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The correlation between body weight, body weight gain and blood parameters in pigs at birth and weaning

[*A correlação entre peso corporal, ganho de peso corporal e parâmetros sanguíneos em suínos ao nascimento e desmame*]

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ABSTRACT

The aim of study was to determine the relationship between metabolic parameters, body weight and body growth of piglets at birth and weaning. The experiment included 80 piglets obtained from F1 generation sows. Body weight was measured at birth (BW0), 24h (BW1) after birth and on day 25 (at weaning, BW2). Blood sampling was performed at the beginning of life (3rd day after birth) and at weaning (21st day after birth). BW0 and BW1 positively correlated with cholesterol and negatively with urea values at the beginning of life and RBC values at weaning. BW2 positively correlates with albumin and cortisol values at the beginning of life, total proteins, and globulins at weaning, and negatively correlates with erythrocyte values at weaning. Piglet growth from birth to weaning (BWG2-0) correlates positively with total proteins, albumin, and cortisol at the beginning of life and total proteins at weaning. ROC analysis shows that MCHC, TPROT, GLOB, CHOL and AST at the beginning of life can distinguish fast-growing from slow-growing piglets from birth to weaning period. The use of blood parameters enables early recognition of growth rate in piglets, which can help to optimize all further steps to achieve the best possible growth.

Keywords: body weight, body weight gain, blood parameters, pig production.

RESUMO

O objetivo do estudo foi determinar a relação entre parâmetros metabólicos, peso corporal e crescimento corporal de leitões ao nascimento e desmame. A experiência incluiu 80 leitões obtidos de porcas da geração F1. O peso corporal foi medido ao nascimento (BW0), 24h (BW1) após o nascimento e no dia 25 (no desmame, BW2). A amostragem de sangue foi realizada no início da vida (3º dia após o nascimento) e no desmame (21º dia após o nascimento). BW0 e BW1 correlacionaram-se positivamente com o colesterol e negativamente com os valores de uréia no início da vida e com os valores de hemácias no desmame. BW2 correlaciona-se positivamente com os valores de albumina e cortisol no início da vida, proteínas totais e globulinas no desmame, e negativamente com os valores de eritrócitos no desmame. O crescimento do leitão desde o nascimento até o desmame (BWG2-0) se correlaciona positivamente com as proteínas totais, albumina e cortisol no início da vida e com as proteínas totais no desmame. A análise ROC mostra que MCHC, TPROT, GLOB, CHOL e AST no início da vida pode distinguir leitões de crescimento rápido de leitões de crescimento lento desde o nascimento até o desmame. O uso de parâmetros sanguíneos permite o reconhecimento precoce da taxa de crescimento em leitões, o que pode ajudar a otimizar todas as etapas posteriores para alcançar o melhor crescimento possível.

Palavras-chave: peso corporal, ganho de peso corporal, parâmetros sanguíneos, produção de leitões

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INTRODUCTION

The body weight of piglets and their age at weaning are two factors that often determine success in overall pig production. Due to the sensitivity of piglets during breastfeeding and various technological errors, it often happens that piglets do not get enough colostrum when there are changes in body temperature, body weight and blood parameters (Devillers *et al.*, 2011). Due to the selection pressure on the size of the litter, there was a decrease in the birth weight of piglets, as well as a decrease in the homogeneity of the litter of piglets, which has a negative impact on sustainable pig production. Quiniou *et al.* (2002) and Beaulieu *et al.* (2010) state that the birth weight of piglets in the litter decreases by 40 g per piglet if the litter increases by one more piglet. According to Paredes *et al.* (2012) increasing the number of lean piglets requires the identification of individuals that can compensate for growth in later stages of production, which requires adjustment of breeding procedures in order to obtain more homogeneous groups of piglets. Foxcroft *et al.* (2009) state that limited placental development due to reduced space within the uterus in early gestation results in the entire litter being smaller at birth. Canario *et al.* (2010), observing birth weight through the prism of economic success, stated that low birth weight significantly affects economically important characteristics in production. According to Almeida *et al.* (2014) due to the increase in litter size, the risk of mortality and scraping increases, which is indicated by the results of Alvarenga *et al.* (2013); Quiniou *et al*. (2002); Kirkden *et al.* (2013) who found that variability in birth weight increases mortality before translation, while Furtado *et al.* (2012) states that cases of piglet mortality are more frequent in the first week of life.

Recent research has examined the metabolic basis of body growth in piglets. The daily gain was found to correlate with the values of haptoglobin, total antioxidant capacity of plasma, free fatty acids, leucine, tryptophan, and 1-methylhistidine (Le Floc'h *et al.*, 2021). Feed efficiency in piglets correlates with specific microbiota and with bacterial – related metabolites in intestine (Wang *et al.*, 2021). Based on metabolic research in the postprandial period in piglets, it has been shown that piglets with lower residual feed intake grow much better in poor hygienic conditions, due to better use of amino acids and better postprandial glucose and insulin dynamics (Zem Fraga *et al.*, 2021). In a study by Kabalin *et al.* (2017) compared metabolic parameters in piglets of low and high birth weight. In piglets of low birth weight, a lower value of glucose was found, and a higher value of urea and triglycerides, and the concentrations of total proteins, globulins and creatinine were below the reference values even before weaning.

The aim of this study was to determine the relationship between metabolic parameters, body weight and body growth. The second goal is to examine the possibility of early recognition of piglets that will have better body weight and growth, based on blood parameters measured after birth.

MATERIAL AND METHODS

The experiment included 80 piglets obtained from F1 generation sows (Yorkshire × Landrace and Landrace × Yorkshire) from the first to the 8th parity. Body weight was measured at birth (BW0), 24 h (BW1) after birth and on day 25 (at weaning, BW2). Gain was measured as the difference in body weight at the end of the first day and at birth (BW1-BW0) as well as at weaning and at birth (BW2-BW0). Body weight was measured with a PR PLUS CAS scale (measurement error ± 5g).

Piglets come from the same farm, from 7 sows that farrowed on the same day (litter size 11 and 12 piglets). All piglets were healthy and under constant veterinary supervision. There were no deaths during this trial. Piglets were suckled only from the sows.

Blood sampling was performed at the beginning of life (3rd day after birth) and at weaning (21st day after birth). Blood was taken in EDTA vacutainers (BD Vacutainers) from the jugularis externa and sent to the laboratory within 2 hours after sampling, after which they were immediately processed in the laboratory. Haematological analyzes were performed on a NIHON KOHDEN analyzer (Japan) with pig blood analysis software. Standard blood counts were determined including leukocytes (WBC), erythrocytes (RBC), hemoglobin (HGB), hematocrit (HTC), erythrocyte indices (MCV, MCH, MCHC). Plasma values of glucose (GLU), total protein (TPROT), albumin (ALB), globulin (GLOB), cholesterol (CHOL), triglyceride (TGC), total bilirubin (TBIL), AST, ALT, urea, alpha amylase (AMYLASE) and lipase (LIPASE) were determined using standard kits from Byosystem (Spain), on a Chemray-Rayto analyzer (China). Determination of the concentration of crotisol (CORT) and insulin (INSUL) was performed on an immunochemical analyzer TOSOH AIA 360 (Japan).

Statistics: The difference in growth and values of the examined blood parameters was determined by t-test of couples. The relationship between metabolic parameters, body weight and weight gain was examined by the Pearson correlation coefficient. The regression line and formula are graphically displayed for the selected correlations. Based on the median value of growth from birth to weaning, piglets were classified into those with better growth (growth above the median, 40 piglets) and those with weaker growth (growth below the median, 40 piglets). The possibility of determining piglets by increment based on the values of metabolic parameters at birth was examined using ROC analysis, calculation, and analysis of the area under the ROC curve (AUC ROC).

Ethics: This experiment is approved by the Ethycal comity for protection of experimental animal welfare of the University of Novi Sad No EK:III-E-2021-02.

RESULTS

Body weight at birth (BW0) positively correlates with body weight at weaning (BW2) and with increment to weaning (BWG2-0), while negatively correlates with increment from birth to the first day (BWG1-0) (Table 1, Figure 1).

Table 1. Correlation between body weight at birth (BW0) and body weight at first day (BW1) with body weight at weaning (BW2), body weight gain in first day (BWG1-0) and at weaning (BWG2-0)

	BW1	BW2	BWG1-0	BWG2-0
BW0	0,869**	0,472**	-0,484**	0,256*
BW1	1	0,572**	0,012	0,401**

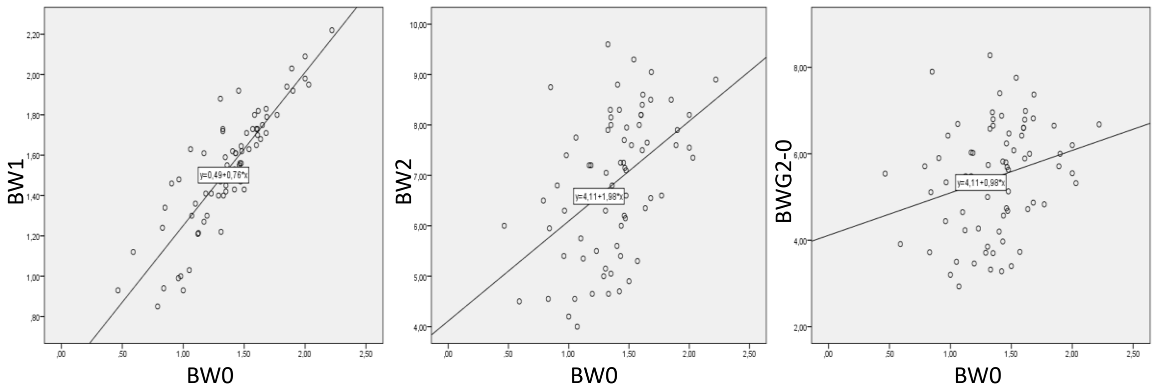

Figure 1. Regression line between body weight at birth (BW0) and body weight at first day (BW1) and weaning (BW2) and bogy weight gain from birth to weaning (BWG2-0). Legend: BW0 – body weight at birth; BW1 – body weight at first day after birth; BW2 –body weight at weaning; BWG2-0 – body weight gain from birth to weaning.

Body weight at birth (BW0) and at the end of the first day after birth (BW1) positively correlated with cholesterol values at the beginning of life and negatively with urea values at the beginning of life and RBC values at weaning. Physical increase in the first day (BW1-BW0) is positively correlated with the values of MCV, TPROT, GLOB and LIPASE, and negatively with the values of AST, TBIL, CHOL and UREA at the beginning of life. Body weight at weaning (BW 2) positively correlates with albumin and cortisol values at the beginning of life, total proteins, and globulins at weaning, and negatively correlates with erythrocyte values at weaning. Growth of piglets from birth to weaning (BW2-BW0) is positively correlated with total proteins, albumin, and cortisol at the beginning of life and total proteins at weaning. The results are shown in Table 2. With regression graphs we presented the movement of body weight as a function of blood protein concentration in piglets (Figure 2).

Table 2. Correlations between body weight, body weight gain and blood hematology and metabolic parameters (*p<0.05, **p<0.01). Legend: 1-at start of life, 2 – at weaning

	BW0	BW1	BWG1-0	BW2	BWG2-0
WBC1	-0.014	-0.038	-0.039	-0.012	-0.010
RBC1	0.194	0.108	-0.201	0.115	0.076
HGB1	0.098	0.087	-0.045	0.161	0.152
HCT1	0.212	0.189	-0.093	0.185	0.147
MCV1	0.028	0.182	0.265*	0.101	0.104
MCH1	0.161	0.145	-0.070	0.150	0.123
MCHC1	0.058	0.150	0.148	0.079	0.072
AST1	0.170	-0.033	-0.403**	-0.070	-0.122
TGC1	-0.207	-0.217	0.036	-0.140	-0.099
CHOL1	0.505**	0.300*	-0.490**	0.083	-0.041
ALT1	0.202	0.179	-0.152	0.119	0.069
GLU1	-0.176	-0.129	0.128	-0.148	-0.116
TPROT1	-0.130	0.029	0.316**	0.190	0.243*
UREA1	-0.277*	-0.357**	-0.071	-0.192	-0.138
AMYLASE1	0.089	0.116	0.026	0.116	0.103
ALB1	0.092	0.187	0.145	0.242*	0.241*
GLOB1	-0.201	-0.056	0.308**	0.110	0.174
LIPASE1	-0.107	0.066	0.333**	0.151	0.194
TBIL1	0.149	-0.019	-0.335**	0.033	-0.003
CORT1	-0.048	0.018	0.128	0.255*	0.292*
INSUL1	-0.102	-0.156	-0.076	0.038	0.068
WBC2	0.209	0.108	-0.232	0.157	0.118
RBC2	-0.279*	-0.249*	0.123	-0.257*	-0.209
HGB2	-0.098	-0.113	-0.002	0.099	0.135
HCT2	-0.027	-0.085	-0.095	-0.039	-0.036
MCV2	-0.170	-0.122	0.129	-0.084	-0.048
MCH2	-0.014	0.066	0.145	0.181	0.203
MCHC2	-0.165	-0.090	0.173	-0.028	0.012
AST2	0.190	0.152	-0.115	-0.001	-0.051
TGC2	-0.064	-0.006	0.118	-0.106	-0.100
CHOL2	0.187	0.036	-0.031	0.022	-0.025
ALT2	0.123	0.158	0.030	0.072	0.047
GLU2	-0.141	-0.011	0.265*	-0.006	0.031
TPROT2	0.108	0.210	0.153	0.273*	0.272*
UREA2	-0.156	-0.215	-0.066	-0.200	-0.178
AMYLASE2	0.006	0.032	0.044	0.110	0.119
ALB2	-0.053	-0.035	0.045	0.008	0.022
GLOB2	0.123	0.201	0.108	0.233*	0.224
LIPASE2	-0.154	-0.091	0.149	0.054	0.099
TBIL2	0.215	0.116	-0.230	0.034	-0.019
CORT2	-0.025	0.007	0.063	0.105	0.122
INSUL2	-0.053	-0.100	-0.070	-0.065	0.086

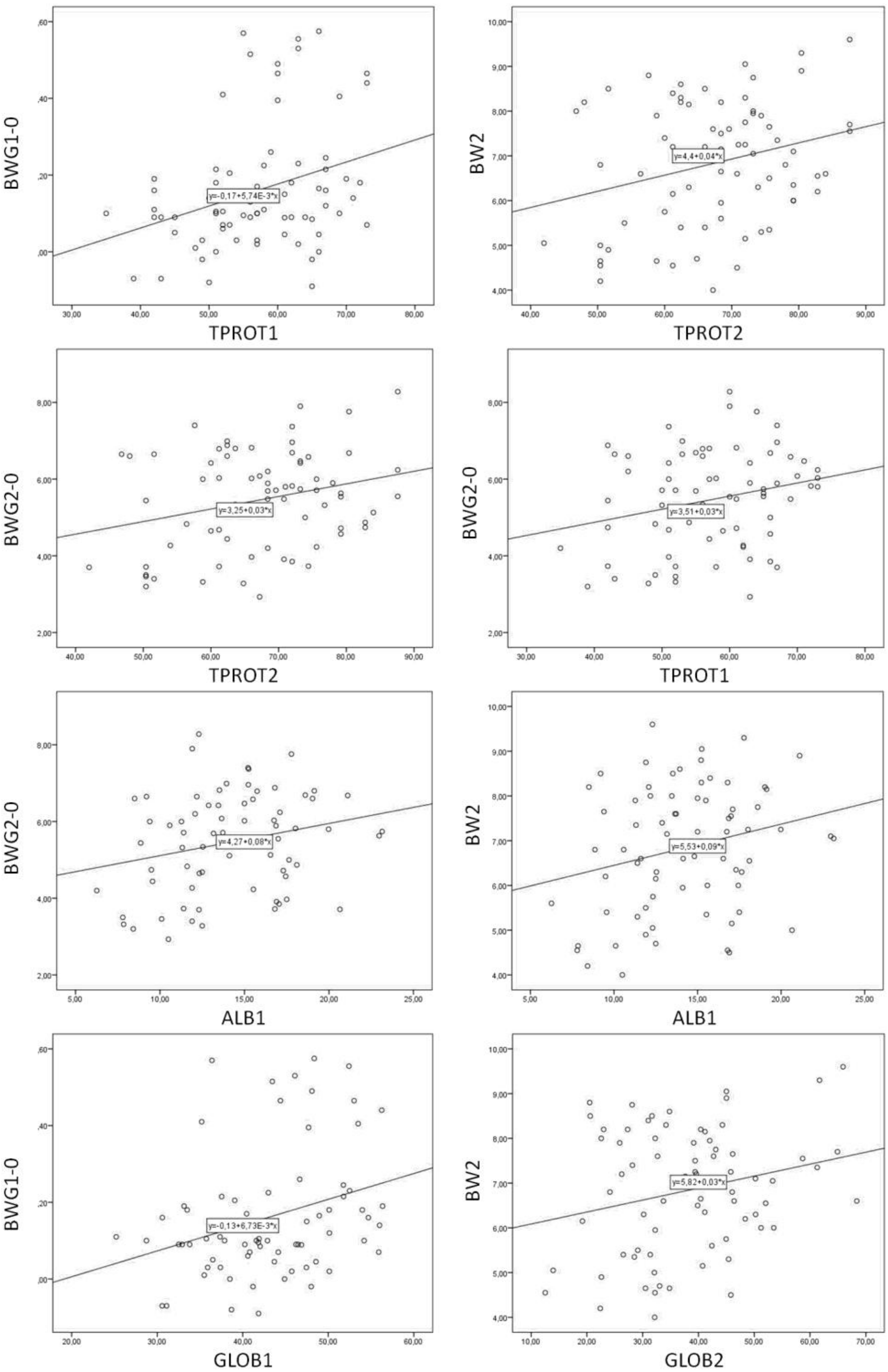

Figure 2. Regression line between protein blood parameters and body weight gain in piglets. Legend: BW2 –body weight at weaning; BWG1-0 – body weight gain from birth to first day after birth; BWG2-0 – body weight gain from birth to weaning; TPROT1 –total protein in blood at start of life; TPROT2 – total protein in blood at weaning; ALB1 – albumin in blood at start of life; GLOB1 – globulin in blood at start of life; GLOB2 – globulin in blood at weaning.

The test results show that there is a significant deviation in the value of body weight on the second measurement (BW2) compared to the first measurement (BW0). Higher body weight, higher erythrocyte count and erythrocyte index, higher total protein and albumin concentration and lower globulin concentration, decreased AST and ALT activity, increased lipase activity, and lower cortisol and insulin levels were found at weaning (21st day after birth) compared to beginning of life (3rd day after birth). Piglets with better growth (above the median) have a higher concentration of TGC, CHOL, TPROT and GLOB at first blood sampling and ALB at second blood sampling, compared to piglets with weaker growth (below the median) at the same time of blood sampling. The moment of blood sampling did not statistically significantly affect the number of leukocytes (WBC) and the concentration of glucose, urea, amylase, and total bilirubin (TBIL). The results are shown in Table 3.

Table 3. Body weight and blood metabolic and hematology parameters at start of life and at weaning in function of growth (BW2-BW0)

Parameters	First blood sampling		Second blood sampling		ANOVA p
	Growth above median (n=40)	Growth below median (n=40)	Growth above median (n=40)	Growth below median (n=40)	
BW (kg)	1.75±0.22[a]	1.49±0.18[b]	7.71±0.69[c]	5.95±0.65[d]	p<0.01
WBC (10^9/L)	10.4±4.12	9.9±3.85	11.1±5.02	12.8±3.99	NS
RBC (10^{12}/L)	3.45±0.71[a]	4.19±0.61[a]	4.93±0.82[b]	5.51±0.73[b]	p<0.01
HGB (g/L)	78.18±12.5[a]	70.4±13.4[a]	110.6±14.3[b]	102.1±12.61[b]	p<0.01
HCT (%)	25.5±4.11[a]	24.6±4.15[a]	35.5±6.3[b]	38.1±6.2[b]	p<0.01
MCV (fL)	66.9±3.2[a]	64.5±3.5[a]	75.6±4.4[b]	73.4±4.35[b]	p<0.01
MCH (pg)	22.2±2.5[a]	20.3±2.6[a]	25.95±3.29[b]	24.72±3.18[b]	p<0.01
MCHC (g/L)	335.5±16.4[a]	324.8±15.2[a]	381.2±23.1[b]	369.4±23.1[b]	p<0.01
AST (IU/L)	90.5±35.7[a]	85.2±34.5[a]	62.3±22.5[b]	58.5±21.6[b]	p<0.01
TGC (mmol/L)	2.01±0.65[a]	1.55±0.58[b]	2.35±0.72[a]	2.3±0.71[a]	p<0.05
CHOL(mmol/L)	2.99±0.51[a]	2.36±0.5[b]	4.19±0.85[c]	3.85±0.82[c]	p<0.01
ALT (IU/L)	83.1±28.1 [a]	89.2±26.2 [a]	74.5±17.5 [a b]	69.8±16.8 [b]	p<0.05
GLU(mmol/L)	5.89±1.3	5.75±1.45	6.32±1.42	6.12±1.56	NS
TPROT (g/L)	62.4±7.7[a]	53.7±8.1[b]	73.6±7.2[c]	69.9±8.5 [c]	p<0.01
UREA(mmol/L)	3.56±2.23	3.95±2.41	3.9±2.25	3.96±2.19	NS
AMYL (IU/L)	815.6±195.7	900.5±190.3	899.3±207.2	902.5±210.4	NS
ALB (g/L)	17.3±3.05[a]	15.4±2.68[a]	36.4±6.71[b]	30.5±6.71[c]	p<0.01
GLOB (g/L)	45.1±7.1[a]	38.3±7.3[b]	37.2±9.95[c]	39.4±10.14[c]	p<0.01
LIPASE (IU/L)	74.85±13.25[a]	75.7±15.4[a]	95.2±19.9[b]	95.3±20.2[b]	p<0.01
TBIL (μmol/L)	41.3±21.81	39.2±16.4	34.8±20.5	36.8±19.9	NS
CORT (ng/mL)	161.3±141.6[a]	130.8±119.1[a]	56.4±31.2[b]	48.2±29.6[b]	p<0.01
INSUL (ng/mL)	5.3±3.52[a]	4.2±3.85[a]	2.65±1.09[b]	2.01±1.1[b]	p<0.01

[a,b,c,d]- different superscript means significant difference of mean

Based on the values of metabolic parameters in the first day after birth, it is possible to determine piglets that will have better growth than those with weaker growth. AUC ROC values were 0.66–0.83 ($p < 0.05$) for TPROT, GLOB, CHOL, MCHC, and AST parameters. It means there is a 66-83% chance that the parameters will be able to distinguish between positive class (better growth, above the median) and negative class (worse growth, below the median) (Table 4, Figure 3).

Table 4. Area under ROC curve (AUC) for blood parameters at birth in piglet with better body weight gain

Parameters	AUC	95%CI	p
TPROT1	0.665	0.513-0.800	<0.05
GLOB1	0.662	0.512-0.811	<0.05
AST1	0.661	0.532-0.805	<0.05
CHOL1	0.723	0.621-0.831	<0.05
MCHC1	0.691	0.562-0.811	<0.05

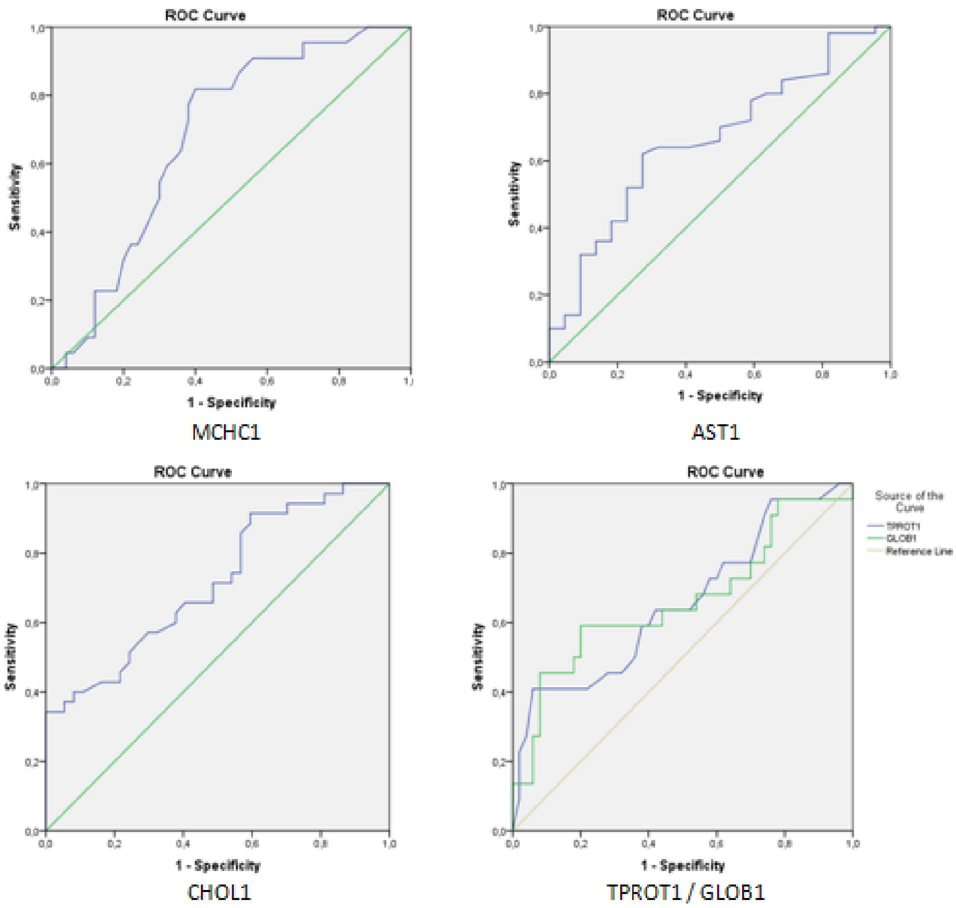

Figure 3. ROC curve for blood parameters at birth in piglet with better body weight gain. Legend: MCHC1 – mean cellular hemoglobin concentration in blood at start of life; AST1 – aspartate transaminase in blood at start of life; CHOL1 – cholesterol in blood at start of life; TPROT1 –total protein in blood at start of life; GLOB1 – globulin in blood at start of life.

DISCUSSION

The results of the research show that there is a connection between body weight at birth and body weight at weaning and growth. Many studies have examined the relationship between birth weight and later weight gain, which match our results. Paredes *et al.* (2012) in their research noted that the body weight of piglets at birth is 1.40±0.37kg, while the body weight in breeding is 7.73±1.79. The same research also indicates that piglets whose birth weight is not less than two standard generations than the average population have the potential to compensate for body weight in the next production stages. Václavková *et al.* (2012) stated that piglets with lower birth weight start life as smaller, fatten more slowly during the entire production phase, and are lighter in the end. Examining the correlations of Alvarenga *et al.* (2013) point out that the birth weight is positively related to the weight of the liver (r = 0.91) and the brain (r = 0.40), which the authors associate with the space inside the uterus. Quiniou *et al.* (2002) noted a statistically significant correlation between birth weight and body weight in translation (r = 0.57). Canario *et al.* (2010) noted a significant effect of birth weight on average daily gain and body weight when translated into fattening. Alvarenga *et al.* (2013) noted that piglets with higher birth weight had a daily gain of 0.247kg compared to lighter piglets with 0.168kg during suckling. Higher daily gain not only reflected faster growth, but also had an impact on the development of internal organs, semi-tendon muscles, small bowel weight, and on brain development. Milligan *et al.* (2002) state that differences in body weight at birth often lead to an increase or stagnation of differences in body weight during breastfeeding, citing the inability of lighter piglets to cope with better breasts and positions during breastfeeding.

Hematological and biochemical parameters are within established reference values and the latest research related to piglets (Ventrella *et al*., 2016; Perri *et al*., 2017; París-Oller *et al*., 2022). The absence of deviations in the values of the investigated parameters confirms that healthy piglets were used in the experiment, and the blood sampling time is optimal and corresponds to the sampling time in the earlier results.

Variation in blood parameters depends on the breed and age of the pig. Whether they are noble or primitive breeds of pigs, the variance RBC, Hgb, Hct, MCV, MCH, MCHC, total proteins, albumins, creatinine, and ALT can be significantly explained by the influence of breed, age, and their interaction (Stevančević *et al.*, 2019), and the influence of farm, race and age was also determined in Ježek *et al.* (2018). Results Chmielowiec-Korzeniowska *et al.* (2012) showed that the concentration of protein, creatinine and urea increases with age, while changes in bilirubin, cholesterol, AST, and ALT do not show significant variation. The values of blood parameters depend on technological interventions such as iron application, diet, and the ability of food to induce fat gain (Stojanac *et al.*, 2016, Abeni *et al.*, 2018, Al-Mashhadi *et al.*, 2018). Rootwelt *et al.* (2012) examining the variability of blood parameters in piglets of several crossbreeds, found that the level of albumin and total protein increases significantly from birth to the end of the first day after birth, which is related to the survival rate to rejection. The change in triglyceride and cholesterol levels may be related to energy intake from food (Kozera *et al.*, 2016).

Petrovič *et al.* (2009) state that there are significant differences in the number of white blood cells (WBC), total immunoglobulins and albumin in two-month-old piglets compared to 30 days of age when piglets are most often translated into rearing. Concentrations of WBC, erythrocytes (RBC) and hemoglobin have a growing trend in the first two months of postnatal life, and the changes are because in the early phase of postnatal development there is extremely rapid development of organs responsible for the formation and maturation of RBC. According to Kabalin *et al.* (2008) the total number of RBCs was continuously lower in piglets of low birth weight. It is also stated that if the whole sucking phase is observed, a significant difference ($P < 0.01$) can be noticed in the total number of erythrocytes at birth and on the 21st day, when there was a significantly higher number of RBCs. the result of accelerated degradation of fetal erythrocytes and their replacement by synthesized ones.

Czech *et al.* (2017) state that WBCs have a primary role in the defense mechanism, but that increased concentrations may occur after exercise and animal nutrition, which is often the case when increased concentrations occur in sows immediately after farrowing, resulting in increased concentrations in piglets. Klem *et al.* (2010) state that the WBC number in pigs has a wide range. Kabalin *et al.* (2008) state that the concentration of RBC is positively correlated with body weight and that the concentration increases until the 14th day of age, and later remains unchanged. When it comes to MCV concentrations, according to Czech *et al.* (2017) the concentration does not increase in piglets with weight gain. The average erythrocyte volume (MCV) increases from birth to day 7, followed by Kabalin *et al.* (2008) falls. Kabalin *et al.* (2008) points out that hematological changes in newborn piglets are associated with maturation and development of organs, degradation of fetal erythrocytes and maternal immunoglobulin. Czech *et al.* (2017) state that the differences in the concentrations of hematocrit, hemoglobulin and the number of RBCs in suckling piglets differ in relation to piglets in rearing and fattening 1. The reasons for this difference are stated by Kabalin *et al.* (2008) and Petrovič *et al.* (2009) as being a consequence of the growth, development, and maturation of organs, as well as the doubling of body weight. The phenotypic characteristics of the complete blood count enable the differentiation of piglets that are resistant to diseases (Bai *et al.*, 2020), which confirms the importance of blood parameters in the assessment of biological characteristics of piglets.

Correlations of the examined blood parameters with body mass and growth have their physiological basis and can be explained in several ways. Body mass at weaning and during the third day correlates positively with CHOL, and negatively with urea. Cholesterol concentration depends on the biosynthetic functions of the liver and the intake of a sufficient amount through food. Cholesterol is transported from the liver to the muscles and from the muscles to the liver, enabling energy exchange and energy storage of nutrients, thus creating conditions for improving body growth (Poklukar *et al*., 2020). Urea increases when there is a protein deficit in the diet, so piglets will use their own protein reserves, when urea is created in the process of protein catabolism, and all the above has a negative effect on the growth and health resistance of piglets (Heo *et al*., 2008). Protein concentration depends. A higher MCV value indicates a better iron status in the piglet's body, which is related to the ability of hemoglobin to bind oxygen and transport it through the body, thus maintaining the buffering role of hemoglobin and reducing oxidative damage. Better piglet growth with an increase in erythrocyte indices occurs because of an increase in blood volume, hemoglobin and hematocrit, which is related to the availability of iron and other nutrients (Williams *et al*., 2018). Lower RBC values at weaning means better growth. This finding can be explained by the fact that the number of RBC increases in absolute value when there is an increased need for oxygen or relatively when there is dehydration of the organism (Berry and Lewis, 2001), and both patterns would reduce growth in piglets. AST negatively correlates with piglet growth in the early days. AST speaks of increased muscle activity, and it can also be a sign of liver damage. Increased muscle activity helps maintain body temperature in hypothermia (Liu *et al*., 2014), and may also be the result of increased competition during sucking. Both conditions will lead to reduced growth. Variation in insulin and cortisol is related to food intake (Koopmans *et al.*, 2006), and stimulating tests show that there is a link between weight gain, cortisol, and IGF-I (which indicates the anabolic effects of insulin), which confirms the importance of these hormones in the anabolic flows of the organism and in the growth of piglets (Larzul *et al.*, 2015).

ROC analysis shows that MCHC, TPROT, GLOB, CHOL and AST at the beginning of life (3rd day after birth) can distinguish fast-growing piglets from slow-growing piglets from birth to weaning period. ROC analysis shows that MCHC, TPROT, GLOB, CHOL and AST at the beginning of life (3rd day after birth) can distinguish fast-growing piglets from slow-growing piglets. The optimal threshold value of blood parameters that allows to detect piglets that will have a faster growth from birth to weaning compared to slow growing piglets was: MCHC>342.5 g/L, TPROT >57.1 g/L, GLOB >47.2 g/L, CHOL >3.2 mmol/L and AST <45.5 IU/L (sensitivity and specificity over 70%). The use of blood parameters enables early recognition of growth rate in piglets, which can help to optimize all further steps to achieve the best possible growth.

CONCLUSIONS

Body weight and blood parameters in piglets differ significantly at birth compared to the period before weaning. There is a significant correlation between several metabolites and body weight, or gain. Of particular importance are total proteins, albumins and globulins that show constant correlations with body weight at birth and weaning and may be important in recognizing piglets with better growth from birth to weaning. ROC analysis shows that MCHC, TPROT, GLOB, CHOL and AST at the beginning of life can distinguish fast-growing from slow-growing piglets from birth to weaning period. The use of blood parameters enables early recognition of growth rate in piglets, which can help to optimize all further steps to achieve the best possible growth.

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