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Changes in blood biochemical indicators during fattening of the high-lean pigs

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Investigated were three groups of pigs differing in fat and meat content of carcass: purebred Polish Landrace (PL, n=20), two-breed Stamboek crosses (S, n=39) and three-breed Torhyb crosses (T, n=39). Live weight gain was recorded and the level of blood biochemical indicators determined in the middle and at the end of fattening. Post-slaughter carcass fat and meat content were determined. Significant differences between groups were found in the growth rate during the first fattening stage (P<0.01 and P<0.05). The highest daily gain was attained by PL pigs (1024 g *vs* 910 g in S and 824 g in T). Also the highest fat content of carcass was found in PL fatteners (19.45% *vs* 17.58% and 17.19%, respectively; P<0.01). Conversely, Torhyb crosses had the highest lean content of carcass (53.72% *vs* 51.07% and 51.42%, respectively; P<0.01). Among the serum biochemical indicators analysed (T_4, T_3, AspAT, ALAT, total protein, urea nitrogen and cholesterol) most differentiated was the cholesterol level during the first fattening stage (102.20 in PL *vs* 94.00 in Stamboek and 87.49 mg/dl in Torhyb pigs; P<0.01 and P<0.05). The level of AspAT in the second stage of fattening period attained the lowest value in PL pigs (51.85 *vs* 68.77 and 78.42 IU/L; P<0.01). The results presented indicate a significant relation between fattening and slaughter traits and blood biochemical indicators during the two fattening stages.

KEY WORDS: biochemical indicators / blood / carcass / crossbreds / fattening / pigs

The majority of performance traits of farm animals is determined by effective metabolism and by maintaining a dynamic equilibrium between the extent of anabolic and catabolic changes in the body. A shift in the state of equilibrium towards synthesis leads to increased protein deposition in the body and a rapid increment in muscle weight, while increased catabolic processes restrict the rate of growth [Reeds *et al*.

1980, Skjaerlund *et al*. 1994, Lobley 1997].

Essential to the growth and development of pigs are the thyroid hormones thyroxine and triiodothyronine, which are the main regulators of metabolism [van Hardeveld 1992] and also regulate lipid metabolism in the body [Migdał *et al*. 2003]. The intensity of metabolic changes, mainly of protein, is also reflected in the concentration of other biochemical indicators of blood, such as total protein, urea, aspartate aminotransferase or alanine aminotransferase [Falkenberg *et al*. 1997, Kapelański *et al*. 2000, Więcek and Skomiał 2000]. Also cholesterol is a major component integral to the morphological and subcellular structure of the muscle as a natural component of cell membranes [Hoelscher *et al*. 1988, Horgan and Kuypers 1988]. Adequate cholesterol level in blood is therefore indispensable for achieving maximum weight gain in growing animals.

The objective of this study was to assess the course of fattening and to compare changes in the level of selected biochemical parametres of blood in fatteners of different genetic composition and meat and fat content of carcass..

Material and methods

Used were 98 castrated male fatteners – Polish Landrace (PL, n=20), two-breed Stamboek crosses (S, n=39), and three-breed Torhyb crosses (T, n=39). The animals were kept in standard conditions of a pedigree farm in Wronie and fattened from about 32 to about 106 kg of body weight. During fattening, identical management and *ad libitum* feeding conditions were applied. Fattening was carried out in two stages: from the start up to about 70 kg body weight (stage I) and from 70 kg body weight to the end of fattening (stage II). Pigs were fed with complete mixtures depending on the stage of fattening, according to Feeding Standards for Pigs [Normy Żywienia Świń, 1993].

Blood for biochemical analyses was drawn twice – at the end of the first fattening stage (day 42) and again at the end of fattening (day 90), *i.e*. at slaughter. Blood serum was analysed for the concentrations of thyroxine (T_4), triiodothyronine (T_3) with radioimmunoassay using RIA kits (SPECTRIA), and aspartate aminotransferase (AspAT), alanine aminotransferase (ALAT), total protein, urea nitrogen, and total cholesterol using EPOLL-20 type Photometer.

Animals were slaughtered following current standards. On the next day after slaughter, detailed dissection of left carcass side was performed according to the European Union procedure developed by Walstra and Merkus [1996].

One-factorial variance analysis was performed and significance of differences between breeds vere assessed by Student t-test. Statistical calculations were made using STATISTICA 5.5 PL software [2000].

Results and discussion

Fattening performance and carcass selected traits are shown in Table 1. Body weight at the start of fattening was almost identical in all three groups of fatteners (about 32 kg). The first stage of fattening lasted 42 days and the body weights obtained during that time were significantly highly different in fatteners' groups. Daily gain calculated for the first fattening stage was highest in PL pigs (1024 g *vs* 910 g in S and 824 g in T (P<0.01 and P<0.05). In the second stage of fattening, gains in all the groups were markedly lower and ranged from 709 g/day in PL to 773 g/day in T, showing no significant inter-group differences.

Carcass backfat thickness (mean from 5 measurements), showed differences between PL and S pigs (2.56 *vs* 2.25 cm, P<0.01). Fat content of carcass (weight of backfat with

Table 1. Fattening performance and selected carcass traits across groups of fatteners

Item	Polish Landrace (n=20)		Stambouk (n=39)		Terbyb (n=39)	
	mean	SD	mean	SD	mean	SD
Initial body weight (kg)	32.55	2.72	32.33	2.62	32.13	2.17
First stage of fattening period (days)	42		42		42	
Body weight (kg)	75.55^{Aa}	6.05	70.56^{Ab}	6.46	67.18^{Ab}	6.48
Daily gain in first stage (g)	1024^{Aa}	129	910^{Ab}	130	824^{Ab}	153
Second stage of fattening period (days)	87.0^{b}	9.4	90.8	9.5	92.8^{a}	9.6
Daily gain in second stage (g)	709	102	739	96	773	132
Daily gain in total fattening period	863^{a}	94	823	88	801^{b}	112
Mean backfat thickness 5 measures (cm)	2.56^{A}	0.40	2.25^{b}	0.39	2.43	0.32
Fat content of carcass (%)	19.45^{Aa}	2.78	17.58^{Ab}	2.45	17.19^{Ab}	2.54
Lean meat content of carcass (%)	51.07^{Aa}	3.59	51.42^{Aa}	2.89	53.72^{Ab}	3.24

^{a,b} / ^{A,B} – Within rows means bearing different superscripts differ significantly at: small letters – P<0.05; capitals – P<0.01.

skin and intermuscular fat in total primary cuts) was highest in PL pigs (19.45% *vs* 17.58% in S and 17.19% in T). Differences in fat content of carcass between PL and remaining two groups were highly significant (P<0.01). Carcass muscling of PL was similar to S and lower than that of T pigs (51.07% and 51.42% *vs* 53.72%, P<0.01).

The level of biochemical indicators of blood collected at the end of the first stage of fattening is given in Table 2. The concentration of individual components was within the upper range of reference values [Winnicka 2000] or exceeded them. Probably, this was due to great intensity of metabolic changes and a high rate of body weight growth in the first stage of fattening in the pig groups studied.

The concentration of thyroid hormones corresponded with the data reported by other authors [Bakke and Tveit 1977, Migdał *et al*. 2003, Karska *et al*. 2004] In the first stage of fattening no changes were shown in the serum levels of thyroxine (T_4) and triiodothyronine (T_3) in the pig groups compared. The concentration of T_4 ranged from 52.80 in PL to 56.08 ng/l in T fatteners. Also T_3 concentration was slightly lower in PL than in T pigs (0.665 *vs* 0.777 ng/l). The level of aspartate aminotransferase

Table 2. Means and their standard deviations (SD) for selected blood serum biochemical indicators at the end of the first fattening stage, across groups of fatteners

Item	Polish Landrace		Stambuek		Torlvib	
	mean	SD	mean	SD	mean	SD
Thyroxine - T_4 (ng/l)	52.00	11.77	53.30	10.40	56.08	11.79
Triiodothyronine – T_3 (ng/l)	0.665	0.194	0.725	0.233	0.777	0.337
AspAT (IU/l)	36.59	11.49	41.24	10.81	37.80	11.72
ALAT (IU/l)	46.26^{a}	8.53	40.17^{b}	10.17	43.97	11.60
Total protein (g/dl)	7.79^{A}	0.42	7.36^{B}	0.43	7.56	0.67
Urea N (mg/dl)	20.25	3.31	19.51	3.73	19.68	4.67
Cholesterol (mg/dl)	102.20^{A}	11.65	94.00^{Ba}	10.77	87.49^{Bb}	12.16

^{a,b,A,B} Within rows means bearing different superscripts differ significantly at: small letters – $P<0.05$; capitals – $P<0.01$.

(AspAT) was similar in all the pigs, while ALAT was higher in PL than in S (46.26 *vs* 40.17 IU/l, $P<0.05$). Likewise, total protein in PL was higher than in S pigs (7.79 *vs* 7.36 g/dl, $P<0.01$). Urea content of blood serum was similar in all the groups and was within the upper range of the reference values [Winnicka 2000].

As can be seen, most of the biochemical parametres of blood related to protein metabolism were higher in PL pigs characterized by a very high rate of growth in the first stage of fattening compared to slower growing S and T crosses. Likewise, the blood concentration of total cholesterol showed clear differences proportional to the differences in the values of daily gains between the pig groups compared (102.20 mg/dl in PL *vs*. 94.00 mg/dl in S and 87.49 mg/dl in T crosses; $P<0.01$ and $P<0.05$).

The level of the biochemical parametres in blood taken after the end of fattening, *i.e*. on the day of slaughter, is given in Table 3. The figures characterize the final stage of fattening, when growth rate decreased and the differences in daily gains between

Table 3. Means and their standard deviations (SD) for selected blood serum indicators at the end of the second fattening stage, across groups of fatteners

Item	Polish Landrace		Stambuek		Torlvib	
	mean	SD	mean	SD	mean	SD
Thyroxine - T_4 (ng/l)	45.86^{a}	11.22	43.45	7.95	39.80^{b}	9.56
Triiodothyronine – T_3 (ng/l)	0.708^{a}	0.241	0.600^{B}	0.132	0.759^{A}	0.171
AspAT (IU/l)	51.85^{A}	16.68	68.77^{B}	18.60	78.42^{B}	27.47
ALAT (IU/l)	69.90	10.79	66.03	14.07	73.58	18.81
Total protein (g/dl)	7.69^{a}	0.89	8.06^{b}	0.54	7.97	0.61
Urea N (mg/dl)	20.20	4.47	18.89	3.72	19.84	3.32
Cholesterol (mg/dl)	105.68	30.70	117.00	25.15	106.39	16.24

^{a,b,A,B} Within rows means bearing different superscripts differ significantly at: small letters – $P<0.05$; capitals – $P<0.01$.

groups were not found significant. The level of blood biochemical parametres in both periods of fattening is compared and discussed in another paper [Kapelański *et al*. 2004]. In the present paper the inter-group differences are discussed.

The level of T_4 in T crosses appeared significantly lower than in PL pigs ($P<0.05$), but that of T_3 was the highest. In other studies with purebred PL, Pietrain and Złotnicka Spotted pigs [Karska *et al*. 2004] significant differences were shown in the level of T_4 and T_3 in blood serum. Pietrain pigs showed a significantly higher concentration of T_4 than Złotnicka Spotted ($P<0.01$] and a higher T_3 level than PL fatteners ($P<0.05$). Migdał *et al*. [2003] report that out of Duroc, Hampshire, Pietrain and Line 990 pigs only the latter was characterized by higher level of T_4 and T_3 ($P<0.05$). When comparing purebred PL and Polish Large White with crosses of a high meat content of carcass, lower serum levels of the growth hormone and triiodothyronine were shown in the latter [Migdał *et al*. 1999]. Because triiodothyronine is several times more active than thyroxine, its absolute blood serum level determined once cannot be a conclusive criterion for evaluating the intensity of metabolic changes in pigs.

Other metabolic indicators closely associated with protein metabolism, such as total protein or AspAT also showed significant differences between the pig groups compared at the end of fattening. PL pigs, which showed the lowest rate of growth in this period, also had a significantly lower serum concentration of total protein and lower AspAT activity (51.85 *vs* 68.77 in S and 78.42 μ/l in T, $P<0.01$).

Many literature data indicate that the blood levels of lipids and cholesterol depend on the breed of pigs, their genotype in relation to lipoproteins, sex and the type of feed given [Barowicz and Pietras 1988, Janik *et al*. 1993, Pond *et al*. 1992, 1997, Barowicz *et al*. 1997, Janik 1997, Migdał *et al*. 1999, Barowicz *et al*. 2000, Migdał *et al*. 2003]. In the present study differences were shown in the concentration of blood serum cholesterol between the pig groups studied only at the end of the first fattening stage. At the end of the second stage*, i.e.* on the day of slaughter no inter-group differences were found. Means exceeded the reference values, but were not so high as those reported by Migdał *et al*. [1999] and ranged from 105.68 to 117.00 mg/dl.

The results presented here indicate that fattening and slaughter traits are clearly related to some blood biochemical indicators during consecutive fattening stages of pigs.

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Zmiany poziomu wskaźników biochemicznych krwi podczas tuczu świń wysokomięsnych

S t r e s z c z e n i e

Badania przeprowadzono na trzech grupach świń różniących się pochodzeniem rasowym i mięsnością. Były to czystorasowe pbz (n=20), mieszańce dwurasowe Stamboek wbp × pbz (n=39) i mieszańce trójrasowe Torhyb [(wbp × pbz) × pietrain] (n=39). Oceniono tempo wzrostu w trakcie tuczu, poziom wskaźników biochemicznych krwi w połowie i przy końcu tuczu oraz otłuszczenie i umięśnienie tuszy.

Wykazano istotne różnice w tempie wzrostu w pierwszej połowie tuczu między porównywanymi grupami świń (P<0,01 i P<0,05). Najwyższe przyrosty dzienne osiągały świnie pbz (1024 wobec 910 i 824 g). One też charakteryzowały się największym procentem tłuszczu w tuszy (19,45 wobec 17,58 i 17,19%; P<0,01). Z kolei świnie Torhyb miały największą zawartość mięsa w tuszy (53,72 wobec 51,07 i 51,42 %). Spośród badanych wskaźników biochemicznych krwi (T_4, T_3, AspAT, ALAT, białko całkowite, mocznik i cholesterol) najbardziej zróżnicowany był poziom cholesterolu w pierwszej fazie tuczu pomiędzy porównywanymi grupami świń (102,20 u świń pbz wobec 94,00 u Stamboek i 87,49 mg/dl u Torhyb; P<0,01 i P<0,05). Poziom AspAT w drugiej połowie tuczu kształtował się odmiennie i najniższy był u świń pbz, pośredni u Stamboek i najwyższy u mieszańców Torhyb (51,85 wobec 68,77 i 78,42 IU/L; P<0,01). Uzyskane wyniki wskazują na wyraźne powiązanie cech tucznych i rzeźnych z poziomem niektórych wskaźników biochemicznych w poszczególnych fazach tuczu.