

Changes in chosen blood plasma biochemical parameters in growing pigs

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The researches included Polish Landrace (PL) breed pigs and Polish Large White (PLW) x PL and PLW x Duroc crossbreds. During the fattening season, blood was collected for biochemical analyses four times. Blood plasma was examined to determine the content of total protein, albumin, creatinine, urea, uric acid, total bilirubin, cholesterol, triglycerides and glucose as well as a level of indicator enzymes of the enzymatic profile, i.e. LDH, GGT, CK, AST and ALT. The present studies have revealed a correlation between the biochemical parameters determined and animal age. The PL pigs showed an increased level of blood metabolic activity. The most stable level of the analyzed parameters was recorded in PLW x PL pig crossbreds.

KEY WORDS: pig / age / biochemical parameter / plasma

Intensive fattening of currently utilized swine breeds necessitates identification of the most possible determinants of porker fattening value. Numerous authors state that knowledge of blood biochemical parameters that reflect metabolism intensity of growing organisms proves to be one of the basic tools to evaluate the effect of factors aiming at animal performance improvement [1, 6, 8]. That arises from a number of interactions between the factors influencing the fattening outcomes, like breed, age, nutrition and the basic elements of protein, lipid, carbohydrate and enzymatic metabolism [7]. Therefore, occurrence of significant deviations of blood biochemical parameters may be indicative of adverse metabolic processes that have a negative impact on standard daily weight gains.

Material and Methods

The investigations were conducted in a private farm of mean 70 gilts in a basic herd. The studies included 24 clinically healthy young boars and gilts (1:1 sex rate) obtained from the 2 and 3 litter of PL breed (n=8) and crossbreds after PLW x PL (n=8)

and PLW x Duroc breeds. All the animals were free from stress susceptibility, with RYR1^{CC} genotype identified by PCR-RLFP technique according to Fuji et al., method [3]. The porkers were fed full ration diet *ad libitum* (Tab. 1) and maintained in straw-bedded deep litter in the chamber equipped with natural-mechanical ventilation at mean stock of 100-120 animals per chamber (mean pen area 0,3-0,5 m²/unit). Piglets on 3 and 13 day of age were supplied with iron preparations in compliance with the prophylaxis program.

Table 1 - Tabela 1

Composition and nutritive value of feed mixtures

Zawartość składników pokarmowych w 1 kg mieszanki dla tuczników

Specification Wyszczególnienie	Contents Zawartość
Metabolizable energy (MJ)	12.3
Energia metaboliczna (MJ)	
Total protein (%)	14.50
Białko ogólne (%)	
Crude fibre (%)	6.00
Włókno surowe (%)	
Crude ash (%)	2.8-4.8
Popiół surowy (%)	
Crude fat (%)	3.10-5.10
Tłuszcz surowy (%)	
Ca (%)	0.50
P (%)	0.18
Na (%)	0.14
Lizyne (%)	0.77
Lizyna (%)	
Methionine (%)	0.25
Metionina (%)	
Methionine + Cystein : (%)	0.49
Metionina + cysteina : (%)	
Tryptophan (%)	0.16
Tryptofan (%)	
Threonine (%)	0.51
Treonina (%)	

The studies commenced in 7 week of piglet life, at 7.5 kg body weight and slaughtered having reached mean body weight of 102 kg. Blood samples for biochemical analyses were taken always at the same time of day, in 7 and 11 week after animal's introduction to the fattening facility and in 18 and 23 week of animal age, that is 4 days prior to slaughter. To minimize the impact of stress on animals, blood collection was carried out in a separate room within 22 seconds (from approaching an animal, its immobilization to procedure completion).

Blood was taken from the jugular vein (*vena jugularis*) to 4.9 ml test tubes S-Monovette (Sarstedt AG&Co., Numbrecht, Germany). Blood plasma was examined to determine a content of total protein, albumin, creatinine, urea, uric acid, total bilirubin,

cholesterol and triglycerides as well as enzymatic profile parameters, i.e. lactic dehydrogenase (LDH), gamma-glutamyltransferase (GGT), creatine kinase (CK), asparagine aminotransferase (AST) and alanine (ALT) using an analyzer YITROS 5.1 FS (Ortho Clinical Diagnostics, Johnson & Johnson Company, USA). Full blood, immediately after collection, was examined to determine a glucose level by a glucometer (Acu Check).

The determination results were summarized in the tables, mean arithmetic (\bar{x}) was given with standard deviation (SD). A level of the analyzed parameters in each series was compared statistically with the ANOVA model using the Statistica v. 6.0 packet.

Results and Discussion

The present researches showed substantial fluctuation of protein metabolic values as well as hepatic enzyme profile in all the pigs. Irrespectively of a genotype of animals, there was observed increased total protein level, including albumins, in blood plasma during the fattening season (Tab. 2). The PL breed pigs were characterized by its highest value (8.7 g/dl) in 23 week of age (Tab. 5). As for urea concentration, it was highest at the fattening period end - mean 30 mg/dl for all the animals (Tab. 2) and 29 mg/dl in the purebred PL pigs (Tab. 5) and 31 mg/dl in PLW x Duroc crossbreds (Tab. 4).

A change of feedstuff type and zoohygienic conditions associated with regrouping and transportation of the animals to the fattening facility caused differences in the blood biochemical profile. The level of some biochemical parameters surpassed the reference values [11] that indicate the burden of liver due to feeding regime change, that is, the transition to feeds appropriate for fatteners. Besides, there was observed a characteristic rise of a total cholesterol level with a concomitant creatinine decline after animal transportation to the fattening unit. Despite increasing cholesterol concentration noted over the further fattening period, marked divergences between animals did not confirm the statistical differences. Only PL breed pigs and PL x Duroc crossbreds showed a constant rise of cholesterol level at $P \leq 0.01$. At the end of the fattening season, this variable obtained the maximal value - 115.1 mg/dl (Tab. 5) and 123.8 mg/dl (Tab. 4), respectively. Elevation of cholesterol content in 11 week of pig age implies some correlations arising from a change of feedstuff used for fatteners' nutrition.

Dietary protein deficit implicates a declined protein level in blood plasma. The present researches have revealed an increase of plasma protein that suggests an appropriate protein concentration in a diet. However, the further fattening stage was marked with elevated urea content in blood which might result from low biological value of protein supplied in feedstuff. Under such conditions, not all amino acids are utilized by organism so the response of enhanced deamination process is observed and urea is produced [4]. In the PL breed pigs, a significant rise of plasma urea concentration was reported as late as at the end of the fattening period when one of the highest levels was obtained. This fact is indicative of intensive deamination processes occurring in the liver or depressed capability of urea elimination through the kidneys.

Table 2-Tabela 2

Changes of biochemical parameters values in blood plasma during the fattening period
Średnie wartości parametrów biochemicznych w osoczu krwi wszystkich badanych świń w okresie tuczu

Parameter Wskaznik	Week of age - Tydzień życia							
	7		11		18		23	
	\bar{X}	SD	\bar{X}	SD	\bar{X}	SD	\bar{X}	SD
Total protein (g/dl)	nb	-	5.14 ^A	0.59	6.68 ^B	0.45	7.58 ^B	0.74
Białko całkowite								
Albumin (g/dl)	nb	-	2.06 ^A	0.41	3.01 ^B	0.55	3.48 ^B	0.29
Albumina								
Creatinine (mg/dl)	1.97 ^A	0.27	1.28 ^B	0.22	1.68	0.27	1.72 ^A	0.25
Kreatynina								
Urea (mg/dl)	24.00 ^A	3.00	24.94	3.43	25.33	2.96	30.00 ^A	2.65
Mocznik								
Uric acid (mg/dl)	0.50	0.05	0.52	0.07	0.48	0.09	0.50	0.01
Kwas moczowy								
Total bilirubin (mg/dl)	0.10	0.05	0.11	0.03	0.10	0.01	0.10	0.01
Bilirubina całkowita								
Cholesterol (mg/dl)	57.13 ^A	7.57	88.13 ^B	13.37	91.14 ^B	13.54	109.20 ^B	13.66
Triglycerides (mg/dl)	nb	-	39.44	19.20	25.45	10.31	37.32	11.23
Trojlicydy								
Glucose (mg/dl)	102.00 ^A	12.23	95.93 ^{AB}	9.57	81.50 ^B	8.42	65.40 ^C	8.76
Glukoza								
LDH (U/L)	nb	-	1671.75 ^A	172.97	2106.25 ^B	292.29	1706.60 ^A	293.64
GGT (U/L)	nb	-	38.19 ^A	9.88	44.50 ^A	9.68	75.20 ^B	18.02
CK (U/L)	nb	-	307.81 ^A	162.45	498.67	268.31	730.80 ^B	117.56
AST (U/L)	nb	-	43.00	9.36	50.50	10.96	48.80	18.87
ALT (U/L)	nb	-	75.56 ^A	8.89	72.50	20.63	61.80 ^B	8.61

Values denoted with the same letters differ significantly at $P \leq 0.05$ (a, b...) and $P \leq 0.01$ (A, B...)

Wartości oznaczone tymi samymi literami różnią się statystycznie dla $P \leq 0,05$ (a, b...) i $P \leq 0,01$ (A, B...)

nb - not evaluated - nie badano

During the fattening time, the PLW x Duroc crossbreds showed a significant ($P \leq 0.01$) decrease of triglyceride content (Tab. 4). The decline was most likely associated with impaired hepatic lipolysis process and lipogenesis stimulation in adipose tissue [9]. Migdał et al., [9] report that both, a level of cholesterol and lipids is dependent on a genotype and animal body weight.

Very high fluctuations were noted for glucose content in blood of the studied animals. It declined with age from 102 mg/dl in 7 week of age to 65.4 mg/dl at late fattening season ($P \leq 0.01$; Tab. 2). A lower fall was observed for the PL breed pigs (Tab. 5). The biochemical studies conducted by Gołębiowski et al., [5] demonstrated an increased glucose level in the PLW pigs only in the early age.

Table 3 - Tabela 3

Means of biochemical parameters values in blood plasma PLW x PL pig crossbreds during the fattening period

Średnie wartości parametrów biochemicznych w osoczu krwi świń mieszańców wbp x pbz w okresie tuczu

Parameter Wskaźnik	Week of age - Tydzień życia							
	7		11		18		23	
	\bar{X}	SD	\bar{X}	SD	\bar{X}	SD	\bar{X}	SD
Total protein (g/dl) Białko całkowite	nb	-	5.34 ^A	0.46	6.66 ^B	0.67	7.27 ^B	0.55
Albumin (g/dl) Albumina	nb	-	2.15 ^A	0.35	2.54 ^A	0.41	3.37 ^B	0.25
Creatinine (mg/dl) Kreatynina	2.01 ^A	0.30	1.30 ^B	0.28	1.78 ^A	0.36	1.60 ^B	0.26
Urea (mg/dl) Mocznik	24.29 ^A	3.35	25.00	3.21	26.40	2.97	30.00 ^A	3.61
Uric acid (mg/dl) Kwas moczowy	0.50	0.01	0.50	0.01	0.44	0.13	0.50	0.01
Total bilirubin (mg/dl) Bilirubina całkowita	0.10	0.01	0.10	0.01	0.10	0.01	0.10	0.01
Cholesterol (mg/dl)	56.89 ^A	8.94	92.09 ^B	10.13	85.98 ^B	18.28	102.37 ^B	13.38
Triglycerides (mg/dl) Trójglicerydy	nb	-	35.89	10.02	24.88	10.42	34.90	13.53
Glucose (mg/dl) Glukoza	107.75 ^A	14.09	95.75 ^B	9.56	78.20 ^B	5.81	62.33 ^B	7.37
LDH (U/L)	nb	-	1722.63	154.71	1988.00	410.06	1880.00	244.22
GGT (U/L)	nb	-	36.25 ^A	7.30	46.00 ^A	8.22	87.00 ^B	9.85
CK (U/L)	nb	-	312.25 ^A	156.15	283.40 ^A	171.46	714.33 ^B	105.46
AST (U/L)	nb	-	42.50	6.78	52.40	15.95	58.67	18.61
ALT (U/L)	nb	-	72.25	8.68	57.60	22.02	66.00	8.72

Values denoted with the same letters differ significantly at $P \leq 0.05$ (a, b...) and $P \leq 0.01$ (A, B...)

Wartości oznaczone tymi samymi literami różnią się statystycznie dla $P \leq 0,05$ (a., b...) i $P \leq 0,01$ (A, B...)

nb - not evaluated - nie badano

The enzymatic profile displayed substantial fluctuations. In all the animals, there was shown high (above the boundary limits) GGT activity, which along with individual development have gradually progressed to obtain the maximum value 75.2 U/l (Tab. 2). That time was also marked with elevating creatinine kinase level with its peak of mean 730.8 U/l recorded in all animals in 23 week of age; the lowest value 631 U/l in PLW x Duroc crossbreds (Tab. 4) and the highest 880 U/l for the PL pigs (Tab. 5).

During the fattening period, there was noted depressed activity of both transaminases (AST and ALT; Tab. 2) at varied intensity in the crossbreds. The most stable level of the analyzed parameters was reported for the PLW x PL pigs (Tab. 3).

Table 4 - Tabela 4

Means of biochemical parameters values in blood plasma PLW x Duroc pig crossbreds during the fattening period
Srednie wartosci parametrów biochemicznych w osoczu krwi świń mieszańców wbp x duroc w okresie tuczu

Parameter Wskaźnik	Week of age - Tydzień życia							
	7		11		18		23	
	\bar{X}	SD	\bar{X}	SD	\bar{X}	SD	\bar{X}	SD
Total protein (g/dl) Białko całkowite	nb	-	4.63 ^A	0.76	6.58 ^B	0.26	7.40 ^C	0.60
Albumin (g/dl) Albumina	nb	-	1.75 ^A	0.50	3.10 ^B	0.24	3.40 ^B	0
Crea inine (mg/dl) Kreatynina	2.10 ^A	0.29	1.25 ^B	0.21	1.60 ^B	0.04	1.90 ^A	0
Urea (mg/dl) Mocznik	22.25 ^A	1.50	25.75 ^A	4.19	25.25 ^A	3.06	31.00 ^B	2.08
Uric acid (mg/dl) Kwas moczowy	0.50	0.01	0.50	0.01	0.50	0.01	0.50	0.01
Total bilirubin (mg/dl) Bilirubina całkowita	0.10	0.01	0.10	0.01	0.10	0.01	0.10	0.01
Cholesterol (mg/dl)	62.43 ^A	5.08	94.20 ^B	11.34	92.05 ^B	5.62	123.80 ^C	3.90
Triglycerides (mg/dl) Trójlicerydy	nb	-	53.05 ^A	34.94	26.05 ^B	8.33	34.10 ^B	6.74
Glucose (mg/dl) Glukoza	98.50 ^A	6.40	104.00 ^A	6.56	88.50 ^B	9.11	62.00 ^C	3.23
LDH (U/L)	nb	-	1585.25 ^A	250.65	2187.50 ^B	87.76	1454.00 ^A	52.11
GGT (U/L)	nb	-	33.00 ^A	10.93	38.00 ^A	7.16	52.00 ^B	3.76
CK (U/L)	nb	-	348.50 ^A	136.32	712.25 ^B	248.26	631.00 ^B	149.83
AST (U/L)	nb	-	49.50 ^A	14.62	50.25 ^A	9.18	33.00 ^B	6.98
ALT (U/L)	nb	-	76.25 ^A	8.34	79.75 ^A	3.30	58.00 ^B	2.98

Values denoted with the same letters differ significantly at $P \leq 0.05$ (a, b...) and $P \leq 0.01$ (A, B...)

Wartości oznaczone tymi samymi literami różnią się statystycznie dla $P \leq 0,05$ (a., b...) i $P \leq 0,01$ (A, B...)

nb - not evaluated - nie badano

The investigations by Odink et al., [10] carried out on the Yorkshire x Landrace crosses indicated that a process of swine maturation contributes to a rise of protein, cholesterol and albumin content but a decline of alkaline phosphatase in blood plasma. The analyses show that a plasma protein level increased from 54.5 mmol/l in 8 week of age up to 61.7 mmol/l in 20 week of life, whereas an albumin content from 26.4 mmol/l up to 33.2 mmol/l. Cholesterol concentration growth, alike the present researches, was most pronounced in 12 week of age, i.e. from 1.87 mmol/l up to 2.65 mmol/l.

Table 5 - Tabela 5

Means of biochemical parameters values in blood plasma of PL pure breed pigs during the fattening period Średnie wartości parametrów biochemicznych w osoczu krwi świń rasy pzb w okresie tuczu

Parameter Wskaznik	Week of age - Tydzień życia							
	7		11		18		23	
	\bar{X}	SD	\bar{X}	SD	\bar{X}	SD	\bar{X}	SD
Total protein (g/dl) Białko całkowite	nb		5.28 ^A	0.43	6.83 ^B	0.25	8.70 ^C	0.14
Albumin (g/dl) Albumina	nb		2.18 ^A	0.35	3.67 ^B	0.15	3.90 ^B	0.09
Creatinine (mg/dl) Kreatynina	1.78 ^{AC}	0.10	1.28 ^B	0.10	1.63 ^A	0.25	1.90 ^C	0
Urea (mg/dl) Mocznik	25.25 ^A	3.30	24.00 ^A	3.92	23.67 ^A	1.15	29.00 ^B	1.87
Uric acid (mg/dl) Kwas moczowy	0.50	0.01	0.58	0.15	0.50	0.01	0.50	0.01
Total bilirubin (mg/dl) Bilirubina całkowita	0.10	0.01	0.13	0.05	0.10	0.01	0.10	0.01
Cholesterol (mg/dl)	52.28 ^A	3.56	85.00 ^B	3.19	98.53 ^C	11.96	115.10 ^D	9.87
Triglycerides (mg/dl) Trójglicerydy	nb	-	32.95	7.10	25.60	16.18	47.80	12.87
Glucose (mg/dl) Glukoza	94.00 ^A	7.35	90.25 ^A	8.77	77.67 ^B	7.09	78.00 ^B	3.92
LDH (U/L)	nb	-	1656.50 ^A	117.22	2195.00 ^B	249.09	1439.00 ^C	152.89
GOT (U/L)	nb	-	47.25 ^A	3.77	50.67 ^B	12.50	63.00 ^{Bb}	9.82
CK (U/L)	nb	-	258.25 ^A	116.98	572.67 ^B	171.45	880.00 ^C	98.21
AST (U/L)	nb	-	37.50 ^A	4.43	47.67 ^B	2.08	35.00 ^A	1.24
ALT (U/L)	nb	-	81.50 ^A	8.54	87.67 ^A	18.72	53.00 ⁸	6.84

Values denoted with the same letters differ significantly at $P \leq 0.05$ (a, b...) and $P \leq 0.01$ (A, B...)

Wartości oznaczone tymi samymi literami różnią się statystycznie dla $P \leq 0,05$ (a., b...) i $P \leq 0,01$ (A, B...)

nb - not evaluated - nie badano

Over the same period of time, there was reported a significant ($P < 0.01$) fall of AST and alkaline phosphatase. The other metabolites showed minor fluctuations. Similar tendencies were observed in the investigations carried out by Gołębiowski et al. [5], where the biochemical analysis showed growth of cholesterol concentration in blood plasma. This level proved to be highly positively correlated ($r=0.96$) with pig age. In the period between 27-70 days of the pig age there was reported low activity of aminotransferases, whereas after 120 day of life, the activity of both enzymes got compromised again.

High stocking density of animals (industrial farms), feeding based only on industrial feeds of inferior quality, animal regrouping, lack of exercise, automated service mode constitute the factors that may negatively affect animal health status. New high-stress

situations necessitate adaptation of all life processes, in that metabolism, to changeable conditions. Complete adaptation to the environment protects animals against diseases. Appropriately balanced diet is of great weight; mainly high quality feed materials are well matched. This fact has been confirmed in the present studies. A change of feed type and place of animals' living implicated significant differences in blood plasma biochemical composition. All the deviations recorded were indicative of the liver burden that might have resulted from changed nutrition. The present investigations revealed a correlation between the analyzed biochemical parameters and animal age. In the PL pigs, there was noted elevated metabolic activity of blood. The most stable level of the determined indices was observed in the PLW x PL crossbred pigs.

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Zmiany wartości wybranych wskaźników biochemicznych w osoczu krwi świń rosnących

Streszczenie

Badania przeprowadzono na świniami rasy pbz oraz mieszańcach wbp x pbz i wbp x duroc. W okresie tuczu czterokrotnie pobierano krew do analiz biochemicznych. W osoczu oznaczano poziom białka całkowitego, albuminy, kreatyniny, mocznika, kwasu moczowego, bilirubiny całkowitej, cholesterolu, trójglicerydów i glukozy, a także poziom enzymów wskaźnikowych profilu enzymatycznego, tj. LDH, GGT, CK, AST i ALT. Przeprowadzone badania wykazały zależność oznaczanych wskaźników biochemicznych od wieku zwierząt. U świń rasy pbz odnotowano podwyższony poziom aktywności metabolicznej krwi. Najbardziej stabilny poziom oznaczanych wskaźników stwierdzono u mieszańców wbp x pbz.