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EFFECT OF FEEDING AZOLLA (*AZOLLA PINNATA*) BASED TOTAL MIXED RATION ON GROWTH PERFORMANCE AND NUTRIENTS UTILIZATION IN GOATS

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SUMMARY

Sixteen crossbred weaned female kids (4-5 months) having body weight 12.82±0.65 kg were divided into four experimental groups (T_1, T_2, T_3 and T_4) of four each. The kids subjected to different groups were fed for three months. The kids of control group (T_1) were fed total mixed ration consisting berseem hay and concentrate mixture in the ratio of 60:40 to meet out the requirements as per feeding standards ICAR, 2013. In the total mixed ration (TMR) of kid's groups T_2, T_3 and T_4, the concentrate mixture was replaced with sundried Azolla on equi-weight basis at levels of 10, 15 and 20 percent, respectively. A metabolism trial was conducted after 30 days of feeding for 6 days including 2 days adoption period to determine feed intake, nutrients digestibility, nutritive value and nitrogen balance. Nutrient digestibility, body weight gain and dry matter, DCP & TDN intake in goat's kids are not affected by replacing 15% concentrate mixture with sundried Azolla in their berseem hay based total mixed ration. Nutritive value of TMR in terms of DCP & TDN percent are not affected at 15% replacement of concentrate mixture with Azolla. Nitrogen balance was not affected up to 15% replacement level. There was net saving of Rs. 7.90 and 5.16, for feed cost per kg weight gain of goat by replacing concentrate mixture with Azolla. It was concluded that dried Azolla can be incorporated up to 15 % of the concentrate mixture of kids to economize the ration without any adverse effect.

Key words : Azolla, growth perfoemance, nutrients, goat

Inadequate availability of good quality feed in developing country like India, is considered as a major constraint to the prevalent livestock production system. The conventional feed ingredients, particularly protein supplements are expensive and are not always available at affordable prices for livestock feeding. Use of animal protein feed ingredients in animal's diet is not preffered by the livestock farmers. This leads to a search for cheap and easily available alternate protein sources. Aquatic plants have long been used in many developing countries as a feed source for livestock and poultry. Recently there is an increased emphasis on the use of aquatic plants in livestock rations because the protein and other nutrient content in them are comparable to certain leguminous plants.

Azolla is a floating fern in shallow water. It floats on the surface of water by means of numerous, small, closely overlapping scale like leaves, with their roots hanging in the water. Azolla form a symbiotic relationship with the blue green algae, which fixes atmospheric nitrogen and convert to plant nitrogen. This had led to the plant being dubbed a "super plant", as it can readily colonize areas of fresh water, and grow at great speed doubling its biomass every two to three days.

Azolla is very rich in proteins, essential amino acids, vitamins (vitamin A, vitamin B_{12}, Beta Carotene), growth promoter intermediaries and minerals like calcium, phosphorous, potassium, ferrous, copper, magnesium etc. and on a dry weight basis, is constituted of 25-35% protein content, 10-15% mineral content and 7-10%, a combination of amino acids, bio-active substances and biopolymers (Kathirvelan *et al.*, 2015). Carbohydrate and oil content in Azolla is very low. Thus the biocomposition of Azolla, makes it one of the most economic and efficient feed substitutes for livestock. Moreover, Azolla can be easily digested by livestock, owing to its high protein and low lignin content. Azolla has been successfully tried as a feed for broiler chicken (Balaji *et al*., 2009; Dhumal *et al*., 2009; Bolka, 2011), goats (Samanta & Tamang, 1993) and buffalo calves (Indira *et al*., 2009). Azolla was also used in diets for sows (Leterme *et al*., 2010) and as partial replacement of

protein source for growing fattening pigs (Becerra *et al*., 1995). Furthermore, it was also tried as a protein supplement for Rabbits (Sadek *et al*., 2010). According to Ambade *et al.,* (2010), milk yield was increased by 15 to 20% after feeding azolla in the diet of dairy cows. Sanginga and Van Hove (1989) reported that the main character influencing the value of azolla as its feed is its amino acid composition. Singh *et al*. (1983) conducted growth cum digestibility trial on crossbred heifers and concluded that the sun-dried Azolla could replace concentrate mixture in the diet to the tune of 100 per cent. Nik-Khah and Motaghi-Talab (1992) reported that the Azolla can be incorporated in the concentrate mixture of lactating cows at the level of up to 35%. They also indicated that the differences between milk yields and milk constituents (fat, protein, ash, lactose and total solids) were not statistically significant (P>0.05). Gavina (1993) revealed that there was no significant difference in the average final weight, feed consumption and feed conversion efficiency of pigs fed diets containing Azolla up to 40 per cent. Sreemannaryana *et al.* (1993) incorporated 10, 15 and 20 per cent of Azolla in commercial feed mixture of New Zealand and Russian Grey Giant rabbits and observed highest average daily weight gain of 27.3 g in 20 per cent inclusion level compared to control, 10 and 15 per cent levels. Tamang and Samanta (1993) indicated that the sun-dried azolla can be incorporated up to 20 per cent of concentrate mixture of goat kids without any deleterious effects on the performance, digestibility of various nutrients, carcass characteristics, haematological and biochemical parameters

In view of the above facts, the objective of the present study was to evaluate the use of Azolla meal as feed supplement in the diet of kids.

MATERIALS AND METHODS

The study was conducted at the Lala Lajpat Rai University of Veterinary and Animal Sciences (LUVAS), Hisar, Haryana, India. The Azolla was produced in a pond in Animal Feed Technology section of Department of Animal Nutrition, COVS, LUVAS (Fig. 1). Sixteen crossbred weaned female kids (4-5 months) having body weight 12.82±0.65 kg were divided into four experimental groups (T_1, T_2, T_3 and T_4) of four each. The kids subjected to different groups were fed for three months. The kids of control group (T_1) were fed total mixed ration consisting berseem hay and concentrate mixture in the ratio of 60:40 to meet out the requirements as per feeding standards ICAR, 2013. The concentrate mixture was comprised of Maize grain (50), groundnut cake (35), wheat bran (12), mineral mixture (2) and common salt (1 part). In the total mixed ration (TMR) of kid's groups T_2, T_3 and T_4, the concentrate mixture was replaced with sundried Azolla on equi-weight basis at levels of 10, 15 and 20 percent, respectively. The body weights and feed intake were recorded at 15 days intervals for two consecutive days to find out growth rate and feed intake during different period of experiment. A metabolism trial was conducted after 30 days of feeding for 6 days including 2 days adoption period to determine feed intake, nutrients digestibility, nutritive value and nitrogen balance. During the trial representative samples of feed offered, residue left, and feces and urine voided were preserved and analyzed for proximate principles (AOAC, 2005) and fiber fractions (Van Soest *et al.,* 1991). Data were analysed statistically (Snedecor and Cochran, 1994). Chemical analysis showed that Azolla meal contained (%DM) 22.93% crude protein, 11.63% crude fibre, 2.82% ether extract, 15.59% ash, 47.03 % NFE, 40.47% NDF and 32.55% ADF (Table 1). All the diets were iso-nitrogenous.

Fig. 1. Azolla production in pond

RESULTS AND DISCUSSION

The chemical composition of berseem hay, concentrate mixture, Azolla and different total mixed rations is presented in Table 1. The results of the study revealed that the mean values of dry matter intake through total mixed rations during the experimental period of 1 to 30 days, 31 to 60 days, 61 to 90 days and 1 to 90 days did not differ significantly due to replacement of concentrate mixture with sun dried Azolla (Table 2). Similarly the mean values of dry matter intake per 100 kg weight were 3.27, 3.28, 3.22 and 3.17 kg in T_1, T_2, T_3 and T_4, respectively, indicating

TABLE 1
Chemical composition (%DM basis) of sun-dried Azolla, berseem hay, concentrate mixtures and different total mixed rations

Attribute	Berseem Hay	Conc. mix.	Azolla	TMR-I	TMR-II	TMR-III	TMR-IV
DM	89.43	93.01	90.70	91.90	92.26	92.51	92.32
OM	86.28	91.27	84.41	87.16	86.96	86.90	86.88
CP	14.27	20.55	22.93	17.33	17.36	17.42	17.50
EE	02.98	4.20	2.82	3.64	3.65	3.57	3.38
CF	22.69	7.83	11.63	17.06	17.14	17.36	17.53
NFE	46.34	58.69	47.03	49.13	48.81	48.21	48.21
Ash	13.72	8.73	15.59	12.84	13.04	13.44	13.38
NDF	43.91	21.26	40.47	33.05	33.85	34.76	35.88
ADF	34.58	12.51	32.55	24.16	25.71	25.82	27.79
Hemicellulose	9.33	8.75	7.92	8.89	8.14	8.94	8.09

TABLE 2
Effect of different levels of Azolla on feed intake (DM basis) and growth performance in goats during progressive period of age

Parameter	Treatments				CD
	T_1 (0% Azolla)	T_2 (10% Azolla)	T_3 (15% Azolla)	T_4 (20% Azolla)	
Feed intake					
DMI (g/d)					
Day 1 - Day 30	434.17±5.63	433.66±13.64	419.33±7.78	409.91±6.72	NS
Day 31 - Day 60	465.41±2.07	469.58±12.93	455.17±8.04	453.92±11.07	NS
Day 61 - Day 90	518.25±3.47	520.00±12.85	503.87±8.43	493.50±8.70	NS
Day 1 - Day 90	480.16±2.22	484.21±12.75	469.57±8.97	458.72±8.85	NS
DMI (%BW kg) (g)	3.27±0.05	3.28±0.07	3.22±0.10	3.17±0.10	NS
Growth Performance					
Initial B. wt. (kg)	12.73±0.22	12.80±0.65	12.88±0.70	12.88±0.64	NS
Final B. wt. (kg)	17.12a±0.21	17.35a±0.70	17.02ab±0.74	16.67b±0.57	1.41
B. wt. gain (kg)	4.40ab±0.04	4.55b±0.08	4.17a±0.08	3.80c±0.07	0.23
DWG (g/d)					
Day 1 - Day 30	51.67a±0.96	48.33a±2.15	44.91ab±2.08	41.69b±0.98	5.13
Day 31 - Day 60	46.66a±1.36	53.33a±2.36	49.16a±2.09	40.83b±0.83	5.51
Day 61 - Day 90	48.33a±0.96	50.00a±1.36	46.95a±1.39	42.12b±0.79	3.59
Day 1 - Day 90	48.89a±0.45	50.55a±0.96	46.95a±1.39	42.22b±0.79	2.98
FCR (DMI/kg gain)	9.82a±0.13	9.58a±0.19	10.01a±0.12	10.87b±0.79	0.68
Cost/ kg gain (Rs)	127.26	119.36	122.10	130.00	-
Net Saving	-	7.90	5.16	-274	-

Mean values with different superscripts in a row differ significantly (P<0.05).

no significant differences among them. The daily weight gain of kids during progressive period of age were significantly (P<0.05) less when 20% concentrate mixture was replaced with sundried Azolla in the berseem hay based total mixed ration. However, up to 15% replacement daily weight gain did not differ significantly. Better FCR was performed by the kids fed 10% sundried Azolla (T_2) followed by T_1 (control) and T_3 (15% Azolla) which among themselves did not differ statistically. The FCR value was significantly (P<0.05) poor in kids fed 20% sundried Azolla in place of concentrate mixture of their total mixed ration. Though the total dry matter intake decreased with increased level of Azolla in the experimental diets, at the same time body weight gain also reduced with increased level of Azolla in the diet. There was net saving of Rs. 7.90 and 5.16 for 1 kg body weight gain by replacing 10 and 15% concentrate mixture with sun dried Azolla, respectively, in TMR of growing goats.

Nutrients digestibility, nutrients intake, nutritive value and nitrogen balance in growing goats under different dietary treatments has been presented in Table 3. The dry matter digestibility decreased with increasing level of Azolla in the diet. This may be due to diarrhoea in the experimental kids fed on TMR containing higher levels of Azolla. Highest digestibility

TABLE 3
Nutrients digestibility, nutrients intake, nutritive value and nitrogen balance in growing goats under different dietary treatments

Parameter	Treatments				CD
	T_1 (0% Azolla)	T_2 (10% Azolla)	T_3 (15% Azolla)	T_4 (20% Azolla)	
Nutrients Digestibility (%)					
DM	70.01a±0.54	70.98a±0.53	69.08ab±0.55	67.46b±0.81	1.94
OM	70.61a±0.33	71.21a±0.39	69.64ab±0.56	67.75b±0.86	1.78
CP	74.29ab±0.80	74.52a±0.41	72.57bc±0.48	71.57bc±0.49	1.74
CF	60.27ab±0.53	61.00a±0.47	58.91b±0.53	56.75c±0.61	1.67
EE	76.36±0.75	77.96±0.65	77.67±0.47	76.03±0.88	NS
NFE	72.47a±0.53	73.62a±0.65	72.55a±0.76	69.57b±1.25	2.62
NDF	57.84±0.43	57.58±0.63	56.68±0.49	56.18±0.79	NS
ADF	51.42±0.52	51.59±0.61	50.35±0.54	50.17±0.81	NS
Nutrients Intake (g)					
DMI/d	459.75±4.18	458.78±13.23	442.77±6.17	436.44±9.49	NS
DMI/100kg wt	3.22±0.06	3.23±0.07	3.14±0.11	3.10±0.13	NS
DMI/Kg W0.75	60.68 ±0.93	62.64±0.64	60.94±1.42	60.77±1.77	NS
DCPI	59.84a±0.70	60.09a±1.51	57.09ab±0.47	55.79b±1.03	3.14
TDNI	299.32a±10.00	304.79a±11.86	286.61ab±5.48	270.91b±4.25	21.61
Nutritive value (%)					
DCP	13.01ab±0.15	13.10a±0.11	12.89bc±0.10	12.79c±0.12	0.19
TDN	65.11a±0.30	66.38a±0.68	64.74a±0.98	62.11b±0.82	2.3
Nitrogen Balance					
N intake (g/d)	12.89±0.12	12.91±0.32	12.59±0.12	12.48±0.24	NS
Faecal N (g/d)	3.32a±0.11	3.29a±0.09	3.45ab±0.08	3.54b±0.10	0.16
Urinary N (g/d)	3.51±0.09	3.54±0.10	3.57±0.10	3.60±0.06	NS
N digested (g/d)	9.58a±0.12	9.62a±0.24	9.13ab±0.08	8.93b±0.16	0.51
N retention (g/d)	6.07a±0.14	6.08a±0.28	5.57ab±0.05	5.33b±0.21	0.59
N retention (%)	47.12ab±1.23	47.02a±1.00	44.25ab±0.65	42.69b±1.03	3.11

Mean values with different superscripts in a row differ significantly (P<0.05).

was observed in T_2 group and lowest dry matter digestibility was observed in T_4. No significant differences were observed between T_1, T_2, and T_3, but was significantly (P<0.05) less in kids fed 20% sundried Azolla (T_4) as compared to T_1 and T_2. Similarly the digestibility values of CP , OM, CF and NFE values were significantly (P<0.05) less in goats of T_4 as compared to T_1, and T_2, however, these value did not differ significantly among T_1, T_2 and T_3 treatment groups. The digestibility values of other nutrients like ether extract, NDF and ADF did not differ significantly among different dietary treatments.

The daily digestible crude protein intake and DCP percent value of ration was significantly (P<0.05) less when concentrate mixture was replaced at 20% level with sun dried Azolla in total mixed ration of growing goats, though at 10 and 15% levels did not differ significantly. The total digestible nutrient intake and TDN percent in different diets were at par in treatment groups T_1, T_2 and T_3, however, were significantly (P<0.5) less in T_4 group, indicating that 20 percent replacement decreases energy intake and energy value of ration.

It was observed that replacement of concentrate mixture with sundried Azolla did not affect N intake, however, nitrogen excreted in faecal was significantly (P<0.05) more in experiment kids fed concentrate mixture having 20% Azolla as compared to control group. It was also noted that part of the nitrogen ingested by animals was significantly (P<0.05) higher in treatment groups T_1 and T_2 as compared to T_4, Similarly, N retention g per day and percent nitrogen retention values were significantly (P<0.05) low on addition of 20% Azolla in concentrate mixture of goats. The results of the study revealed that N ingestion and retention are not affected due to replacement of concentrate mixture with Azolla up to 15% levels, in berseem based total mixed ration of growing goats. These findings indicated that dried Azolla can be incorporated up to 15 % of the concentrate mixture of kids without any adverse effect.

CONCLUSION

It could be concluded that dried Azolla can

be incorporated up to 15 % of the concentrate mixture of kids to economize the ration without any adverse effect on growth performance.

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