A note on the protein metabolism in lambs fed the diet supplemented with bioplex and linseed or linseed oil*

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In trial R two groups of rams, beginning with 16 kg live weight (control group and experimental group - Rc and Re, n=8 and n=9) were fattened with the concentrate containing 231 g CP and 12.0 MJ ME per kg dry matter. During 3 months Re lambs were given 3 g linseed with 3 g bioplex mineral supplement per day/ram. Both Rc and Re lambs were slaughtered at the age of 140 days. In trial E two groups of ewes, beginning with 8 kg live weight (control group and experimental group - Ec and Ee, n=10 and n=11) were fattened with the concentrate (207 g CP and 12.5 MJ ME/kg DM). Moreover, Ee lambs were given 3 g linseed oil with 3 g bioplex mineral supplement per day/ewe during 5 months. Both Ec and Ee lambs were slaughtered at the age of 158 days.

In longissimus dorsi muscle (LD) and in liver (L) measured were activities of cathepsin D (CatD), pepstatin-sensitive cathepsin D (PSCatD), acid autolytic activity (AAA), pepstatin-insensitive AAA (PIA) and leupeptin insensitive AAA (LIA). Moreover, determined were protein, RNA and DNA content in both tissues.

No differences in tissues composition were found between Rc and Re lambs. In LD the 10³RNA/protein ratio was by 35.4% (P≤0.000) and RNA concentration by 15.7% higher (P≤0.007) in Ee than in Ec ewes, but protein/10³DNA ratio was by 15.7% lower in Ee than in Ec ewes. In the liver, RNA/protein ratio was higher by 25.0% (P≤0.01), but DNA concentration by 49.5% higher in Ee than in Ec group (P≤0.001). Protein/DNA ratio was higher by 77.9% (P≤0.000), but RNA/DNA higher by 42.2% in

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Ec than in Ee ewes (P≤0.000). Higher proteolytic activities occurred in rams: CatD (P≤0.001), CatD+pepstatin (P≤0.002) and LIA (P≤0.000) in LD. CatD and PSCatD were higher in ewes LD (P≤0.001 and P≤0.003). In the liver, however, AAA (P≤0.042) and LIA (P≤0.016) were higher in rams while PIA in ewes (P≤0.004). No differences were found between groups in both trials in inhibition of cathepsin D activity in LD and in liver at pH 3.75 judging by pepstatin inhibition and in AAA inhibition by pepstatin in LD and in the liver. In trial R, leupeptin inhibited by 23.3% more (P≤0.01) in Rc than in Re rams, but in trial E no difference was found in inhibition rate between groups. The rise of the activity of mostly CatD (by 27.3%), PSCatD (by 12.3%) and LIA (by 69.5%) in the linseed fed rams (Re) and of CatD (by 18.0%) and PSCatD (by 23.9%) in the linseed oil fed ewes (Ee), both indicate a higher protein breakdown in their tissues, much more intensive by cathepsin D in rams than in ewes, where the higher thiol proteinases activity was found.

KEY WORDS: bioplex / cathepsin D / lambs / linseed / protein metabolism / thiol proteinases

The turnover of most functional proteins in the body is a continual process involving the destruction of individual protein molecules by proteolysis and their replacement by the processes of protein synthesis. The final stages of proteolysis involve either the lysosomal – cathepsins – or nonlysosomal route of intracellular protein catabolism – mostly calpains and proteasomes [Goll et al. 1989, Johari et al. 1993, Thompson and Palmer 1998]. Whereas nonlysosomal degradation occurs at a fairly constant rate of 1-1.5% in most cells, the lysosomal contribution varies from 0 to 4% of the total protein content of the cell per hour, depending on nutritional and hormonal conditions [Seglen and Bohley 1992]. Cathepsin system degrades intracellular and extracellular proteins, and actin and myosin are the main myofibrillar proteins degraded by these enzymes. Increased myofibrillar proteolysis is responsible for whole body wasting and changes in protein turnover as well as the meat tenderness and quality [Quali 1992]. According to some authors, the rate of protein degradation varies in the same way as activity of cathepsin D in various rat muscles [Millward et al. 1981] and chicken muscle [Stauber et al. 1977]. Therefore, by measuring the changes in the activity of cathepsin D one can easily follow changes in the degradation rate of proteins.

During the last few years, in the trade with the European Union, there has been a quite dynamic increase in lean meat product characterized by high nutritive value. To improve the dietetic value of the lamb meat, in the feeding programmes of animals, the supplementation of a diet with either seed of oily plants or oils rich in non-saturated fatty acids allows to modify the profile of fatty acids in the tissues [Choi et al. 1999, Jakobsen 1999, Piechnik et al. 1999, Mir et al. 2000]. The purpose of modifying animal fats is to produce high quality products, which meet the dietary recommendations as far as the optimum ratio of saturated to non-saturated fatty acids is concerned. In the case of lamb, the change of fatty acids profile can be achieved by feeding the animals with the addition of oily seeds (100 g/lamb/day) during one month [Patkowska-Sokoła et al. 2000. Reklewski [2000] showed, that 3 g linseed together with 3 g bioplex fed daily per goat during a month led to desirable changes in the profile of fatty acids of milk.
Such a low addition of oily seeds does not increase the diet energy level significantly, which in the case of higher doses applied to ruminants may reduce the milk production or increase the fattening of animals.

In light of this, small doses of linseed or linseed oil with bioplexes were used to estimate their effect when fed to lambs on some aspects of protein metabolism (activity of selected lysosomal proteolytic enzymes) and to get an insight into the nature of muscle composition (RNA, DNA and protein content) of longissimus dorsi muscle and liver of lamb. Fattening performance and slaughter quality indicators of lambs used in this study are being subjected to a separate elaboration.

**Material and methods**

**Animals**

Crossbred lambs were used (50% Booroola, 50% Olkuska sheep) born on the Institute Farm at Jastrzębiec. The lambs were fed according to Polish Feeding Standards [1996]. Metabolizable energy level of the concentrate was calculated according to Urbaniak [1994] based of proximate analysis and equation of regression.

**Trial R.** Ram-lambs at the age of 55 (±2.6) days and live body weight of 16 (±2.5) kg were randomly assigned to control (Rc, n=8) and experimental (Re, n=9) group. Rams from both groups were kept in individual straw-bedded pens and individually fed ad libitum a granulated concentrate diet (231 g crude protein and 12 MJ metabolizable energy per kg dry matter) with free access to water up to the live body weight of 35 (±3.4) kg. To ensure proper rumen function, all the lambs were offered about 0.1 kg first-cut meadow hay per head daily. The lambs were fed over a period of 3 months (mean daily gain about 230 g/head), in which Re animals were administered 3 g of linseed and 3 g of bioplex (Ca, Mg, Fe, Cu, Co, Mn, Zn, Se) per head daily, between 9.00 and 10.00 a.m. Mixed supplements were administered individually to each experimental animal directly into the oesophagus, using a syringe. The rams were housed to the age of 141 (±15.6) days. At the beginning and at the end of experiment the mean live body weights and ages were similar in Rc and Re lambs. For biochemical determinations the samples were taken from randomly chosen four Rc and five Re lambs.

**Trial E.** Ewe-lambs at the age of 22 (±2.4) days and live body weight of 8 (±1.3) kg were randomly assigned to control (Ec, n=10) and experimental (Ee, n=11) group. Ewes of each group were kept together in one straw-bedded pen and fed ad libitum a concentrate diet (207 crude protein and 12.5 MJ metabolizable energy per kg dry matter) with access to their dams udders to suck milk (up to the age of 2 months) and free access to water, up to the body weight of 25 (±2.2) kg. To ensure proper rumen function about 0.1 kg first-cut meadow hay was offered per ewe/day. The feeding regimen described was maintained over a period of 5 months (mean daily gain about 120 g), in which the Ee lambs were administered 3 g linseed oil and 3 g bioplex (Ca, Mg, Fe, Cu, Co, Mn, Zn, Se) per head daily, between 9.00 and 10.00 a.m. The
supplements were mixed together and administered individually with the syringe
directly to the oesophagus. The ewes were housed up to the age of 158 \( \pm 2.7 \) days.
At the beginning and at the end of a trial the body weights and the ages of Ec and Ee
ewes were similar.

At the end of both trials, the lambs after 14 hours of fasting were weighted and
slaughtered. For biochemical analyses the LD muscle and liver samples were taken
out immediately, weighted and placed on ice, then frozen at \(-70^\circ\text{C}\) for subsequent
determination of protein, RNA, and DNA as well as lysosomal enzymes activity. Liver
samples were taken always from the same part of a tissue, and the muscle samples from
the middle part of LD.

**Analytical**

**Proteolytic enzyme activities.** Proteolytic activities were measured according
to the procedure of Rosochacki [1985]. Briefly, the tissue were homogenized in 10
vol. of cold 0.1% Triton X100 in water (all manipulations being done on ice). All
enzymatic activities were performed in 500 mM formic buffer, pH 3.75 (only for
autolytic activity with pepstatin the pH was 3.25) at 45°C during 1 hour. The activity
of cathepsin D was determined as pepstatin sensitive activity (PSCatD) towards 1%
hemoglobin. Pepstatin-insensitive-acid (PIA) and leupeptin-insensitive-acid (LIA)
autolytic activities were measured in the presence of 1 mM Mg\(^{++}\). Pepstatin is an
inhibitor of cathepsin D while leupeptin inhibits thiol proteinases. The activity of
proteinases is defined as \( \mu \text{g} \) of tyrosine released per mg of protein.

**Nucleic acids and protein content assays.** The nucleic acid content – RNA and
DNA – was determined in about 100 mg tissue samples according to the procedure
of Munro and Fleck [1966]. The protein level was determined in the alkaline solution
of the tissue homogenate (for enzyme assay) and of RNA and DNA samples, in RNA
solution – for the correction of RNA estimation, as well as in the proteolysis products
dissolved in 3% trichloracetic acid with Folin-Lowry reagent [Lowry 1951].

**Statistical**

The data were analysed separately for trial R and E (ram-lambs and ewe-lambs,
respectively) with analysis of variance [Harvey 1990] according to the model:

\[
y_{ij} = \mu + a_i + e_{ij}
\]

where:

- \( y_{ij} \) – an observation;
- \( \mu \) – overall mean;
- \( a_i \) – fixed effect of \( i \)-th feeding regimen (without or with the supplemen-
tation, \( i = 1, 2 \));
- \( e_{ij} \) – random error.
To evaluate the differences between per cent activity inhibition, the square root transformation was done, and than analysis of variance was performed.

**Results and discussion**

As the retention of muscle proteins is a difference between their synthesis and degradation, both processes are very important for the final muscle weight gain. In both trials no significant differences were found in the protein content of both examined tissues between lambs fed with or without supplements (Tab. 1 and 2).

There is evidence of remarkable sensitivity of the overall rate of protein degradation in muscle and liver to nutritional factors [Waterflow *et al.* 1978, Millward *et al.* 1980] The control of protein degradation in skeletal muscles is important for energy and protein homeostasis and muscle and body growth. All measured enzymatic activities were higher in experimental animals (Re and Ee) except PIA in rams and AAA in ewes; some of them were significantly different between control and experimental lambs (Tab. 1). In trial R the rams’ LD showed higher activities of some lysosomal enzymes in experimental, i.e. linseed fed animals (Re group) – CatD, CatD + pepstatin and LIA – P≤0.01, P≤0.002 and P≤0.000. Higher, but not significantly, were also PSCatD and AAA activities in Re as compared to Rc lambs. It should be emphasized that similar rise in CatD + pepstatin (by 60.1%) and LIA (by 69.5%) activities were obtained, both reflecting cathepsin D with hemoglobin and muscle’s own proteins (homogenate) as

<table>
<thead>
<tr>
<th>Trait</th>
<th>Trial R (rams)</th>
<th>Trial E (ewes)</th>
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<tr>
<td></td>
<td>group Rc (n=4)</td>
<td>group Re (n=5)</td>
</tr>
<tr>
<td>Protein (%)</td>
<td>mean 16.1 0.59</td>
<td>mean 16.5 0.51</td>
</tr>
<tr>
<td>CatD</td>
<td>83.5 2.91</td>
<td>106.3 5.35</td>
</tr>
<tr>
<td>CatD+PEP</td>
<td>31.6 1.65</td>
<td>50.6 3.10</td>
</tr>
<tr>
<td>PSCatD</td>
<td>51.9 3.58</td>
<td>58.3 4.76</td>
</tr>
<tr>
<td>% of inhibition</td>
<td>62.0 2.66</td>
<td>56.1 1.23</td>
</tr>
<tr>
<td>AAA</td>
<td>55.3 1.21</td>
<td>60.7 2.37</td>
</tr>
<tr>
<td>PIA</td>
<td>14.7 1.27</td>
<td>14.5 1.48</td>
</tr>
<tr>
<td>% of inhibition</td>
<td>73.5 1.90</td>
<td>76.2 1.76</td>
</tr>
<tr>
<td>LIA</td>
<td>16.4 1.06</td>
<td>27.8 0.99</td>
</tr>
<tr>
<td>% of inhibition</td>
<td>70.3 1.50</td>
<td>53.9 2.59</td>
</tr>
<tr>
<td>Body weight (kg)</td>
<td>37.1 1.84</td>
<td>36.4 1.49</td>
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1Abbreviations: Cat D – cathepsin D, PSCat D – pepstatin-sensitive cathepsin D (measured towards 1% hemoglobin); AAA – acid autolytic activity, PIA – pepstatin-insensitive acid autolytic activity, LIA – leupeptin-insensitive acid autolytic activity, PEP – pepstatin.
a substrate, respectively. In the case of ewes fed linseed oil –group Ee – significantly different activities from group Ec were found only in CatD and PSCatD in the LD muscle (P≤0.001 and P≤0.003), although some other activities were higher in the same experimental (Ee) group (except AAA). In ewes, mean PIA was 33.4 vs. 14.6 in rams showing the probably much better participation of thiol cathepsins in the destruction of the muscles’ protein in this group of animals, but also the effect of the linseed oil supplement to the diet. The ratio of PSCatD/PIA was highest in rams – 3.53 and 4.02 in Rc and Re lambs, respectively – compared to 1.04 and 1.21 in ewes (group Ec and Ee, respectively). Despite the different feeding programmes in two trials, this ratio indicates higher participation of CatD in the process of proteolysis in the muscle of rams as compared to the muscle of ewes, but in the ewes muscle mostly thiol cathepsin was active.

In the liver, AAA (P≤0.042) and LIA (P≤0.016) activities were significantly higher in Re than in Rc lambs, while PIA activities in ewes were by 16.4% higher in Ee than in Ec group (P≤0.004). PIA was also higher in the LD of ewes than in the LD of rams. PSCatD/PIA ratio was similar in both groups of animals, indicating similar pattern of protein breakdown in the liver.

Higher proteolytic enzymes activity (e.g. of cathepsin) in both Re and Ee lambs could result from the effect of supplement as such and the changes in cathepsin-cystatin interactions rather, than from gene expression. The mean inhibition rates of CatD by pepstatin and of AAA by leupeptin were lower by about 9.5% and 23.3%, respectively in Re than in Rc lambs. So, the level of aspartic and thiol enzymes in the muscle was lower in Re than in Rc lambs, but their activities were much higher. That means, that proteolytic enzymes were more active in Re rams. In the present study, the AAA

### Table 2. Enzymatic activity in the liver of lambs (μg of tyrosine per mg protein) and inhibition (%) of cathepsin D by pepstatin and acid autolytic activity by pepstatin and leupeptin

<table>
<thead>
<tr>
<th>Trait</th>
<th>Trial R (rams)</th>
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<th>Trial E (ewes)</th>
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<tr>
<td></td>
<td>group Rc (n=4)</td>
<td>group Re (n=5)</td>
<td></td>
<td></td>
<td>group Ec (n=10)</td>
<td>group Ee (n=11)</td>
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<tr>
<td></td>
<td>mean SE</td>
<td>mean SE</td>
<td>P</td>
<td>mean SE</td>
<td>mean SE</td>
<td>P</td>
<td>mean SE</td>
<td>mean SE</td>
</tr>
<tr>
<td>Protein (%)</td>
<td>17.4 0.50</td>
<td>16.1 0.95</td>
<td>0.078</td>
<td>17.1 0.4</td>
<td>17.5 0.3</td>
<td>0.392</td>
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<tr>
<td>CatD</td>
<td>503.0 32.0</td>
<td>545.0 20.0</td>
<td>0.290</td>
<td>578.0 17.0</td>
<td>570.0 13.0</td>
<td>0.735</td>
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<tr>
<td>CatD+PEP</td>
<td>283.0 13.0</td>
<td>319.0 15.0</td>
<td>0.127</td>
<td>337.0 7.0</td>
<td>326.0 7.0</td>
<td>0.294</td>
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<tr>
<td>PSCatD</td>
<td>221.0 24.0</td>
<td>226.0 20.0</td>
<td>0.864</td>
<td>242.0 16.0</td>
<td>244.0 13.0</td>
<td>0.903</td>
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<tr>
<td>% of inhibition</td>
<td>43.5 2.53</td>
<td>41.4 2.70</td>
<td>0.588</td>
<td>42.0 1.6</td>
<td>42.6 1.6</td>
<td>0.784</td>
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<tr>
<td>AAA</td>
<td>353.0 21.0</td>
<td>413.0 14.0</td>
<td>0.042</td>
<td>410.0 11.0</td>
<td>435.0 11.0</td>
<td>0.114</td>
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<tr>
<td>PIA</td>
<td>189.0 13.0</td>
<td>187.0 16.0</td>
<td>0.925</td>
<td>195.0 18.0</td>
<td>227.0 6.0</td>
<td>0.004</td>
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</tr>
<tr>
<td>% of inhibition</td>
<td>46.0 3.11</td>
<td>54.9 2.9</td>
<td>0.084</td>
<td>52.2 2.2</td>
<td>47.7 1.2</td>
<td>0.072</td>
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<tr>
<td>LIA</td>
<td>299.0 15.0</td>
<td>362.0 13.0</td>
<td>0.016</td>
<td>348.0 8.0</td>
<td>356.0 4.0</td>
<td>0.370</td>
<td></td>
<td></td>
</tr>
<tr>
<td>% of inhibition</td>
<td>15.1 1.29</td>
<td>12.4 1.0</td>
<td>0.140</td>
<td>15.1 1.3</td>
<td>16.5 1.1</td>
<td>0.203</td>
<td></td>
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</tr>
</tbody>
</table>

Abbreviations are explained at the bottom of Table 1.
inhibition rates by leupeptin in LD were higher than 50% in all groups (Tab. 1), and similar to those described in bulls by Rosochacki et al. [2004], but much higher than in chicken, where the inhibition by leupeptin – Rosochacki et al. [1986] – was 26% and 17% in pectoral and leg muscle, respectively. This inhibition in isolated anterior latissimus dorsi and posterior latissimus dorsi chicken muscles was about 20.9% in control and 16.5% in hypertrophic muscles [Rosochacki 1985]. This suggests that the extent of enzymatic response to the catabolism of protein in lambs is similar to that in bulls, but differs substantially from that in chickens, which may be connected with the different fates of feed in the digestion tract. It supports the hypothesis that in chicken muscles some other proteolytic systems substantially participate in the degradation of myofibrillar proteins. To the contrary, in the muscle of lambs aspartic and thiol proteinases have the major contribution in miofibrillar proteolysis. To our knowledge, this is a first attempt to characterize the degrading system in these tissues in lambs.

No significant differences were identified in the tissue composition in rams LD muscle and liver. The maximum capacity for protein synthesis – CPS – (measured as 10^3 RNA/protein ratio) was found only in the LD of Ee lambs (P≤0.000), being 1.53 (i.e. by 35.4% higher than in Ec) at the age of 158 days being in accordance with the higher protein content of the ewes muscles (Tab. 1 and 3). In Piedmontese bulls aged 18 months (about 540 days) the ratio was 1.126, and only 0.968 in Black-and-White bulls [Rosochacki et al. 2004]. In our earlier experiment with much younger animals, the CPS values in a semidentinosus muscle were 6.84 for 0-34 days-old, 6.00 for 66-115 days-old and 4.8 for 190 days-old calves [Rosochacki et al. 1990]. In isolated ALD- slow (red) and PLD-fast (white) muscles of adult chicken the respective values were 9.4 and 5.0 [Rosochacki 1985]. The CPS in LD of 6-month-old Duroc pigs was 1.96, but in Pietrain – 1.60 [Rosochacki et al. 2000]. Results described in the present report show that the capacity of protein synthesis in lamb LD is quite small as compared to the muscles of other animal species. CPS also decreases with the animal’s age. As it can be seen from Table 3, the CPS was by about 35.4% higher in Ee than in Ec lambs. This difference can mostly be attributed to a rise in rRNA transcription, as the measured RNA is mostly of ribosomal origin. This is in accordance with the concentration of RNA, being higher by 15.7% in the same group of animals. From the present report it appears that ewe-lambs fed the diet enriched with linseed oil and mineral bioplex (group Ee) accumulated protein in the cells faster than did those from remaining groups.

Protein/10^3DNA ratio, called functional cell size (FCS), is a suitable indicator of estimating cell size as the imaginary volume of cytoplasm controlled by a single nucleus [Cheek et al. 1971]. Within a given muscle there are different proportions between individual fibre types and these may affect its size and metabolism. The results presented here demonstrate quite marked differences occurring between groups of lambs. FCS was found much higher in control (by 13.0% in rams and by 37.0% in ewes) than in experimental groups (P≤0.001), being probably influenced by the difference in diet and also indicating higher FCS in rams than in ewes. In our
earlier experiment with *semitendinosus* muscle of calves [Rosochacki et al. 1990] protein/10^3 DNA ratio increased with the animals’ age – 2.3-fold in hypertrophic muscle and 2.6 fold in control calves – reaching in six months-old animals about 787 and 755, but in 15 weeks-old ones 522 and 452, respectively. The lower DNA concentration and higher protein/DNA ratio in rams than in ewes suggest that rams reached higher muscle (and physiological) maturity, which may also be related to the quality of meat.

Composition of lambs liver is shown in Table 4. Significant differences were identified only within ewes – trial E. CPS (10^3 RNA/protein) was higher by 25.0% (P≤0.01) and DNA concentration by 49.5% (P≤0.001) in Ee, whereas FCS (protein/10^3 DNA) was higher by 77.9% and RNA/DNA ratio by 42.2% in Ec (P≤0.01 and P≤0.000).

The rise in the activity of proteolytic enzymes – mostly CatD (by 27.3%), CatD+pepstatin (by 60.1%), PSCatD (by 12.3%) and LIA (by 69.5%) with the

### Table 3. Composition of lambs’ LD muscle

<table>
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<tr>
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<tbody>
<tr>
<td></td>
<td>group Rc (n=4)</td>
<td>group Re (n=5)</td>
</tr>
<tr>
<td>mg RNA/g tissue</td>
<td>mean SE</td>
<td>mean SE</td>
</tr>
<tr>
<td>10^3 RNA/protein (CPS)</td>
<td>24.7 1.44</td>
<td>25.7 0.99</td>
</tr>
<tr>
<td>mg DNA/g tissue</td>
<td>0.91 0.03</td>
<td>1.07 0.10</td>
</tr>
<tr>
<td>Protein/10^3 DNA (FCS)</td>
<td>28.4 1.98</td>
<td>28.0 2.11</td>
</tr>
<tr>
<td>RNA/DNA</td>
<td>939.0 76.0</td>
<td>831.0 57.0</td>
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</table>

### Table 4. Composition of lambs’ liver

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</tr>
<tr>
<td>mg RNA/g tissue</td>
<td>mean SE</td>
<td>mean SE</td>
</tr>
<tr>
<td>10^3 RNA/protein (CPS)</td>
<td>213.0 8.0</td>
<td>203.0 11.0</td>
</tr>
<tr>
<td>mg DNA/g tissue</td>
<td>7.70 0.26</td>
<td>8.69 0.47</td>
</tr>
<tr>
<td>Protein/10^3 DNA (FCS)</td>
<td>143.0 9.0</td>
<td>124.0 8.0</td>
</tr>
<tr>
<td>RNA/DNA</td>
<td>196.0 13.0</td>
<td>191.0 10.0</td>
</tr>
</tbody>
</table>

earlier experiment with *semitendinosus* muscle of calves [Rosochacki et al. 1990] protein/10^3DNA ratio increased with the animals’ age – 2.3-fold in hypertrophic muscle and 2.6 fold in control calves – reaching in six months-old animals about 787 and 755, but in 15 weeks-old ones 522 and 452, respectively. The lower DNA concentration and higher protein/DNA ratio in rams than in ewes suggest that rams reached higher muscle (and physiological) maturity, which may also be related to the quality of meat.

Composition of lambs liver is shown in Table 4. Significant differences were identified only within ewes – trial E. CPS (10^3RNA/protein) was higher by 25.0% (P≤0.01) and DNA concentration by 49.5% (P≤0.001) in Ee, whereas FCS (protein/10^3DNA) was higher by 77.9% and RNA/DNA ratio by 42.2% in Ec (P≤0.01 and P≤0.000).

The rise in the activity of proteolytic enzymes – mostly CatD (by 27.3%), CatD+pepstatin (by 60.1%), PSCatD (by 12.3%) and LIA (by 69.5%) with the
significance level of differences as high as $P \leq 0.000$ in Re and in CatD by 18.0% ($P \leq 0.001$), PSCatD by 23.9% in the Ee lambs ($P \leq 0.003$), indicates a higher protein breakdown by cathepsin D in the tissue of Ee and Re, than of Ec and Rc lambs. It can be concluded that thiol proteinases were more active in linseed oil-fed ewes than in linseed-fed rams. Some changes might be connected with the protein metabolism (among some other physiological changes in the muscle) in ewes, as result of higher PSCatD and thiol proteinases activities in the muscles.

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Protein metabolism in lambs fed the supplement of bioplex with linseed or linseed oil

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Metabolizm białka jagniąt żywionych z dodatkiem biopleksu i siemienia Inianego lub biopleksu i oleju Inianego

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

Doświadczenia przeprowadzono na jagniętach mieszanych (50% boorooli i 50% owcy olkuskiej). W doświadczeniu R (trial R) tryczki o średniej wyjściowej masie ciała 16 kg tuczono do średniej masy ciała 35 kg i ubijano. W okresie tucz tryczki grupy kontrolnej (Re, n=8) i doświadczalnej (R, n=9) żywiono indywidualnie do woli pełnoporcjowym granulatem, zawierającym 231 g białka ogólnego i 12 MJ energii metabolicznej w kg suchej masy, podając dousznie każdemu tryczkowi z grupy Re trzy gramy siemienia lnianego lub biopleksu dziennie. W doświadczeniu E (trial E) maciorki o średniej wyjściowej masie ciała 8 kg tuczono do uzyskania masy ciała 25 kg i ubijano. W okresie tucz maciorki grupy kontrolnej (Ec, n=10) i doświadczalnej (Ee, n=11) żywiono grupowo do woli pełnoporcjową mieszaną treściwą zawierającą 207 g białka ogólnego i 12,5 MJ energii metabolicznej w kg suchej masy, podając dousznie każdej maciorce z grupy Ee trzy gramy oleju lnianego i trzy gramy biopleksu dziennie. Po ubiciu jagniąt pobrano (losowo od czterech tryczków z grupy kontrolnej i pięciu z grupy doświadczalnej oraz od wszystkich 21 maciork) próbki mięśnia najdłuższego grzbietu (LD) i wątroby do analiz biochemicznych. W pobrany materiale mierzono aktywność katepsyny D (CatD), katepsyny D czulej na pepstatynę (PSCatD), kwaśną aktywność autolityczną (AAA), AAA odporną na pepstatynę (PIA) i odporną na leupeptynę (LIA) oraz zawartość DNA, RNA i białka. W LD, wydajność w syntezie białka (capacity for protein synthesis - CPS) była wyższa o 35.4% (P≤0.000), a stężenie RNA wyższe o 157 % (P≤0.007) w grupie Ee niż w Ec. „Czynnościowa wielkość komórki” (functional cell size - FCS) była o 37.0% wyższa w grupie Ec (P≤0.001) niż w Ee. W wątrobie, CPS była wyższa o 25.0% (P≤0.01), a stężenie DNA wyższe o 49.5% w grupie Ec niż w Ee (P≤0.000). FCS była wyższa o 77.9% (P≤0.000), a stosunek RNA/DNA większy o 42.2% u maciorek kontrolnych (P≤0.000). W LD tryczków doświadczalnych (Re) zastosowano wyższą aktywność CatD (P≤0.01), LIA (P≤0.000) i CatD+pep (P≤0.002). W LD maciorek doświadczalnych (Ee) aktywność CatD i PSCatD (P≤0.001 i P≤0.003), a w wątrobie aktywność AAA (P≤0.042), i LIA (P≤0.016) u tryczków, a LIA u maciorek (P≤0.004). Pepstatyna hamowała aktywność AAA w 75.0% w LD tryczków i w 35.0% w LD maciorek. Wzrost aktywności CatD (o 27.3%), PSCatD (o 12.3%) i LIA (o 69.5%) u tryczków grupy Re oraz wzrost CatD (o 18.0%) i PSCatD (o 23.9%) u maciorek Ee świadczą o większym stopniu degradacji białek w tkankach i wyższym udziale CatD w tym procesie u tryczków niż u maciorek. Katepsyny siarczkowe degradowały więcej białka u maciorek. Uzyskane wyniki wskazują na różnice w katabolizmie białka między jagniątami żywionymi z dodatkiem siemienia Inianego i biopleksu bądź oleju Inianego i biopleksu a jagniątami kontrolnymi.