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Intake, nutrient utilization, rumen fermentation, microbial hydrolytic enzymes and hemato-biochemical attributes of lactating goats fed concentrate containing *Brassica juncea* oil meal

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ABSTRACT

The effect of incorporation of *Brassica juncea* oil meal (BJM) was evaluated on intake, nutrient utilization, performance, rumen fermentation, microbial hydrolytic enzymes and hemato-biochemical attributes of Jamunapari goats in a 60 days feeding experiment. Eighty lactating goats during the 2nd week of lactation were randomly divided into 4 equal groups and were allocated to one of the four concentrate pellets. Animals of control group (BJM-0) received concentrate pellets with expeller extracted linseed oil meal (LSM; 300 g/kg). The LSM was replaced (w/w) by BJM at 75, 150 and 225 g/kg in other three concentrate pellets, these pellets were fed to goats of BJM-75, BJM-150 and BJM-225 groups. Each goat received 720 g dry matter (DM) of respective concentrate pellets in two equal meals at the morning and evening milking, along with 6–8 h daily grazing. The BJM contained total glucosinolate (GLS) 72.58 μmol/g DM, which contributed GLS 5.44, 10.89 and 16.33 μmol/g DM respectively in concentrate pellets with BJM 75, 150 and 225 g/kg. The BJM feeding did not change intake and digestibility of DM and other nutrients. Rumen fluid pH, NH_3-N, total volatile fatty acids and extracellular microbial hydrolytic enzymes (protease, α-amylase, carboxymethyl cellulase) were similar among four goat groups. Similarly, nitrogen (g/kg DM) and ME (MJ/kg DM) contents of ingested diets were respectively from 24.1 to 24.6 g and 11.33 to 11.48 MJ, whereas intakes of N (g/kg $W^{0.75}$) and ME (N (MJ/kg $W^{0.75}$) were varied from 1.96 to 2.06 g and 0.92 to 0.96 MJ respectively, which were similar among four goats groups. Goats of BJM-0 group lost LW whereas goats fed concentrates with BJM gained LW and had increased ($p < 0.001$) milk yield. The goats of BJM-225 group had a 15% increased milk yield. BJM feeding also increased ($p = 0.031$) milk thiocyanate content. The BJM feeding did not change the levels of serum protein, albumin, globulin, aspartate transaminase and alanine transaminase. Decreased level of blood urea nitrogen in goats fed concentrates with BJM indicated higher N utilization efficiency of BJM. However, hemoglobin (Hb), hematocrit and red blood cells (RBC) decreased ($P < 0.05$) by BJM inclusion levels. Therefore, BJM with

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72.58 μmol GLS/g DM could be incorporated in the concentrates up to 225 g/kg. Lactating goats in present experiment tolerated a daily intake of GLS 11.76 mmole, which amounted 9.45-μmol GLS/g diet DM. However, goats fed concentrates with BJM reduced blood Hb, RBC and hematocrit, and these observations needed further investigation.

1. Introduction

Protein supplements are the most expensive feed ingredients used in animal feed formulation. Alternate feed resources are being added to the animal feed chain to increase the availability of feed resources as well as to lower the cost of feeding. Ground nut cake, soybean meal, linseed, and til cake are conventional protein supplements used in goat feeding. However, these are very costly, and their availability for ruminant feeding is limited. Mustard cake is widely available at cheaper prices, but its utilization in goat feeding is limited by its bitter taste and glucosinolate (GLS) content. The GLS level of the *Brassica* products contributed to the degree of bitterness (Tripathi and Mishra, 2007). Rapeseed–mustard is the second most important edible oilseed crop in India after groundnut. Rapeseed–mustard accounted 30% of the total oilseeds produced in the country (GOI, 2010) and the GLS content of these cultivars ranged from 128 to 186 μmol/g DM (Tyagi, 2002). Replacement of conventional protein supplements with high GLS rapeseed–mustard oil meals (RSM) have reduced feed value and performance of sheep (Tripathi et al., 2001a), goat (Pailan and Singhal, 2007) and calves (Tripathi et al., 2001b; Ravichandiran et al., 2008). However, above studies have recommended limited quantities of RSM because of high GLS content and suggested added supplements or treatments for the use of the higher amounts of RSM in feed formulations. The GLS are biologically non-active secondary compounds of *Brassica* plants however; metabolites of GLS have varying biological effects in animal. The GLS are hydrolyzed by the myrosinase enzyme, which is inherently present in plant and/or produced by intestinal microflora in to isothiocyanates, nitriles, thiocyanates or oxazolidithione. Enzymatic hydrolysis of GLS of BJM mainly produced goitrin (5-vinyloxazolidine-2-thione) and thiocyanate ions (Tripathi and Mishra, 2007). Genetic manipulation reduced the major GLS (3-butenyl, 2-propenyl and 4-pentenyl) of Indian BJM (Tyagi, 2002) and produced low GLS *Brassica* cultivars. Therefore, oil industry by-products, the oil meals of *Brassica* could be utilize in animal feeding without detrimental effects. At present moderate GLS containing oil meals of mustard (*Brassica juncea*) are sufficiently available in the country. More recently, *Brassica* forage and oil meals feeding have shown the reduced methane production potential (Sun et al., 2012) and, the polyunsaturated fatty acids, nitrate and sulphate contents were considered as the hydrogen sinkers in the rumen (Barry, 2013). The chemical reduction of one mole of nitrate can reduce methane by one mole (Sun et al., 2012). *Brassicas* forages have been recommended a viable option for methane mitigation from pastoral based animal production system (Sun et al., 2012) and oil meals from pen feeding or supplementary feeding based livestock production system.

Therefore, in view of the potential availability, low prices, methane mitigation potential and reduced GLS content of BJM. The objectives of present study were to assess the effect of feeding of concentrate pellets with graded levels of BJM on intake, nutrient utilization, rumen fermentation, blood hemato-biochemical attributes and milk production performance, and the GLS tolerance levels of goats.

2. Materials and methods

The experiment was conducted at the ICAR – Central Institute for Research on Goats (CIRG), Makhdoom, Mathura, India from December 2012 to February 2013. Institute located at 27°10′ N latitude and 75°28′ E longitude and 169 m above sea level. The climate is hot and semi-arid, during the experiment minimum and maximum temperature ranged from 9.5 to 11 °C and 26.5 to 31.5 °C respectively, while relative humidity varied from 58.0 to 94.0% and rainfall was 68.4 mm.

2.1. Animals and feedings management

Eighty lactating Jamunapari goats (4.5 years of age; 37 ± 0.57 kg live weight) during their second week of lactation were selected from the general flock of the Institute, divided randomly into four groups homogenous in age and live weight. Goats were housed in four well-ventilated enclosures with open paddocks and were allowed 6–8 h daily grazing on *Chenchrus ciliaris* dominated pasture. The pasture was natural with carrying capacity of 2–3 ACU/ha. Each goat individually received 800 g concentrate pellet in two equal meals at milking in the morning 08:00 and evening 16:00 h, and the concentrate pellets were fed following the recommendations of ICAR (1998) for lactating Jamunapari goats on grazing. The concentrate pellets contained oil meal (BJM or linseed), barley, wheat bran, molasses, mineral mixture and salt (Table 1). The BJM was included at 0 (BJM-0), 75 (BJM-75), 150 (BJM-150) and 225 (BJM-225) g/kg, which substituted linseed oil meal (LSM, w/w). The goats of control group received concentrate pellets with LSM and designated the BJM-0 group, while other three goat groups received one of the three concentrate pellets with graded levels of BJM.

2.2. Live weight change and milk production

Live weights (LW) of animals were recorded for two consecutive days on day 0, followed by 30 and 60 day of experiment. Milk yields of goats were recorded at weekly intervals (Fig. 1) by hand milking at 08:00 and 16:30 h, and total milk yield was the sum of morning and evening milk. Thiocyanate was estimated in stored (−20 °C) morning milk samples.

2.3. Digestibility trial

A digestibility trial was carried out after 45 days of feeding on ten representative animals of each group. Feeding was the always same during experiment and digestibility trial. The animals under trial were dosed with 1 g chromic oxide (Cr_2O_3) in a paper capsule at 08:00 h and 17:00 h for 10 consecutive days, initial 5 days were for uniform Cr_2O_3 excretion in the feces and during the later 5 days, the feces samples (2 g) were manually collected from the rectum in the morning and evening. Feces samples collected over a 5-day period were pooled and representative samples were drawn, one set was preserved at −20 °C for nitrogen analysis, while another sets of samples were dried in an oven at 60 °C to a constant weight and ground to pass a 1-mm screen for chemical analysis. The Cr_2O_3 content