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Azolla: An alternate feed resource for ruminants

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Abstract

Azolla is a well-known aquatic fern belongs to the family of Azollaceae, consisting of a short, branched, floating stem, bearing roots which hang down in the water. The biomass gets doubled within 4-5 days, depending on conditions, and yield can reach 8-10 t fresh matter/ ha in Asian rice fields. In India yields of 37.8 t fresh weight/ha (2.78 t DM/ ha) have been reported for *Azolla pinnata*. It is an excellent source of proteins, essential amino acids, vitamins (vitamin A, vitamin B12, Beta Carotene), growth promoter and minerals like calcium, potassium, phosphorous, ferrous, magnesium, copper etc. Based on proximate analysis of Azolla it contains 7% dry matter and on a dry matter basis it is constituted of 23.75% protein content, Crude fibre 11.5%, Ether extract 3.01%, 24.91% ash and 6-8%, a combination of amino acids, bio-active substances and biopolymers. Thus, the bio composition of Azolla makes it one of the most economic and efficient feed substitutes for ruminants and poultry. Moreover, Azolla can be easily digested by ruminants and poultry. Research and promotion of Azolla as a livestock feed has been increasing in recent few years because of higher protein content than most green forage crops and aquatic macrophytes. In present study two bulls were selected and fed with 2Kg Azolla per day up to 3 months. A continuous feeding of Azolla give rise to 15 to 16% increase in biomass of bulls.

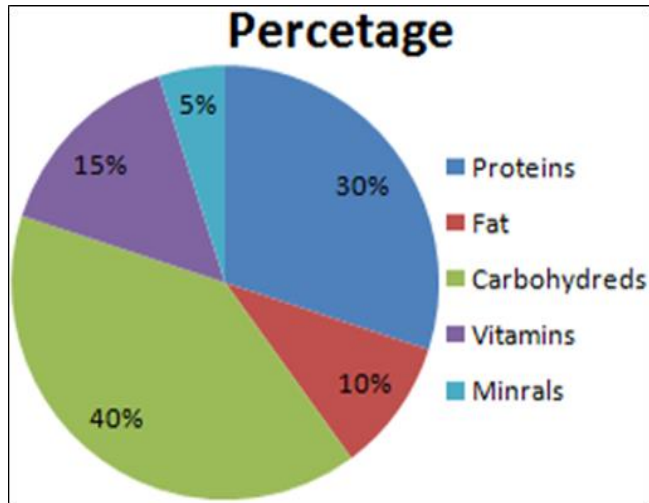
Keywords: Azolla, poultry, protein, ruminants

1. Introduction

Azolla (water fern, duckweed fern, fairy moss, mosquito fern) is a floating fern and has a place with the family of Azollaceae. This streams on the water surface and has an overall appropriation from temperate to tropical atmospheres. The name is alluded to conjugation of two Greek words, Azo (to dry) and allyo (to murder) on the grounds that the plant is executed by dry season. Azolla fronds are triangular or polygonal in shape and float on the water surface individually or in mats with minimum depth of 15 to 30 inches. Plant diameter ranges from 1/3 to 1 inch (1-2.5 cm) for small leafy species, such as *Azolla pinnata*, to 6 inches (15 cm) or more for *A. nilotica*. The plant duplicates rapidly and gives high dry matter yield notwithstanding its high-water content. Pillai *et al.*, (2005) had revealed that a pit of 2 x 2 x 0.2 m give rise to 500-600 g of fresh Azolla every day from following 10-15 days of initial culture. Azolla has very rich nutritive value given in the table below (Table 1) and explained with the help of pie chart.

Table 1: The composition of Azolla

The Elemental composition for Azolla on (% D.M. basis)		
Nitrogen	:	2.4-3.6
Phosphorus	:	0.16-1.01
Potassium	:	0.22-5.45
Calcium	:	0.47-1.29
Magnesium	:	0.28-0.53
Sulphur	:	0.18-0.71
Sodium	:	0.12-1.19
Chlorine	:	0.54-0.78
The Elemental composition for Azolla on (% D.M. basis)		
Crude Protein	:	23.75
Crude Fibre	:	11.50
Ether Extract	:	03.01
Dry Matter	:	07.01
Organic Matter	:	75.09
Total Ash	:	24.91
Gross Energy	:	4.06 MCal



Azolla nutrient composition in pie chart

2. Advantages of Azolla

1. It easily grows *ex vivo* and *in vivo* condition also.
2. The production of azolla can be easily done in large quantity required as green manure in both the seasons-Kharif and Rabi.
3. One of the very important features of it is ability to fix atmospheric N_2 and CO_2 and nitrogen to form carbohydrates and ammonia respectively and after decomposition it adds available nitrogen for crop uptake and organic carbon content to the soil.
4. It released oxygen due to oxygenic photosynthesis, helps the respiration of root system of the crops as well as other soil microorganisms.
5. It has potential to solubilises Zn, Fe and Mn and make them available to the rice.
6. Azolla can suppress tender weeds such as Chara and Nitella in a paddy field.
7. Azolla also releases plant growth regulators such as Auxin, cytokinin and vitamins which enhance the growth of the rice plant.
8. It can be a substitute for chemical nitrogenous fertilizers to a certain extent (20 kg/ha) and it increases the crop yield and quality. Besides this it can increase the utilisation efficiency of chemical fertilizers.
9. 10. It reduces water evaporation rate from the irrigated rice field which is essential for sub-tropical areas.

3. Benefits of azolla

3.1 Feeds for livestock: Azolla contain very high amount of proteins, amino acids, vitamins B12, Beta carotene and minerals, so it is the excellent nutrient feed for livestock. Also, Azolla has low ligniform content. So, animal easily digest. It is observed that feeding Azolla to poultry birds improve the weight of broiler, chicken and increase the egg production of layers birds, also in animals, it showed an overall increase in milk production upto 15-20% when 1-2 Kg Azolla was combined with regular feed and given to sheep, goat, cow, rabbit, fish and pig (Ahmed *et al.*, 2016) [3].

3.2 Biofertilizer: It fixes atmospheric nitrogen and stored in leaves. It can be used as green manure. It is observed that it can increase crop production upto 20% and also utilize for biogas production (Das *et al.*, 2005).

3.3 Weed control: It forms thick layer in the field of paddy and control weed.

3.4 Mosquito control: Azolla has ability to control mosquito by suppressing its breeding process.

4. Azolla cultivation

Cultivation of Azolla require, a shallow fresh water pond is ideal. The step by step procedure for the production of Azolla is given below.

4.1 Selection of location for the pond: It is better to select an area near to the house to ensure regular upkeep and monitoring of the pond. A suitable water source usually near to tube well should be nearby for regular water supply. The site should be under partial shade is ideal or else, shade has to be created. It will help to minimise the evaporation of water and also, ensures better growth of Azolla. The floor area of the pond should be free of pointed stones, roots and thorns that can puncture the sheet and if that happens, the holes in the sheet will cause leakage of water.

4.2 Pond size and construction

The size of pond depends on many factors like number of animals, quantity of supplemental feed required and availability of resources. For small farmers, a neighbourhood of 6 X 4 feet for Azolla cultivation is sufficient to supply about one kg of supplemental feed per day throughout the year to feed their cattle's.



Pond size and construction

Selected area should be cleaned and levelled. The side walls of the pond are often of either bricks or raised embankment with the excavated soil or strong plastic sheets. After spreading the durable plastic sheet (silpauline, a polythene tarpaulin) within the pond, all the edges need to be secured properly by placing bricks over the side walls. The sheet should not have any holes or cracks to prevent the leakage of water. After the inoculation of culture, the pond must be covered with a net to supply partial shade and also, to stop the autumn of leaves and other debris into the pond. Thin wooden poles or bamboo sticks are to be placed over the pond walls to support the shade net. Bricks or stones are often used as weights on the sides for securing the plastic sheet and also, internet over the pond area. These weights will make sure that the sheet or net aren't blown away by strong winds.

4.3 Azolla production

Sieved fertile soil mixed with trash and water got to be spread

uniformly within the pond. About one kilogram of fresh Azolla culture is required for a pond of 6 x 4 feet size. It has to be applied uniformly in the pond. Biogas slurry also can be used rather than dung. The depth of water should be four to six inches. The bottom of the pond must be even to make sure uniform depth of water within the entire pond area. During the monsoon season, if rain water are often harvested from the roof tops and used for cultivation of Azolla, it'll ensure excellent and faster growth of Azolla. A few farmers in Chitradurga district in Karnataka used this practice within the project area and got encouraging results. The merits of using rain water are its near neutral pH and therefore the presence of nutrients like potassium, phosphorus, calcium, nitrogen etc. If the entire salt content of the water used for growing Azolla is high, it'll adversely affect the expansion.

4.4 Maintenance of the pond: Application of about one kg of cow dung and about 100 grams of super phosphate once in 15 days will ensure better growth of Azolla. The pond must be emptied once in six months. The cultivation should be restarted with fresh Azolla culture and soil.

4.5 Harvesting and feeding of azolla: Counting on the initial quantity of culture added, environmental conditions and nutrition, Azolla's growth within the pond are going to be complete in about two to three weeks' time. It can be harvested daily after the full growth. Plastic sieves are often used to harvest the biomass from the pond's surface. If any litter is noticed within the pond, it should be removed.

One kg of fresh Azolla (mean yield per day in a season) can easily be produced from an area of 6 x 4 feet. If a farmer has two cows, it is better to go for a pond of 12 x 4 or 14 x 3 feet size to produce about two kg of Azolla per day. In the event of overproduction of Azolla, it can be dried in the shade and safely preserved for future use. Azolla are often fed to the livestock either in fresh or dried form. It is often given directly or mixed with concentrates to cattle, poultry, sheep, goat, pigs and rabbits. In the studies with over 100 dairy farmers done at various villages of Chitradurga district of Karnataka under NAIP livelihood project, feeding of Azolla @ 800 grams (fresh weight) on an average per day, improved the monthly milk yield by at least 10 liters per cow.

It takes a couple of days for the animals to get used to the taste of Azolla. So, it's better to feed it alongside the concentrates within the initial stages. Azolla has got to be washed thoroughly with water to get rid of the smell of dung. The water used for rinsing are often applied to the pond to stop the wastage of water.

5. Economics

The expenditure on preparing a 6 x 4 feet pond is minimal at Rs. 500 (sheet plus labour cost). The dairy farmers within the project area could recover this cost within three months through the sale of additional milk yield 30 liters from single milch animal. Based on the study by National Bureau of Soil Survey and Land Use Planning regional station, Bangalore, the economics of Azolla cultivation were worked out (Table 2).

Table 2: Economics of Azolla production (per year)

Item	Cost (Rs.)
Cost of Bricks and sheets, labour for construction	500
Maintenance of pond	1000
Extra milk yield	120 liters
Additional returns from milk	1920
Savings from reduced usage of concentrates feeding	3650
Net returns	4070

6. Material and Methodology

Fresh azolla procured from agriculture market and fed to bulls at School of Agricultural Sciences, Dabok. There were two bulls taken under study marked as A (age-18 months) and B (age-17 months) and their initial weight recorded. Before feeding trial faecal sample of bull collected and testing of faecal worm load. They found liver fluke so deworming of bull completed with Levamisole and oxcyclozanide and given liver tonic (Live-52) 100 ml /day for 5 days to each bull. They were fed 2.00 kg azolla per day along with a healthy diet

(Table 3 and 4) for about 3 months. After completion of three months their percent increase in biomass was calculated. To find out percent increase in weight of bull the weight of bull taken manually on regular interval of 15 days by using following formula-

$$\text{Weight of Animal in (Kg)} = \frac{\text{Diameter of Heart Girth (inch)} \times \text{Length of Animal (inch)}}{660}$$

Table 3: Composition of feed

S. No.	Food Supplied	Feed Amount (Kg)	C.P%	Total CP	M.E./Kg (Mcal)	Total M.E. (Mcal)
1.	Maize grain	22	9	1.98	3.1	68.2
2.	Wheat grain	5	11	0.55	2.8	14.5
3.	Barley grain	10	12	1.2	2.9	28
4.	Cotton seed cake	10	22.8	2.28	2.5	25
5.	Groundnut cake	15	40	6.00	2.8	42
6.	Mustard cake	5	38	1.9	2.9	14.5
7.	Wheat Bran	15	16	2.40	2.7	40.5
8.	Gram Chunni	10	15	1.50	2.5	25
9.	Mollasia	5	2	0.10	2.6	13
10.	Salt	1.5	0	0	0	0
11.	Mineral mix hire	1.5	0	0	0	0
12.	Total	100		17.91		270.7

Table 4: Feeding of Bull

S. No	Type of food given	Feed (kg)	DM (kg)	CP (kg)	Energy (M Cal)
1.	Concentrate feed	2.5	2.25	0.40	6.09
2.	Wheat straw	3.0	2.7	0.08	3.78
3.	Azolla	2.0	0.14	0.04	0.56

1 Kg TDN = 4.4 M cal, CP-Crude Protein, DM-Dry Matter, M Cal- mega calories.

7. Result

After feeding an ideal diet for 3 months to the bull A and B supplemented with azolla have been compared with their initial weight i.e. 200 Kg and 175 kg respectively reached up to 233.44 Kg and 209 Kg for both the bulls. Continuous feeding for three months of Azolla has shown 16.7% to 19.42% increase in biomass of both the bull (Table 5 and 6) and their continuous gain in weight is also illustrated in graph

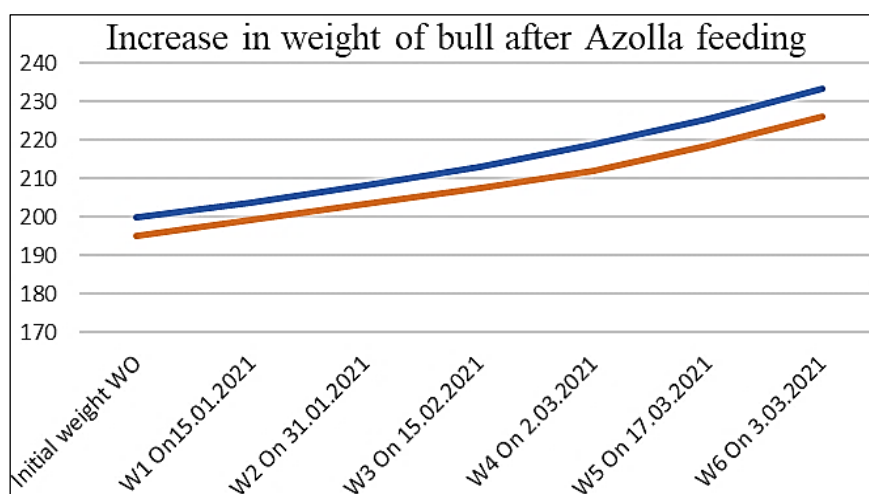
i.e. rising upwards.

Table 5: Initial and final weight of Bull

S. No.	Initial Weight of Bulls (Kg)	Final Weight of Bulls (Kg)
1.	200	233.44
2.	175	226.17

Table 6: Weight of bulls after subsequent 15 days

S. No.	Dates of Month	Weight of Bull A (Kg.)	% Increase in weight for A	Weight of Bull B (Kg.)	% Increase in weight for B
1.	Initial weight W ₀	200		195	
2.	W ₁ on 15.01.2021	203.75	1.87	199.20	2.15
3.	W ₂ on 31.01.2021	208.25	4.12	203.17	4.18
4.	W ₃ on 15.02.2021	213.12	6.56	207.29	6.30
5.	W ₄ on 2.03.2021	218.82	9.41	212.09	8.76
6.	W ₅ on 17.03.2021	225.57	12.78	218.52	12.06
7.	W ₆ on 3.03.2021	233.44	16.72	226.17	15.98

**Graph 1:** Increase in weight of Bulls while feeding Azolla

8. Discussion

Azolla is a very good nutritive feed for cattle's as it has around 23% crude protein and other essential nutrition (mineral such as Ca and P etc.) that can improve their health of cattle's as well as milk production in mulching animal. High protein diet also increases muscle mass and bone growth of the growing cattle (Bhatt *et al.*, 2020) [7]. Besides its nutritive value Azolla can be cultivated in a small size pond and it is easy to harvest for farmers.

9. Conclusion

Azolla cultivation can be easily taken up by the livestock owners with bare minimum cost as the expenditure for preparing a 6 X 4 feet pond is just Rs. 500 (sheet plus labour cost). Azolla is a nutritive feed supplement for the livestock. Its feeding improves body weight (body score) and the monthly milk production, on an average, by 10 liters per cow in the low yielders. A farmer can realize a net profit of Rs 4,070 per annum from the additional milk yield and reduced usage of concentrates' feeding for livestock.

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