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Rumen degradable nitrogen requirements for optimum microbial protein synthesis and nutrient utilization in sheep fed on finger millet straw (*Eleucine coracana*) based diet

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ABSTRACT

Studies were conducted to determine the rumen degradable nitrogen (RDN) requirement levels for optimum microbial protein synthesis and nutrient utilization in Nellore rams fed on finger millet straw (FMS) based diet. Thirty six Nellore sheep were randomly divided into four groups of nine animals each using the balanced completely randomized design. Animals in all the groups were fed finger millet straw as a basal roughage and groundnut cake (GNC) was offered daily in two equal halves in the morning (8.00 AM) and evening (4.00 PM) as RDN source. The animals in group I (GI) were fed with *ad libitum* FMS. Animals in group II, III and IV (GII, GIII, and IV) were offered GNC @ 12.4, 16.6, and 21.1 g RDN/kg digestible organic matter (DOM) along with FMS. The daily total dry matter (DM) and organic matter (OM) intakes linearly increased ($P<0.05$) with increasing level of RDN supplementation while there was no difference in total DM and OM intake/kg $W^{0.75}$ among different experimental groups. The digestibility coefficients of DM ($P<0.001$), OM ($P<0.001$), crude protein (CP) ($P<0.001$), ether extract (EE) ($P<0.001$), neutral detergent fibre (NDF) ($P<0.01$) and acid detergent fibre (ADF) ($P<0.03$) increased quadratically with increasing level of RDN supplementation from GI to GIV. The purine derivatives (PD) excretion, microbial purine absorption and microbial nitrogen supply (MNS g/day) linearly increased ($P<0.001$) as the level of RDN supplementation increased. There was no difference in nitrogen capture efficiency (NCE) and microbial nitrogen to total urinary nitrogen ratio (MN:UN) among the RDN supplemented groups. This study indicated that 12 g RDN/kg digestible organic matter intake (RDN g/kg DOMI) or 18 g RDN/kg OM apparently digested in the rumen (RDN g/kg DOMR) may be adequate for optimum microbial protein synthesis and digestibility of nutrients, there by improved plane of nutrition in sheep fed on finger millet straw based diet.

Abbreviations: ADF, acid detergent fibre; CP, crude protein; DM, dry matter; DMI, dry matter intake; DOM, digestible organic matter; DOMI, digestible organic matter intake; DOMR, OM apparently digested in the rumen; EE, ether extract; EMNS, efficiency of microbial nitrogen supply; FMS, finger millet straw; GNC, groundnut cake; kg $W^{0.5}$, kg metabolic body weight; MN:UN, microbial nitrogen to urinary nitrogen ratio; MNS, microbial nitrogen supply; NCE, nitrogen capture efficiency; NDF, neutral detergent fibre; OM, organic matter; OMI, organic matter intake; PD, purine derivatives; RDN, rumen degradable nitrogen.

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1. Introduction

Indian livestock production system is mainly based on crop residues and agricultural by products. Despite their availability in huge quantities, these crop residues are poorly utilized by the ruminants because of unbalanced nutrient profile. These low quality feeds are primarily deficient in nitrogen which leads to poor performance of animals. This deficit in dietary nitrogen levels results in inadequate supply of ammonia nitrogen in rumen leading to a suboptimal microbial growth. Therefore, the fermentation of these low quality roughages might produce a reduced amount of microbial protein. Therefore, it is hypothesized that, supplementation of these crop residues with RDN is necessary for optimum microbial protein synthesis. Groundnut cake (GNC) is one of the most commonly used protein source for livestock feeding in India. Since GNC is rich in nitrogen content and is rapidly degraded in the rumen, its use in appropriate levels in livestock feeding is necessary for optimum microbial protein synthesis which otherwise might results in wastage of large quantities of nutrients, particularly nitrogen which might add to cost of production and ultimately lead to environmental pollution.

Hence, the objective of the present study was to determine RDN requirement for optimum microbial protein synthesis and optimum utilization of nutrients in Nellore sheep fed on finger millet straw based diet.

2. Materials and methods

Thirty six Nellore sheep were randomly divided into four groups of nine animals each using the balanced completely randomized design. Randomization of animals to the treatment groups was performed using PROC PLAN procedure of SAS 9.2 (2009) (SAS Institute Inc., USA). The animals in all groups were fed finger millet straw (FMS) as a basal roughage source. Groundnut cake (GNC) was used as a rumen degradable nitrogen (RDN) source and offered daily in two equal halves in the morning (8.00 AM) and evening (4.00 PM) as RDN source. The RDN content of GNC was determined by estimating the dry matter (DM) and crude protein (CP) disappearing from samples in nylon bags (Pore size 40 μm) of size 100 mm × 170 mm, incubated in the rumen of crossbred fistulated steers for 3, 6, 9, 12 and 24 h (Mehrez and Orskov, 1977). The RDN provided by straw was not taken into account for calculating the total RDN of the diet.

The animals in group I (GI) were fed with *ad libitum* FMS. Animals in group II, III and IV (GII, GIII and GIV) were offered GNC to provide 15, 22 and 30 g RDN/kg digestible organic matter (DOM), respectively along with FMS. Fresh clean water was made available at all times. All the experimental animals were dewormed and kept in individual pens with feeding and watering arrangements.

2.1. Experimental period, sample collection and preparation

The experimental feeding period was continued for 15 days followed by a 7 day metabolism trial during which total urine excreted and faeces voided daily were collected. Representative sample of feeds offered, left over, faeces and urine was collected for 7 days and preserved for further analysis. Prior to the experimental period, all the animals were adapted to a diet of FMS supplemented with GNC once daily in the morning for a period of one month, till intakes become stable.

2.2. Urine collection and preservation

The urine excretion from each sheep was collected in a separate container maintained for each sheep which contained sufficient quantity of H_2SO_4 (100 g/L) to maintain pH below 3.0. Representatives samples of daily urine were diluted with distilled water in such a way that the concentration in the final samples would fall with in the range of standards (5–50 mg/L) used in the assays for estimation of purine derivatives. These samples were diluted in order to avoid precipitation of uric acid during storage. These diluted samples were centrifuged and filtered through surgical gauze and stored at −20 °C. These representative samples colleted from each sheep for 7 days were bulked to give finally one composite sample from each animal.

2.3. Chemical analysis

Feeds and faecal samples. Dry matter, ash, ether extract of the feed and faecal samples was analyzed using Association of Official Analytical Chemistry (AOAC, 1997) procedure numbers 930.15, 942.05 and 920.39. Total N in samples was determined with an N gas analyzer (LECO FP-528, LECO Corporation, Italy) using an induction furnace and thermal conductivity (procedure number, 990.03). For analysis of fibre fractions, NDF and ADF were assayed without a heat stable amylase and sodium sulphite and expressed inclusive of residual ash, as per Van Soest et al. (1991).

2.4. Purine derivatives analysis in urine

The total urine samples collected were thawed, sonicated (Sonics Vibra Cell™, Sonics and Materials Inc., Newtown, USA), centrifuged and filtered through a Millex-HV 0.45 μm pore size filter (Millipore) and a 5 μl of the filtrate was injected into HPLC column for estimation of purine derivatives such as allantoin, uric acid, hypoxanthine and xanthine. Purine derivatives content in urine samples were analyzed as per the method suggested by Resines et al. (1992) using HPLC system (Waters)