The Pharma Innovation Journal 2022; SP-11(7): 2684-2686

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; SP-11(7): 2684-2686
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www.thepharmajournal.com
Received: 05-05-2022
Accepted: 14-06-2022

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Economics of green azolla (*Azolla pinnata*) feeding in Sirohi kids

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Abstract
The aim of this study was to find out the economics of feeding (cost of feed) on green Azolla (*Azolla pinnata*) along with concentrate diet in Sirohi goat kids under different treatment groups. A feeding trial of 90 days was conducted on 16 Sirohi kids of 4-6 months of age. These kids were randomly distributed in 4 groups with 4 kids in each group. The experimental kids were divided in 4 treatment groups *viz*. T_1 - Control (Basal roughage + concentrate); T_2 - (Basal roughage + concentrate + 150gm green *Azolla*); T_3 - (Basal roughage + concentrate + 250 gm green *Azolla*); and T_4 - (Basal roughage + concentrate + 350 gm green *Azolla*) respectively. All the kids were offered basal roughages (methi straw) *ad lib*. The results revealed that highly significant effect of feeding green Azolla (*Azolla pinnata)* on cost of feeding per day as well as cost of feeding per kg body weight gain in different treatment groups. Feed cost per kg body weight gain was significantly (p<0.01) lowest for T_3 group. It was concluded that feeding of green Azolla (*Azolla pinnata)* @ 250gm along with concentrate diet was found economical as compared to other groups.

Keywords: Azolla, Sirohi, cost, economical

Introduction
India's livestock sector is one of the largest in the world with a holding of 535.78 million of livestock population which consist of Buffaloes 20.45% (109.85 million), Cattle 35.94% (192.49 million), Sheep 13.87% (74.26 million), Goats 27.80% (148.88 million) [20th livestock census (2019)]. According to 20th livestock census (2019) goat's population in India is estimated to be 148.88 million. Rajasthan state has 20.84 million goats of the country.

This huge population of livestock requires about 475 million tones dry fodder, 800 million tones green fodder and 78 million tones concentrates annually. Whereas one of the estimate indicated that there is availability of 358 million tons of dry fodder, 641 million tons of green fodder and 53 million tons of concentrates in meeting the nutritional demand of existing livestock strength (Gorti *et al*., 2012) [7]. In present scenario, the acute shortage of feed and fodder existing to the tune of 32.05% for concentrate, 24.63% for dry fodder and 19.87% for green fodder and appears to be worse.

Goat rearing has large economic and social importance in India. India has the world's largest and varied (in size, production type and level of products) goat population which is growing at a rate faster than any other livestock species. The importance of goat rearing has increased due to its economic returns. Goat rearing needs minimum input such as supplementary feeding, veterinary aid and labour. The increasing demand for meat has also contributed to growing interests in goat forming.

Goat farming is one of the best choice for the rural people in developing countries because of low investments, wide adaptability, high fertility and fecundity, low feed and management needs, high feed conversion efficiency, quick pay-off and low risk factors. Goat is one of the major livestock species contributing to the livelihood security of farmers. It is responsible for providing employment and means of earning to the rural poor. Goat farming in India is mainly based upon 'zero input' management system and contribute meat, milk, skin, fibre as well as manure and serve as the sole or subsidiary source of livelihood for a large number of small and marginal farmers as well as landless labourers in India. It can thrive well in adverse climatic conditions using sparse vegetation.

Sirohi goat is the most preferred goat breed in Southern part of Rajasthan which includes the districts like Chittorgarh, particularly Udaipur, Sirohi, Pratapgarh, Bhilwara, Rajasamand, Banswara and Dungarpur. Sirohi goats are dual-purpose animals, being reared for both milk

and meat. The animals are popular for their weight gain and lactation even under poor quality rearing conditions. The animals are resistant to major diseases and are easily adaptable to different climatic conditions.

To enhance the productive performance of goats there is need to supply enough nutrients. There are various newer and non-conventional feeds which may be incorporated for goat feeding. One of such feed is Azolla. It is believed that through Azolla, the consumption and digestibility of feed is improved therefore animals get more nutrients from the ration. *Azolla pinnata* may be an alternative to green fodder and as supplementary protein diet due to its high palatability and enhanced yield.

Azolla is considered as the most economic and efficient feed substitute and a sustainable feed for livestock. It is a potential source of nitrogen and thereby a potential feed ingredient for livestock (Lumpkin, 1984; Pannaerker, 1988) [13, 15]. 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 macrophytic and a rather favourable essential amino acid composition for animal nutrition. In this way, Azolla has all the earmarks of being a potential wellspring of nutrients. The farmers, particularly in South East Asia and probably elsewhere had developed the use of Azolla as a source of nutrients for livestock. There are some reports on the use of Azolla as feed supplement for poultry and livestock, in which normal feed protein sources have been replaced by Azolla on an iso-nitrogenous basis (Chatterjee, 2013) [4]. Azolla may be grown by minimum cost of labour, utilizing minimum land and can supply high quality nutrients throughout the year.

Azolla has been successfully tried as a feed for buffalo calves (Indira *et al.*, 2009) [10] and broiler chicken (Balaji *et al*., 2009; Dhumal *et al.*, 2009; Bolka, 2011) [2, 5, 3]. All these facts suggested that Azolla can be used as unconventional feed with protein supplement for many species including ruminants, poultry, pigs and fish (Hossiny *et al*., 2008) [8].

On the basis of above background, the present investigation was under taken to study the Economics of Azolla (*Azolla pinnata*) feeding in Sirohi kids.

Materials and methods

Production of Azolla

For present investigation, Azolla was produced in water troughs. The bottom of water trough was sealed with cement and maintained a uniform layer of water in the trough. A thin layer of about 10 cm of fine soil was spread and then water trough was filled with water and maintained the constant level of water. About 2-2.5 kg of cow manure was dissolved in 3.5 liters of water and spread evenly in the water trough. Fresh Azolla seeds were inoculated in water troughs at 0.5kg/m^2. Azolla was spread all over trough within 15 days and build up a thick met like structure.

Experimental animals

Sixteen male Sirohi kids of almost same age group (4-6 months) and of uniform affirmation were selected randomly. These male kids were divided in to four groups for feeding trial. Each group had four kids.

Experimental design

The experimental Sirohi male kids were distributed by completely randomized block design on the basis of body weight into four groups of four kids in each and subjected to different treatment.

Experimental feeds

The production of Azolla was done in water troughs of and it was washed for three time before feeding to kids. Experimental Sirohi kids were fed with the basal roughage (methi straw), concentrate mixture with and without green Azolla (*Azolla pinnata*). Experimental kids were divided in four treatment groups *viz*. T_1 - Control (Basal roughage + concentrate); T_2 - (Basal roughage + concentrate + 150gm green *Azolla*); T_3 - (Basal roughage + concentrate + 250 gm green *Azolla*); and T_4- (Basal roughage + concentrate + 350 gm green *Azolla*) respectively. The experimental animals were fed as per ICAR (2013) [9] feeding standard to meet their nutrient requirement.

Recording of body weight and body measurements

Body weight, Body height, Body length and Chest girth were recorded at 15th day in all treatment groups up to 90 days.

Feed conversion ratio

Feed consumption and body weight gain were recorded at 15th day in all treatment group up to 90 days. Feed conversion ratio was calculated by dividing the feed intake by body weight gain of Sirohi kids for every 15 days.

Statistical procedure

The data obtained in the experiment were analyzed using statistical procedures as suggested by Snedecor and Cochran (1994) and significance of mean difference was tested by Duncan's New Multiple Range Test (DNMRT) as modified by Kramer (1957) [12].

Results and Discussion

Economics of feeding (cost of feed) on green Azolla along with concentrate diet in Sirohi kids under different treatment groups is depicted in Table

Cost of the feed per day was calculated as Rs. 20.04, 23.86, 26.17 and 28.80 in treatment group T_1, T_2, T_3 and T_4, respectively. The cost of feeding per day was recorded as lowest in T_1group compared to T_2, T_3 and T_4group. It is indicated that concentrate mixture without green Azolla reduced the cost of feeding. With regard to cost of feed per kg body weight gain, were calculated as Rs. 33.24, 31.16, 30.67 and 36.98 in T_1, T_2, T_3 and T_4 group, respectively. It is apperent that feeding Azolla @ 250gm along with concentrate mixture T_3 resulted in economic feeding of Sirohi kids.

On comparison of mean, the highest cost in terms of cost of feed per day was observed in Sirohi kids of T_4 group (concentrate supplemented diet with 350gm green Azolla) followed byT_3 (concentrate supplemented diet with 250gm green Azolla) and T_2 group (concentrate supplemented diet with 150gm green Azolla). The lowest cost of feed per day were observed in T_1 group (concentrate supplemented diet without green Azolla).

With regard to cost of feed per kg body weight gain, the lowest cost of feed per kg body weight gain in Sirohi kids was observed in T_3 group (concentrate supplemented diet with 250gm green Azolla), followed by T_2 group (concentrate supplemented diet with 150gm green Azolla) and T_1 group (concentrate supplemented diet without green Azolla). The highest cost of feed per kg body weight gain in Sirohi goat kids was observed in T_4 group (concentrate supplemented diet with 350gm green Azolla).

It was observed that the total cost of feed per kg body weight gain was lowest in T_3group less than control. It is concluded that green Azolla (*Azolla pinnata*) feeding @ 250 gm with concentrate mixture was economical for Sirohi kids.

The statistical analysis of data revealed highly significant ($P<0.01$) effect of feeding green Azolla (*Azolla pinnata)*along with concentrate diet on cost of feed per day as well as cost of feed per kg body weight gain in Sirohi goat kids (Table).It was more economical than control.

Similar findings were reported by Indira *et al.* (2009) [10] in buffalo calves, Ghodake *et al.* (2012) [6] in Osmanbadi kids, Ahmed *et al.* (2016) in sheep reported that lowest cost of feeding per kg of gain was observed in 6% level of Azolla among 0, 6, 12, 18 and 24% Azolla replacing with concentrate, Shekh *et al.* (2016) [17] in lambs, Toradmal *et al.* (2017) [20] in Osmanbadi goat kids, Katole *et al.* (2017) [11] in livestock, Sadmek (2018) [16] in Osmanbadi kids, Sihag *et al.*,(2018) [18] in crossbred female kids and in animals.

Table 1: Economics of Feeding (Cost of Feed) in Sirohi Kids under Different Treatment Groups

Attributes	Treatment groups				
	T_1	T_2	T_3	T_4	SEm±
Cost of Feed (cost/d)	20.04^{d}	23.86^{c}	26.17^{b}	28.8^{a}	1.86
Cost of Feed (per kg b.wt gain)	33.24^{b}	31.16^{c}	30.67^{d}	36.98^{a}	1.44

Note: Means superscripted with any one different letters within a row for a particular data differ significantly from each other.

Table 2: ANOVA of Economics of Feeding (Cost of Feed)

Attribute	SOV	DF	MSS	F-Value	Level of Sig.
Cost of Feed (cost/d)	Block	3	0.014	1.247	NS
	Treatments	3	55.188	4876.686	**
	Error	9	0.011	-	-
Cost of Feed (per kg b.wt gain)	Block	3	0	1	NS
	Treatments	3	32.949	70605.36	**
	Error	9	0	-	-

NS = Non-Significant

** = Significant at 1% level of probability ($P<0.01$)

Conclusion

It was concluded that feeding of green Azolla (*Azolla pinnata)* @ 250gm along with concentrate diet was found economical as compared to other groups.

Acknowledgments

We gratefully acknowledge the help offered by Dean, College of Veterinary and Animal science, Navania, Udaipur and O/I LFC and O/I Azolla unit College of Veterinary and Animal science, Navania, Udaipur for Providing infrastructure and necessary facilities to conduct the research.

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