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Azolla Filiculoides as a Nutritious and Cost - Effective Feed for Livestock, Poultry, and Fish

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Abstract: ***Azolla is a unique freshwater fern, being one of the fastest growing plants on the planet due to its symbiotic relation with a cyanobacteria called Anabaena. Extensive studies to evaluate the potential of Azolla to be applied as a green manure in rice fields, feed supplement for aquatic and terrestrial animals, human food, medicine, water purifier, bio fertilizer, weeds and mosquitoes controlling agent, or removal of nitrogenous compounds from water are carried out. The present study aims to determine the nutritive value of Azolla filiculoides. The parameters like moisture content, ash content, dietary fibre, protein, total phenol, calcium and phosphorus were analysed. The protein content of Azolla was found to be 9.11g, The fibre content of Azolla was found to be 9.5g. The parameters of calcium and phosphorus was found to be 325mg and 128 mg. The ash content of Azolla was found to 6.3 The results obtained shows that Azolla has the potential to be available as a cost effective feed for variety of animals species since it has good amount of protein fibre and minerals. The results re-enforce the growing awareness that aquatic plants can contribute essential nutrients. Hence it can be considered as a nutritive aquatic feed and used as livestock feed, animal feed and also fish feed. Based on the results of the present study, it may be concluded that Azolla filiculoides could be used as a food source having a potential to be used as poultry feed, animal feed and fish feed.***

Keywords: Azolla filiculoides, Nutritive value, Protein, Moisture content, Ash content, Calcium, Phosphorus and aquatic fern

1. Introduction

Azolla (water fern) is a unique freshwater fern, being one of the fastest growing plants on the planet due to its symbiotic relation with a cyanobacteria called Anabaena. The name Azolla comes from the Greek word “azo” - to dry and “ollymi”- to Kill or to destroy, suggesting the death from drought .It is otherwise known as mosquito fern, duckweed, fairy moss or water fern.

The monogeneric family Azollaceae consists of small, floating, non-drought - tolerant fern species, found throughout the tropical and temperate zones of the world. .Azolla is traditionally grown under cool, wet conditions. Azolla consist of a short, branched, floating stem, bearing roots which hang down in the water. The leaves are alternately arranged, each consisting of a thick aerial dorsal lobe containing green chlorophyll and a slightly larger thin, colourless, floating ventral lobe. The plant's colour depends on its maturity, changing as the plant grows: it is light green when it is germinated, then to darken gradually, turning red and silver. Unlike all other plants, Azolla is able to get its nitrogen directly from the atmosphere. That means that it is able to produce bio fertilizer, livestock feed, food and biofuel exactly where they are needed and, at the same time, draw down large amounts of CO2 from the atmosphere, thus helping to reduce the threat of climate change.

Azolla belongs to the Kingdom: Plantae, Division: Pteridophyta, Class: Pteridopsida, Order: Salviniales, Family: Azollaceae, Genus: Azolla. The genus Azolla consists of two subgenera and six living species. Subgenus Euazolla include four species: Azolla filiculoides, Azolla caroliniana, Azolla microphylla, Azolla mexicana. The Subgenus Rizosperma include two species: Azolla pinnata and Azolla nilotica

Figure 1: Azolla caroliniana

Figure 2: Azolla mexicana

Figure 3: Azolla microphylla.

Figure 4: Azolla filiculoides

During the last few years, there have been extensive studies to evaluate the potential of Azolla to be applied as a green manure in rice fields, feed supplement for aquatic and terrestrial animals, human food, medicine, water purifier, bio fertilizer, weeds and mosquitoes controlling agent, or removal of nitrogenous compounds from water. Azolla has been applied to the rich field as a classic fertiliser. It is a good source of protein and contains almost all essential amino acids and minerals. Various research has been done and is still ongoing to determine the capability of Azolla as a phytoremediation and to be used as a sustainable bioenergy source.

Figure 5: Azolla as biofertilizer in Cultivable Land

Azolla is used as a food supplement for a variety of animals like cattle, goats, pigs, rabbits, chickens, ducks and fish. Seultrope, 1967 conducted an experiment and reported that Azolla can be utilised as fodder for cattle and pigs.

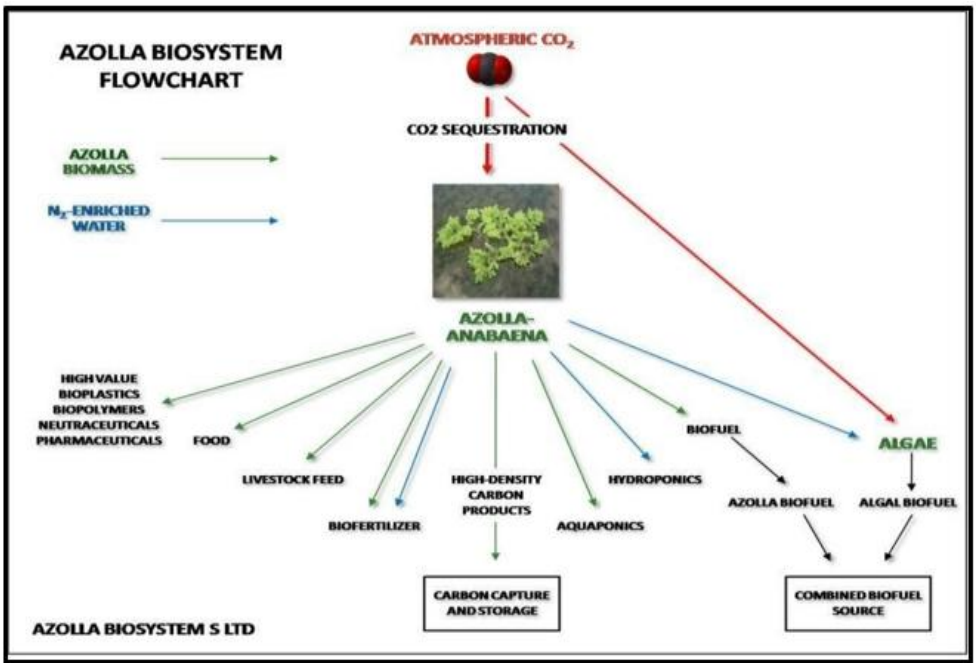

Figure 6: Azolla Biosystem Flow Chart

It was also found that broilers feed with Azolla resulted in growth and body weight values similar to those resulting from the use of maize-soya bean meal. Das et al., 1994 found that digested Azolla slurry remaining after biogas production was suitable as fish pond fertiliser.

Figure 7: Azolla as Feed for Poultry

Azolla is also rich in proteins, essential amino acids, vitamins (vitamin A, vitamin B12, â Carotene), growth promoter mediators and minerals including calcium, phosphorous, magnesium, potassium, iron and copper. Among all the species, Azolla filiculoides is native to warm climates and tropical regions of the Americas as well as most of the old world, including both Asia and Australia .Azolla Filiculoides also grows in South America, western ,North America, Alaska, and Europe. Being a floating Aquatic fern, it can be found in usual stagnant waters, wetlands, and rice paddies in warm temperate and tropical regions, which is spread over lake surfaces to cover the water entirely. It takes only a few months to cover a lake.

Figure 8: Azolla filiculoides

Azolla filiculoides was also used in diets for sows and as partial replacement of protein source for growing-fattening pigs. In view of the above facts, the present experiment was undertaken to explore the nutritive value of Azolla filiculoides as a feed.

2. Materials and Method

The fresh plants of Azolla was collected at Tamilnadu Fisheries University, Madhavaram , Chennai-600-051.The plant authentication was done at Siddha Central Research Institute & Hospital, Chennai- 600 106.

Azolla Sample Preparation:
The fresh plants were shade dried at room temperature and the samples were ground into a fine powder using a mixer grinder. The powdered samples were then stored in the air tight container and used for the analysis. The moisture content, ash content, protein, calcium, phosphorus, dietary fibre and total phenol were determined from the fern sample.

Figure 9: Shade Dried Azolla

Figure 10: Powdered Azolla

Determination of Moisture Content:

1) 10g fresh sample of Azolla was taken and weighed using weighing machine and dried in an oven at 100-150℃ and cooed in a desiccator.
2) The process of heating and cooling was repeated till a constant was achieved.
3) The formula to calculate moisture content is
   MOISTURE (%) = (Initial weight – Final weight) ×100/weight of sample.

Determination of Ash Content:

1) 5g of sample was weighed accurately into a ceramic crucial bowl.
2) Place the ceramic crucial bowl inside the muffle furnace under 500℃ for 2 hours.
3) Then the total ash content was calculated as:
   ASH CONTENT (%) =Weight of ash ×100/weight of sample taken

Estimation of Total Phenol
Estimation of total phenol was done by Folin phenol method. The value of total phenol content of Azolla was expressed as g/100g.

Estimation of Proteins:
Estimation of protein was done by Bradford method. The value of protein content of Azolla was expressed as g/100g.

Estimation of Dietary Fibre:
The total dietary fibre assay was done by AOAC method. This method is the simplified modification of the AACC total dietary fibre (TDF) method. The value of dietary fibre of Azolla was expressed as g/100g.

Test for Minerals:
CALCIUM: Determination of calcium was done by AOAC 20th edition .2017. The value of calcium of Azolla sample was expressed as mg/100g.

PHOSPHORUS: Determination of phosphorus was done by AOAC 20th edition .2016. The value of phosphorus of Azolla sample was expressed as mg/100g.

3. Results

Table 1: Represents the Moisture content and Ash content of Azolla filiculoides

S. No	Parameters	Results (%)
1	Moisture	90.5%
2	Ash	6.3%

Table 2: Represents the levels of Protein and Dietary Fibre of Azolla filiculoides.

S. No	Parameters	Results (g/100g)
1	Protein	9.11
2	Dietary Fibre	9.5

Table 3: Represents the levels of Calcium and Phosphorus of Azolla filiculoides.

S. No	Parameters	Results (mg/100g)
1	Calcium	325
2	Phosphorus	128

Table 4: Represents the levels of Total Phenol of Azolla filiculoides.

S. No	Parameters	Results (g/100g)
1	Total Phenol	1.158

4. Discussion

There is always an ever ending search for the availability of nutritionally rich and cheap food resources in developing countries. Aquatic plants are gaining much interest in food and biomedical research owing to its broad range of uses such as human food, animal fees and bio fertilizers. Recent study reveals that aquatic plants are good sources of primary and secondary metabolites. Although much of the research investigation in azolla were done to explore its bio-fertilizing activities, very few studies were carried out to investigate its nutritional profiling. Hence the present study was carried out to study the nutritional aspects of Azolla filiculoides. The results of study showed that Azolla filiculoides has good nutritional content. The following parameters were analysed [Ash content, Moisture content, Protein, Dietary fibre, Total phenol, Calcium and Phosphorus].

A high percentage of water content (90.8%) was observed. Azolla contained high moisture content is near to the previous finding by Sreenath et al (2015) with 91.81%of moisture content. The ash content of Azolla was found to be 6.3% which shows the mineral content of it. The protein content of Azolla was found to be 9.11g, which indicated that Azolla could be used as a potential natural source of protein for animal feeds. The high protein content could be due to high nitrogen content fixed by the endosymbiotic nitrogen fixing bacteria (Pillai et al 2002)

The fibre content of Azolla was found to be 9.5g. This shows that it can be used in animal feed and fish farming (Ellazi et al 2015). Table 3 shows the phenol level of Azolla. From the results it is very clear that it has good amount of phenol which can be responsible for antioxidant activity. The parameters of calcium and phosphorus were found to be 325mg and 128 mg respectively. Both these minerals are required by animals for their growth and bone formation. From the results obtained, it is clear that azolla has the potential to be available as a cost effective feed for a variety of animal species, since it has a good amount of protein fibre and minerals. The results re-enforce the growing awareness that aquatic plants can contribute essential nutrients. Hence it can be considered as a nutritive aquatic feed and used as livestock feed, animal feed and also fish feed.

5. Conclusion

Based on the results of the present study it may be concluded that Azolla filiculoides could be used as a food source having a potential to be used as poultry feed, animal feed and fish feed.

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