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Nutrient intake, digestibility and growth performance of Washera lambs supplemented with graded levels of sweet blue lupin (*Lupinus angustifolius* L.) seed

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ABSTRACT

The experiment was conducted to evaluate nutrient intake, digestibility and growth performance of Washera lambs fed natural pasture hay-based diet supplemented with graded levels of sweet blue lupin (*Lupinus angustifolius* L.) seed. Twenty male intact Washera lambs with average age of four months and initial body weight of 16.9 ± 0.32 kg (mean ± SD) were used in 90 days feeding trial followed by 10 days digestibility trial. The design of the experiment was randomized complete block design (RCBD) with five replications. The four supplement feeds were; 150 g wheat bran (WB) (control-T_1), 150 g WB + 195 g sweet lupin seed (SLS) (T_2), 150 g WB + 245 g SLS (T_3) and 150 g WB and 295 g SLS (T_4). Natural pasture hay was offered *ad libitum*. Digestibility trial was conducted at the end of the growth trial. Data were analyzed using the General Linear Model (GLM) procedures of SAS (version 9.2). Means were separated using Duncan's Multiple Range test. Correlation between nutrient intake, digestibility of nutrients and weight gain were analyzed using Pearson correlation procedure. Results showed that supplementation of SLS significantly increased total dry matter, crude protein and organic matter intakes. Supplementation of SLS improved the digestibility of dry matter and organic matter ($P < 0.05$) and crude protein ($P < 0.001$). However, the digestibility of NDF and ADF were not affected by supplementation ($P > 0.05$). Average daily gain (ADG) was higher ($P < 0.001$) for the SLS supplemented groups (61.8–89.1 g/day). It was concluded that sweet blue lupin seed could serve as alternative CP supplement in natural pasture hay-based feeding of Washera sheep. Based on the biological performance of the experimental lambs (ADG and FCE values), T_3 could be recommended for practical feeding of lambs if optimum performance is targeted.

1. Introduction

Ethiopia is a country with varying agro-ecologies and diversified livestock species (FAO, 2004), subject to climatic conditions typical of dryland areas. Sheep is the dominant one next to cattle. About 29 million sheep are estimated in the country (CSA, 2013). They have multipurpose roles for smallholder farmers such as income, meat, skin, manure, fibre, and social security mainly during crop failure (Tibbo, 2006; Getachew et al., 2010).

However, the potential contribution of this sub-sector to food- and nutrition-security and the country's economy is very low because of different and persistent constraints (Mengistu, 2006; Tolera, 2012; Assefa et al., 2010; Tegegne and Assefa, 2010; Ergano and Duncan (2013)). Sheep in Ethiopia, like other livestock, suffer from low production levels and poor reproductive performance. This is exemplified by poor feed conversion efficiency, poor daily weight gain, low mutton/meat yield, low off-take rates, low conception and lambing rates, longer lambing intervals, and high mortality (MoA, 2014, unpublished).

For so long, inadequate nutrition has been identified as a major constraint to the low productivity of Ethiopian livestock (AACM, 1984; FAO, 1993, 1998; Mengistu, 2006; Tolera, 2012; Assefa et al., 2010; Tegegne and Assefa, 2010; IPMS, 2012). Natural pasture grazing, crop residues and grass hay are the main feed sources of sheep in Ethiopia (Mengistu, 2006; Tolera, 2012; Yami, 2008; Tegegne and Assefa, 2010). The nutritive value of these feed sources (Bediye and Sileshi, 1989) is below optimum requirement for maintenance (Van

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Soest, 1994; McDonald et al., 2002) let alone supporting growth and milk production (NRC, 1985). According to Van Soest (1994) and McDonald et al. (2002), nutrient deficiencies that reduce the activities of rumen microorganisms are liable to reduce feed intake. The most common is protein or nitrogen deficiency, which may be corrected by supplementation with rumen-degradable protein or with a simple source of nitrogen. Consequently, sheep in Ethiopia are sold in the market with poor body condition (low in meat quality and quantity). This significantly affects *per capita* meat consumption at household and national levels (<10 kg) (FAO, 2014) and the economic return of the smallholder farmers and the exporting value for the country. To meet the ever increasing demand for livestock products, there is a need to significantly improve livestock production and productivity (MoA, 2014–unpublished). If ruminants in general and sheep in particular are to contribute their share, supplementation is highly recommended. Crude protein has been identified as the most limiting nutrient in the tropics especially during dry seasons. Dietary supplementation is known to improve intake by increasing the supply of nitrogen to the rumen microbes. This has a positive effect in increasing rumen microbial population and efficiency, thus enabling them to increase the rate of breakdown of the digesta. As the rate of breakdown of digesta increases, feed intake is accordingly increased (Van Soest, 1994; McDonald et al., 2002). In Ethiopia, protein source concentrates are unavailable or unaffordable for smallholder livestock producers. Thus, supplementing sheep with legume grains which are less competitive in human food system is commendable.

White lupin (*Lupinus albus* L.) is produced by smallholder subsistent farmers in Ethiopia (Tefera, 2010; Yeheyis et al., 2010). It is a valuable multipurpose, but underutilized, plant contributing for improving soil fertility, food for humans and animal feed. Very recently, however, farmers have shown increasing interest in cultivating white lupin (*Ibid*). Because of the presence of high alkaloid content (16,752 mg/kg DM) (Yeheyis et al., 2011), raw seed of local white lupin is bitter, unpalatable and often toxic for humans and livestock. As an alternative, sweet blue lupin (*Lupinus angustifolius* L.) has been introduced to Ethiopia and its adaptability and productivity (both forage dry matter and seed yield) were studied and currently it is produced by smallholder farmers with an increasing interest in a wider utilization of this legume seed (Yeheyis et al., 2012). Only limited information is available about the feeding value of sweet lupin grain in sheep nutrition in Ethiopia. Yeheyis et al. (2012) reported that sweet blue lupin seed has a potential to substitute the commercial concentrate supplement feed. The relatively high crude protein content and lower alkaloid content coupled with its palatability shows the potential of sweet blue lupin seed to be used as an alternative protein source (*Ibid*). The current study was, therefore, conducted to evaluate the effects of graded levels of sweet lupin seed on nutrient intake, digestibility and body weight change of Washera lambs.

2. Materials and methods

2.1. Description of the study area

The experiment was conducted at Zenzelima campus of Bahir Dar University, which is located between latitude and longitude of 11°37′N 37°29′E coordinates and an elevation of 1912 m above sea level (Google Earth, 2013). The long-term (47 years) average daily minimum and maximum temperatures were 7 °C and 29 °C, respectively. The average annual rainfall calculated for the same period was 1445 mm. The main rainy season is from June to September. The soils are dominantly fine soils (i.e., clays and silt clays) developed on basaltic bedrocks (Haregeweyn et al., 2012).

2.2. Experimental animals, their management and treatments

Twenty intact Washera lambs with average age of four months and initial body weight of 16.9 ± 0.32 kg (mean ± SD) were purchased from Adet livestock market which is 45 km southeast of Bahir Dar. The age of the lambs was determined using dentition and birth history (verbal reports) from farmers. The lambs were de-wormed and vaccinated against endo- and ecto-parasites and diseases and they were adapted for 15 days to the experimental diets and individual pens. The experimental animals were kept under experimental house constructed according to ILRI (International Livestock Research Institute) standard design (Osuji et al., 1993).

The design of the experiment was randomized complete block design (RCBD). Experimental animals were grouped into five blocks of four animals each based on their initial body weight. Natural pasture hay was provided as a basal diet and offered *ad libitum* with 20% refusal.The hay used in this study was local mixed grass hay which was harvested from natural pasture during November 2013 (matured) and purchased from surrounding farmers during March 2014. The four experimental supplement feeds were 150 g wheat bran (WB) (T_1), 150 g WB + 195 g sweet lupin seed (SLS) (T_2), 150 g WB + 245 g SLS (T_3) and 150 g WB and 295 g SLS (T_4).

The SLS used for this study was purchased from local growers in Arebgebeya (50 km East of Bahir Dar) and Durbete (60 km southwest of Bahir Dar). The cultivar of sweet blue lupin seed used in this study was 'Sanabor'. From the three treatments (T_2, T_3 and T_4), T_3 was assumed to provide 127 g/day CP which is recommended by NRC (1985) for early weaned lambs weighing 10 kg, as a benchmark, while the other two treatments were formulated to provide 110 and 144 g/day CP, respectively. Mineral block (common salt) and water were provided *ad libitum*. The supplemental feeds were divided in to two halves and offered twice a day at 9:00 and 16:00 h.

Daily feed intake was calculated as a difference of daily offer and daily left over from each animal. Body weight measurements were taken by Salter scale (50 kg capacity with 100 g precision) weekly after overnight fasting. Average daily gain (ADG) was determined as a difference between final and initial body weight divided over the feeding days. Feed conversion efficiency was calculated as the proportion of daily weight gain to daily dry matter intake. Feed conversion ratio was calculated as the proportion of daily dry matter intake to daily weight gain. Digestibility trial was conducted at the end of the growth trial. Lambs were acclimatized to faecal collection bags for 3 days followed by 7 days of total faecal collection for each lamb. Feed refusals and faeces voided by each lamb within 24 h period were collected and weighed. After weighing the daily total faecal output of each animal, the faeces was thoroughly mixed and sub sample of 10% was taken to make up a single weekly composite for each lamb. Composite samples were taken in air tight plastic bags and stored at -4^0c pending for chemical analysis. Apparent digestibility of nutrients was calculated as the proportion of the difference between nutrient consumed and nutrient in faeces to nutrient consumed.

2.3. Chemical analyses

Chemical analyses were done for individual feeds and faeces samples. Rrepresentative samples of daily feed offers and faeces were taken, air dried and ground to pass screen size of 1 mm. The ground samples were analyzed for contents of DM, ash and N using the procedure of AOAC (1990). NDF, ADF and ADL were analyzed following the procedure of Van Soest et al. (1991). Both the feed and faces samples were analyzed at the Animal Nutrition Laboratory of Debre Berhan Agricultural Research Centre, Ethiopia.