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Effect of Strategic Supplementation of Fat Sources on Nutrient Intake, Digestibility and Nitrogen Balance in Growing Barbari Goats

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ABSTRACT

Feeding trial was conducted on eighteen growing male Barbari goats (6-7 months age and mean body weight 13.17±0.83 kg). They were divided into three groups (Gr C, Gr S1 and Gr S2) and fed with basal diet of concentrate pellet and gram straw. Animals of Gr C was control and fed with basal diet without any supplementation, while animals of Gr S1 was fed with basal diet and around 3% fat source mixture (flaxseed oil, sunflower oil @1.5% of DMI each and 20g NV1810) and Gr S2 was fed with basal diet and around 6% fat source mixture (flaxseed oil, sunflower oil@3.0 % of DMI each and 20g NV1810). After 75 of experimental feeding a metabolism trial of 6 days duration was conducted to estimate the effect of fat supplementation on intake, digestibility of nutrients and nitrogen utilization. There was no significant difference (P>0.05) on daily dry matter intake being 695g for Gr C, 624g for Gr S1and 614g for Gr S2. Digestibility of dry matter, organic matter, ether extract and total carbohydrate was statistically similar (P>0.05) among different groups of growing goat. There was significant depression in the crude protein, NDF and ADF digestibility in Gr S2 as compared to Gr C and Gr S1. Total nitrogen excretion (g/day) was significantly (P<0.05) lower in Gr S1 (7.01) as compared to Gr C (8.88) and statistically similar to Gr S2 (7.91). Similarly nitrogen balance (g/day) was significantly better in Gr S1 (4.12) as compared to Gr C (3.03) and Gr S2 (2.83). Nitrogen balance (as % of intake and absorbed) was significantly (P<0.05) higher in Gr S1 as compared to Gr C of animals. Present study concluded that supplementation of fat at approximately 3% of DMI improved the nitrogen utilization in growing goats without adverse effect on intake and digestibility of nutrient while higher level, of 6% of DMI, adversely effected the fibre digestibility.

KEY WORDS: Digestibility, Fat supplementation, Growing goats, Nitrogen utilization

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INTRODUCTION

Fats or lipids are concentrated source of energy, providing more than twice the energy of carbohydrate on a weight basis. Generally fat content of ruminant's diets is low, as plants have a low fat content. Plant waxes are fats that goats consume as they graze and browse. Fat may be added to diets to increase the energy content. However, high levels of added fat depress fiber digestion unless treated to be inactive in the rumen. These fat sources are termed "bypass" and may be used in dairy goat diets but are generally not used in meat goat diets (Hart, 2008). Goat meat is considered healthier than other red meats (Anaeto et al., 2010) because it has leaner protein, less fat, and is high in iron and vitamin B_{12}. It also has balanced amino acids, saturated/unsaturated fatty acids, low n6:n3 ratio, and high conjugated linoleic acid (Chin et al., 1992). Increasing efforts are being made to improve nutrient utilization (Mir and Kumar, 2012) and to produce healthier meat with a fatty acid configuration that is more favourable (PUFA/SFA and n-6/n-3 ratio) and an enhanced conjugated linoleic acid (CLA) content that decreases the risk of cardiovascular disease and other chronic illnesses. Observations have found that this ratio and CLA content in the products is highly affected by the fatty acid makeup of the feed offered to ruminants (Jalè et al., 2009). Therefore, appropriate feeding strategies are needed to improve the ruminant meat's nutritional composition and fatty acid profile matching the levels recommended by the health agencies (Rotondi et al., 2018). Reports indicate that feeding of linoleic and linolenic acids rich oil seeds and oils augmented the CLA and vaccenic acid content in tissues of lambs, beef cattle, cattle milk fat, sheep and goats, in varied quantities depending upon the source of oils (Roy et al., 2013). However strategic supplementation of oils or fat can hamper the digestibility and balance of nutrients, there by affecting the overall productivity of animals. Keeping in view these facts present study was conducted to evaluate the dose of supplementation of fat sources for improving meat quality on the intake, digestibility and balance of nutrients in growing meat Barbari goats.

MATERIALS AND METHODS

Animal and feeding

Eighteen growing male Barbari goats (6-7months age and mean body weight 13.17±0.83 Kg) were divided into three groups of six each as per randomized block design and fed with Bengal gram straw and concentrate pellet to meet their nutrient requirement as per NRC (2007). Concentrate pellet was fed @ 1.5% of body weight and straw was fed *ad libitum.* Each goat was housed individually in pens measuring 1.2 m ×1 m each and fed individually as per their requirement. Goats of Gr C served as control and was fed with Basal diet (Concentrate pellet and *adlib* gram straw), Gr S1 was fed with basal diet and around 3% of DMI fat source mixture(flaxseed oil, sunflower oil@1.5% of DMI each and 20g NV1810) and Gr S2 was fed with basal diet and around 6% fat source mixture(flaxseed oil, sunflower oil@3.0 % of DMI each and 20g NV1810).The concentrate pellet was containing 20% maize grain, 20% barley grain, 6% groundnut cake, 5% soybean meal, 5% mustard cake, 5% guar korma, 15% wheat bran, 14% de-oiled rice bran, 7% molasses, 2% mineral mixture, and 1% salt. The supplemented oils are rich in C18:1 (MUFA), C18:2 and C18:3 (PUFA) and were included in the diet as a source of these fatty acids. NV1810 is a commercial product of Fine Organic Industries Ltd., Mumbai. This is an unsaturated fatty acid-rich multipurpose dietary supplement with low bacterial degradation capabilities, derived from refined vegetable oils stated to have a positive effect on body condition scores. These fat sources were supplemented to improve the meat composition of the goats.

Experimental procedure

The duration of experiment feeding was 120 days and metabolic trial was conducted after 75 days of experimental feeding. The experiment was conducted in Sep-Dec 2021. Weighed quantities of concentrate pellet were offered to goats at 08:00AM and 2.00 PM, and gram straw was provided *ad lib*. Supplement was mixed in the concentrate and fed to animals of Gr S1 and Gr S2. Water was provided *ad lib* and was changed twice daily throughout the experimental period. Metabolism trial was conducted in metabolic cages having facility for individual feeding and separate collection of faeces and urine. Representative samples of pellet offered and remnants were taken daily in previously tared trays and kept in a hot air oven at 100±2°C overnight for DM estimation. The dried material obtained during the trial period was pooled, ground and stored for proximate and fibre analysis. The faeces voided in 24 h by the individual animal were collected in a previously weighed container. After weighing the faecal container, the faeces were thoroughly mixed and a representative sample from each animal was taken in a previously labeled polythene bags. From the sample a suitable aliquot (10%) of faeces was kept for drying at 100±2°C in a hot air oven for dry matter determination. The dried faecal sample obtained daily was pooled, ground and used for chemical analysis. Another portion of aliquot (1% of fresh faeces) was thoroughly mixed with 10 ml of 1:4 sulphuric acid and kept for nitrogen estimation. Urine collected was measured at the end of the 24 h period in order to assess the daily output. A suitable aliquot (2% v/v) of daily urine from individual animals was kept in Kjeldahl flasks containing 40 ml of laboratory grade sulphuric acid.

Laboratory and statistical analysis

Nutrient composition of feed, residue, urine and faeces were analysed as per the standard protocol of AOAC (2006). Neutral detergent fiber (NDF), acid detergent fiber (ADF) and hemicellulose (HC) were determined as per Van Soest et al. (1991). The recorded data is presented as mean and SEM. The difference between the groups was analyzed using ANOVA and difference between means were compared using Duncan's Multiple Range Test and declared significant at 95% confidence interval as described by Snedecor and Cochran (1989).

RESULTS AND DISCUSSION

Chemical composition of the concentrate pellet and gram straw used in experimental feeding of goats and fatty acid profile of concentrate pellet, fat supplements is presented in Tables 1a and 1b. The crude protein content (%) of concentrate pellet and gram straw was 18.18 and 6.11. Ether extract (%) was 3.17 for concentrate pellet and 0.42 for gram straw. Sunflower oil was rich in C18:1 and C18:2 while Flaxseed oil was rich in C18:3 and C18:1. NV1810 has high (69.59%) content of C18:1 (MUFA).

Table 1 a. Chemical composition (% dry matter) of feed used in experimental feeding

Attributes	Gram straw	Concentrate pellet
Organic matter	91.7	93.4
Crude protein	6.11	18.1
Total ash	8.24	6.51
Ether extract	0.42	3.17
Neutral detergent fibre	63.2	23.8
Acid detergent fibre	49.4	12.7

Table 1b. Fatty acid profile of oil sources for experimental goats.

Fatty acids (%)	Feed pellet	Sunflower oil	Flaxseed oil	NV1810
C14:0	0.62±0.02	-	-	0.26±0.01
C16:0	27.9±0.85	11.5±0.12	5.53±0.15	9.48±0.37
C17:1	-	-	-	1.13±0.38
C18:0	1.47±0.08	4.45±0.25	4.92±0.10	-
C18:1C	34.6±1.37	21.5±0.05	20.0±0.99	69.5±2.73
C18:2C	28.8±0.45	54.0±0.50	12.2±0.54	9.40±0.38
C18:3N3	1.40±0.01	6.44±0.03	49.28±1.22	
C20:1	0.21±0.21	0.49±0.01	-	7.01±3.84
C18:3 N6	-	-	-	1.88±0.42
C23:0	1.68±0.03	-	-	-
C22:2	2.29±0.23	-	6.88±0.21	0.47±0.06

n=6

The effect of supplementation of fat sources on intake and digestibility of nutrient during digestion trial is presented in Table 2.There was no significant difference (P>0.05) on daily dry matter intake being 695.06g for Gr C, 624.50g for Gr S1 and 614.53g for Gr S2. The concentrate pellet and roughage intake (g/d) was 368 & 326 for Gr C; 358 &265 for Gr S1 and 339 &274.87 for Gr S2. The ratio of concentrate to roughage intake was 1.16 for Gr C, 1.36 for Gr S1 and 1.24 for Gr S2.

Table 2. Effect of supplementation of fat sources on nutrient intake and digestibility of nutrients

Attributes	Gr C	Gr S1	Gr S2	SEM	P-value
Body weight (Kg)	25.6	24.8	22.9	0.51	0.08
Metabolic body size ($W^{0.75}$) (Kg)	11.4	11.1	10.5	0.17	0.08
Dry matter intake (g/day)	695	624	614	15.71	0.06
Dry matter intake (%body weight)	2.72	2.53	2.68	0.05	0.25
TDN intake (g/day)	383	375	336	6.29	0.22
DCP intake (g/day)	47.7^{a}	46.3^{a}	36.3^{b}	2.14	0.05
Digestibility (%)					
Dry matter	63.1	68.3	62.3	1.54	0.23
Organic matter	65.0	69.9	64.1	1.49	0.23
Crude protein	63.9^{a}	66.5^{a}	54.0^{b}	2.44	0.05
Ether extract	71.2	79.2	73.8	1.57	0.10
Total carbohydrate	63.4	69.1	63.9	1.57	0.29
Neutral detergent fibre	39.4^{ab}	47.3^{a}	34.9^{b}	2.49	0.04
Acid detergent fibre	32.6^{ab}	35.8^{a}	24.0^{b}	2.44	0.02

[a,b,] Values with different super script in a row differ significantly (P<0.05)
Gr C: control group (fed with basal ration concentrate pellet and gram straw); Gr S1: supplemented group (Basal ration daily supplemented flaxseed oil, sunflower oil@1.5% of DMI each and 20g NV1810); Gr S2 supplemented group (Basal ration daily supplemented flaxseed oil, sunflower oil@3.0% of DMI each and 20g NV1810); SEM: Standard error of mean

However lower intake was reported in supplemented groups of goats. The % DMI was 2.72, 2.53 and 2.68 in Gr C, Gr S1 and Gr S2 respectively. Francisco et al. (2015) also reported a lesser dry matter intake (DMI) due to oil supplementation of up to 9.6%. However Roy et al. (2013) reported no significant effect of plant oil supplementation on feed intake, FCR, ADG and body weight in goats. Over all, during our feeding trial we found no statistically significant effect on dry matter intake and over all body weight gain (Verma et al., 2023). TDN and DCP intake was also similar in all the group of goats. Digestibility of dry matter, organic matter, ether extract and total carbohydrate was (P>0.05) statistically similar among different groups of growing goat. There was significant depression in the crude protein, NDF and ADF digestibility in Gr S2 (around 6% of DMI fat supplemented group) as compared to Gr C and Gr S 1. The depression in the fibre digestibility may be attributed to the higher dose of supplemental fat which may have adverse effect on fibre degrading rumen microbes. Digestibility of the fibrous carbohydrate fraction is especially susceptible to rumen-active fats from plant sources. Their activity is quite dependent on dose level and they have the potential to interfere with microbial fermentation in the rumen and reduce feed digestibility to varying degrees. Generally in ruminant diet if fat level is more than 5% adverse effect on fibre digestibility is reported. However at lower dose level (Gr S1) improvement in nutrient digestibility has been found. Candyrine et al. (2019) reported that supplementation of 4% linseed oil in the diet of goats did not adversely affect, and in fact in some cases even enhanced nutrient digestibility and thus digestible nutrient intakes of most nutrients. Similarly, while several studies seem to suggest that oil supplementation reduced feed digestibility (Bhatt et al., 2011) and no effect (Bhatt et al., 2013). The inconsistency could be due to the type of oil and dose of oil, used in the different studies, which are made up of different composition of fatty acids. Zhang et al. (2008) stated that fatty acids with higher degree of unsaturation are more toxic towards the rumen microbes, thus reducing digestibility. Lower level of oil supplementation resulted in reduction of protozoa (Faciola and Broderick, 2014) leading to a higher population of bacteria, hence, increased in feed digestibility (Nhan et al., 2007). However higher (>5%) level fat supplementation reduced the fibre digestibility in the ruminants.

Effect of supplementation of fat sources on nitrogen balance in growing goats is presented in table 3. The intake of nitrogen was statistically similar in all the groups of goats being lower in Gr S2, which might be due to lower feed intake. Total nitrogen excretion (g/day) was significantly (P<0.05) lower in Gr S1 (7.01) as compared to control Gr C (8.88) and statistically similar to Gr S1 (7.91). Similarly nitrogen balance (g/day) was significantly better in Gr S1 (4.12) as compared to Gr C (3.03) and Gr S2 (2.83). Nitrogen balance (as % of intake and absorbed) was significantly (P<0.05) higher in Gr S1 as compared to control group of animals (Gr C).

Table 3. Effect of supplementation of fat sources on nitrogen intake and balance

Attributes	Gr C	Gr S1	Gr S2	SEM	P value
N intake (g/d)	11.9	11.1	10.7	0.24	0.12
N excretion in faeces (g/d)	4.28	3.72	4.94	0.27	0.19
N excretion in urine (g/d)	4.60^{a}	3.29^{ab}	2.97^{b}	0.30	0.05
Total N excretion (g/d)	8.88^{a}	7.01^{b}	7.91^{ab}	0.30	0.02
N Balance (g/d)	3.03^{ab}	4.12^{a}	2.83^{b}	0.24	0.05
N absorbed (g/d)	7.64^{a}	7.41^{a}	5.81^{b}	0.34	0.05
N Balance (%) of N intake	25.3^{b}	37.0^{a}	26.3^{b}	2.13	0.03
N Balance (%) of N absorbed	38.8^{b}	56.0^{a}	49.7^{ab}	3.21	0.05

[a,b,] Values with different super script in a row differ significantly (P<0.05).
Gr C: control group (fed with basal ration concentrate pellet and gram straw); Gr S1: supplemented group (Basal ration daily supplemented flaxseed oil, sunflower oil@1.5% of DMI each and 20g NV1810); Gr S2 supplemented group (Basal ration daily supplemented flaxseed oil, sunflower oil@3.0% of DMI each and 20g NV1810); SEM: Standard error of mean

However at higher level of fat supplementation nitrogen balance gets reduced. Machmüller et al. (2006) reported that additional ether extract supplementation from rumen-protected fat, coconut oil, rapeseed, sunflower seed or linseed in growing lambs resulted in trends for higher apparent nitrogen digestibilities (significant with coconut oil; $P < 0.05$) and body nitrogen retention ($P < 0.1$). Urinary nitrogen losses and their proportion of manure nitrogen did not differ significantly among groups. This concluded that supplementation of fat at approximately 3% level improved the nitrogen utilization in growing goats.

CONCLUSION

Present study concluded that supplementation of fat at approximately 3% of DMI improved the nitrogen utilization in growing goats without adverse effect on intake and digestibility of nutrient. However higher level of 6% of DMI adversely effected the fibre digestibility.

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