al., 2021). A decrease in the level of TBA-P and LHP reduces damage to the phospholipid layer of hepatocyte membranes, which leads to a decrease in the intensity of cytolysis and, accordingly, to a decrease in the concentration of liver enzymes in blood serum (Sapian et al., 2022).

An additional mechanism is the anti-inflammatory effect of polyphenols, manifested by the suppression of pro-inflammatory cytokine expression and reduction of the systemic inflammatory response characteristic of the early postpartum period. This reduces cytokine-induced liver tissue damage and contributes to normalising biochemical parameters (Laurent et al., 2012). PCV is known to improve microcirculation in the liver, increase the efficiency of sinusoidal blood flow, and activate detoxification enzymes, thereby reducing the hypoxic and metabolic stress experienced by hepatocytes. Furthermore, PCV mitigates the severity of fatty liver infiltration, which is common during lactation, thereby reducing the extent of lipotoxic cell damage (Charradi et al., 2014). Thus, the decrease in the activity of hepatospecific enzymes in postpartum female dogs under the influence of PCV is due to the combined antioxidant, membrane-stabilizing, anti-inflammatory, and metabolic protective effect aimed at preventing cytolysis and restoring the functional state of the liver.

The absence of significant changes in the level of thyroid hormones and E2 with a simultaneous tendency to reduce cortisol, insulin, and, to a lesser extent, progesterone under the influence of PCV reflects the selectivity of its effect on endocrine regulation. The obtained data are consistent with the known mechanisms of action of polyphenols, which mainly affect the stress-reactive, metabolic, and inflammatory links, but do not interfere with the hypothalamic-pituitary-thyroid and hypothalamic-pituitary-gonadal axes (Khadher et al., 2022; Navarro-Masip et al., 2023). The stability of thyroid hormones and estradiol is explained by the fact that polyphenols do not have a direct thyrotropic or estrogen-modulating effect — their effect on peripheral metabolism is limited to antioxidant and anti-inflammatory effects that do not affect the synthesis of T4, T3 and E2, which is regulated mainly by central mechanisms and the state of the ovaries, in particular in bitches in the postpartum period these hormones are physiologically stabilized, and the absence of their changes under the influence of the complex confirms its safety with respect to the main endocrine axes (Chen et al., 2022).

The trend towards a decrease in cortisol reflects a decrease in systemic stress and inflammatory load, as it is known that polyphenols reduce the production of pro-inflammatory cytokines and reduce the intensity of oxidative stress, which leads to a weakening of the stimulation of the hypothalamic-pituitary-adrenal axis, as a result of which the need to maintain an elevated level of cortisol, characteristic of early postpartum period, which is accompanied by lactation load, inflammatory changes in the uterus and metabolic restructuring,

decreases. The decrease in insulin during the experiment is associated with an improvement in tissue sensitivity to insulin and a decrease in the severity of postpartum insulin resistance, because the antioxidant and anti-inflammatory properties of polyphenols reduce the effect of cytokines and lipoperoxidation products on insulin receptors, improve glucose transport, and reduce the need for compensatory hyperinsulinemia. An additional factor is the normalization of lipid metabolism and the reduction of hepatic steatosis, which also contributes to the restoration of insulin sensitivity (Campos et al., 2021; Ferrier et al., 2022).

The slight decrease in progesterone is explained by its physiological decline in the postpartum period and the lack of a stimulating effect of the complex on luteal structures. Polyphenols do not interfere with steroidogenesis, but their anti-inflammatory effect can accelerate uterine recovery and reduce peripheral need for progestogenic effects, which is manifested in a tendency to reduce hormone levels. Therefore, the detected changes reflect the predominant effect of PCV on stress-induced and metabolic components of endocrine regulation while maintaining the stability of the main hormonal axes (Mei et al., 2021; Kuljarusnont et al., 2024).

The tendency towards improved immune defense in PCV-treated female dogs reflects the immunomodulatory effect of polyphenols, aimed primarily at strengthening the innate link — these changes are consistent with the known biochemical effects of proanthocyanidins, catechins and resveratrol, which do not stimulate the immune system, but normalize its activity by reducing inflammatory stress, improving antioxidant status and normalizing phagocyte functions (Apostolou et al., 2013; Prata et al., 2025). The increase in bactericidal and lysozyme activity of blood serum during the experiment is due to the fact that polyphenols reduce the level of lipoperoxidation products and stabilize protein structures involved in humoral defense. Lysozyme and complement components are particularly sensitive to oxidative damage characteristic of the postpartum period, and the reduction of oxidative stress under the influence of the complex leads to the restoration of their functional activity, which is manifested by an increase in bactericidal and lysozyme activity of blood serum. The increase in neutrophil phagocytic activity and phagocytic index is explained by the improvement of the metabolic state of phagocytes, since polyphenols increase the efficiency of mitochondrial respiration, reduce the accumulation of ROS inside cells and prevent neutrophil depletion that occurs during chronic inflammation and lactation stress, as a result of which phagocytes demonstrate a higher ability to absorb and destroy microbial particles (Massot-Cladera et al., 2014; Magrone et al., 2019).

An additional mechanism is the reduction of cortisol levels, which has a pronounced immunosuppressive effect. The reduction in cortisolemia under the influence of PCV leads to a partial restoration of the activity of innate immunity, which is especially noticeable in

relation to the phagocytic link, and the reduction in insulin levels and improvement of tissue sensitivity to it also contribute to the normalization of neutrophil functions, since hyperinsulinemia and insulin resistance are associated with inhibition of phagocytosis. Taken together, the data obtained indicate that PCV has a positive effect on the restoration of antioxidant balance, improvement of liver function, reduction of stress-induced endocrine shifts, and strengthening of innate immunity in postpartum female dogs.

Conclusions. As a result of the study, the biological activity of the polyphenolic complex *Vitis vinifera* L. (PCV) was established when it was applied to the bodies of female dogs in the postpartum period:

1. The use of PCV was accompanied by a pronounced improvement in antioxidant status, which was manifested by a decrease in the intensity of lipoperoxidation processes and the restoration of the activity of endogenous antioxidant systems.

2. Against the background of normalization of free radical metabolism, a decrease in the activity of hepatospecific enzymes was noted, which reflects a

decrease in the degree of cytolytic damage to hepatocytes and an improvement in the functional state of the liver.

3. The hormonal background of female dogs remained stable in terms of thyroid hormones and estradiol, which confirms the absence of PCV effect on the main endocrine axes. At the same time, a tendency toward decreased cortisol, insulin, and, to a lesser extent, progesterone was observed, which may be associated with reduced systemic inflammation, reduced metabolic stress, and a partial restoration of tissue sensitivity to insulin.

4. Immunological indicators showed positive dynamics: a tendency to increase the bactericidal and lysozyme activity of serum, as well as an increase in the phagocytic activity of neutrophils and the phagocytic index was noted. These changes reflect the normalization and optimization of innate immunity, due to reduced oxidative and inflammatory stress and improved functional state of immunocompetent cells under the action of PCV.

Declaration of competing interest. The authors declare that they have no conflict of interest.

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