

EFFECT OF SOWS' CONDITION ON MORPHOLOGICAL AND BIOCHEMICAL BLOOD INDICATORS

WPŁYW KONDYCJI LOCH NA WSKAŹNIKI MORFOLOGICZNE I BIOCHEMICZNE KRWI

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ABSTRACT

The aim of the study was to determine the effect of sows' condition, being expressed as fat reserve – the mean from two measurements ($P_2 + P_4$)/2 on the 104th day of pregnancy ($\pm 2 - 3$ days) on hematological indicators in blood of PLW x PL sows. Classification of sows into two groups was performed on the basis of lifetime evaluation of backfat thickness in 97 sows (primiparous: multiparous – 30%:70%); group I consisted of the sows with $(P_2 + P_4)/2 > 20$ mm and group II with $(P_2 + P_4)/2 \leq 20$ mm. The condition of sows, as expressed by backfat thickness in three dates (late pregnancy, parturition, weaning) amounted to $> 3,5$ for group I and ≤ 2.5 for group II on a 5-point scale. The examination of hematological indicators was performed on a representative group of 32 randomly chosen sows, 16 animals from each group. Blood for analyses was sampled from the sows on the 104th day of pregnancy and on the 21st day of lactation. Any significant differences between group I and II in respect of morphological indices, excluding significantly higher MCV in sows from group I vs. II on the 21st day of lactation ($P \leq 0.05$), were not found. In late pregnancy, significant differences were recorded for the content of ALB and TP ($P \leq 0.05$), BUN ($P \leq 0.01$), HDL ($P \leq 0.001$) and in final stage of lactation – HDL ($P \leq 0.01$) (higher in group I vs. II). The mean values of the studied blood indicators of the sows were found within the standards for the species, production group and stage of reproduction cycle, irrespectively of the condition of the females.

Keywords: sows, condition, late pregnancy, lactation, blood indicators

STRESZCZENIE

Celem badań było określenie wpływu kondycji loch, wyrażonej rezerwą tłuszczu w ciąży wysokiej – średnią z dwóch pomiarów $(P_2 + P_4)/2$ (104 dni $\pm 2-3$ dni), na wskaźniki hematologiczne krwi loch mieszańców PBZ x WBP. Lochy (97 sztuk; pierwiastki : wieloródki – 30%:70%) podzielono na dwie grupy na podstawie przyżyciowego badania grubości słoniny; do grupy I zaliczono lochy z $(P_2 + P_4)/2 > 20$ mm, a do grupy II z $(P_2 + P_4)/2 \leq 20$ mm. Kondycja loch, określona na podstawie

pomiarów grubości słoniny w trzech terminach (ciąża późna, oproszenie, odsadzenie) wynosiła $>3,5$ dla grupy I i $\leq 2,5$ dla grupy II, w 5 punktowej skali. Badania morfologiczne i biochemiczne krwi wykonano u losowo wybranych 32 loch, po 16 sztuk z grupy. Krew do analiz pobierano od loch w 104 dniu ciąży i 21 dniu laktacji. Nie stwierdzono istotnych różnic między grupami I i II we wskaźnikach morfologicznych krwi, za wyjątkiem istotnie większej MCV u loch z grupy I vs II w 21 dniu laktacji ($P \leq 0,05$). W ciąży wysokiej istotnie różniły się: zawartość ALB i TP ($P \leq 0,05$), BUN ($P \leq 0,01$), HDL ($P \leq 0,001$), a w końcowej fazie laktacji HDL ($P \leq 0,01$) (wyższe wskaźniki w grupie I vs II). Średnie wartości badanych wskaźników morfologicznych i biochemicznych krwi loch mieściły się w granicach normy dla gatunku, grupy produkcyjnej i fazy cyklu reprodukcyjnego, niezależnie od kondycji samic.

Słowa kluczowe: lochy, kondycja, ciąża wysoka, laktacja, wskaźniki krwi

DETAILED ABSTRACT

Celem badań było określenie wpływu kondycji loch, wyrażonej rezerwą tłuszczu w ciąży wysokiej – średnią z dwóch pomiarów $(P2 + P4)/2$ (104 dni $\pm 2-3$ dni), na wskaźniki hematologiczne krwi loch mieszańców F1 ras Polska Biała Zwistoucha x Wielka Biała Polska. Pomiar grubości słoniny w punktach P2 i P4 (3 i 8 cm od linii grzbietu, na wysokości ostatniego kręgu piersiowego) wykonano aparatem Pig-log 105 u loch w ciąży wysokiej, przy oproszeniu i w 21 dniu laktacji. Lochy (97 sztuk; pierwiastki : wieloródki – 30%:70%) podzielono na dwie grupy na podstawie przyżyciowego badania otłuszczenia; do grupy I zaliczono lochy z $(P2 + P4)/2 > 20$ mm, a do grupy II z $(P2 + P4)/2 \leq 20$ mm (I vs II - $P \leq 0,001$). Kondycja loch, określona grubością słoniny w trzech terminach (ciąża późna, oproszenie, odsadzenie) wynosiła $>3,5$ dla grupy I i $\leq 2,5$ dla grupy II w 5 punktowej skali. Żywienie i utrzymanie loch w eksperymencie było ujednolicone [1, 2, 14].

Badania morfologiczne i biochemiczne krwi wykonano u losowo wybranych 32 loch, po 16 sztuk z grupy. Krew do analiz pobierano od loch w 104 dniu ciąży i 21 dniu laktacji. W krwi pełnej oznaczano: stężenie hemoglobiny (HB), liczbę krwinek czerwonych (RBC), liczbę krwinek białych (WBC), hematokryt (HCT), średnią objętość krwinki czerwonej (MCV), liczbę krwinek płytkowych (PLT) (analyzer hematologiczny ABACUS firmy Diatron). Oznaczano skład białokrwinkowy, liczbę granulocytów obojętnochłonnych, kwasochłonnych i zasadochłonnych oraz limfocytów i monocytów. W surowicy krwi oznaczano: albuminę (ALB), glukozę (GLU), azot mocznika (BUN), białko całkowite (TP), fosfatazę zasadową (ALP), cholesterol całkowity (CHOL), triglicerydy (TRIG), frakcje lipoprotein o wysokiej, niskiej i bardzo niskiej gęstości (HDL, LDL, VLDL) (metoda tzw. suchej chemii; aparat VITROS DT 60 II System, zestawy diagnostyczne ICN Instruments Polska Sp. z o.o.). Zebrane wyniki opracowano statystycznie; wykonano jednoczynnikową analizę wariancji z zastosowaniem metody najmniejszych kwadratów [18].

Nie stwierdzono istotnych różnic między grupami I i II we wskaźnikach morfologicznych krwi, za wyjątkiem istotnie większej MCV u loch z grupy I vs II w 21 dniu laktacji ($P \leq 0,05$). W ciąży wysokiej istotnie różniły się: zawartość ALB i TP ($P \leq 0,05$), BUN ($P \leq 0,01$), HDL ($P \leq 0,001$), a w końcowej fazie laktacji HDL ($P \leq 0,01$) (wyższe wskaźniki w grupie I vs II). Średnie wartości badanych wskaźników morfologicznych i biochemicznych krwi loch mieściły się w granicach normy dla gatunku, grupy produkcyjnej i fazy cyklu reprodukcyjnego, niezależnie od kondycji samic.

INTRODUCTION

Values of morphological and biochemical blood indicators of animals are dependent on the species, sex, age, condition, diseases, nutrition and maintenance conditions [3, 4, 6, 8, 11, 12, 21]. Some researchers indicate, however, a lack of effect of breed and gender on blood parameters [13]. The level of haematological indicators may be affected by condition, dependent on the nutrition state and the accumulated protein and fat reserves in animal body. Optimum condition of the utilized sows during the successive stages of reproduction cycle should be found on the following level: 3.0 points – mating and pregnancy; 3.5 points – pregnancy and parturition; 2.5 points – weaning on a 5-point scale [16]. In sows, due to a naturally occurring subcutaneous fat, it is recommended to perform lifetime measurements of backfat thickness and their practical utilization in evaluation of their condition. Three points on the scale correspond to backfat thickness in point P_2 from 18 to 20 mm [16].

The aim of the work was to determine the effect of the condition of the sows in late pregnancy on morphological and biochemical blood indicators.

MATERIAL AND METHODS

The experiment was conducted in May and June on sows living in one farm. The unified maintenance conditions matched the welfare requirements. The results of production analysis have already been published in Beyga and Rekiel [2].

Animals and experimental design

The experiment included two groups of sows – crossbreds of Polish Large White x Polish Landrace (PLW x PL) (97 animals); participation of multiparous and primiparous sows amounted to 70 and 30%, respectively. The sows were divided into groups on the 104th day of pregnancy ($\pm 2-3$ days) on the basis of arithmetic mean backfat thickness – $(P_2 + P_4)/2$. It was calculated on the basis of the results of ultrasound measurements of fatness in two points, i.e. P_2 and P_4 (over the last rib, 3 and 8 cm from the dorsal midline); ultrasound device Pig-log 105. Group I included the sows for which $(P_2 + P_4)/2 > 20$ mm and group II – the females with $(P_2 + P_4)/2 \leq 20$ mm. The condition of the sows, being expressed as the mean backfat thickness was determined three times, i.e. on the 104th day of gestation, at parturition and after the completed lactation (at weaning on the 21st day). According to the assumptions, the

mean fatness of the sows from the compared groups, at three examined dates, differed significantly ($P \leq 0.001$); it amounted to 26.19, 24.91 and 21.60 mm, respectively, for group I (what corresponded to >3.5 points) and 15.24, 16.25 and 12.29 mm respectively, for group II (what corresponded to ≤ 2.5 points) in 5-point scale of sow condition evaluation [16].

The sows were fed a complete diet (12.7 MJ ME/ kg, 17% protein, 1% lysine) [1] in accordance with Polish Swine Nutrition Requirements [14]. Feed was administered twice during pregnancy and three times a day during lactation.

Blood indicators

Blood for analyses was sampled from the sows on the 104th day of pregnancy (late pregnancy – LP) and on the 21st day of lactation (lactation – L). It was collected from the *v. cava cranialis* from 16 sows from each group, before morning feeding. Firstly, test tubes with anticoagulant (EDTA) were taken to collect blood for morphological tests. In this part, the following blood indicators were measured: haemoglobin concentration (HB), red blood cells count (RBC), white blood cells count (WBC), haematocrit (HCT), mean corpuscular volume (MCV) and number of platelets (PLT). Determinations were performed in haematological analyzer ABACUS of Diatron Company. In the leukogram, the percentage of neutrophilic, acidophilic and basophilic granulocytes and of lymphocytes was determined. Secondly, clean test tubes were taken to collect blood for biochemical analyses. In this part of the experiment blood was centrifuged at 3500 rpm for 10 minutes. In blood serum, the following biochemical indicators were determined: albumin (ALB), glucose (GLU), urea nitrogen (BUN), total protein (TP), alkaline phosphatase (ALP), total cholesterol (CHOL), triacylglycerides (TRIG), fractions of lipoproteins with high, low and a very low density (HDL, LDL, VLDL). Determinations were performed by the method with the VITROS DT 60 II System, using the diagnostic kits of ICN Instruments Polska Ltd.

Statistical analysis

The results were analyzed statistically by one-way analysis of variance using the last-squares method. Calculations were made using the SPSS 12.0 statistical package [18].

RESULTS AND DISCUSSION

Any significant differences in morphological blood indicators in the sows from group I and II were not found during the period of late pregnancy and on the 21st day of lactation, excluding significantly higher MCV value in the sows from group I vs. II at the second sampling (Table 1).

Insignificantly higher content of HB in blood of the sows from group I vs. II, as found in the own studies, might result from the greater fat reserves in the body of the females from the group I. According to Žvorc et al. [21] higher values of certain

Table 1. Morphological blood indicators of sows
Tabela 1. Wskaźniki morfologiczne krwi loch

Indicators Wskaźniki	LP		SEM	L		SEM	
	I	II		I	II		
	Erythrocytes, 10 ¹² /l Erytrocyty, 10 ¹² /l	5.33		5.59	0.159		5.32
Haematocrit, l/l Hematokryt, l/l	0,32	0,32	0.007	0,32	0.31	0.007	
Mean corpuscular volume, fl Objętość krwinki czerwonej, fl	61.00	57.88	0.784	59.69	56.75*	0.641	
Hemoglobin, mmol/l Hemoglobina, mmol/l	6.78	6.68	0.280	6.92	6.77	0.136	
Leukocytes, 10 ⁹ /l Leukocyty, 10 ⁹ /l	13.04	13.56	0.512	14.04	14.14	0.502	
Leukogram, % Leukogram, % Neutrophil granulocytes Granulocyty obojętne	Rod-like Pałeczkowate	1.36	1.69	0.340	1.94	1.75	0.316
	Segmented Segmentowane	51.50	53.06	2.533	59.62	57.00	1.764
	Eosinophils Eozynofile	3.21	2.81	0.398	2.75	3.50	460
	Bazophils Bazofile	0.00	0.00	0.000	0.00	0.06	0.031
Lymphocytes Limfocyty	43.93	42.44	2.478	35.69	37.69	1.968	
Platelets, 10 ⁹ /l Płytki krwi, 10 ⁹ /l	152.57	206.38	15.696	261.56	258.06	16.166	

*Means differ statistically significantly at P≤0.05; SEM – standard error of mean.

* Średnie statystycznie istotne przy P≤0.05; SEM - błąd standardowy średniej.

Group I – (P₂+P₄)/2>20 mm; Group II – (P₂+P₄)/2≤20 mm.

Grupa I – (P₂+P₄)/2>20 mm; Grupa II – (P₂+P₄)/2≤20 mm.

LP - Late pregnancy (104th day); L - Lactation (21st day).

LP – Ciąża późna (104 dzień); L - Laktacja (21 dzień).

morphological indicators are explained by greater reserves of lipids in organism. Irrespectively of the fatness of the sows, the level of haemoglobin is lowered during lactation, and its concentration amounts averagely to 7,44 mmol/l [21].

Reese et al. [15] did not find any effect of energy intake together with the feed on haematocrit value but they observed its differentiation between pregnancy and lactation.

The results of the present study in relation to haematological indicators in the sows are supported by literature data [6]. In pregnancy RBC is lowered and continues to decline until the end of lactation [4, 6]. Literature concerning on the subject reports slightly different relationships and namely lower values of RBC, HB, HCT and MCV in the pregnant sows as compared to the suckled females [21]. It is connected with the mother's HB mobilization to blood circulation of the fetuses; it is also a result of the dilution of plasma, the quantity of which is increased during the discussed period.

The own results for leukocytes and leukogram were consistent with the reference values, standard for the species, sex and physiological state and with the results, obtained in the studies with the pregnant and suckled sows [3, 6, 20, 21]. They confirm good health state and proper condition of the sows. Literature data indicate also that the number of leukocytes in the suckled sows remained on the constant level [5, 21].

The results of the present study show that in pregnant sows from group I and II, differences in biochemical indicators were found (Table 2). On the 21st day of lactation, somewhat higher values of indicators were also found in the sows from group I vs. II.

Optimal level of biochemical indicators is specified in standards [20]. Their values indicate the level of metabolic changes. They are most frequently studied in growing pigs e.g. with different rate of protein depositing [11, 12] and also, in the ones utilized for reproduction or subjected to stressors' effect [9, 10]. The evaluation focuses on the biochemical indicators in the sows and their levels depending on the employed nutrition [3]. The effect of the condition of females on haematological indicators, however, is not too often the subject of the studies and available literature is scarce. Elbers et al. [5] and Revell et al. [17] did not find any differences in glucose level between the groups of sows with different fat reserves.

The level of nutrition affects the reserves of protein and fat in the body; therefore, the blood indicators are studied in pigs. Weldon et al. [19] did not find any differences in glucose concentration, when feeding the sows in lactation period – in a restrictive way or *ad libitum*. A different content of protein, administrated in feed during lactation, did not cause changes in the level of glucose in the suckled sows [17].

ALB and TP level was relatively stable in the groups and stages of reproduction cycle (lower levels of ALB and TP in group II vs. I for pregnant sows, $P \leq 0.05$). During the late pregnancy, the level of BUN in group I vs. II was higher by 14.2% ($P \leq 0.01$),

Table 2. Biochemical indicators in blood serum of the sows

Tabela 2. Wskaźniki biochemiczne w surowicy krwi loch

Indicators Wskaźniki	LP		SEM	L		SEM
	I	II		I	II	
ALB - albumin, g/l Albumina, g/l	43.13	39.71*	0.679	41.06	39.88	0.586
GLU - glucose, mmol/l Glukoza, mmol/l	3.74	3.55	0.119	2.78	2.76	0.138
BUN – urea nitrogen, mmol/l Azot mocznika, mmol/l	5.02	4.31**	0.120	4.17	3.93	0.123
TP – total protein, g/l Białko całkowite, g/l	71.00	65.29*	1.259	67.00	66.76	1.047
ALP – alkaline phosphatase, U/l Fosfataza alkaliczna, U/l	55.71	51.65	3.088	65.08	49.20	7.029
TRIG – total triglyceride, mmol/l Triglicerydy, mmol/l	0.66	0.66	0.530	0.36	0.38	0.018
CHOL - cholesterol, mmol/l Cholesterol, mmol/l	2.11	1.88	0.061	1.89	1.75	0.065
HDL - high-density lipoprotein fraction, mmol/l Fracja lipoprotein o wysokiej gęstości – mmol/l	0.95	0.74***	0.024	0.88	0.72**	0.026
VLDL - very low-density lipoprotein fraction, mmol/l Fracja lipoprotein o bardzo niskiej gęstości, mmol/l	0.26	0.26	0.021	0.15	0.15	0.007
LDL - low-density lipoprotein fraction, mmol/l Fracja lipoprotein o niskiej gęstości, mmol/l	0.89	0.85	0.048	0.79	0.85	0.053

*Means differ statistically significantly at $P \leq 0.05$; **Means differ statistically significantly at $P \leq 0.01$; ***Means differ statistically significantly at $P \leq 0.001$.

* Średnie statystycznie istotne przy $P \leq 0.05$; ** Średnie statystycznie istotne przy $P \leq 0.01$;

*** Średnie statystycznie istotne przy $P \leq 0.001$.

SEM – standard error of mean.

SEM - błąd standardowy średniej.

Group I – $(P_2+P_4)/2 > 20$ mm; Group II – $(P_2+P_4)/2 \leq 20$ mm.

Grupa I – $(P_2+P_4)/2 > 20$ mm; Grupa II – $(P_2+P_4)/2 \leq 20$ mm.

LP - Late pregnancy (104th day); L - Lactation (21st day).

LP – Ciąża późna (104 dzień); L - Laktacja (21 dzień).

between the groups of the sows, any statistically confirmed differences after 21 days of lactation were not found. This could be a result of different intensity of biochemical processes in various stages of reproduction cycle.

The changes in metabolic profile, represented by the lowering of TP, BUN and GLU below the standard, with the simultaneous distinct increase of AST and ALT activity and a very high level of total bilirubin and ALP in the sows indicate the deficit of protein and carbohydrates in feed and the accompanying necrotic phenomena [7]. This may be caused by toxic factors or be a result of kachetic action of cytokines. Action of the two above mentioned factors may bring change of tissue metabolism into catabolism [7]. Such changes were not found in the sows covered with the own studies.

Alkaline phosphatase activity (ALP) in gilts and sows should amount to 115-434 and 36-272 U/L, respectively [6]. Values for pigs, as specified in Polish reference requirements are equal to 92 – 294 U/L; physiological increase of ALP activity occurs in pregnancy [20]. In the own studies, ALP activity was consistent with the American standards [6].

The condition of the sows, being expressed by backfat thickness and defined in three periods (late pregnancy – parturition – weaning) was deviated from the optimum level (2.5 – 3.5 points); group I vs. II differed in the backfat thickness. Its effect on morphological blood parameters was not, however, found, excluding MCV. Values of biochemical indicators were lower in group II vs. I for most of the indicators; significantly for ALB, BUN, TP and HDL (late pregnancy) and HDL only (lactation).

CONCLUSION

The mean values of the studied blood morphological indicators and biochemical blood serum parameters of the sows were found within the standards for the species, production group and stage of reproduction cycle, irrespectively of the condition of the females.

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