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Short communication

Daily and alternate day supplementation of *Moringa oleifera* leaf meal or soyabean meal to lambs receiving oat hay

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ABSTRACT

We hypothesized that *Moringa oleifera* foliage which is high in crude protein and almost free in main secondary compounds could replace soyabean meal used in supplementation strategies of livestock. Therefore, this experiment aimed to evaluate the effect of daily and alternate day supplementation of Moringa leaf meal (MLM) or soybean meal (SBM) to sheep on intake and digestion and glucose, protein and urea in blood plasma. Twenty Barbarine male lambs (average initial body weight, 27.3 ± 3.0 kg), were randomly divided into four groups of five lambs each. They were adapted for 22 days to dietary treatments before starting a 6-day total collection period. All animals consumed oat hay *ad libitum* supplemented with concentrates composed of barley grain only (C-BAR) or mixed with SBM (C-SBM), or MLM (C-MLM) as protein sources. Groups 1 and 2 received daily C-SBM and C-MLM, respectively. However, groups 3 and 4 had access to concentrates containing the protein sources (C-SBM and C-MLM) with alternate day that means they received for one day these concentrates and in the following day they received barley grain only (C-BAR). Soybean meal and MLM incorporation in concentrates had similar effects ($P > 0.05$) on water, hay, and digestible organic matter (OM) intakes and DM, organic matter (OM) and neutral detergent fiber (NDF) digestibility. Daily substitution of SBM by MLM increased ($P = 0.024$) crude protein (CP) intake and apparent total tract digestibility. However, the alternate day supplementation decreased apparent total tract CP digestibility but increased CP intake for SBM treatment. The concentration of ruminal ammonia nitrogen before feeding was higher ($P = 0.012$) in groups 1 and 3 than in the other groups. The concentration of blood glucose was similar ($P > 0.05$) among treatments. However, lambs receiving C-SBM exhibited highest concentrations of protein ($P = 0.039$) and urea ($P = 0.001$) in the blood. It is concluded that MLM administered at two day-intervals had similar effects on feed intake, digestion and blood metabolites to SBM incorporated in concentrate distributed to sheep receiving oat hay.

1. Introduction

Livestock reared in dry areas is facing feed shortage and fed on low quality diets. These constraints are impacting negatively on their performances. Therefore, the development of cost-effective supplementation strategies is targeted in

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these areas. Barley cropping is a common practice in North Africa and is contributing to a large extent in energy supplementation of ruminants. However, the main protein source used in livestock feeding in Tunisia and in many other countries is soyabean meal (SBM) which is expensive, thus not easily affordable to small-scale farmers. Soybean meal is widely used in livestock feeding as it improved productive and reproductive performances of ruminants (Molle et al., 1997). Cozzi et al. (1995) showed that feather and blood meal can partially replace SBM in diets of sheep. However, the FAO has recommended banning the use of mammalian meat and bone meal as protein sources in ruminant feeding as this may have a negative impact on human health (Food and Agriculture Organization, 2001). Therefore, the use of local legume plants as alternative protein supplements is recommended. Malunga et al. (2009) concluded that lambs receiving SBM performed better than those receiving *Mucuna pruriens*. However, the cost to benefit ratio would favor the use of *Mucuna* instead of SBM. *Moringa oleifera* holds promise as an alternative protein supplement for ruminants. It yields high consumable biomass (24 t/ha/year) that is high in CP (193–264 g/kg DM) and true protein (Makkar and Becker, 1997). Studies on sheep response to *Moringa* foliage are scarce and the few literature data suggest that sheep (Murro et al., 2003) and goat (Manh et al., 2005) could benefit from this plant species. *Moringa oleifera* has been introduced in Tunisia in 2009. But, there is no information on the response of local sheep breeds to this plant species. Alternate supplementation of protein sources, *e.g.* soya bean meal, could be a solution to alleviate feeding cost (McGuire et al., 2013a,b). Therefore, we designed this experiment to determine the effect of daily and alternate day supplementation of SBM and MLM on feed and water intakes, diet apparent digestibility, ruminal fermentation and blood parameters in lambs. The comparison of sheep response to daily and alternate distribution of SBM or MLM-containing concentrates would indicate whether the use of these two protein sources could be reduced or not, thus whether the feeding cost could be alleviated or not.

2. Materials and methods

2.1. Study site and feeds

A digestibility trial was carried out at the National Institute of Agricultural Research of Tunisia (INRAT) in January–February 2011. Oat hay bales (18–20 kg) and barley grain were produced in the Experimental Station of INRAT at Bourbia. However, SBM and mineral and vitamin supplements were purchased from the local market. Air-dried Moringa leaves powder was prepared in the laboratory of the Animal and Forage Production of INRAT. Moringa plantation was established in the National Institute of Agricultural Research of Tunisia (INRAT) and harvested every 6 weeks. Then, *Moringa* leaves were air-dried for 2 weeks and crushed before mixing it with barley grain and the mineral and vitamin supplement. Three types of concentrates were used in this trial. All of them contained barley grain without or with soyabean meal (common protein source) or dried Moringa leaf meal (alternative protein source). The composition of these concentrates is reported in Table1.

Table 1
Proportions of ingredients in concentrates and chemical composition of feeds.[a]

	C-SBM	C-MLM	C-BAR	Oat hay
Ingredients (g/kg)				
Soybean meal	190	0	0	
Barley grains	780	505	970	
Dried Moringa leaves	0	465	0	
Mineral and vitamin supplement	30	30	30	
Chemical composition				
DM (g/kg)	880	880	880	950
OM (g/kg DM)	980	920	980	930
CP (g/kg DM)	135	158	113	26
NDF (g/kg DM)	250	270	273	770
ME (MJ/kg DM)	13.8	13.6	13.7	11.3
Total phenols (g/kg DM)[b]	3	11	2	6
Total tannins (g/kg DM)[b]	2	7	2	3
Saponins (g/kg DM)[c]	15	42	26	28

[a] C-SBM: soyabean meal-containing concentrate, C-MLM: Moringa leaf meal-containing concentrate, and C-BAR: barley concentrate.
[b] Equivalent tannic acid.
[c] Equivalent diosgenin.

2.2. Animals and treatments

Twenty adult Barbarine lambs (average initial body weight = 27.3 ± 3.0 kg) which had been treated with anthelmintics were selected on the basis of live weight and used in this study. The lambs were allocated to four groups of five animals each; group 1 and 2 received concentrates containing SBM (C-SBM) and MLM (C-MLM), respectively at daily frequency. However, groups 3 and 4 were supplemented by these concentrates (day n) and barley concentrate (C-BAR, day $n+1$) at alternate days for the whole period of this experiment. The feed ingredient, formulation and chemical composition are shown in Table 1. After a 21-days adaptation to dietary treatments (Day1–21), lambs were moved into individual metabolism crates for a 10 days digestibility trial (4 days for adaption to the new housing conditions (Day 22–Day 25) and 6 days for collection of excreta (Day 27–Day 31).

2.3. Sampling and measurements

Samples of SBM, MLM, barley grain and oat hay were collected daily throughout this experiment. Each sample was divided into two parts. One part was used for DM determination (80 °C) and the other was dried at 50 °C and used for chemical analysis. Blood samples were taken in the two first and the two last days of the digestibility trial (Days 26, 27, 30 and 31) from the jugular vein of each lamb before the distribution of the morning meal and centrifuged at 3000 × *g*. Plasma was recuperated and conserved at −20 °C until analyzed. Blood samples were analyzed for glucose, total proteins and urea using standard kits (Biomaghreb).

2.4. *in vivo* digestibility study

Lambs housed in metabolic cages were acclimated to the new housing conditions for four days before starting fecal collection over six consecutive days. Every day, the animals were given oat hay and clean water *ad libitum*.