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Effect of Dietary Supplementation of Azolla Meal on Feed Intake and Digestibility in Sangamneri Kids

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ABSTRACT

Twenty-four Sangamneri kids aged between 3 to 6 months and weighing between 8 to 12 kg were selected for the experiment and distributed into four treatments viz., T0 (control), T1 (10 % concentrate replaced by Azolla meal), T2 (15% concentrate replaced by Azolla meal) and T3 (20 % concentrate replaced by Azolla meal). The feeding trial was conducted for the period of 3 months. Roughages to concentrate ratio was kept as 67:33. Feed samples and faeces of different treatments were collected and chemically analyzed. The DM, CP, CF, EE, NFE, total ash, lignin and silica content in Azolla meal were 92.1, 22.4, 16.3, 2.87, 53.1, 7.90, 9.35 and 3.12 percent respectively and the concentrate mixture had 90.2, 19.1, 8.2, 4.95, 62.8, 4.6, 1.72 and 1.31 percent DM, CP, CF, EE, NFE, total ash, lignin and silica respectively. Average daily dry matter intake was 0.405, 0.520, 0.590 and 0.509 (kg/day) in T0, T1, T2 and T3 respectively. Average DM intake per 100 kg body weight during period of experiment were 2.86, 3.57, 3.81 and 3.50 per cent. Feed consumption difference due to different treatments were found statistically significant ($P<0.5$). Feed conversion efficiency w-as highest in treatment T0 (16.6 %) followed by T2 (16.1 %), T3 (15.4 %) and T1 (14.5 %). The inclusion of 15 % Azolla in feed was found to be effective looking to the total weight gain in different treatments. Digestibility of DM differed significantly ($P<0.5$) between different treatments. Higher digestibility of DM was observed in T0 followed by T1, T2 and T3 respectively. This might be due the increasing level of lignin which reduces the digestibility of DM. The digestibility of the CP, EE and lignin was highest in the T0 group followed by T1, T2 and T3 and there was significant difference ($P<0.5$) among different treatments. This clearly indicated that the increase in Azolla level decreases the EE digestibility. Digestibility of CF and NFE showed significant difference at 5 per cent among different treatments. Highest digestibility of CF and NFE was in T0 followed by T2, T1 and T3. The inclusion of Azolla meal up to 15 percent in the ration of Sangamneri kids is effective, beyond that level the DM intake of kids was reduced.

KEYWORDS: Azolla, Digestibility, Dry matter and kids

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INTRODUCTION

India is primarily an agricultural country, with agriculture employing 60% of the country's population (Anonymous, 2021). India's livestock industry is among one of the world's largest. Goats have the broadest ecological range among all farm animals and have been the most stable source of income for poor people since their domestication around 10,000 years ago in the Neolithic Revolution. Goats provide supplemental income and it is a livelihood for millions of resource poor farmers and landless laborers in rural India. Small ruminant farming provides employment and work as a safety net in times of adversity, such as drought and hunger for them. The important goat breeds reared in Maharashtra are Osmanabadi, Sangamneri, Konkan kanyal and Berari. Sangamneri goat breed is mostly bred for meat and in less quantity for milk production in subtropical and scarcity zones. It is a hardy and well adapted breed under adverse climatic situations of central India (Western Maharashtra region of Maharashtra).The free-floating fern Azolla, which belongs to the Azollaceae family, is a good source of protein and contains almost all essential amino acids,

minerals such as iron, calcium, magnesium, potassium, phosphorus, manganese, vitamins A precursor beta-carotene and vitamins B12, among other nutrients (Gupta et al., 2018). *Azolla pinnata* is a popular type that is easy to grow and requires little investment. It thrives in the tropics and subtropics. It thrives in stagnant water found in sewer, canal, ponds, rivers and marshy areas. Due to ease in cultivation, high productivity and nutritional value, Azolla is seen to be the most promising. In goats, *Azollapinnata* was utilized as a feed (Cherryl et al., 2014). It thrives in aquatic habitat absorbing nutrients from the water. Hence, this investigation was planned to study effect of dietary supplementation of Azolla meal on feed intake and digestibility of Sangamneri goat kids.

MATERIALS AND METHODS

Feeding trial

Twenty four dewormed and vaccinated Sangamneri goat kids, ranging in age from three to six months and weighing between eight to twelve kg were separated into four equal groups of six goat kids, with each group having roughly the same average body weight initially during the study. Using "Randomized Block Design" the selected goat kids were subjected to different treatments. Green Azolla was cultivated on pits, harvested and dried for feeding. Chickpea straw and other fodder available at the field were used to fed goat kids under study. To achieve the nutritional requirements, the experimental kids were fed according to the (ICAR 1985) feeding standard methods. The experimental treatment details were as under, T0 Concentrate mixture 100 % without Azolla meal, T1 Concentrate mixture 90 % + 10 % Azolla meal, T2 Concentrate mixture 85 % + 15 % Azolla meal and T_3 Concentrate mixture 80 % + 20 % Azolla meal. The concentrate mixture utilized was made at farm. The proximate contents of Azolla fed to kids were evaluated. The kids were fed at rate of 3 to 4 per cent DM of their body weight. While feeding, the roughages to concentrate ratio was fixed at 67:33. All experimental animals were stall fed and offered for different feeds. Concentrate and azolla were offered at 8.00 a.m. and other feed like dry roughages were offered at around 11 a.m. and 4.00 p.m. The experimental weighted quantity dry feeds were fed *ad lib* to every kid separately and observations on feeding were taken twice in a week. The dry matter consumption of individual kids under different treatments was determined by recording their daily feed consumption twice a week.

Digestion trail

After completion of three month experiment, seven day digestion trail was conducted. Treatment feed were fed to kids daily to calculate the digestibility. During feeding, the feed given to the kids was recorded and at next day, the leftover feed was also recorded. Voided faeces were collected and kept for further analysis. At last day of seven days collection period, all collected samples of seven days were mixed to make a representative sample of 500 gm of every treatment. These samples were kept for further chemical analysis. From each kid's compartment, voided faeces during 24 hours were collected daily. 1/10th of total faeces sample was weighted in an aluminium tray and dried in hot air oven at 100°C for 24 hours for determination of DM. Empty tray plus faecal samples were weighted and then kept for chemical analysis. The proximate analysis was done as per recommended (BIS IS 7874 Part-1 1975) procedure.

Stastical analysis

The data generated during the experimental period was subjected to statistical analysis by Randomized Block Design. Overall differences between treatment means were considered significant when $P<0.5$.

RESULTS AND DISCUSSION

Chemical composition

The chemical composition of the Azolla meal and concentrate fed to the goat kids during the experimental period are presented in Table 1. The DM, CP, CF, EE, NFE, TA, lignin and silica per cent in Azolla were 92.1, 22.4, 16.3, 2.87, 53.1, 7.90, 9.35 and 3.12 respectively and the concentrate mixture had 90.2, 19.1, 8.2, 4.9, 62.8, 4.6, 1.72 and 1.31 per

cent DM, CP, CF, EE, NFE, TA, lignin and silica respectively. From result, it can be noticed that Azolla meal is more protein containing feed than concentrate. It can be used as the adequate protein source for growing animals and can replace concentrate effectively. However higher amount of lignin and silica in Azolla meal puts limitations in feeding of Azolla. This indicates the importance of inclusion of proper amount of Azolla in diet of animals.

Chemical composition of experimental feeds of different treatments

The results obtained from the analysis of the treatment feeds are given in Table No. 1. It can be observed from the obtained results that CP is more in T3 followed by T2, T1 and lowest in T0. Crude fibre is less in T0 than T1, T2 and T3 and it increases from T1 to T3. Whereas ether extract is more in T0 than T1, T2 and T3 and it increases in ascending order from T1 to T3. NFE is highest in T1 followed by T0, T2 and T3, respectively. Ash content is highest in T0 followed by T3, T1 and T2, respectively. The Presence of lignin and silica is more in T3 and decreases in T2, T1 and T0, respectively. These results were in agreement with those of the following researchers. **(**Gouri et al., 2012) reported that Azolla has crude protein content 15.4 percent; crude fibre 14.1 percent; ether extract 2.7 percent; nitrogen free extract 47.4 percent and total ash 20.4 percent. (Cherryl et al., 2014) observed that Azolla has 23.4, 14.7, 3.7, 24.2 and 33.8 percent of CP, CF, EE, TA and NFE respectively and revealed that Azolla is a good and rich source of proteins including nearly all essential amino acids and minerals such as iron, calcium, phosphorus, magnesium, and manganese. Ahmed et al. (2016) concluded that total Ash was 19.65 percent and CP, EE, CF and NFE in azolla feed were 20, 2.65, 14.25 and 46.2 percent, respectively.

Table 1. Chemical composition of experimental feed used fed to Sangamneri goat kids (percent on DM basis)

Sr. No.	Attributes	Treatments			
		T0	T1	T2	T3
1	DM	90.2	90.3	90.8	91.2
2	CP	19.1	19.6	19.7	20.3
3	CF	8.20	9.75	12.7	15.7
4	EE	4.95	2.95	3.05	3.60
5	NFE	62.8	63.5	60.8	56.0
6	Ash	4.90	4.10	3.78	4.42
7	Lignin	1.72	3.66	5.69	7.25
8	Silica	1.31	2.84	2.88	2.96

Feed intake

From Table 2 it is revealed that, During first fortnight, total intake of feed was calculated as 0.296, 0.352, 0.417 and 0.362 (kg/day) and at final fortnight total feed intake was 0.490, 0.580, 0.730 and 0.630 (kg/day/head) in treatment groups T0,T1, T2 and T3 respectively. Similarly, average total feed intakes were 0.405, 0.520, 0.590 and 0.509 (kg/day) in treatment groups from T0 to T3 respectively. It can be noticed that the feed intake in T2 was significantly ($P<0.5$) more than T0 and T1 and it was less in T3 than T2 indicating that the effectiveness of Azolla meal is better at 15 percent in concentrate ration than 20 percent due to more fibre and lignin content in Azolla meal.

Table 2. Average daily DM intake by kids during experimental period (kg)

Fortnights	Treatments				Mean	S. E. ±	C.D. at 5 %
	T0	T1	T2	T3			
1	0.29	0.35	0.41	0.36	0.35	0.047	NS
2	0.33^{d}	0.47^{b}	0.49^{a}	0.40^{c}	0.42	0.006	0.02
3	0.44^{d}	0.53^{b}	0.59^{a}	0.47^{c}	0.50	0.004	0.01
4	0.41^{c}	0.56^{b}	0.61^{a}	0.55^{b}	0.54	0.007	0.02
5	0.46^{c}	0.61^{b}	0.69^{a}	0.61^{b}	0.56	0.009	0.02
6	0.49^{d}	0.58^{c}	0.73^{a}	0.63^{b}	0.60	0.007	0.02
Mean	0.40^{c}	0.52^{b}	0.59^{a}	0.50^{b}	0.50	0.022	0.04

Table No.3 reported that, the average percent DM intake of experimental kids under different treatments differed significantly ($P<0.05$). The DM intake percent was more in T2 (3.81 %) followed by T1 (3.57 %), T3 (3.50 %) and T0 (2.86 %). Further the results indicated that as the percentage of Azolla meal feeding increases from 15% to 20%, daily DM intake in kids decreased significantly. Therefore, the inclusion of Azolla meal up to 15 percent in the ration of Sangamneri kids is effective, beyond that level the DM intake of kids was reduced which might due to result of fibrous nature and odd flavor of Azolla meal. The current research work was agreed upon by the following researchers. While conducting feeding trials on Jalauni lambs to determine nutrient intake and utilization (Das and Satapaty, 2017) stated that the average daily DMI in the T2 and T3 groups was 3.77 and 3.49 per cent of body weight, respectively. Pandhare (2019) reported that average feed intake in T0, T1 and T2 group was 479.285, 592.086, and 507.505 g per day respectively, where control (T0) group was fed with concentrate and roughages. Azolla meal was used to replace 15 and 20 per cent in concentrate in the T1 and T2 groups, respectively.

Table 3. Percent DM intake by kids during experimental period

Fortnight	Treatments				Mean	SE ±	CD at 5%
	T0	T1	T2	T3			
1	2.62^{d}	3.10^{c}	3.62^{a}	3.24^{b}	3.15	0.007	0.02
2	2.73^{c}	3.78^{a}	3.84^{a}	3.25^{b}	3.40	0.083	0.25
3	3.21^{d}	3.75^{b}	3.87^{a}	3.69^{c}	3.63	0.011	0.03
4	2.81^{d}	3.69^{b}	3.81^{a}	3.56^{c}	3.49	0.009	0.03
5	2.92^{d}	3.69^{c}	3.92^{a}	3.72^{b}	3.56	0.011	0.02
6	2.87^{d}	3.26^{c}	3.79^{a}	3.55^{b}	3.37	0.009	0.03
Mean	2.86^{c}	3.57^{b}	3.81^{a}	3.50^{b}	3.42	0.069	0.20

Feed conversion efficiency

Feed conversion efficiency was calculated from the recorded data of feed intake and total gain in weight of kids during trial. In the treatment groups T0, T1, T2 and T3, the average feed conversion efficiency was 16.6, 14.5, 16.1 and 15.4 per cent respectively. It can be noticed from the calculated outcomes that feed conversion efficiency was numerically better in T0 followed by T2, T3 and T1, respectively. Non-significant difference was observed among the treatments. It was observed that feed conversion efficiency in T2 treatment group was more than T1 and T3. Therefore it can be stated that the inclusion of Azolla up to 15 % into concentrate feed of kids is effective however more inclusion than this might have negative effect on feed conversion efficiency.

Digestibility in experimental groups

In the experiment, a seven day digestibility trial was undertaken and the data tabulated in table no. 4, Significant difference (P<0.5) among the nutrient digestibility of treatment feeds can be observed. Digestibility of DM was significantly higher (P<0.5) in T0 followed by T1, T2 and T3. This is may be due the increasing level of lignin which reduces the digestibility of DM. The digestibility of the CP was highest in the T0 followed by T1, T2 and T3 and there was significant difference (P<0.5) between the treatments. The decreasing trend of CP digestibility may be due the inclusion of Azolla meal as the protein from Azolla meal was less digestible than the T0 may be result of Azolla protein binding with lignin and silica content.

Table 4. Average digestibility coefficients of nutrients of treatment feeds

Treatments	Apparent digestible coefficients					
	DM	CP	CF	EE	NFE	Lignin
T0	79.2^{a}	78.1^{a}	74.9^{a}	74.5^{a}	79.9^{a}	24.9^{a}
T1	76.7^{a}	76.5^{ab}	72.1^{bc}	72.4^{ab}	77.7^{ab}	21.4^{b}
T2	75.3^{b}	75.1^{b}	74.5^{ab}	70.5^{b}	79.09^{ab}	19.7^{b}
T3	72.4^{b}	73.7^{b}	71.1^{c}	68.03^{b}	76.2^{b}	18.1^{bc}
Mean	75.9	75.9	73.1	71.4	78.2	20.9
S.E.±	1.00	0.73	0.56	1.14	0.95	0.79
C.D. at 5%	3.01	2.20	1.67	3.42	2.87	2.39

The digestibility of EE was found to be significantly (P<0.5) higher in T0 followed by T1, T2 and T3. This clearly indicated that the increase in Azolla level decreases the EE digestibility. The digestibility of CF also showed significant difference at 5% among different treatments. It was highest in T0 followed by T2, T1 and T3. It can be interpreted from the results that the fibrous nature of Azolla can reduce the digestibility.

The digestibility of NFE was highest in treatment T0 followed by T2, T1 and T3 and there was significant difference (P<0.5) among treatments. The digestibility of lignin was significantly more (P<0.5) in treatment T0 than T1, T2 and T3. The lignin digestibility was seen to be in the reducing trend form T0 to T3 and lignin was seen to be very less digestible. These results are in accordance with (Shanigaram et al., 2013) showed that the Azolla fed to ruminants had average *in vitro* dry matter digestibility of 79.5 per cent. In nutrient digestibility experiment (Fadzlin et al., 2020) reported that feeding of 10 and 15 per cent of Azolla spp. led to significant improvement (P<0.5) in nutrient digestibility.

CONCLUSION

Azolla meal's chemical composition was determined to be superior than concentrate feed in terms of crude protein, crude fibre and ash. The inclusion of Azolla meal up to 15 percent in the ration of Sangamneri kids is effective, beyond that level the DM intake of kids was reduced. Feed conversion efficiency was highest in treatment T0 followed by T2, T3 and T1. The decreasing trend of CP digestibility may be due to Azolla protein binding with lignin and silica content. The EE and lignin digestibility was seen to be in the reducing trend form T0 to T3.

REFERENCES

Ahmed, H.A., Ganai, A.M. and Beigh, Y.A. 2016. Performance of growing sheep on Azolla based diet. Indian Journal of Animal Research. 50(50): 721-724.

Anonymous, 1975. B.I.S. 1975. Part- 1. Bureau of Indian Standard, New Delhi.

Anonymous, 1985. Nutrient requirement of livestock and poultry. Indian Council of Agricultural Research, New Delhi.

Anonymous, 2021. Statistical Research Department.https://www.statista.com/topics/4868/agricultural-sector-in-india.

Cherryl, D.M., Prasad, R.M.V., Jagadesswararao, S., Jaylaxmi, P. and Kumar, S.D. 2014. A study on the nutritive value of *Azollapinnata*. Livestock Research Int.2 (1):13-15.

Das, S.K. and Satapaty, K.K. 2017. Performance of Bengal goat on roughages feeding. Environment and Ecology. 24(3):614-616.

Fadzlin, A.A., Idris, L.H., Hassim, H.A. and Goh, Y.M. 2020. Effects of Azolla spp. as feed ingredient on the growth performance and nutrient digestibility of broiler chicken. Journal of Animal Nutrition and Animal Physiology. 104(6): 1704-1710.

Gouri, M.D., Sanganal, J.S., Gopinath, C.R. and Kalibavi, C.M. 2012. Importance of Azolla as a sustainable feed for livestock and poultry. A Review. Agriculture Review. 33(2):93-103.

Gupta, S.K., Chandra, R., Dey, D., Mondal, G. and Shinde, K.P. 2018. Study of chemical composition and mineral content of sun-dried *Azolla pinnata*. Journal of Pharma and Phyto. 7(6): 1214-1216.

Pandhare, K.S. 2019. Effect of feeding Azolla meal on growth performance in Osmanabadi kids. M.V.Sc. Thesis Submitted to Maharashtra Animal and Fishery Science University, Nagpur.

Shanigaram, P., Swain, P.S. and Nagalakshmi, D. 2013. Protein fractionation and *in vitro* digestibility of Azolla in ruminants. Online Journal of Animal and Feed Research. 3(3): 129-132.