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The effect of nutritional and fermentational characteristics of grass and legume silages on feed intake, growth performance and blood indices of lambs

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ABSTRACT

The objective of this study was to determine the effects of feeding silage made from different plant species to lambs. The experimental materials comprised 24 Kamieniec rams weaned at 70 days of age, allocated into one of three groups, and offered ad libitum three types of silage: red clover silage (RC), alfalfa silage (ALF), grass silage (GR). All lambs also received 0.5 kg ground barley per animal per day and 12.5 g mineral–vitamin premix per animal per day. The animals were kept in individual pens throughout a 60-day experimental period. The growth rate and selected blood biochemical indices of lambs were determined. On day 60, the greatest (34.7 kg) and the least (31.8 kg) body weights of lambs were from groups ALF and GR, respectively ($P \leq 0.01$). The difference between groups RC and GR was also significant. The nutritional regime had no effect on blood parameters, whereas lambs fed legume silages were characterized by increased blood glucose levels, decreased total blood protein levels ($P \leq 0.05$) and greater urea concentrations ($P \leq 0.01$), compared with lambs receiving grass silage. Lambs offered legume silages showed better growth performance, in comparison with those offered grass silage, which resulted from greater intake and supply of metabolizable energy and protein from alfalfa silage, and more effective utilization of nutrients contained in red clover silage.

1. Introduction

Recent advances in food research have contributed to raising consumer awareness of food quality issues. Functional foods, known to provide health benefits, are receiving increasing attention worldwide. Lamb meat is a rich source of functional components and is highly valued for its health-promoting properties (Milewski, 2006). Meat with superior health benefits is obtained when lamb rations are based on organic feeds – the greater share of natural feed ingredients in diets fed to lambs, the greater quality of the end product (Santos-Silva et al., 2002). In the winter, lambs in Poland are fed silage as the basal diet.

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Usage of silages from different plant materials in diets of sheep may significantly influence the characteristics of health quality of meat, particularly intramuscular fat content, fatty acid profile, the level of vitamins A and E and concentration of cholesterol (Purwin et al., 2013). Agri-environmental programs of EU (subsidies to legume crops) resulted a significant increase in the acreage of red clover and alfalfa.

Sugar:buffer capacity ratio causes that silages produced from these plants are characterized by excessive secondary fermentation. In Poland, due to high cost of silage additives, the most popular way to improve the quality of fermentation is still wilting of herbages (Purwin et al., 2014). Furthermore, the problem in production of wilted silage from legumes in silos is insufficient density, so the use of round bales technology for this material is common in our conditions.

Differences in chemical composition and proteolytic potential of red clover and alfalfa affect the content of fermentation products and products of protein degradation in silages (McDonald et al., 1991). In turn, this influence changes of the taste and smell of silages and chemostatic mechanism of intake regulation and consequently leads to increased lamb productivity. Silage intake has also been found to be reduced by an unfavorable less percentage of protein nitrogen to total nitrogen (Dulphy and Van Os, 1996; Purwin et al., 2006).

Speijers et al. (2005) reported improvement of performance 6 monthly finishing store lambs as a result of the use of red clover silage compared with grass silage.

The aim of this study was to evaluate the effect of feeding alfalfa or red clover silages compared with grass silages on the intake and growth performance and biochemical parameters of lambs. The correctness of feeding was evaluated by selected blood biochemical parameters as follows: glucose as parameters of energetic metabolism, cholesterol and triglycerides as lipid metabolism, urea and total protein as protein metabolism and AST, LDH, GGTP, ALP as parameters of liver functions, CK parameter muscle functions, Ca, Mg, P inorganic as mineral metabolism. Acid–base balance parameters and ionic composition of blood were estimated as indices of measurement of potential influence of silages on the occurrence of metabolic acidosis.

2. Materials and methods

2.1. Silages

Experimental silages were produced at the Experimental Station in Łężany, owned by the University of Warmia and Mazury in Olsztyn (NE Poland), from second year and second-cut alfalfa (cv. Alba), red clover (cv. Nike) and red fescue (cv. Godolin). All plants were cut on 8 August 2009 between 3.00 p.m. and 6.00 p.m. The regrowth period was 44 days. The raw material was harvested with a Claas roll baler (density180 kg DM/m^3) after partial drying for 48 h. The time between the formation and hermetic wrapping of respective bales did not exceed 60 min. The bales were wrapped with six layers of stretch film, 30 μm × 750 mm, using a SIPMA bale wrapping machine (Białystok, Poland).

Bales were weighed before stretch wrapping and before the feeding after removing the stretch to calculate the efficiency of forage per hectare and conservation efficiency (bale weight before feeding after removing stretch × DM content of silage/bale weight before wrapping × DM content in dried forage).

Prior to feeding, experimental silages were cut with an electric chopper (straw length – 20 mm), and were stored in polyethylene bags at 4 °C, in accordance with the method proposed by Speijers et al. (2005). Silage from each bale was offered to lambs for up to 7 days. Digestibility of dry organic matter (DOMD), ether extract and crude fiber of silage were determined in vivo by the balance trial, before fattening. All animals were placed in metabolic cages, and were fed only experimental silages, ad libitum. After a 10-day adaptation period, the amount of administered feed was recorded, and refusals and feces samples were collected for 5 days.

2.2. Animals and feeding

A feeding trial was conducted at the Animal Research Laboratory of the Department of Animal Nutrition and Feed Science, University of Warmia and Mazury in Olsztyn. The experimental materials comprised 24 single Kamieniec rams weaned at around 70 days of age. Kamieniecka ewes are a perfect maternal component for commercial crossing with meat-type rams in Poland and Warmia – Mazury region, raised within a framework of a conservation program. This breed is characterized by very good reproductive performance as well as milk and meat yield (Milewski and Ząbek, 2007).

The animals were kept in individual pens throughout a 60-day experimental period, and intake of feeds was controlled every day, body weight measurement was conducted before (0 day), on the 30 and 60 day of the experiment. The lambs were allocated to one of three treatments (based on a criterion of body weight) and placed in metabolic cages (eight animals per group), and were offered ad libitum three types of silage: red clover silage (RC), alfalfa silage (ALF), grass silage (GR). All lambs also received 0.5 kg (fresh matter) ground barley per animal per day and 12.5 g mineral–vitamin premix per animal per day. The mineral–vitamin premix contained (%): calcium carbonate 15.95%; sodium chloride 10%; magnesium oxide 5%; natrium-calcic phosphate and phosphate 1-Ca 4%; Mn, 10,400 mg; Zn, 19,500 mg; Cu, 3450 mg; I, 400 mg; Se, 120 mg; Co, 100 mg. Vitamins: A, 2,000,000 IU; D, 200,000 IU; E, 12,000 mg; of group B, 20,750 mg per kg. A fixed level of concentrate feeding was used during the whole time of the fattening, which was established at the start of the fattening at 60% of the daily requirement of lambs (for body weight – 25 kg and daily gains – 200 g) on ME and 48% on CP (DLG, 1997). The concentrate was fed twice daily, in the morning and in the afternoon. Silage intake was expressed as g DM/day and g DM/day/kg metabolic weight (LW$^{0.75}$ – live weight$^{0.75}$). During the experiment, all animals were kept under identical microclimate conditions: temperature – +8 °C, relative humidity – 80%, natural light – the ratio of window area on the floor of the room was 1/15.

2.3. Sampling and chemical analysis

Silage samples (1.0 kg) were collected before the experiment and three times during the experiment. Refusals were collected and weighed daily and pooled into one sample per each 20 days of the experiment. Samples of barley were collected two times: before and in the middle of the experiment to determine the average chemical composition. Silage samples and subsamples of refusals were stored at −25 °C. After thawing, selected samples were dried at 60 °C in a Binder dryer, and were ground in a Retsch 200 mill to a particle size of 1 mm. Feed and refusal samples were assayed for dry matter (DM), crude ash, crude protein (CP), ether extract (EE), crude fiber (CF) by standard methods (AOAC, 2005), aNDF by the method proposed by Mertens (2002) and ADF – proposed by Van Soest et al. (1991) using the ANKOM 220 fiber analyzer. Silage samples were also assayed for: pH – with a HI 8314 pH-meter, concentrations of lactic, acetic and butyric acids in aqueous extracts – by high-performance liquid chromatography (HPLC) using the Shimadzu HPLC system with a VARIAN MetaCarb 67H column, protein nitrogen (protein N) – with the use of trichloroacetic acid (TCA) (Licitra et al., 1996), water-soluble carbohydrates (WSC) – by the method Thomas (1977). The nutritional value of barley was determined according to the DLG table (Deutsche Landwirtschaft–Gesellschaft) however, the nutritional value of silage was expressed as ME according to the below equation:

$$ME = 0.0312 \times dEE + 0.0136 \times dCF + 0.0147 \times (DOMD - dEE - dCF) + 0.00234 \times CP$$