EFFECT OF OLIGOSACCHARIDES SUPPLEMENTATION ON THE MEAT PERFORMANCE TRAITS AND SELECTED INDICATORS OF HUMORAL IMMUNITY IN LAMBS

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Abstract

The experiment was performed on 32 suckling Kamieniec lambs divided into two equal groups: I – control and II – experimental. Over a period of 60 d, experimental lambs were fed a diet supplemented with Saccharomyces cerevisiae yeast with an increased β-1,3/1,6-D-glucan and mannan-oligosaccharide content. The following meat performance parameters were determined: body weight, daily gains, growth rate, the dimensions of musculus longissimus dorsi sections, skin and subcutaneous fat thickness, and fat thickness over the loin „eye” area. Serum humoral immunity parameters: lysozyme and ceruloplasmin activities, total protein, and γ-globulin contents were determined. The yeast supplement significantly increased the values of the analysed meat performance traits. As regards the investigated humoral immunity parameters, i.e. lysozyme activity, ceruloplasmin activity (throughout the entire experiment), and γ-globulin content (from experimental day 30 to 60), significantly higher values were noted in the experimental group, compared with the control group. Statistically significant differences between the compared groups were not observed only with respect to total protein content.

Key words: lambs, β-glucan, mannan-oligosaccharide, meat performance, humoral immunity.

Rational lamb feeding is a crucial factor, which may contribute to improving the quality of sheep meat. The preferred feeding practices should account for the natural conversion of feed into lamb meat, a product of high nutritive value that delivers health benefits (16), while ensuring optimal production profitability, which is lower in traditional feeding condition. Higher effectiveness may lead to increased sheep production. One of the most recommended solutions is based on supplementation of lamb diets with natural prebiotics (7). Compounds with prebiotic activity include β-glucans and mannan-oligosaccharides (MOS), which are present in the cell walls of Saccharomyces cerevisiae yeast (15), and show immunomodulative properties (13, 24, 27, 28). Administration of Biolex–MB40 (Inter Yeast®, Poland), a prebiotic extracted from brewer's yeast (Saccharomyces cerevisiae), which contains 25%-30% of β-1,3/1,6-D-glucan and 20%-25% of MOS, had a beneficial effect on the meat performance of suckling lambs (17). Significant changes in haematological blood indicators were reported in lambs fed the yeast preparation, indicating that the above supplement had a stimulating effect on the tested animals' immune system. This problem was further analysed in this study.

The objective of this study was to determine the effect of a feed supplement containing increased levels of natural immunomodulators, β-1,3/1,6-D-glucan and MOS, extracted from Saccharomyces cerevisiae brewer's yeast, on the meat performance traits and selected indicators of humoral immunity in suckling lambs.

Material and Methods

The experiment was performed on 32 suckling Kamieniec lambs from a breeding herd. Lambs aged 30±3 d were divided into two equal groups: I – control and II – experimental, identical in terms of body weight, sex, and origin to eliminate any differences in milk yield. Animals were kept indoors, on deep litter, under the same conditions. Uniform feeding standards were applied in both groups, in line with lamb breeding requirements (19). In addition to ewe’s milk, suckling lambs were fed meadow hay, hay-silage of grass and
legumes, and CJ concentrate. The quantity of administered feed and leftovers was monitored throughout the experiment. Total amount of nutrients served in feed for 60 d of the experiment was equal in both groups, and per one lamb it was: metabolic energy (ME) 20.23 MJ, crude protein (CP) 563.12 g, and neutral detergent fibre (NDF) 718.80 g. Experimental lambs were fed the Biolex–MB40 preparation, extracted from brewer's yeast (*Saccharomyces cerevisiae*) and containing 25%-30% of β-1,3/1,6-D-glucan and 20%-25% of MOS, mixed with CJ concentrate in the amount of 3 g/kg of the diet. CJ concentrate doses, the same for both groups, were increased every 10 d by 0.05 kg/animal/d, starting from 0.15 kg/animal/day. At the beginning of the experiment (day 0) and on days 15, 30, and 60 of the study, blood was sampled from the jugular vein to determine selected indicators of humoral immunity.

The following meat performance traits were analysed: body weight at the beginning of the experiment and on days 30 and 60 of the study, daily gains and growth rate in the following periods: 1-30, 31-60, and 1-60 d of the experiment, meatiness and fatness determined in vivo by ultrasound examination directly after the experiment. Growth rate (GR) was calculated based on the following formula:

\[
GR = \frac{\text{final body weight} - \text{initial body weight}}{\frac{1}{2} (\text{initial body weight} + \text{final body weight})} \times 100 \, (\%)
\]

The dimensions of *m. longissimus dorsi* sections, including depth, width, and area, as well as skin and subcutaneous fat thickness, and fat thickness over the loin „eye” area were determined by ultrasonography. The measurements were performed behind the last rib, in accordance with the method proposed by Ślósarz (28) with the use of an SSD 500 Aloka ultrasound scanner equipped with a 7.5 MHz linear probe.

The humoral immunity of lambs was determined based on serum activity of lysozyme and ceruloplasmin and serum content of total protein and γ-globulin. Lysozyme activity was determined by the turbidimetric method proposed by Parry *et al.* (20) modified by Siwicki and Anderson (23), ceruloplasmin activity – by the method developed by Siwicki and Studnicka (25), total protein – by spectrophotometry, applying the method proposed by Lowry *et al.* (14) and modified by Siwicki and Anderson (23), and γ-globulins – by the precipitation method, as described by Siwicki and Anderson (23).

The results concerning meat performance traits were analysed statistically by Student’s *t*-test, in turn the results concerning immunity indicators in respective periods were processed statistically by a one-factorial analysis of variance in an orthogonal design. The significance of differences between groups was verified with the Duncan’s test.

**Results**

No significant differences in feed consumption were noted between the groups during the experiment. Small amounts of roughage leftovers were reported; therefore nutrient intake, including the intake of the studied yeast preparation, was similar in both groups: I – ME 20.10 MJ, CP 562.20 g, NDF 718.2 g, II – ME 20.0 MJ, CP 562.9 g, NDF 717.8 g. The administered feed supplement had a significant effect on the meat performance traits of lambs (Table 1).

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Meat performance of lambs</th>
</tr>
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<tbody>
<tr>
<td><strong>Group</strong></td>
<td>I</td>
</tr>
<tr>
<td><strong>Traits</strong></td>
<td>Mean</td>
</tr>
<tr>
<td>Body weight (kg):</td>
<td></td>
</tr>
<tr>
<td>at the beginning of the experiment</td>
<td>11.96</td>
</tr>
<tr>
<td>after 30 d of the experiment</td>
<td>17.90&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>after 60 d of the experiment</td>
<td>24.82&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Daily gains (g) in the period (d):</td>
<td></td>
</tr>
<tr>
<td>1-30</td>
<td>197.86&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>31-60</td>
<td>230.95</td>
</tr>
<tr>
<td>1-60</td>
<td>214.40&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Growth rate (%) in the period (d):</td>
<td></td>
</tr>
<tr>
<td>1-30</td>
<td>40.54&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>31-60</td>
<td>32.64</td>
</tr>
<tr>
<td>1-60</td>
<td>70.60&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td><em>M. longissimus dorsi</em> ultrasound scanning:</td>
<td></td>
</tr>
<tr>
<td>depth (cm)</td>
<td>1.84</td>
</tr>
<tr>
<td>width (cm)</td>
<td>5.33&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>area (cm²)</td>
<td>7.92&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Skin and subcutaneous fat thickness over the loin „eye” area (cm)</td>
<td>0.47</td>
</tr>
<tr>
<td>Fat thickness over the loin „eye” area (cm)</td>
<td>0.22</td>
</tr>
</tbody>
</table>

<sup>a, b</sup> - P≤0.05; <sup>A, B</sup> - P≤0.01 M.L.
The body weight of experimental lambs was significantly higher (P ≤ 0.05) in comparison with control lambs (group I), after both 30 and 60 d of the experiment. The above resulted from higher daily weight gains. The noted differences between groups II and I were statistically significant on the first 30 d (P ≤ 0.01), as well as throughout the entire experimental period (P ≤ 0.05). The above affected the growth rate, which was significantly higher throughout the entire experimental period and on the first 30 d in the group fed the preparation (P ≤ 0.05), while the second half of the experiment brought similar results to those observed in the control lambs. A higher growth rate corresponded to the dimensions of m. longissimus dorsi measured in an ultrasound examination. The width and area of the muscle were significantly higher in experimental lambs (P ≤ 0.05).

As regards the investigated indicators of humoral immunity, i.e. lysozyme and ceruloplasmin activities throughout the entire experiment, and serum concentrations of γ-globulins between day 30 and 60 of the study, significantly higher values (P ≤ 0.01; P ≤ 0.05) were found in the experimental group than in the control group (Table 2). Animals from group II showed a significant (P ≤ 0.01) increase in lysozyme and ceruloplasmin activity on successive days of the experiment (day 15, 30, and 60) in comparison with day 0. Statistically significant differences between the experimental group and control group were not observed only with regard to serum concentration of total protein throughout the entire period of the study.

**Discussion**

The acquired results concerning stimulating influence of Biolex MB-40 on lambs growth rate confirms the earlier findings of Milewski (17). The growth rate of all lambs was slower in the second half of the experiment, most probably due to a decrease in the ewes' milk yield with the progress of lactation. It was also noted that the parameters showing a positive correlation with total carcass fat content, i.e. fat thickness, skin and subcutaneous fat thickness measured over the loin „eye” area (8, 28), were similar in all lambs. This was a positive trend, which showed that the administered preparation did not increase the body fat content in lambs. Therefore, the increased values of m. longissimus dorsi parameters in experimental lambs, particularly of the muscle area highly correlated with the total meat content of the carcass (28), which indicates that the tested preparation had a favourable effect on tissue composition.

The positive effect of Biolex–MB40 in lamb nutrition and the resulting health benefits are due to the prebiotic qualities of the product. The meat performance parameters noted in this study correspond to the findings of Milewski (17) concerning lambs raised until 70 d of age. This author reported significant changes in haematological blood indicators, which suggests that Biolex–MB40 had a stimulating effect on the immune system of lambs. The above findings were clearly validated by this study. Biolex–MB40 was also found to exert a beneficial effect on animal productivity in a study of cows (5) where it increased milk yield by around 9%, and had a stimulating impact on the immune system of cows. The analysed prebiotic improved also the performance of calves (27). In the above experiment, the animals were fed Alphamune (Alpharma), a preparation containing β-1,3/1,6-glucans and β-mannans. In addition to higher weight gains, a significant increase in the activity of IL-1 interleukin, and consequently quantitative changes in lymphocyte subpopulations were observed in calves. Animals fed the above preparation were characterised by much higher vitality, improved body condition and much lower susceptibility to infections than control group calves. Biolex–MB40 owes its immunostimulating effect to the activity of β-1,3/1,6-D-glucans and MOS (4, 10, 12, 13, 27, 29, 30). The mechanism of activity of β-1,3/1,6-glucans is mainly based on the stimulation of immunocompetent cells (3, 13, 24, 30), leading to an increase in the number of released acute phase proteins, such as ceruloplasmin (9), lysozyme – a natural anti-viral and anti-microbial agent (1), and γ-globulins (6). MOS have a more complex mechanism of their activity. In our study, level of ceruloplasmin – an acute phase

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### Table 2

Humoral immunity parameters of lambs

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Group</th>
<th>Investigation days</th>
<th>Mean</th>
<th>SD</th>
<th>Mean</th>
<th>SD</th>
<th>Mean</th>
<th>SD</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lysozyme activity (mg/L)</td>
<td>I</td>
<td>0</td>
<td>0.79</td>
<td>0.08</td>
<td>0.79</td>
<td>0.09</td>
<td>0.77</td>
<td>0.08</td>
<td>0.81</td>
<td>0.06</td>
</tr>
<tr>
<td></td>
<td>II</td>
<td>15</td>
<td>0.79</td>
<td>0.06</td>
<td>1.09</td>
<td>0.09</td>
<td>1.14</td>
<td>0.06</td>
<td>1.17</td>
<td>0.04</td>
</tr>
<tr>
<td>Ceruloplasmin</td>
<td>I</td>
<td>0</td>
<td>31.75</td>
<td>0.61</td>
<td>31.28</td>
<td>1.15</td>
<td>31.60</td>
<td>0.49</td>
<td>31.22</td>
<td>0.61</td>
</tr>
<tr>
<td></td>
<td>II</td>
<td>15</td>
<td>31.20</td>
<td>0.77</td>
<td>37.18</td>
<td>0.98</td>
<td>37.52</td>
<td>0.7</td>
<td>37.48</td>
<td>1.38</td>
</tr>
<tr>
<td>Total protein</td>
<td>I</td>
<td>0</td>
<td>57.18</td>
<td>4.07</td>
<td>62.28</td>
<td>3.88</td>
<td>57.30</td>
<td>2.26</td>
<td>58.15</td>
<td>3.22</td>
</tr>
<tr>
<td></td>
<td>II</td>
<td>15</td>
<td>57.70</td>
<td>2.85</td>
<td>61.67</td>
<td>2.24</td>
<td>56.17</td>
<td>1.53</td>
<td>56.25</td>
<td>3.75</td>
</tr>
<tr>
<td>Lysozyme concentration (g/L)</td>
<td>I</td>
<td>0</td>
<td>0.79</td>
<td>0.08</td>
<td>0.79</td>
<td>0.09</td>
<td>0.77</td>
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<td>1.15</td>
<td>31.60</td>
<td>0.49</td>
<td>31.22</td>
<td>0.61</td>
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<td>II</td>
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<td>0.77</td>
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<td>56.17</td>
<td>1.53</td>
<td>56.25</td>
<td>3.75</td>
</tr>
</tbody>
</table>

a, b - P ≤ 0.05; A, B - P ≤ 0.01,
* - P ≤ 0.05 in relation to day 0,
** - P ≤ 0.01 in relation to day 0.
protein, increased in serum of animals fed the MOS preparation. Similar results were observed by Burkey et al. (2) in pigs supplemented with MOS – in this trial authors noticed an elevation in serum haptoglobin. The reason for these phenomena was unknown, similarly to our study, and its explanation needs further investigations. It has been suggested that in addition to the immunostimulating function of MOS, they affect intestinal morphology and functions (11). MOS change the structure of microbial flora colonising the digestive tract. By becoming attached to mannose-binding proteins, MOS create competitive bonds to those formed between fimbrial lectins and the host's carbohydrate receptors (22). The above mechanism prevents pathogenic bacteria from colonising the gastrointestinal system (18). Oligosaccharides are not degraded by the digestive enzymes of the small intestine, therefore the activities as well as Simultaneously, increased lysozyme and ceruloplasmin as a higher growth rate and better muscle development, immunity. In meat performance range, it is manifested MOD, which led to a significant improvement in overall production results.

It may be concluded that the administration of yeast preparations containing β-1,3/1,6-D-glucan and MOS to suckling lambs has a stimulating effect on meat performance traits and selected indicators of humoral immunity. In meat performance range, it is manifested as a higher growth rate and better muscle development, without disadvantageous fatness increase. Simultaneously, increased lysozyme and ceruloplasmin activities as well as γ-globulin concentration in blood serum suggest active influence of adopted preparation on defence mechanism. It seems that an increase in lambs' immunity had significant influence on their meat performance traits.

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