Original Research Article

Effect of Azolla (*Azolla pinnata*) Feeding on Cow Milk Production

ABSTRACT

Conventional green fodder unavailability throughout the year is a serious concern for dairy industry in India so in the hills. Due to urbanization, industrialization and change in demographic pattern, the fodder and pasture land are reducing continuously. Under such situation, alternate fodder source need to be explored. Hence, the present study was carried out by KVK (ICAR-VPKAS), Kafligair, Bageshwar, Uttarakhand for assessing the Azolla-an aquatic fern as an alternate fodder source and substitute for concentrate cattle feed. During 120 days of experiment, the results of T_2, T_3 and T_4 groups were in increasing order in terms of Azolla substitution (i.e., 1.0 kg, 1.5kg and 2.0 kg) and in milk yield (i.e., 0.5 lit, 1.0 lit and 2.0 lit). Among treatment groups it was found 5-15 percent increase in milk yield, when Azolla was incorporated 1-2 kg as a concentrate substitute daily. That reduced feed cost by 20 to 40 rupees per day and increased net return from Rs. 37 to 90 daily. Among treatment groups no significant differences (P=.0125) were recorded. It was also found easy to cultivate at low input cost and easy to digest by animals. Azolla adaptability among cattle, fish and Poultry farmers has been increased in the district Bageshwar of Uttarakhand.

Key Words: Azolla, Green Fodder, Non-conventional, Concentrate feed, Milch animals.

1. INTRODUCTION-

In India, as the human population increasing, there is rising demand for milk and milk products which is creating new opportunities for the profitability of dairy farming as a profession. Simultaneously, there is a significant decline in the availability of forage (Pillai *et al.,* 2002). As per ICAR-IGFRI, Jhansi vision 2050 report the fodder deficit in India in terms of green fodder, dry fodder and concentrates was 26 million tons (MT), 21 MT, and 34 MT in 2015, which would be expected to reach 40 MT, 21 MT and 38 MT by 2025, respectively. Due to introduction of large part of dwarf varieties of cereals with high yields, reduction in forest and grassland areas this deficit is happening. In addition, the area devoted to food crops is diminishing due to urbanization and industrialization. Due to the ever-decreasing area under cereals and fodder crops, a shortage of fodder is being compensated by an increase in the use of commercial cattle concentrate feed, resulting in higher milk production costs (Reddy, 2007). Feed alone represent 70-75 per cent of total cost of production. Availability of quality feed at a reasonable price is a key for sustainable and profitable dairy production system (Kumar *et al.,* 2020). There have been numerous attempts to find alternative sources of cattle feed. Azolla is regarded as the most cost-effective, efficient feed substitute and a sustainable animal feed. It is a potential source of nitrogen and thus a potential livestock feed ingredient (Lumpkin, 1984; Pannerker, 1988). Azolla (***Azolla pinnata***), a floating water fern, is an unconventional feed ingredient as it is not accepted by most of the dairy owners. They consider it a noxious weed (Lumpkin and Plucknett., 1980). Adaption of Azolla in India has been slow and sporadic due to less awareness, poor yield, pest handling, storage and labor difficulties (Tamizhkumaran and Rao, 2012). The name Azolla comes from the Greek words azo (to dry) and allyo (to kill), signifying that the plant dies when it dries. Azolla belongs to class Pteridophyta, order Salvinales, family Azollaceae or Salviniaceae. The genus Azolla is further categorized into two sub-genera- ***Euazolla*** **and** ***Rhizosperma***. *Euazolla* is characterized by the presence of three megaspore floats and septate glochidia. It comprises; *A. Caroliniana, A. Mexicana, A. microphylla, A. filiculoides* and *A. rubra* are mostly found in temperate, subtropical and tropical regions of America (Hills and Gopal, 1967). The Rhizosperma subgenus is distinguished by the presence of nine megaspore floats, papillae all over the vegetative body and a short branched stem called a rhizome that is covered with small, alternate, overlapping leaves. The

sporophyte is organized dorsiventrally. Which comprises *Azolla nilotica* and *A. pinnata- A. pinnata var. pinnata* and *A. pinnata var. imbricate* are worldwide distribution (Wagner, 1997). Thus, there are seven Azolla species with agricultural significance. Blue-green nitrogen-fixing algae- *Anabaena azollae has* the symbiotic relationship between Azolla which increases the protein concentration of Azolla, making it one of the best alternative protein-rich feed sources. It is also an excellent source of several vitamins and minerals (Pyati *et al.,* 2022). Azolla is very rich in nutrients, including proteins, minerals, vitamins and growth stimulants. Azolla is composed of 25-35% protein (all essential amino acids, especially lysine), 10-15% minerals, vitamin A, vitamin B12, beta Carotene, and 7-10% bioactive substances and biopolymers on a dry weight basis. Azolla has a very low carbohydrate and oil content. The bio-composition of Azolla makes it one of the most cost-effective and efficient livestock feed alternatives. In addition, livestock can easily digest Azolla due to its high protein and low lignin content. Azolla was discovered to be a highly nutritious and inexpensive feed substitute for dairy cattle. It can also be used as an unconventional feed with protein supplement for a variety of species, including poultry, duck, pigs and fish (Basak *et al.* 2002; Sithara and Kamalaveni, 2008). *Azolla pinnata* is cultivated in a few Indian states for animal feed. In Uttarakhand, particularly in hilly regions, Azolla cultivation is in its infancy stage due to a lack of awareness and the paucity of stagnant water. Hence, the main objective of this study was to access the effect of azolla green fodder feeding on cow milk production.

2. MATERIALS AND METHODS

Present study was conducted in the form of On Farm Trials (OFT) by KVK (ICAR-VPKAS), Kafligair Bageshwar, Uttarakhand. Which is situated at 1,221 meter from mean sea level and has Latitude 29° 45̍130̎ and longitude 79° 44’545’’. The problem diagnosed in the district Bageshwar was the scarcity of green fodder. Hence, a On farm trial was designed, in which there were four treatment groups, each group was consisting of 10 milking cows with 10 liters of milk yield daily. In first group (T_1) no treatment was given only 4.0 kg commercial concentrate feed + green fodder was given to all 10 animals. In second group (T_2) of animals were given 1.0 kg Azolla and 3.0 kg commercial concentrate feed + green fodder on daily basis whereas third groups (T_3) of animals received 1.5 kg Azolla and 2.5 kg commercial concentrate feed + green fodder and the fourth groups (T_4) were fed 2.0 kg Azolla and 2.0 kg commercial concentrate feed + green fodder. The total duration of experiment was 120 days which was counted from the first harvesting of Azolla fodder. The study area covered all the three blocks viz; Bageshwar, Garur and Kapkot

blocks. Azolla plots were established at selected Farmers field and they were given proper hands-on training about scientific Azolla farming and also motivated on feeding Azolla to their milch crossbred cows between 2nd to 4th lactation. Harvested Azolla was washed thoroughly with fresh water to remove unwanted things and sun dried to remove dung smell. All animals were kept in pucca house with separate feed mangers. All the animals were managed scientifically, monitored regularly during 4 months period of experiment and milk data and other activities such as deworming and vaccination details were recorded properly. Data were analyzed through One Way ANOVA test by "R" software 3.6.1. version.

Table 1 Azolla Feeding Schedule to Milch Animals

Group	Treatments	Feeding period
T_1 (n=10)	Control group only4.0 kg commercial conc. feed+ Green fodder	120 days
T_2 (n=10)	1.0 kg Azolla and 3.0 kg commercial conc. feed +Green fodder	120 days
T_3 (n=10)	1.5 kg Azolla and 2.5 kg commercial conc. feed +Green fodder	120 days
T_4 (n=10)	2.0 kg Azolla and 2.0 kg commercial conc. feed +Green fodder	120 days

3. RESULTS AND DISCUSSION

Data presented in table 2 indicated the economics of Polytrenchs construction at farmer's field as well as at KVK farm, Kafligair, Bageshwar, Uttarakhand. It also indicated that about 2.0 rupees we have to spend for one kilogram azolla green fodder production. Phosphorus is essential ingredient for growth of Azolla. Hence, Super phosphate along with cow dung was incorporated.

Table 2 Details of Kuccha Polytrenchs/pits construction and Azolla production

S. N.	Particulars	Specifications	Amount (Rs.)
1	Digging charge (3 pits each unit)	3x1x0.25m X 3 pits	100.00
2	Cost of UV stabilized Silpauline sheet of 120 GSM (20x Rs 60/m^2)	5mx4m for 3 pits	1200.00
3.	Cow dung – 45kg (15kgx3 times)	45 kg @Rs. 0.50/kg	23.00
4	Super phosphate 60gm	60gm (20gmx3 times)	5.00
5.	New Azolla Culture @150gm/m^2	3kg x@Rs.20/kg	60.00
		Total input cost	**1388.00**
6.	Total production per year	2kg/dayx365days	730.00 kg
7.	Cost of per kg Azolla production	1388/730	1.90 ~ 2.00

The different regimes of Azolla feeding along with commercial concentrate feed were shown in Table No. 1. Treatment group one (T1) is considered as control group. After azolla incorporation the milk yield in T_2, T_3 and T_4 groups were 10.50 lit, 11.00 lit and 11.50 lit

respectively. The percentage of an average increased milk yield in the present study was 5 to 15 per cent. The similar findings were also reported by Pillai *et al*. (2002) who showed that fresh Azolla feeding increased 10-15 per cent milk production in dairy cattle and saved 20-25% of commercial regular feeds. Various other researchers reported that Azolla-fed group showed a significant increase in Milk yield i.e., 11.85% (Nidhi *et al.* 2015), 13% (Kumar *et al.* 2020), 15-20% (Gauri *et al*, 2012), 20.96% (Mathur *et al*. 2013). Ambade (2010) reported that there is increase in milk yield by 15 to 20% after feeding of azolla in the diet of dairy cows and 15 to 20% commercial feed can be replaced with azolla. Presence of high protein and minerals with low lignin content in azolla, that contribute for better digestibility and nourishment which might be the cause of increase in milk yield. In hills, during summer month particularly May to July is considered as lean period (i.e., scarcity of green fodder due to lack of irrigation facilities) in which Azolla feeding to milch animals will be beneficial. Since Azolla is a protein rich feed, easily cultivated at low input cost round the year. Hence, it is accepted and adopted by all categories of farmers. Along with increased milk yield, health conditions of milch animals were also improved. Since *P* value is 0.0125, which is lesser than 0.05. It is concluded that there is significant difference among treatment groups.

Since optimum growth of Azolla obtained when environmental temperature ranges from 18-25 degree centigrade. But in hills, temperature goes below 15 degree centigrade in winter season; hence growth of Azolla becomes slow. Under this low temperature regime, covering of Azolla ponds with low cost poly-tunnels was found beneficial to safeguard the Azolla crop from adverse effect of frost and may be practiced. In addition to the farmers of district Bageshwar, the farmers of nearby districts such as Chamoli, Almora and Pithoragarh are taking keen interest to avail the benefits of Azolla not only for dairy animal feed but also for Grass carp Fish and Poultry feed.

Table 3. Economics of Azolla production at KVK Farm as well as Farmers Fields

Azolla feeding status	**Particulars**	**T_1**	**T_2**	**T_3**	**T_4**
Before Azolla feeding	Milk yield/day	10 liters	10 liters	10 liters	10 liters
	Commercial Concentrate feed	4.0 kg	4.0 kg	4.0 kg	4.0 kg
	Cost of Concentrate	Rs. 88.00	Rs. 88.00	Rs. 88.00	Rs. 88.00

	feed only @Rs.22/kg				
	Total cost of production of milk	Rs. 220.00	Rs. 220.00	Rs. 220.00	Rs. 220.00
	Revenue from milk@Rs.35/lit.	Rs.350.00	Rs.350.00	Rs.350.00	Rs.350.00
After Azolla feeding	Feeding of Azolla+ concentrate feed	0+4	1+3	1.5+2.5	2+2
	Feed Cost (Azolla + Concentrate feed)	Rs. 88.00	Rs. 68.00	Rs. 58.00	Rs. 48.00
	Total cost of production	Rs. 220.00	Rs. 200.00	Rs. 190.00	Rs. 180.00
	Milk yield/day	10 Lit	10.50 Lit	11.00 Lit	11.50 Lit
	Percent increase in milk yield	0 %	5 %	10 %	15 %
	Revenue from milk	Rs.350.00	Rs.367.00	Rs.385.00	Rs.402.00
	Gross cost (Rs.)	220.00	200.00	190.00	180.00
	Gross return (Rs.)	350	367	385	402
	Net Return (Rs.)	130	167	195	222
	B:C Ratio	1.59	1.83	2.02	2.23

4. CONCLUSION

Present study showed that Azolla has multifaceted alternate quality feed. Azolla feeding to milch cow enhances 5-15 per cent in milk yield daily when it is used as a green fodder and the substitute of concentrate feed. Cultivation of Azolla is very easy and low cost input affair. Being a phosphorus loving nature, adding of super phosphate fertilizer in culture pits enhances the growth of Azolla. For accessing the other characters of Azolla further studies are required.

Conflict of Interest- There is no conflict of interest in conduction of the present research work.

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