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Effects of replacing grass silage harvested at two maturity stages with maize silage in the ration upon the intake, digestibility and N retention in wether sheep

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Abstract

The objective of this experiment was to study the effects of interactions between medium quality grass silage (GS1) and maize silage (MS) as well as between low-quality grass silage (GS2) and MS on *ad libitum* intake, digestibility and N retention in wether sheep. Two grass silages (GS1 and GS2) were ensiled in round bales, without additives, from the primary growth of orchard grass (*Dactylis glomerata* L.) harvested at two different maturity stages. The study consisted of seven feeding treatments incorporating GS1, GS2 and MS fed alone and forage mixtures of GS1 and MS as well as GS2 and MS (67:33% and 33:67%, respectively, DM (dry matter) basis).

Delayed harvesting lowered ($P<0.05$) the crude protein (CP) concentration in GS2 compared to GS1. The DM content (g kg^{-1} fresh sample) and starch concentration (g kg^{-1} DM) of MS were 264 and 211, respectively.

Inclusion of MS in the GS1-based ration had positive linear effects on CP and starch digestibility ($P<0.05$ and $P<0.01$, respectively) and N intake ($P<0.01$) while a negative effect on neutral detergent fibre (NDF) and acid detergent fibre (ADF) digestibility ($P<0.05$ and $P<0.01$, respectively). A positive associative response of GS1 and MS was observed for DM *ad libitum* intake (g kg^{-1} $M^{0.75}$ day^{-1}) (quadratic, $P<0.05$), CP digestibility (quadratic, $P<0.01$), N intake (quadratic, $P<0.01$) and N balance (quadratic, $P<0.05$). Inclusion of MS into the GS2-based ration had a positive linear effect on the ration fresh matter *ad libitum* intake (kg day^{-1} and g kg^{-1} $M^{0.75}$ day^{-1}) ($P<0.01$ and $P<0.001$, respectively), NDF *ad libitum* intake (kg day^{-1} and g kg^{-1} $M^{0.75}$ day^{-1}) ($P<0.01$), digestibility of DM ($P<0.01$), organic matter (OM) ($P<0.01$), ADF ($P<0.05$), starch ($P<0.001$), digestibility of OM in DM (*D*-value) ($P<0.001$), and N intake ($P<0.01$). Positive associative effects of GS2 and MS were observed on all the intake and digestibility parameters measured, N intake (quadratic, $P<0.001$) and N balance (quadratic, $P<0.05$). It was concluded that, as expected, a positive associative response of GS2 and MS was recorded for all the measured parameters while that of GS1 and MS for a limited number of parameters, probably due to lower quality of MS (lower starch concentration) than required for improved utilization of the GS1-based ration.

Keywords: Grass silage; Maize silage; Intake; Digestibility; N retention

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1. Introduction

Grass silage (GS) production in Croatia does not have a long tradition, which may partly account for its variable quality. Monitoring the grass silage quality over 2 years on 19 farms, large variations were observed for dry matter (DM) content (123–825 g kg^{-1} fresh sample), crude protein (CP) (50–217 g kg^{-1} DM) and neutral detergent fibre (NDF) concentration (300–605 g kg^{-1} DM), pH value (3.5–6.2), digestibility of organic matter (OM) in DM (*D*-value) (44–73%) and metabolizable energy (ME) concentration (7.1–12.4 MJ ME kg^{-1} DM) (Vranić et al., 2004, 2005a). According to Chamberlain and Wilkinson (1996), the average quality of GS produced on family farms in Croatia is of medium to low quality (less than 150–175 g CP kg^{-1} DM, less than 11 MJ ME kg^{-1} DM, and more than 50 g NH_3–N kg^{-1} total N).

Grass silage has a great potential in sheep nutrition, especially over 4–5 months of winter-feeding when sheep are kept indoors. There are certain concerns about improving the quality of the ration based on GS in sheep nutrition by its partial replacement with other forage, possibly maize silage (MS), which is widely produced in Croatia.

When GS or MS of nearly equal DM content (213 and 219 g kg^{-1} fresh sample, respectively) were fed as a sole feed, sheep preferred MS to GS rations (O'Doherty et al., 1997). Previous investigations with sheep have shown increased intake and digestibility when GS was partially replaced with molassed sugar beet feed (Rouzbehan et al., 1996) as well as increased N retention when MS was partially replaced with red clover hay (Margan et al., 1994).

The hypothesis of this study was that replacement of GS with MS would have positive associative effects on feed intake, digestibility of DM, OM, NDF, acid detergent fibre (ADF), CP, starch, *D*-value, and N retention in sheep. The objectives of the experiment were to examine the effects of interactions between the medium and low quality GS dominated by orchard grass and MS, with no supplementary feed provided, on feed intake, digestibility and N retention in wether sheep.

2. Materials and methods

2.1. The sward and silage making

Grass silage was made in 2002 from predominately orchard grass (*Dactylis glomerata* L.) meadow harvested at the late vegetative (18 May) and early flowering (6 June) stages of orchard grass (GS1 and GS2, respectively). Two applications of a commercial inorganic fertilizer were provided during the growing season: 450 kg ha^{-1} of N–P–K fertilizer (8:26:26) in February 2002 and 150 kg ha^{-1} of ammonium nitrate thirty-five days prior to harvesting. Green and DM yield (t ha^{-1}) was determined at mowing by calculating the weight of 30 forage samples randomly taken by quadratic frame (0.25×0.25 m^2). Botanical composition was determined from the same samples by manual separation of grasses, clovers and forbs. The sward contained 80.6% orchard grass, 13.7% legumes, 2.3% other grasses and 3.4% forbs on a DM basis. Forage DM content at harvest was 169 and 276 g kg^{-1} fresh sample, while DM yield amounted to 5.4 and 7.0 t ha^{-1} of GS1 and GS2, respectively.

The crop was mown and allowed to wilt for 24 h before harvesting with a round baler. Bales were wrapped in four layers of 500-mm-wide white plastic film. The weather at harvest was warm and sunny. No additive was applied.

The maize crop (*Zea mays* L., cultivar BC 566) was sown on March 8, 2002 into a ploughed and rolled seedbed. The crop was sown with a row space of 75 cm and the establishment target was 70,000 plants ha^{-1}. Whole crop maize was harvested on September 23, 2002 to a nominal stubble height of 25 cm above ground (pre-harvest DM of 275 g kg^{-1} fresh weight). The DM yield of forage maize at harvest was 13.5 t ha^{-1}, while the cob DM to total DM ratio was 6:1. The forage was chopped at harvest to a chop length of 1.9 cm, ensiled immediately into a clamp silo, without any additive, and rolled thoroughly before being sheeted with plastic and covered with rubber tyres to ensure exclusion of air.

2.2. Dietary treatments

The treatments consisted of either GS1, GS2 or MS alone, a forage mixture (DM-based) of GS1 and MS of 670 g kg^{-1} GS1 and 330 g kg^{-1} MS (GS1MS), and 330 g kg^{-1} GS1 and 670 g kg^{-1} MS (MSGS1), or a forage mixture (DM-based) of GS2 and MS of 670 g kg^{-1} GS2 and 330 g kg^{-1} MS (GS2MS), and 330 g kg^{-1} GS2 and 670 g kg^{-1} MS (MSGS2). Seven feeding treatments were examined in all. Just before the experiment started the MS for the experimental needs was compressed into 8 plastic containers (approximately 200 L each) and stored in a cold chamber maintained at a temperature of 4 °C.

The GS1 and GS2 were chopped to approximately 3–5 cm using a commercial chopper. The chopped material was compressed into plastic bags (approximately 10 kg