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Alfalfa as a supplement of dried cornstalk diets: Associative effects on intake, digestibility, nitrogen metabolisation, rumen environment and hematological parameters in sheep

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Abstract

The aim of the current study was to investigate the associative effects of a cornstalk-based diet supplemented with alfalfa (*Medicago sativa*) hay on intake, digestibility, nitrogen (N) metabolisation, rumen environment and hematological parameters in Xiaoweihan sheep. We also investigated the optimal range of alfalfa hay to achieve positive associative effects and avoid negative effects. Xiaoweihan sheep ($n=5$; fitted with rumen T-cannula) were fed five cornstalk-based diets in a 5×5 Latin square design. Diets contained 0, 50, 150, 300, 450 g alfalfa, and were supplemented with 100 g concentrate, respectively. Our results suggested that supplementation of 300 g alfalfa hay reduced ($P<0.05$) cornstalk intake, but significantly increased dry matter (DM) intake ($P<0.05$). Additionally, DM digestibility of 150 g alfalfa hay supplementation was slightly higher than that noted in other diets. Metabolism studies showed 50–150 g alfalfa hay supplementation had a positive associative effect ($P<0.05$) on N utilization, with the greatest benefit noted with 150 g per day ($P<0.05$) compared to unsupplemented diets. Alfalfa supplementation (50–450 g per day) resulted in an elevated trend of ammonia nitrogen (NH_3–N) with 50 or 150 g of alfalfa hay more likely to promote sheep rumen environment, with a noticeable increase ($P<0.05$) in serum urea nitrogen (UREAN) concentrations observed with 300 g alfalfa hay per day. Our data suggested that the optimal range to achieve beneficial effects and avoid negative effects was 150–300 g per day for cornstalk-based diets for sheep.

Keywords: Cornstalk; Alfalfa; Associative effects; Rumen; Hematological parameter; Sheep

1. Introduction

Associative effects of supplementation on digestibility, intake, and utilization of poor quality feeds are often reported (Coombe and Tribe, 1962; Schneider and Flatt, 1972; Mould et al., 1983; Nelson and Finley, 1989; Grant and Mertens, 1992; McAllan et al., 1994; Haddad, 2000). Positive or negative associative effects are known as the effects of supplementation on feed utilization, greater or smaller than what would be expected of the nutrient content alone (Schiere and Wit, 1995; Lu, 2004). First reported by Forbes (1931), associative effects among dietary ingredients are a common factor in terrestrial

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Table 1
CP and DM content of feedstuff utilized (concentrate, alfalfa hay and cornstalk) and measured as described in Methods

	CP (%)	DM (%)
Concentrate	21.14	87.33
Alfalfa hay	14.42	92.23
Cornstalk	7.44	89.84

herbivore nutrition (Mould, 1988; Pond et al., 1995). In spite of increased research on the topic, little is known regarding associative effects on intake, digestibility, N metabolisation, rumen environment and hematological parameters. Additionally, the optimal amount of supplementation needed to achieve beneficial effects and to promote efficiency of livestock production has not yet been determined clearly.

The residue from corn (*Zea mays*), a major cereal crop, is used as cornstalk for livestock, particularly sheep, in the Songnen Plains of northeast China. While cornstalk is abundant and inexpensive, and is consequently the predominant forage source for ruminants, it is typically considered low quality roughage and does not meet the nutritional requirements of animals when fed alone (Broudiscou et al., 2003). Constraints limiting the greater use of low quality roughages by the livestock industry include low digestibility, low digestible energy and protein, prolonged rumen retention time, bulkiness and low palatability resulting in lower intake over time (Campling, 1966; Aitchison et al., 1986). These constraints may be overcome by the positive associated effects of supplements added to low quality roughages (Perdok et al., 1982; Van Der Hoek et al., 1989). The value of forages as supplements is mainly dependent on their capacity to provide essential nutrients to the rumen microbial population, meeting the animal's nutritional requirement and increasing the efficiency of feed utilization (Elliot and McMeniman, 1987). Previous research has suggested that straw-based diets supplied with legumes promoted the availability of diets. Protein content is greater in legume than in other forages and protein supplementation of low quality roughages has been shown to improve the use of these feeds (McCollum and Galyean, 1985). It has been well established that alfalfa (*Medicago sativa*) has a higher nutritional value and is relatively less expensive than other forages, and research suggests that fungus spore in rumen is increased in diets supplemented with alfalfa (Akin et al., 1990). Recent studies have shown that legumes increased fiber digestion in the rumen by promoting the growth of cellulolytic microbes (Ndllovu and Buchanan-Smith, 1985). Improved utilization of low quality roughages with alfalfa supplementation has also been demonstrated by Klopfenstein and Owen (1981) and Mosi and Butterworth (1985). The benefits associated with the use of legume forages result from the integration of many factors, and demonstrate that positive associative effects can develop the utilization of straws (Haddad, 2000).

In China, as in many parts of the world, large arable regions are cropped and animal production is dependant on limited pasture and abundant crop residues. The aim of the current study was to investigate the associative effects of a cornstalk-based diet supplemented with alfalfa hay on intake, digestibility, N metabolisation, rumen environment and hematological parameters in Xiaoweihan sheep. We also investigated the optimal range to achieve positive associative effects and avoid negative effects of alfalfa supplementation to dried cornstalk-based diets.

2. Materials and methods

2.1. Diets and animals

This study was conducted at the Institute of Grassland Science, Northeast Normal University, Changchun, Jilin province, China. Diets consisted of alfalfa hay, cornstalk and air-dried concentrate. Cornstalk (sun dried) and alfalfa hay (50% flowering at harvest) used in experiments were obtained locally and concentrate was obtained from commercial sources. Forages were chopped using a hammer-mill fitted with a 15 mm screen. Samples of cornstalk, alfalfa hay and concentrate were dried (60–65 °C, 48 h) and analyzed for crude protein (CP) and DM content (Table 1) following standard procedures (Association of Official Analytical Chemists, 1990).

Xiaoweihan sheep ($n=5$, 8 months old; male; 23.51 ± 3.53 kg average live weight and obtained from a single source) were dewormed with Albendazole (5 mg/kg) and fitted with rumen T-cannula (30 mm internal diameter).

2.2. Experimental design and feeding management

Sheep were housed individually in metabolism crates (18 °C with a 12:12 h on:off light cycle) and randomly assigned to five dietary treatments (Table 2), in a 5 × 5 Latin square design, in such a way that each sheep

Table 2
Composition of diets fed to sheep

	Concentrate (g)	Alfalfa hay (g)	Cornstalk
Diet B	100	0	ad libitum
Diet D	100	50	ad libitum
Diet C	100	150	ad libitum
Diet A	100	300	ad libitum
Diet E	100	450	ad libitum