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Effect of different level of Azolla Meal on Nutrient Utilization and Growth Performance in Goat Kids

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ABSTRACT

An attempt was made to assess the nutritional potential of Azolla meal in a total mixed ration (TMR) at different dietary level on nutrient utilization and metabolic status of goats under hot humid agro climatic condition in Bihar. Eighteen growing male kids of 3-4 months age were distributed into three groups of six animals each on the basis of body weight in a randomized block design. The animals were fed graded level of Azolla meal (0, 20 and 40 %) mixed with concentrate mixture and green fodder berseem. In this study different parameter like feed intake, body weight gain, feed conversion ratio, digestibility of nutrient, blood biochemicals, serum biochemistry of Black Bengal goats (cross) were observed. This experiment was conducted for 90 days. The total DMI (g/d) of T1, T2 and T3 group were 458.12, 449.54 and 494.66 respectively. The intake of DM in each group was comparable and so is the R:C ratio. However, CP, DCP and TDN obtained was quite significant in T2 group than T1 and T3 group. The digestibility of other nutrients such as OM, NDF, ADF, CP, EE, CF, TA and NFE were numerically higher in T2 group and lowest in T3 group. The digestibility percentage of dry matter was from 58.16 in T3 to 63.15 in T2 group. The final body weight was higher in T2 and lowest in T3 group as compared to control group. The body weight (kg) and average daily gain (g/d) was significantly higher ($P \leq 0.05$) in T2 as compared to T1 and T3 group. The ADG obtained was highest in T2 group (60.33 g/d) and lowest in T3 group (45.66 g/d). The total DMI by the animals of T2 group was higher than T3 and T1groups, respectively. The FCR in T2 (20% Azolla meal) supplemented group was lower than T3 (40% Azolla) and T1 group. The body weight changes observed at sixth fortnight was significant in T2 group (20% azolla meal). The weight gained after sixth fortnight was significantly higher in T2 group, i.e (5.73 to 11.16 kg) in T2 group, (5.76 to 10.29 kg) in T1 group and (5.66 to 9.77 kg) in T3 group.

KEYWORDS

Azolla, Weight gain, Black Bengal goats, Feed conversion ratio, Digestibility

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INTRODUCTION

Azolla is important among aquatic plants due to the occurrence of both photosynthesis and nitrogen fixation in the leaves and also because of its growth habits, it appears a greater potential than tree leaves as a source of protein minerals and vitamins for animals. Azolla, a small aquatic fern is distributed through the tropical, subtropical and temperate fresh water ecosystem. Azolla is an aquatic fern consisting of a short, branched, floating stem, bearing roots which hang down in the water. The leaves are alternately arranged and each consists of a thick aerial dorsal lobe containing green chlorophyll and a thin floating ventral lobe of slightly larger size that is colorless. They form a symbiotic relationship with the blue green algae *Anabaena azollae*, which fix atmospheric nitrogen, giving the plant access to the essential nutrient. Azolla is highly productive plant. It doubles its biomass in 3-10 days depending on condition and yield can reach 8-10 times of fresh matter. Azolla in turn, provides the carbon source and favorable environment for the growth and development of the algae. It is unique symbiotic relationship that makes azolla a wonderful plant with high protein content. Among their species the water fern, Azolla which groups in association with blue green algae Anabaena azollae, is perhaps the most promising from the point of view of else of cultivation, productivity and nutritive value (Lumpkin and Plucknett, 1982) and VanHove and López (1983). The water fern Azolla consists of various varieties viz., *Azolla pinnata*, *A. maxicana*, *A. nilotica*. Among them, Azolla pinnata is an important variety which can be grown easily with less initial investment cost. It is commonly found in tropics and subtropics. It grows naturally in stagnant water of drains, canals, ponds, rivers and marshy lands. Anabaena azollae living in the cavity of Azolla leaf can fix amount of atmospheric dinitrogen due to presence of symbiotic algae in the leaves (Becking, 1979). Azolla is most economical and efficient feed supplement for livestock. Research and promotion

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of azolla as a livestock feed has been growing because azolla has a higher protein content 19-30% than most green forage crops and aquatic macrophytic and a rather favourable essential amino acid composition for animal nutrition. Azolla is rich in protein, essential amino acid, vitamins, growth promoter intermediaries and minerals like calcium, phosphorus, potassium, ferrous, copper, magnesium. Dry weight basis, it contains 25 -35 percent protein, 10-15 percent minerals and 7-10 percent of amino acids, bio-active substances and biopolymers and 15% of total ash. Tamang and Samanta (1993) observed that Azolla pinnata contained 7.0 percent dry matter, 15.40 percent crude fibre, 2.80 percent ether extract, 20.40 percent total ash, 47.40 percent NFE, 51.90 percent acid detergent fibre, 67.70 percent neutral detergent fibre, 1.50 percent calcium and 0.40 percent phosphorus on dry matter basis. Livestock easily digest it, owing to its high protein and low lignin content. Azolla as a good protein source can partially replace the concentrate for livestock feeding (Panda *et al*, 2019) and (Singh *et al*, 2019). Mixing of Azolla meal in wheat and rice straw based complete feed block can enhance the growth performance in crossbred calves as reported by Singh *et al* (2016) . Azolla can be mixed with concentrates or can be given directly to livestock. High total ash is a limiting factor in Animal Nutrition.

MATERIALS AND METHODS

The present study was designed to investigate the effect of feeding of Azolla meal on growth performance and nutrient utilization in growing (goat) kids for a period of three months at goat unit of Instruction Livestock Farm Complex (ILFC), Bihar Veterinary College, Patna, India.

Azolla Meal Preparation

Azolla pinnata were collected initially from ICAR-RCER, Patna. The whole plant materials were grown at Instruction Livestock Farm Complex, BVC Patna, Bihar. They were shade dried, powdered at regular interval and used as concentrates according to objective of the experiments.

EXPERIMENTAL ANIMALS

Eighteen growing male kids of Black Bengal cross (N= 18) of 3-4 months age with average body weight of 5.76 ± 0.80 kg were distributed randomly into three groups of six animals each. Randomized block design experiment was followed. Kids were maintained in the ILFC, BVC, Patna for three months.

Feeding management

The goats were penned individually in a well-ventilated shed with cemented floor. The animals were fed Azolla meal (0, 20 and 30 %) mixed in concentrate mixture in T1, T2, and T3 groups, respectively. Green berseem fodder was fed ad libitum. Concentrate allowance was adjusted in such a way that the proportion of concentrate intake did not exceed 50 % of DMI and thus the concentrate: roughage ratio was maintained in all the groups. The basal concentrate mixture was composed of wheat bran (30%), maize (35%), solvent extracted soyabean meal (32%), mineral mixture (2%) and salt (1%).Three treatments were controlled without Azolla meal(T1) and the other two groups were fed on a diet supplemented with 20(T2) and 40 percent(T3) Azolla meal as substitute of concentrates mixture. The green fodder was offered when the animals finished concentrate allowance. Fresh and clean drinking water was made available ad libitum thrice a day. Feed intake was recorded daily. The animals were weighed fortnightly up to 90 days. The feeding experiment was followed by a metabolism trial of 10 days duration with four days adaptation in metabolic cages and 6 days collection to evaluate the effect of feeding different level of Azolla meal on nutrient utilization and nitrogen balance in kids.

Green Berseem

Green Berseem was chopped and then used for feeding to experimental animals of all three groups. The dry matter content of green Berseem was estimated by placing the samples of Berseem in the oven at 100°C for 2 consecutive days at a fortnightly interval throughout the experimental period.

Disease and mortality

In adaptation the period the animals were properly dewormed. Experimental kids were inspected daily for any disease and mortality. There was neither any disease nor mortality in the kids during the whole experimental period of 90 days.

Measurement of body weight gain and intake

Weighing of the animals

All the animals prior to feeding were weighed consecutively on two days on a spring balance at fortnightly intervals during morning time. Water was withhold held overnight. Thus, each observation on body weight was an average of two observations.

Measurement of feed intake

Feed intake of the animals was measured by offering weighed amount of concentrate mixture and roughage (berseem) to the animals and taking record of the residue left at weekly intervals consecutively on two days.

Analytical technique

Metabolic trial study

After 90days of experimental feeding, a metabolic trial of ten days duration was conducted including four days adaptation and six days collection period on all the 18 black Bengal kids (cross) in a specially designed stall. Body weights of the animals were recorded before and after digestibility trial on two consecutive days. A proper record of total quantity of concentrates, green fodders offered, refusal, consumed and faeces voided by each kid was maintained during the trial period.

Sampling of Feeds and Residues

A well-mixed representative sample from concentrates, green fodder was kept in previously labelled polythene bags in the morning, the residue of each animal was collected, weighed and then a uniform representative sample was collected and kept in a polythene bag. 10g sample each from feeds offered and residue was taken in aluminium tray and kept in an oven at 100 ± 5°C, for 24 h for the estimation of dry matter content. The dried samples were stored for further proximate composition and VanSoest analysis.

Collection of Faeces

Collection of faeces was done. As and when faeces were voided by kids, they were placed directly into the pre-weighed and labelled buckets kept for each kid separately. Collection of faeces was done for 6 days period.

Sampling of Faeces

The total faeces voided by each kid during the 24 h period was weighed individually and thoroughly mixed in a trough. After thorough mixing a representative faecal sample of each kid was taken in a pre-marked polythene bag. The bags were then shifted to laboratory for further aliquoting of faeces for sample analysis purpose.

For dry matter estimation, $1/10^{th}$ of the total faeces voided in 24 h of each animal was taken in a pre-labelled shallow aluminium tray, spread evenly and dried at $100 \pm 5^{\circ}$C for 24 h in a hot air oven. Dry matter of faeces was determined daily and dried faeces samples were kept for further proximate principals and Van Soest analysis (VanSoest *et al*, 1991).

Separate aliquots of fresh faeces ($1/30^{th}$ of total faeces voided in 24 h by each animal) were preserved for seven days in pre-weighed plastic bottles (1 kg capacity) after adding 25 ml of 25 percent sulphuric acid in each bottle on 1^{st} and 4^{th} day of collection of faeces. At the end of 7 days collection period, the contents were weighed; mixed thoroughly and 5 g sample was taken in a Kjeldahl flask (300 ml capacity) for digestion and estimation of nitrogen in faecal samples.

Statistical analysis

Statistical analyses of the data were done as per Snedecor and Cochran (1967). SPSS versions 17.0 were used to analyzed the whole data (Anova).

RESULTS AND DISCUSSION

Basic constraint in goat rearing is unavailability of sufficient feeds of adequate quality. Availability of conventional feed to sustain livestock feeding is a major constraint in developing countries. Hence, pressure on utilization of unconventional feed resources has been increasing to develop low cost rations. Research and promotion of azolla as a livestock feed has been growing, because azolla has a higher protein content (19-30%) than most green forage crops and aquatic macrophytes and a rather favorable essential amino acid composition for animal nutrition (notably lysine). Azolla can be a valuable protein supplement for many species including ruminants, poultry, pigs and fish (Hasan and Chakrabarti, 2009). Azolla feeding can increase milk yield by 20 per cent. It also improves the quality of milk. Azolla can be fed to sheep, goat, pig, and rabbit as feed substitute However, literature available on the nutritional potential of azolla in ruminants are scanty. Hence, an attempt is made to assess nutritional potential of azolla in a total mixed ration (TMR) at different dietary level on nutrient utilization and metabolic status of goats under hot humid agro climatic condition in Bihar. This study will give more information about the effective utilization of proteinous fodder, which will help in developing feeding strategies for better utilization of nutrient from protein rich feeds by goats under Bihar condition.

Chemical composition of feed

The chemical composition (on percent DM basis) of feeds (concentrate mixture, azolla meal and berseem fodder) fed to the kids is presented in Table 1. The concentrate mixture had OM 92.60, CP 20.78 and EE 4.37%. The DM (%) of concentrate mixture and azolla meal is almost similar and DM% of Berseem is 20. The DM content of azolla meal was 90.31 % and it contained CP 26.35, EE 2.85, CF 15.16, NFE 36.38, Total Ash 15.70, NDF 30.46, ADF 20.08%. As protein content is quiet higher in azolla and easily available in cheap rate. Therefore, it can helpful in growth performance in kids and can be use as substitute of concentrate mixture. Tamang and Samanta (1993) observed that Azolla pinnata contained 7.0 per cent dry matter (fresh basis), 15.40 per cent crude protein, 14.10 per cent crude fibre, 2.80 per cent ether extract, 20.40 per cent total ash, 47.40 per cent NFE, 51.90 per cent acid detergent fibre (ADF), 67.70 per cent neutral detergent fibre (NDF), 1.50 per cent calcium and 0.40 per cent phosphorus on dry matter basis. Azolla contained 26.70 per cent crude protein, 11.0 per cent crude fibre, 4.60 per cent ether extract 0.8 per cent calcium and 0.4 per cent total phosphorus (Becerra *et al*, 1995) which is in agreement with the present findings.

Table 1: Chemical composition of feeds and fodder being fed to black Bengal goat (on % DM basis)

Sl. No.	Principles	Concentrate Mixture	Berseem Green fodder	Azolla
1	Dry matter	90.55	20.00	90.31
2	Organic matter	92.60	92.25	84.30
3	Crude protein	20.78	16.88	26.35
4	Ether extract	4.37	2.46	2.85
5	Crude fibre	9.57	30.12	15.16
6	Nitrogen free extractives	52.42	46.35	36.38
7	Total ash	7.40	7.75	15.70
8	Neutral detergent fibre*	26.10	58.15	30.46
9	Acid detergent fiber*	16.15	35.17	20.08

*Determined on ash-free basis

Effect of feeding of different level of Azolla Meal on fortnightly body weight changes in goats.

Effect of feeding protein rich feed (Azolla meal) on fortnightly growth performance (kg) of goats is presented in Table 2. There were significant changes occurred on growth performance at different fortnights in kids fed 20% azolla in concentrate mixture. The average body weight changes (kg) of different fortnight were ranged from 5.73 to 6.63 to 7.53 to 8.44 to 9.43 to 10.26 to 11.16 kg in first, second, third, fourth, fifth and sixth fortnight, respectively, whereas in T3 group fed 40%

azolla meal in concentrate mixture their growth rate recorded was quite low in comparison to T2 group this might be due to inclusion of 40% azolla which probably hampers growth and decreases the digestibility. Indira *et al* (2009) fed buffalo calves 50% of groundnut meal protein was replaced by (fresh) azolla protein. Supplementation of azolla resulted in higher daily gains (294 vs 240 g/d) and feed efficiency and in lower feed costs. Tamang and Samanta (1993) studied on Black Bengal goats, replacement of the concentrate up to 50% sun-dried azolla. Inclusion of dried azolla up to 20% maintained growth with no adverse effect. 50% inclusion rate resulted in profuse diarrhea. The best daily gain was achieved when Azolla was included at 20% and feed efficiency was negatively affected by a 30% inclusion rate.

Table 2: Effect of feeding different level of Azolla Meal on fortnightly body weight changes (kg) in goats

Period (No of days)	T1	T2	T3
0	5.76±0.80	5.73±0.74	5.66± 0.78
15	6.51^{b}±0.79	6.63^{c}±0.72	6.34^{a} ± 0.86
30	7.28^{b} ± 0.77	7.53^{c} ±0.67	7.03^{a} ± 0.83
45	8.04^{b} ± 0.78	8.44^{c} ± 0.64	7.72^{a} ± 0.81
60	8.79^{b} ± 0.74	9.43^{c} ± 0.67	8.39^{a} ± 0.85
75	9.54^{b} ± 0.88	10.26^{c} ± 0.72	9.07^{a} ± 0.83
90	10.29^{b} ± 0.78	11.16^{c} ± 0.88	9.77^{a} ± 0.85

^{abc} means with different superscript within a row differ significantly ($p \leq 0.05$; $p \leq 0.01$)

Growth performance and nutrient utilization in goats

Effect of feeding azolla on bodyweight changes and feed conversion efficiency of goats is presented in Table 3. The initial body weight (kg) of kids in T1, T2 and T3 was similar. The final body weight after 90 days of experiment was found statistically significant among the groups with mean values 10.29, 11.16 and 9.77 in T1, T2 and T3 group respectively. The final body weight was higher in T2 and lowest in T3 group as compared to control group. This is perhaps because of higher intake of azolla which must have hampered the growth rate of kids in T3 group from this it can also be concluded that amount of azolla which should be given as concentrate mixture should not increase much more than 20% in diet. The body weight (kg) and average daily gain (g/d) was significantly higher ($p \leq 0.05$) in T2 as compared to T1 and T3 group. The ADG is 50.33 in T1 60.33 in T2 and 45.66 in T3 group. Here we can see that ADG is highest in T2 group and lowest in T3 group as compared to control group. On this basis it can also be said that though azolla is helpful in growth and performance of the animal but in limited quantity and higher amount leads to hampered growth. Becerra *et al* (1990) reported the effect of Azolla filiculoides as partial replacement for traditional protein supplements in diets for growing-fattening pigs based on sugar cane. In the growing phase, pig performance decreased as the amount of Azolla in the diet increased.

Table 3: Effect of feeding different level of Azolla Meal on body weight changes and feed conversion efficiency of goat

Attributes	T1	T2	T3	SEM
Initial BW (kg)	5.76 ± 0.80	5.73 ± 0.74	5.66 ± 0.78	1.10
Final BW (kg)	10.29^{b} ± 0.78	11.16^{c}± 0.88	9.77^{a}± 0.85	1.20
BW gain(kg)	4.53^{b} ± 0.08	5.43^{c} ± 0.01	4.11^{a} ± 0.03	0.04
ADG(g/d)	50.33^{b} ±0.33	60.33^{c} ±0.76	45.66^{a} ±0.93	0.06
Concentrates DMI(g/d)	134.5^{b} ±0.31	145.19^{c} ±0.20	125.3^{a} ±0.198	0.81
Roughages DMI (g/d)	240.16^{b} ±0.20	250.72^{c} ± 0.16	225.27^{a} ±0.194	0.64
Azolla meal (g/d)	0.00^{a}	28.20^{b} ± 0.22	57.68^{c} ± 0.56	0.94
TDMI (g/d)	374.97^{a}± 0.17	424.11^{c} ± 0.18	408.25^{b} ± 0.20	0.30
FCR(Feed/gain)	7.49^{b} ± 0.041	7.04^{a}± 0.06	8.93^{c} ± 0.05	0.01
Dry Matter Intake (g/kg $^{0.75}$)				
Initial Metabolic body Size	3.75 ± 0.052	3.71 ± 0.056	3.70 ± 0.33	0.08
Final Metabolic body size	5.73^{b} ± 0.03	6.13^{c} ± 0.04	5.54^{a} ± 0.05	0.05
Concentrates DMI(g/d)	37.82^{a} ± 1.96	41.79^{b} ± 0.05	37.39^{a}± 0.09	6.92
Roughages (g/d)	60.95 ± 0.08	62.88 ± 0.06	58.11 ± 0.07	0.22
Total DMI(g/d)	85.38^{a} ± 0.02	93.43^{c} ± 0.33	90.61^{b} ± 0.06	0.02

^{abc} means with different superscript within a row differ significantly ($p \leq 0.05$; $p \leq 0.01$)

Furthermore, Chatterjee *et al* (2013) studied utilization of *Azolla Microphylla* as feed supplement for crossbred cattle. The average daily live weight gain (ADLG) was significantly ($p \leq 0.05$) higher in the treatment group (423.6±14.0 g/d)) than the Control group (389.9±14.9 g/d). The feed conversion efficiency also improved significantly. The concentrate and roughage DMI (g/d) ranged from 134.5 ,145.19 ,125.3 and 240.16 ,250.72 ,225.27 respectively in T1, T2 and T3 groups. Azolla meal was given (g/d) as 10 , 20 and 40% respectively. There was significantly higher ($p \leq 0.01$) concentrate and roughage intake in T2 group as compared to control. The total DMI (g/d) significantly higher ($p \leq 0.05$) in T2 group as compared to control. The total DMI by the animals of T1 group was lower in comparison to both T3 and T2 group.

Table 4: Effects of feeding different levelsof azolla meal on intake (g/d) and digestibility % of nutrients in goat

Attributes	T1	T2	T3	SEM
Body wt (kg)	$10.68^{b} \pm 0.13$	$11.93^{c} \pm 0.10$	$10.20^{a} \pm 0.08$	0.39
Metabolic body size	$5.87^{a} \pm 0.02$	$6.59^{b} \pm 0.03$	$5.71^{a} \pm 0.03$	0.13
Dry matter				
Total intake	$458.12^{a} \pm 0.05$	$449.54^{c} \pm 0.29$	$494.66^{b} \pm 0.13$	0.69
Digested	$270.98^{c} \pm 0.07$	$283.88^{b} \pm 0.18$	$287.69^{a} \pm 0.12$	0.41
Digestibility	$59.15^{b} \pm 0.07$	$63.15^{c} \pm 0.11$	$58.16^{a} \pm 0.08$	0.42
Organic matter				
Total intake	$407.26^{c} \pm 0.11$	$373.32^{a} \pm 0.1$	$388.55^{b} \pm 0.15$	0.36
Digested	$273.54^{c} \pm 0.16$	$257.63^{b} \pm 0.14$	$252.89^{a} \pm 0.15$	0.53
Digestibility	$67.64^{b} \pm 0.13$	$69.30^{c} \pm 0.19$	$65.87^{a} \pm 0.14$	0.46
NDF				
Total intake	$290.55^{b} \pm 0.12$	$300.61^{c} \pm 0.15$	$287.66^{a} \pm 0.17$	0.32
Digested	$166.75^{b} \pm 0.24$	$190.63^{c} \pm 0.14$	$161.62^{a} \pm 0.16$	0.93
Digestibility	$57.72^{b} \pm 0.17$	$63.87^{c} \pm 0.20$	$56.73^{a} \pm 0.17$	0.59
ADF				
Total intake	$150.00^{b} \pm 0.15$	$151.23^{c} \pm 0.02$	$148.5^{a} \pm 0.33$	0.86
Digested	$70.5^{b} \pm 0.23$	$75.5^{c} \pm 0.36$	$66.51^{a} \pm 0.04$	0.76
Digestibility	$47.52^{b} \pm 0.12$	$50.05^{c} \pm 0.21$	$45.52^{a} \pm 0.32$	0.82
CP				
Total intake	$62.32^{b} \pm 1.12$	$64.20^{c} \pm 2.12$	$61.00^{a} \pm 0.86$	0.62
Digested	$39.06^{b} \pm 0.67$	$43.01^{c} \pm 0.98$	$37.50^{a} \pm 0.74$	0.45
Digestibility	$63.00^{b} \pm 0.92$	$67.00^{c} \pm 1.65$	$61.50^{a} \pm 0.58$	0.52
Ether extract				
Total intake	$16.65^{b} \pm 0.16$	$18.69^{c} \pm 0.11$	$16.30^{a} \pm 0.16$	0.47
Digested	$10.64^{b} \pm 0.12$	$12.83^{c} \pm 0.02$	$10.10^{a} \pm 0.12$	0.56
Digestibility	$64.52^{b} \pm 0.23$	$70.52^{c} \pm 0.22$	$62.05^{a} \pm 0.35$	0.38
Crude fibre				
Total intake	$107.50^{b} \pm 0.25$	$113.52^{c} \pm 0.65$	$103.72^{a} \pm 0.03$	0.21
Digested	$57.80^{b} \pm 0.52$	$65.54^{c} \pm 0.41$	$53.60^{a} \pm 0.72$	0.36
Digestibility	$54.08^{b} \pm 0.62$	$58.23^{c} \pm 0.75$	$52.25^{a} \pm 0.09$	0.96
Ash				
Total intake	$62.25^{b} \pm 0.02$	$69.25^{c} \pm 0.25$	$60.51^{a} \pm 0.97$	0.12
Digested	$33.52^{b} \pm 0.72$	$40.07^{c} \pm 0.12$	$31.45^{a} \pm 0.07$	0.72
Digestibility	$54.05^{b} \pm 0.06$	$58.05^{c} \pm 0.07$	$52.25^{a} \pm 0.02$	1.72
NFE				
Total intake	$275.32^{b} \pm 1.60$	$300.05^{c} \pm 1.20$	$272.2^{a} \pm 0.25$	0.97
Digested	$203.52^{b} \pm 1.6$	$234.25^{c} \pm 0.02$	$195.85^{a} \pm 0.126$	0.36
digestibility	$74.62^{b} \pm 0.92$	$78.05^{c} \pm 1.12$	$72.05^{a} \pm 0.76$	1.30

^{abc} means with different superscript within a row differ significantly ($p \leq 0.05$)

The increase in total DMI in treatment groups may be due to higher body weight gain during the experiment.

The feed conversion efficiency was significantly ($p \leq 0.01$) better in T2 than control group. Reddy *et al* (2011) found that Nellore Sheep fed an Azolla and Sheanut-based diet gained more average daily live weight than those fed a control diet. There was also an increase in FCR with low cost production, as well as the digestibility of all parameters.

Intake and digestibility of nutrients in goats

Intake and digestibility of various nutrients by goats during metabolic trials are presented in Table 4. The daily dry matter intake (g/d) of T1, T2 and T3 were 458.12, 449.54 and 494.66, respectively. The dry matter intake was numerically higher in T3 group as compared to others. Kids were fed 20% azolla in T2 group along with concentrate mixture which did not hamper voluntary feed intake in growing goats rather it improves the feed intake up to 20% level. But at the level of 40 %, digestibility and improvement in goats were significantly lower as compared to T1 and T2 group. The intake of other nutrients such as OM, NDF, ADF, CP, EE, CF, TA and NFE were numerically higher in T2 group as compared to T1 and T2 group and statistically were different ($p \leq 0.05$). The digestibility percentage of dry matter was 59.15 in T1 63.15 in T2 and 58.16 in T3 group. The DM digestibility was higher in T2 group as compared to control. Here we can also see that DM digestibility of T3 group is low compared to control group, this is because of higher intake of azolla which leads to decrease in DM digestibility. There were significant changes ($p \leq 0.05$) found statistically in respect of nutrients digestibility in T2 compared to T1 and T3 which might be due to better effect of azolla feed supplement on nutrient digestibility if use it in moderate level.

CONCLUSION

Pressure on utilization of alternative feed resources has been increasing to develop least cost rations. An attempt is made to assess nutritional potential of *Azolla* in a total mixed ration (TMR) at different dietary level on nutrient utilization and metabolic status of goats under hot humid agro climatic condition in Bihar. This study will which will help in developing feeding strategies for better utilization of nutrient from protein rich feeds by goats under Bihar condition. Azolla meal upto 20% level may be incorporated in goat ration for better performances and cost effective production under Bihar condition without any adverse effect. More studies on Azolla meal with increased dietary percentage should be conducted in goats for deciding optimum inclusion level and awareness of farmers to know its nutritional importance.

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