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AZOLLA: A SUSTAINABLE FEED SUPPLEMENT

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The world's largest livestock population resides in India. Certain new techniques must be modified to satisfy the input needs for the production of livestock and their byproducts in order to meet the demands of the expanding human population in the present and the future. Even though India produces more milk than any other country in the world on average, this needs to be improved. This could be because of poor nutrition caused by a lack of access to high-quality fodder and feed. For effective livestock production, this has led to the discovery of alternative sources of high-quality unconventional feed and fodder. The discovery of the amazing plant Azolla during the quest for substitutes for concentrates, fodder, and feed for many types of animals has the potential of delivering a sustainable feed for livestock and poultry.

Image: Growing azolla

Only 4% of the area of fully cultivable land is dedicated to the production of fodder, which has led to a dramatic reduction in the supply of fodder. As a result, cattle in the majority of India rely on agricultural wastes, which have low nutritional quality, high levels of crude protein, and high levels of fibre, as their main source of food. These issues, along with the rising demand for animal products brought on by urbanization and rapid population growth, made it necessary to conduct studies in India to improve the use of crop residues and the diets of both ruminants and non-ruminants in order to increase growth, production, and animal health. Utilizing readily accessible, marketable feed is not always economical and lowers net income.The country's needs cannot be met by the usual feed sources, including roughage and

concentrate. A multi-dimensional approach, which includes the use of unconventional feed resources as a complement or replacement for standard feed, without affecting the quality, in conjunction with appropriate technologies, can help to achieve desirable livestock growth and production. in order to bridge this enormous gap between demand and nutrient supply and ensure optimum livestock production throughout the year. Profitability in animal husbandry is heavily influenced by feed costs, which are the biggest cost in the industry. By limiting manufacturing costs through the use of selection strategies to improve feed effectiveness and maintain the right growth rate and body weight, a significant boost in profitability might be achieved. When cultivated in these conditions, azolla can operate very well since it uses little land, requires little labour, and consistently produces high-quality nutrients.

Importance of Azolla

Azolla is a member of the Azollaceae family and is a dichotomously branching, free-floating water fern. It grows naturally in ditches, marshy ponds, and moist soil. The fern Azolla is home to the symbiotic blue-green algae *Anabaena azolla*, which fixes and absorbs nitrogen from the atmosphere. The BGA symbiont can grow and develop because of the carbon source and hospitable environment provided by azolla. It is incredibly rich in minerals, including calcium, phosphorus, potassium, ferrous, copper, magnesium, vital amino acids, vitamins (Vitamin A, B12, beta carotene), growth promoters, and proteins. On dry weight basis, it is made up of 25–35% protein, 10-15% minerals, and 7–10% of a mixture of amino acids, bioactive compounds, and biopolymers. The amount of oil and carbohydrates in azolla is quite minimal. As a result, Azolla's bio-composition makes it one of the most cost-effective and effective feed supplements.

Azolla as a Feed

For a range of animals, including pigs, rabbits, chickens, ducks, and fish, azolla is used as a food supplement. It is gathered in enormous amounts and used as pig and cattle fodder. When broilers were fed Azolla, their growth and body weight results were comparable to those obtained when using a maize-soybean meal. After producing biogas, the digested slurry from azolla could be used as pond fertilizer. Milk yields and fat content could be maintained at the same levels as with conventional feeds when Azolla was utilized as a feed additive in lactation cows.

Table 1. Comparison of chemical composition (% DM basis) of Azolla meal with other feed

Parameters	Azolla	Berseem	Cowpea
Proximate composition			
DM	**88.72**	87.26	88.69
OM	**75.79**	87.96	90.89
CP	**25.63**	18.51	17.68
EE	**4.12**	2.24	3.29
Total Ash	**20.21**	12.04	9.11
NFE	**33.57**	39.21	47.27
Cell wall constituents			
NDF	**46.89**	59.15	53.14
ADF	**33.81**	37.18	29.66
Cellulose	**16.02**	30.04	24.39
Hemicellulose	**13.08**	21.97	23.48
ADL	**10.11**	6.67	4.95

Source: Sharma *et al.*, 2015

Table 2. Comparison of protein fractions (% CP) of Azolla meal with other feeds

Feed	Protein fraction					
	A	B_1	$A+B_1$	B_2	**B_3**	C
Azolla	11.98	4.63	16.61	12.39	**55.80**	15.20
Berseem fodder	21.08	7.30	28.38	18.38	**44.89**	8.59
Cowpea fodder	16.59	19.61	36.20	18.14	**30.77**	14.65

A- Instantaneously degradable; $A+B_1$- highly degradable in the rumen; B_2- less Degradable; B_3- very less degradable; C- neither degraded in rumen nor digested in lower tract

Source: Sharma *et al.*, 2015

Table 1 compares the chemical composition of *Azolla microphylla* with that of different proteinaceous diets. Azolla had a higher level of crude protein (CP) and EE than Berseem and Cowpea. Azolla had a significantly lower Crude fibre (CF) concentration than berseem and cowpea. Due to the high total ash content, Azolla had a significantly lower Organic matter (OM) content than other areas. Cowpea had the highest level of Nitrogen Free Extract (NFE), followed by berseem and azolla. Neutral Detergent Fibre (NDF) and Acid Detergent Fibre (ADF) content in azolla meal was lower than in berseem. Compared to azolla, cowpea fodder contained more NDF and less ADF. Azolla had less cellulose and hemicellulose than berseem and cowpea feed did. Azolla has a greater acid detergent lignin concentration than berseem and cowpea. Azolla has a high plant protein content and a low percentage of crude fibre, which suggests that it is a rich source of nutrients.

In Table 2, fraction A includes Non-protein Nitrogen (NPN) compounds like NH_3, AA, and peptides (instantaneously degradable), and ($A+B_1$) represents the soluble portion, which is highly degradable in the rumen. Fraction B_2 is less degradable, whereas B_3 is very less degradable, and fraction C is the portion of the protein that is neither degraded in the rumen nor digested in the lower tract, and In Azolla, the part B_2 was the lowest. Azolla had the highest level of B_3 percent, which was followed by berseem and cowpea.

As compared to berseem and cowpea, fraction A, B_1 and B_2 were lower in azolla, indicating less rumen digestion. Azolla had the largest B_3 percentage, a protein linked to plant cell walls, nevertheless. In the small intestine, B_3 fraction is thoroughly digested but slowly destroyed in the rumen. Even though Azolla had a greater C fraction, it was still on par with cowpea fodder. A feed or fodder's protein fractions serve as a gauge for the protein's quality. These percentages are also associated, either favourably or unfavourably, with the protein's ruminal degradability and post-ruminative digestibility. The table demonstrates that Azolla had lower fractional values for A, B_1 and B_2, and a larger fractional value for B_3, indicating a smaller proportion of rumen-degradable protein and a higher proportion of undegradable protein in Azolla.

Azolla: Its Cultivation

Azolla production is dependent on a number of factors, including the location of the nursery and sunshine accessibility. Azolla can be produced more effectively in plastic-covered, cement structures that receive the ideal amount of light and shade. This can be built in the backyard of a house, in the corners of a cattle stable, or in an open area with enough sunshine. Azolla can also be utilized as green manure in rice fields, provided that 10% of the area is reserved for azolla cultivation. Any area of the cattle shed with enough sunlight can be used to produce azolla for livestock, especially milch animals. It can be cultivated in a compact brick and cement tank-like construction. The structure's depth should be 20 cm, and its length can be customized to meet the needs. A typical structure for caring for one dairy animal measures 2.5 m long, 1.5 m wide, and 20 cm deep. In addition, the structure receives 15 kg of well-sieved soil and 2-3 kg of farmyard manure, and the water level is always maintained at a depth of 10 cm. A 10 cm layer of soil and farmyard manure mixture should be applied. Farmyard manure is applied because it is a good source of carbon, and soil is applied to contain and supply nutrients to azolla. A nutrient mixture containing phosphorus, potassium, magnesium, and other nutrients is applied. The dairy cattle who eat the azolla

benefit from this mixture of nutrients, particularly the micronutrient application. 2-3 g of carbofuran are introduced the day before the vaccination and thoroughly mixed. The substance is allowed to settle before being examined for the development of foam on the water's surface. Water is left undisturbed and foam is removed overnight. If horticulture is being done in a hot climate, shade net should be placed over the building. Following that, 200 g of Azolla are injected into the water.In the summer, it is important to ensure that there is a minimum of 10 cm of water in the soil and to give shade with green fabric or coconut leaves to prevent excessive water loss and to block off too much sunshine. Azolla totally covers the water after 10 to 15 days. A net is used to extract it, and a small amount is left in the water to act as an inoculant for future production.

Precautions

1. The Azolla-producing unit should be placed in a shaded area with enough sunshine, ideally under a tree and avoid standing in direct sunlight.
2. The pit's corners should all be at the same level in order to maintain a constant water level.
3. When necessary, plant protection measures against pests and diseases should be implemented.
4. To avoid nitrogen build-up in the bed, 25 to 30 % of the water must also be replenished with new water once every ten days.
5. After replacing the soil and water, Azolla should be re-injected at least once every six months.

Harvesting

A plastic tray with 1 cm^2 mesh-sized holes should be used to harvest azolla so that any excess water may be drained. The tray should be stored in a bucket that is half full with water. To get rid of the stench of cow poo, wash Azolla. Separating the little plantlets that drain out of the dish is another benefit of washing. You can refill the original bed with the plantlets and water from the bucket. To feed cattle, the freshly gathered azolla should be combined 1:1 with commercial feed. Azolla as such can be fed to poultry, including both layers and broilers. However, it is advised to start by blending Azolla 1:1 with regular feed for a week. Livestock may be fed Azolla alone, without the addition of regular feed, after a fortnight of receiving it mixed with regular feed.

Other uses of Azolla

1. Azolla offers a variety of advantages to plants and the environment in addition to serving as a nutrient supplement for cattle.
2. The use of Azolla as a green manure or biofertilizer in rice fields has become extremely essential due to its quick multiplication rate and rapid decomposition capability.
3. Azolla pinnata has a remarkable capacity to concentrate metals such as cadmium, nickel, lead, and nutrients from contaminated or sewage water. It also decreases the heavy metals iron, copper, and chromium from polluted water.
4. Azolla (or a mixture of Azolla and rice straw) can be anaerobically fermented to produce methane gas, which can be used as fuel.
5. The remaining effluent, which contains all the nutrients that were originally incorporated in plant tissues with the exception of a small amount of nitrogen lost as ammonia, can be used as fertilizer.
6. When Azolla-Anabaena is cultivated in a nitrogen-free environment and/or a water medium containing nitrate, the nitrogenase in the symbionts develops hydrogen using water as the source, making Azolla a non-polluting, high-energy fuel.
7. Due to the high protein content is used successfully in western countries as a salad and traditional cough medication.

Conclusion

In addition to its usage as a biofertilizer for wetland paddy, azolla is a good source of nutrients with high-quality protein and low crude fibre content, making it an appropriate feed supplement for cattle, fish, pigs, and poultry.

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