Animal Science Papers and Reports vol. 22 (2004) no. 4, 429-434
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Relations between blood serum biochemical indicators and weight gain and fat and lean meat content of carcass in pigs

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(Received August 22, 2004; accepted Septemer 5, 2004)

In 98 growing pigs serum biochemical indicators (T_4, T_3, AspAT, ALAT, total protein, urea nitrogen and total cholesterol) were determined twice, at the end of the first fattening phase and next at slaughter. Correlations were determined between serum biochemical indicators, daily gains in the two fattening stages and carcass quality characteristics.
We found a number of significant changes in serum concentration of particular components during the fattening period. T_4 level was lower at the end of fattening ($P<0.01$), no visible changes were found in T_3 and urea nitrogen, whereas the remaining indicators, particularly transaminases, displayed a significant increase ($P<0.01$). Some of the indicators were significantly correlated with weight gain (total serum protein, urea, AspAT and ALAT) or with carcass fatness (T_4, urea, cholesterol, AspAT) and carcass lean meat content (urea, AspAT). The results proved the significant effects of biochemical metabolic processes on some fattening performance traits as well as on the fat and lean meat content of carcass in pigs.

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

The growth rate of pigs from birth to slaughter shows the greatest intensity at 60-70 kg and decreases from 90-100 kg body weight [Fandrejewski 1997, van Lunen and Cole 1998]. Daily gain largely reflects the body's capacity to absorb and deposit protein [Gy *et al*. 1992, Fandrejewski 1999, Fandrejewski and Raj 2002]. The process involves many physiological and biochemical mechanisms that determine the animal's metabolism, as well as thyroid hormones which are considered the key regulators of

protein and lipid metabolism in the body [Migdał *et al*. 2003].

The level of many metabolites of protein metabolism which pass from body cells to the blood indicates the intensity of metabolic changes responsible for the productivity of farm animals.

The aim of this study was to compare biochemical indicators – thyroxine (T_4), triiodothyronine (T_3), aspartate aminotransferase (AspAT), alanine aminotransferase (ALAT), total protein, urea and cholesterol of blood serum towards the end of the first and second stage of fattening and to assess their changes during fattening. Correlations were also calculated between the blood indicators level, weight gain and fat and lean meat content of carcass.

Material and methods

Three groups of fattening pigs were investigated, combined into one population: 20 Polish Landrace, 39 Polish Landrace × Polish Large White from the Dutch programme Stamboek, and 39 [(Polish Large White × Polish Landrace) × Pietrain] from the Torhyb programme. Fattening was carried out for 90 days, from 32 kg to about 105 kg of body weight. Blood for biochemical analyses of serum was taken at the end of the first fattening stage and then at slaughter.

The methods and procedures used are described in detail by Kapelański *et al*. [2004]. The data collected for the first and second stage of fattening were subjected to analysis of variance and the differences were evaluated with the Student t-test. Correlations were calculated between the data from the first and second stage of fattening.

Results and discussion

The parametres analysed changed considerably during the fattening (Tab. 1). Daily gains decreased from 899 to 747 g in the second stage of fattening ($P<0.01$). A similar trend was observed for serum T_4 concentration ($P<0.01$). T_3 concentration also decreased, but the difference was not found significant (0.732 *vs*. 0.684 ng/l). The activity of AspAT and ALAT transaminases increased during fattening by about 70%. A similar trend for serum concentrations of both transaminases was observed by Kapelański *et al*. 2000].

AspAT and ALAT are intracellular enzymes engaged in protein metabolism and their serum concentration may be indicative of the intensity of both protein synthesis and degradation in the body of growing pigs. It is known that muscle proteins, both cytoskeletal and sarcoplasmic, have a half-life of about 42-43 days. The increased body weight, which indicates the domination of anabolic over catabolic processes, may be responsible for the high serum concentration of both transaminases at the end of fattening.

The low but significantly greater serum total protein concentration was shown at the end of fattening (7.95 *vs* 7.53 g/dl, $P<0.01$). On the other hand, urea level which is

Table 1. Blood serum biochemical indicators across fattening stages

Trait	First fattening stage (n=98)		Second fattening stage (n=98)	
	mean	SD	mean	SD
Daily gain (g)	899[A]	157	747[B]	124
Thyroxine – T$_4$ (ng/l)	54.10[A]	11.26	42.52[B]	9.53
Triiodothyronine – T$_3$ (ng/l)	0.732	0.272	0.684	0.187
AspAT (IU/l)	38.89[A]	11.36	69.06[B]	24.07
ALAT (IU/l)	42.96[A]	10.63	69.78[B]	15.79
Total protein (g/dl)	7.53[A]	0.56	7.95[B]	0.66
Blood urea N (mg/dl)	19.81	4.01	19.53	3.74
Cholesterol (mg/dl)	93.17[A]	12.69	110.56[B]	23.73

[AB]Within rows means bearing different superscripts differ significantly at P≤0.01.

the end- product of nitrogen metabolism, did not show significant changes, similarly as in the earlier report [Kapelański *et al*. 2000]. Other authors, however, observed higher serum concentrations of urea, both when the rations contained more protein and when the ration's amino acids were improperly formulated [Więcek and Skomiał 2000].

Highly significant differences were shown in the serum cholesterol between the middle and the end of fattening (93.17 *vs* 110.56 mg/dl). Similar results were obtained by Kapelański *et al*. [2000]. Total cholesterol concentration in blood depends both on the amount of dietary cholesterol and on its endogenous production, mainly by hepatic cells. A certain explanation of the effect of dietary cholesterol on its level in blood is offered by Pond *et al*. [1992]. They selected pigs for high or low blood cholesterol for three generations and then offered them feeds high or low in fat and cholesterol. Marked differences in the effect of the diets appeared in the animals selected for low blood cholesterol. Further studies of these authors [Pond *et al*. 1997] showed that selection continued over seven generations resulted in significant differences in the level of cholesterol only until generation 4. In further generations the differences in cholesterol content of blood between the two lines did not increase and remained on the level of about 40-50%.

To show closer relationships between fattening and slaughter traits of the pigs and their serum biochemical indicators as determined for the first and second fattening stage, the respective correlation coefficients were calculated (Tab. 2 and 3).

Values given in Table 2 concern the relationship between the indicators of blood from the end of the first fattening stage and performance traits of pigs. The level of thyroxine determined was negatively correlated with backfat thickness (r = -0.290**) and fat per cent of carcass (r = -0.249*). Considering that the increment in adipose tissue occurs in pigs at a later stage of growth, mainly in the second stage of fattening, the relationship between T_4 concentration and carcass fatness points to a very strong effect

Table 2. Correlation coefficients between blood serum biochemical indicators determined during the first fattening stage and body weight gain and carcass characteristics

Correlated traits	First fattening stage						
	T_3	T_4	AspAT	ALAT	total protein	blood urea N	cholesterol
Daily body weight gain (g)							
first fattening stage	-0.038	0.075	-0.009	0.176	-0.087	0.101	0.190
second fattening stage	0.047	-0.144	-0.005	0.043	-0.247*	-0.062	0.189
total fattening period	0.011	-0.028	-0.018	0.169	-0.228*	0.028	0.280*
Mean backfat thickness from 5 measures (cm)	-0.290**	-0.162	-0.011	0.228*	0.065	0.194	0.122
Fat per cent of carcass	-0.249*	-0.094	0.119	0.185	0.192	0.319**	0.311**
Lean per cent of carcass	0.153	0.067	-0.099	-0.043	-0.069	-0.281*	-0.161

*P≤0.05; **P≤0.01.

Table 3. Correlation coefficients between blood serum biochemical indicators determined during the second fattening stage and body weight gain and carcass characteristics

Correlated traits	Second fattening stage						
	T_3	T_4	AspAT	ALAT	total protein	blood urea N	cholesterol
Daily body weight gain (g)							
first fattening stage	0.025	-0.017	-0.239**	-0.088	-0.234*	-0.036	-0.086
second fattening stage	0.109	0.053	0.194	0.266*	-0.033	0.330**	0.093
total fattening period	0.095	0.032	-0.077	0.116	-0.183	0.178	-0.002
Mean backfat thickness from 5 measures (cm)	0.061	0.110	-0.163	0.062	-0.035	0.082	0.038
Fat per cent of carcass	0.129	0.021	-0.237*	0.027	-0.041	0.215*	0.056
Lean per cent of carcass	-0.028	0.166	0.238*	0.148	-0.067	-0.110	-0.131

*P≤0.05; **P≤0.01.

of thyroid hormones on the basic energy metabolism of the body. The lack of significant correlations between the level of triiodothyronine and the studied performance traits of pigs can be attributed to the fact that T_3, unlike T_4, is not bound by carrier proteins and, consequently, is several times more biologically active than thyroxine and has a short half-life [Malinowska, 1999].

The contribution of AspAT and ALAT transaminases to the formation of performance traits in pigs is obscure. Nevertheless, the present study showed that the higher AspAT activity in the serum of blood taken at slaughter was significantly correlated with lower weight gain during the first half of fattening ($P<0.01$), with lower fatness ($P<0.05$) and with greater meat content of carcass ($P<0.05$) – Table 3. The total protein content of blood taken in the first and second stage of fattening was significantly correlated

with daily gain. Higher gain was accompanied by lower total protein concentration ($P<0.05$) – Table 2. Serum urea level also proved correlated with the carcass traits. Its blood content at the end of the the first stage of fattening was positively correlated with fat content ($r = 0.319^{**}$) and negatively with lean content ($r = -0.281^{*}$) of carcass (Tab. 2). On the other hand, the level of urea in blood taken at slaughter (Tab. 3) was positively correlated with daily gain ($r = 0.330^{**}$) in the second stage of fattening and fat content of carcass ($r = 0.215^{*}$) .

The cholesterol content of serum only in the first stage of fattening was found related to weight gain during the whole fattening period ($r = 0.280^{*}$) and to greater fat per cent of carcass ($r = 0.311^{*}$) – Table 2. This agrees with the report of Pond *et al*. [1993], who demonstrated correlations between serum cholesterol content at the age of 8 weeks and weight of piglets at four and eight weeks of age ($r = 0.44^{**}$ and 0.46^{**}, respectively).

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Powiązania między poziomem wskaźników biochemicznych krwi a wielkością przyrostów, otłuszczeniem i umięśnieniem tuczników

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

W surowicy 98 tuczników oznaczono pod koniec pierwszej fazy tuczu i przy uboju poziom tyroksyny (T_4), trójjodotyroniny (T_3), aminotransferazy asparaginianowej (AspAT), alaninowej (ALAT), białka całkowitego, azotu mocznika i cholesterolu całkowitego. Oszacowano różnice w zawartości badanych wskaźników w surowicy krwi występujące w trakcie tuczu. Obliczono korelacje między ich stężeniami we krwi a wielkością przyrostu dziennego w obu fazach tuczu oraz wynikami rzeźnej oceny tuszy.

Wykazano szereg istotnych zmian w stężeniu poszczególnych składników w okresie tuczu. Pod koniec tuczu zmalał tylko poziom T_4 ($P<0,01$), bez istotnych zmian kształtował się poziom T_3 i mocznika, natomiast pozostałe wskaźniki, a szczególnie transaminazy wykazały znaczny wzrost ($P<0,01$). Poziom niektórych wskaźników był istotnie skorelowany z przyrostami masy ciała (białko całkowite, mocznik, AspAT i ALAT) lub z otłuszczeniem tuszy (T_4, mocznik, cholesterol i AspAT) i zawartością mięsa w tuszy (mocznik i AspAT). Uzyskane wyniki potwierdziły znaczącą rolę przemian metabolicznych organizmu w kształtowaniu cech tucznych i rzeźnych świń.