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# THE EFFECT OF FEEDING CORN SILAGE ON WEIGHT GAINS AND MEAT QUALITY OF LAMBS

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*Production of lamb depends, among other things, on the feeding system, including the type of feed. One of the cheapest feeds in the winter feeding of sheep can be good quality corn silage. The aim of this study was to determine the effect of corn silage on weight gain of lambs and on the physicochemical characteristics of their meat. The study included 30 lambs of old-type Polish Merino Sheep, divided into three experimental groups of 10 each, with equal sex ratio. The control group (K) received a diet consisting of meadow hay and concentrated feed, while experimental groups were fed a diet with corn silage (D0 – without silage additive, D1 – with biological silage additive). During the experiment the lambs were weighed three times. On the last day of the study, the animals were slaughtered and longissimus dorsi muscle (loin) was subjected to meat quality assessment. The results were statistically analysed. The feed supplemented with corn silage had no effect on the body weight gains of lambs and physicochemical characteristics of their meat.*

*Key words: corn silage, lamb, meat quality, weight gain*

Production of good quality lamb meat depends on production technology, weight standard of the lambs, their breed, and feeding system (Borys and Borys, 2011; Sanudo et al., 1998). Of the dietary factors, the type of ingested feed has the greatest effect on the quality of their meat (Grześkowiak et al., 2009).

Corn is a very popular crop plant with high yield potential. Other advantages of corn include the large number of varieties and well-known production technology. In Poland, corn is essentially grown for two types of feed: whole crop silage, and grain or cobs. Although the advantages of corn silage in the nutrition of ruminants, mainly dairy cows, have been long known, its use in sheep is not very common. According to Wand and Topp (2014), corn silage is a potentially profitable way to get energy into a ewe's

rations and is a viable alternative to feeding concentrates and dry fodder. In our study, lambs were fed 23% corn silage on a d.m. basis. Luimes (2011) concluded that feeding lambs with corn silage at 25% of a ration on a d.m. basis was associated with poorer body weight gains and lower quality of meat, while a 50% corn silage ration resulted in slower increase in body weight of the young lambs. According to Beukes (2013), 20% corn silage on a d.m. basis can be included during the final period of fattening without a negative effect on feed intake, performance, and meat quality. It was also pointed out that in the case of other parameters, such as dressing percentage, feeding lambs with a lower proportion of corn silage (25–50% of the ration d.m.) produced better results than corn silage fed at 70% of the ration d.m. (van de Vyver et al., 2013).

The aim of the study was to determine the effect of dietary inclusion of corn silage on body weight gains of lambs and on physicochemical characteristics of their meat.

## Material and methods

Chemical analysis of the feeds was performed at the Laboratory of the Department of Animal Nutrition and Feed Management, Faculty of Animal Breeding and Biology, UTP University of Science and Technology. The chemical composition of the silages and of the other feed ingredients in the lamb rations was determined by the Weende method (Table 1).

Table 1. Dry matter and nutrient content in the dry matter of individual fodders

| | Type of fodder | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | silage KD | silage KB | oat straw | oat grain | rapeseed meal | hay | barley grain | wheat bran |
| Dry matter (%) | 34.40 | 32.40 | 93.81 | 91.76 | 89.97 | 91.80 | 90.48 | 89.14 |
| Crude ash (%) | 4.22 | 5.74 | 7.64 | 3.66 | 7.17 | 8.60 | 2.58 | 4.74 |
| Crude protein (%) | 9.74 | 9.75 | 6.78 | 11.40 | 40.76 | 14.60 | 11.80 | 15.84 |
| Crude fat (%) | 3.98 | 3.98 | 2.32 | 5.66 | 3.38 | 1.82 | 2.30 | 3.63 |
| Crude fibre (%) | 15.29 | 15.83 | 41.31 | 12.15 | 12.80 | 26.23 | 5.42 | 7.84 |
| Nitrogen-free extracts | 66.77 | 64.70 | 41.95 | 67.13 | 35.89 | 48.75 | 77.90 | 67.95 |

KD – corn silage with the biological silage additive.
KB – corn silage without the silage additive.

The study involved 30 old-type Polish Merino lambs, which were divided into 3 experimental groups of 10 each, with equal sex ratio. Different feeding regimens were the experimental treatment. The control group (K) was fed according to the system existing on the farm, which was based on meadow hay and concentrates (barley grain, oat grain and wheat bran). The experimental groups (D0, D1) received rations consisting of corn silage and concentrates, in particular group D0 was fed corn silage without silage additive, and group D1 corn silage with the biological silage additive, which contained (in 1 g) $6.0 \times 10^{10}$ c.f.u. of lactic fermentation bacteria (*Lactobacillus plantarum*, *Lactobacillus casei*, *Lactobacillus brevis*, *Enteroccocus faecium*), manufactured by Agrifood. In the experimental groups, a slight amount of oat straw was supplemented for physiological reasons (Table 2). All the rations were formulated according to the Feeding Recommendations for Ruminants and Feed Tables (Strzetelski et al., 2014).

Lambs were fattened for 8 weeks at the body weight of around 27 kg. During the experiment, animals were weighed three times – at the start, after 3 weeks, and at the end of the experiment. On the last day of the trial, the lambs were deprived of feed, slaughtered, and their carcasses were dissected according to the methods of the National Research Institute of Animal Production (Nawara et al., 1963). Meat quality was evaluated on the *m. longissimus dorsi* (loin) collected 48 h postmortem. The meat samples were subjected to physichemical analysis. The acidity of meat (ultimate pH – $pH_k$) was measured with a portable pH meter fitted with a combination glass electrode. Meat colour was determined with a Minolta CR 310 colorimeter, based on the CIE LAB model (1976) (Itten, 1997). Water holding capacity (WHC) was determined with a filter paper method (Grau and Hamm, 1952), as modified by Pohja and Niinivaara (1957). WHC was expressed as percentage of free water in meat. The area of the pressed meat sample was taken to measure plasticity of the meat (Grajewska et al., 1998). The amount of total meat pigments was measured as hematin according to the procedure of Hornsey (1956). Meat tenderness was determined by an instrumental method with INSTRON 3342 tensile tests using a Warner-Bratzler attachment. The samples for the analysis were frozen stored. After thawing, they were heated in a water bath (in 0.85% sodium chloride solution) until the internal temperature of 70°C. Next, muscle sticks were cut parallel to the orientation of the muscle fibres using a cork borer. The results were expressed in $N \bullet cm^{-2}$ as maximum shear force needed to cut the muscle fibre (Szalata et al., 1999). Meat water content was calculated from the difference between the weight of raw and freeze-dried sample. The freeze-dried samples were analysed for the content of intramuscular fat using ANKOM XT10 semi-automatic extractor (AOCS, 2004).

Table 2. Dietary ration for lambs weighing 27 kg

| | | | Requirement | | | | |
|---|---|---|---|---|---|---|---|
| | | | UFV (day-1) | PDI (g•day-1) | | Ca (g•day-1) | P (g•day-1) |
| Type of fodder | Ram lambs | | 0.77–0.93* | 84–86* | | 6.4 | 2.6 |
| | Ewe lambs | | 0.85–0.98* | 80–82* | | 6.4 | 2.6 |
| | Amount (kg) | Dry matter (kg) | UFV (day-1) | PDIN (g•day-1) | PDIE (g•day-1) | Ca (g•day-1) | P (g•day-1) |
| **experimental groups (d0 and d1)** | | | | | | | |
| Oat grain | 0.46 | 0.40 | 0.392 | 29.6 | 33.6 | 0.40 | 1.60 |
| Oat straw | 0.40 | 0.35 | 0.137 | 7.00 | 16.8 | 1.225 | 0.35 |
| Rapeseed meal | 0.11 | 0.10 | 0.102 | 28.80 | 27.2 | 0.84 | 1.24 |
| Corn silage | 1.00 | 0.25 | 0.200 | 13.25 | 16.0 | 0.75 | 0.50 |
| Total | 1.97 | 1.10 | 0.831 | 78.65 | 93.6 | 3.215 | 3.69 |
| **control group (k)** | | | | | | | |
| Meadow hay | 0.41 | 0.35 | 0.252 | 27.65 | 30.10 | 2.275 | 1.225 |
| Barley grain | 0.29 | 0.25 | 0.278 | 20.00 | 25.25 | 0.15 | 0.75 |
| Oat grain | 0.34 | 0.30 | 0.294 | 22.20 | 25.20 | 0.30 | 1.20 |
| Wheat bran | 0.12 | 0.10 | 0.084 | 11.40 | 9.60 | 0.15 | 1.28 |
| Total | 1.16 | 1.00 | 0.908 | 81.25 | 90.15 | 2.875 | 4.455 |

*Demand depending on the growth potential.

UFV – feed unit for maintenance and meat production.

PDI – protein digested in the intestine.

PDIN – protein digested in the intestine plus protein of microorganisms, calculated on the basis of availability of nitrogen from feed in the rumen.

PDIE – protein digested in the intestine plus protein of microorganisms, calculated on the basis of energy from feed available in the rumen.

The results were statistically analysed using Statistical Analysis System (SAS) software. Basic statistical measures – arithmetic mean and standard deviation – were calculated. The effect of feeding on body weight gains and meat quality was determined with one-way analysis of variance. The effect of sex on physicochemical traits of the meat was also evaluated. Post hoc (Scheffe) tests were also performed for pairwise comparison of the means in all the combinations.

## Results

### Results of chemical analysis of feeds

Dry matter percentage in the analysed feeds ranged from 32.40% in corn silage without silage additive to 93.81% in straw. The analysed feed also differed in nutrient content. Crude protein was highest in rapeseed meal and lowest in straw. The lowest crude fat content in dry matter was observed in straw, and the highest in oat grain. The highest proportions of crude ash and crude fibre in dry matter were found in straw, and the lowest in oat grain (Table 1).

Comparison of the two silages shows that corn silage with silage additive was characterized by a higher dry matter content. The analysed silages had a similar content of crude protein and crude fat in dry matter. Corn silage without additive was richer in crude ash and crude fibre, and the silage with additive contained more nitrogen free extracts.

### Results of body weight measurements of lambs

All the lambs studied here were weighed three times: at the start, after 3 weeks, and at the end of the experiment. The results are presented in Table 3. All the animals gained weight during the experiment, but clear changes in body weight were only seen towards the end of the study. Body weight of the lambs at the second weighing did not differ much from their initial weight. Over the 8 weeks of the experiment, animals from group K showed the highest average weight gain.

There was no effect of supplementing corn silage to the rations on daily weight gains of the lambs, but animals fed meadow hay and concentrate achieved 5.69% higher daily weight gains in comparison with animals receiving the diets with unsupplemented corn silage, and 7.31% higher daily weight gains compared to animals fed corn silage with biological silage additive.

### Results of lamb meat quality

The results of lamb meat quality are listed in Table 4. Adding corn silage to the diet of lambs had no effect on physicochemical characteristics of the meat. Moreover, sex had no statistically significant effect on lamb quality.

Table 3. Average weight and daily gains obtained by the lambs from all groups

| Grupa Group | Termin ważenia/ Date of weighting | | | |
|---|---|---|---|---|
| | 15 X | 5 XI | 10 XII | Przyrost masy dla całego doświadczenia [kg]/ Increase during the entire study [kg] |
| | Średnia masa ciała [kg]/ Average weight [kg] | | | |
| D0 | 27,10 | 27,95 | 33,60 | 6,5 |
| D1 | 27,30 | 28,35 | 33,70 | 6,4 |
| K | 27,42 | 28,65 | 34,30 | 6,88 |
| | | | | Przyrosty dobowe dla całego doświadczenia [g]/ Daily gains during the entire study [g] |
| | Przyrosty dobowe [g]/ Daily gains [g] | | | |
| D0 | - | 40,5 | 161 | 116 |
| D1 | - | 50 | 153 | 114 |
| K | - | 59 | 161 | 123 |

Table 4. Indicators of lamb loin quality

| | Group | | | Group | | | Group | | |
|---|---|---|---|---|---|---|---|---|---|
| | D0 | | | D1 | | | K | | |
| | Sex | | | Sex | | | Sex | | |
| | Total | Ewe lambs | Ram lambs | Total | Ewe lambs | Ram lambs | Total | Ewe lambs | Ram lambs |
| N | 10 | 5 | 5 | 10 | 5 | 5 | 10 | 5 | 5 |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| pH | x | 5.61 | 5.57 | 5.65 | 5.61 | 5.57 | 5.66 | 5.64 | 5.65 | 5.62 |
| | SD | 0.07 | 0.05 | 0.07 | 0.09 | 0.03 | 0.11 | 0.07 | 0.10 | 0.02 |
| Water holding capacity (%) | x | 20.11 | 20.87 | 19.35 | 20.35 | 21.10 | 19.59 | 20.86 | 20.99 | 20.73 |
| | SD | 1.64 | 1.08 | 1.85 | 2.08 | 1.31 | 2.57 | 1.85 | 1.61 | 2.24 |
| Plasticity ($cm^2$) | x | 2.60 | 2.50 | 2.70 | 2.46 | 2.42 | 2.49 | 2.65 | 2.59 | 2.70 |
| | SD | 0.21 | 0.16 | 0.22 | 0.20 | 0.16 | 0.25 | 0.18 | 0.23 | 0.11 |
| Tenderness ($N•cm^{-2}$) | x | 40.46 | 38.56 | 42.36 | 33.66 | 36.29 | 31.03 | 45.34 | 38.96 | 51.72 |
| | SD | 17.43 | 24.68 | 8.11 | 12.88 | 15.55 | 10.69 | 13.06 | 7.97 | 14.79 |
| Intramuscular fat content (%) | x | 1.73 | 1.62 | 1.83 | 1.70 | 1.56 | 1.85 | 1.59 | 1.74 | 1.44 |
| | SD | 0.46 | 0.46 | 0.49 | 0.34 | 0.43 | 0.16 | 0.43 | 0.54 | 0.27 |
| Water (%) | x | 75.99 | 75.89 | 76.09 | 75.96 | 76.04 | 75.89 | 76.15 | 76.22 | 76.08 |
| | SD | 0.67 | 0.44 | 0.89 | 0.8 | 1.07 | 0.53 | 0.57 | 0.76 | 0.37 |
| L* Lightness | x | 41.72 | 41.85 | 41.60 | 42.13 | 41.73 | 42.53 | 42.22 | 41.94 | 42.50 |
| | SD | 1.26 | 1.72 | 0.76 | 1.01 | 0.59 | 1.24 | 1.29 | 1.52 | 1.12 |

cd. tabeli 4 – Table 4 contd.

| 1 | | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| a* Redness | x | 18.34 | 18.71 | 17.97 | 18.19 | 17.60 | 18.77 | 18.16 | 18.90 | 17.41 |
| | SD | 1.05 | 1.40 | 0.40 | 1.95 | 2.51 | 1.19 | 1.41 | 0.95 | 1.48 |
| b* Yellowness | x | 2.08 | 2.22 | 1.93 | 2.45 | 2.44 | 2.45 | 2.41 | 2.22 | 2.60 |
| | SD | 0.78 | 0.78 | 0.84 | 0.75 | 1.00 | 0.52 | 0.61 | 0.68 | 0.53 |
| Pigments | x | 126.96 | | 130.97<br>122.94 | 124.24 | | 127.70<br>120.77 | 118.57 | 120.77 | 116.38 |
| ($\mu g \cdot g^{-1}$) | SD | 15.04 | 16.39 | 14.15 | 10.54 | 12.16 | 8.50 | 17.29 | 19.15 | 17.14 |

## Discussion

Although corn silage is not widely used in sheep nutrition, this feed appears to be a cheaper alternative to concentrates during the winter period (Wand and Topp, 2014). According to Luimes (2011), dietary inclusion of 25% corn silage on a d.m. basis has no adverse effect on weight gains of lambs and quality of their meat; only an increase to 50% d.m. results in slower weight gains of the lambs. Likewise, Beukes (2013) holds that a low dietary level of corn silage (20% on a d.m. basis) in the finishing period does not have a negative effect on feed intake, performance, and meat quality. In our study, animals receiving meadow hay and concentrate achieved slightly higher daily gains compared to animals fed 23% corn silage on a d.m. basis, regardless of whether the biological silage additive was used or not. However, it should be noted that differences between the groups were not significant. When adding corn silage to the rations of lambs, a slight decrease in body weight gains is to be expected. Before a final decision concerning the inclusion of corn silage in the winter feeding of young sheep is made, it is necessary to perform economic calculation with consideration of current cereal prices.

Supplemental corn silage had no effect on physicochemical characteristics of the lamb meat. The raw meat sourced from the lambs of all the groups is considered a good quality product. Our findings for meat acidity are comparable with the results of other authors (Gardzielewska et al., 2010; Grześkowiak et al., 2009; Keles et al., 2018). The average water holding capacity of meat for animals from all the groups was lower than that of lambs fattened with dry feeds or forage diets (Grześkowiak et al., 2009) and the meat of lambs receiving 50% corn silage ration on a d.m. basis (Keles et al., 2018). The lower value of this trait is indicative of good water binding in the meat of the studied animals. The most favourable tenderness was observed for the meat of D1 animals. The results obtained for tenderness were much lower compared to those reported by other authors (Grześkowiak et al., 2009; Strzelecki et al., 2008). In our study, meat lightness was slightly higher than for the meat of lambs fed dry feeds or forage diets (Grześkowiak et al., 2009) and lambs receiving 50% corn silage ration on a d.m. basis (Keles et al., 2018), but slightly lower compared to the results obtained in coarse-haired sheep lambs fed on a low plane of nutrition (Gardzielewska et al., 2010). We observed much higher a* values compared the results reported above for young sheep (Gardzielewska et al., 2010; Grześkowiak et al., 2009; Keles et al., 2018). Similarly to the case of other

parameters, we found no effect of including corn silage in lamb diets on the yellow colour coordinate value, unlike the study of Grześkowiak et al. (2009), in which feeding system (fattening of lambs with concentrate or forage) had an effect on b* value. According to Kędzior (2005), the content of intramuscular fat depends, among others, on feeding method. As already noted, however, in our experiment we found corn silage to have no effect on the mean content of this parameter. The results were lower than those obtained for the meat of lambs fed dry feeds or forage diets (Grześkowiak et al., 2009). The mean water content of the lamb meat corresponded to the findings of Grześkowiak et al. (2009).

In summary, supplemental corn silage had no effect on physicochemical characteristics of lamb meat. There was also no statistically significant effect of sex on meat quality. The dietary inclusion of corn silage for young sheep did not have any influence on the body weight of the animals.

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# THE EFFECT OF FEEDING CORN SILAGE ON WEIGHT GAINS AND MEAT QUALITY OF LAMBS

SUMMARY

Production of lamb depends, among other things, on the feeding system, including the type of feed. One of the cheapest feeds in the winter feeding of sheep can be good quality corn silage. The aim of this study was to determine the effect of corn silage on weight gain of lambs and on the physicochemical characteristics of their meat. The study included 30 lambs of old-type Polish Merino Sheep, divided into three experimental groups of 10 each, with equal sex ratio. The control group (K) received a diet consisting of meadow hay and concentrated feed, while experimental groups were fed a diet with corn silage (D0 – without silage additive, D1 – with biological silage additive). During the experiment the lambs were weighed three times. On the last day of the study, the animals were slaughtered and *longissimus dorsi* muscle (loin) was subjected to meat quality assessment. The results were statistically analysed. The feed supplemented with corn silage had no effect on the body weight gains of lambs and physicochemical characteristics of their meat.

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