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Using of Azolla Meal as a Diet of Aquatic Animal

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ABSTRACT

Azolla is a member of the Salviniacea family of aquatic ferns. Rich in proteins, azolla also includes vital minerals and amino acids. The feed business has been using azolla for a number of reasons, including affordability and availability , efficacy, durability, etc. Azolla is a good for protein in primary source like oil and meal, depending on the species' feeding habits. They can be utilized as concentrated, fermented, dried, powdered, uncooked, and fresh. When making fish feed, it can be used either directly or in part or in addition to fish meal. Fish such as prawns, mrigal carp, rohu, tilapia Zilli , and Nile tilapia.

INTRODUCTION- ORIGIN

The name "Azolla, " which refers to a small-leafed floating plant and aquatic fern, is a combination of the Greek words "Azo" (to burn) and "Allyo" (to kill), which describe a plant's incapacity to endure dry conditions [1]. It belongs to the genus Azolla and family Azollaceae . Rhizosperma and Euazolla are the two subgenera of the azolla [2]. A. caroliniana Willd., A. mexicana Presl ., A. microphylla Kaulf ., A. rubra, and A. filiculoides are the five species of Euazolla . There are just two species of rhizosperma, A. pinnata and A. nilotica.

DISTRIBUTION

Azolla is indigenous to Asia, America, and Africa's warm temperate regions, as well as the subtropics and tropics [4], [5]. It typically grows in watery environments such ditches, canals, paddy fields, ponds, and stagnant waters . The Caribbean and Eastern North America are home to Azolla Caroliniana, while the Americas are home to Azolla Mexicana from Northern South America to Western North America, Azolla filiculoides from Western North America to Alaska. Three Azolla species—A. Microphylla, A. pinnata, and A. Microphylla—are widely distributed over the Indian subcontinent. The distribution of Azolla species is linked to freshwater ecosystems in tropical and temperate regions worldwide, according to Kannaiyan and Kumar (2006) [7].

MORPHOLOGY

When azolla is submerged in water, it resembles a red or green carpet [8].Azolla plants' roots are constantly submerged in water . Azolla is a triangle plant that is 1.5–3 cm long and 1-3 cm wide. In species like A. pinnata and the largest, A. nilotica, the Azolla macrophyte, also known as a frond, varies in length from 1 to 2.5 cm [9]. Azolla has tiny leaves arranged in succession and a main rhizome that is separated into minor rhizomes . In shallow water, the roots may come into contact with the soil and take up nutrients from it.roots also absorb all nutrients from the water. A ventral lobe and achlorophyllous aerial dorsal lobe that is partially submerged in water make upa leaf. The symbiotic Anabaena Azolla is housed in a leaf canal found in each dorsal lobe.

2.GROWTHING AND FARMING OF AZOLLA

Nine tons of protein can be harvested annually per hector of pond by azolla . Azolla has demonstrated the ability to quadruple biomass in less than 2 days in a lab setting and within three to five days and five to ten days in a typical field setting.

a) In a typical Azolla pond, little ponds of 320 meters should be constructed

b) The ponds should have 10–15 cm of standing water.

c) Green azolla cultures weighing 50-200 g/sqm should be combine with one supper phosphate (20 kg / ha) as a source of phosphorus before being released into the pond.

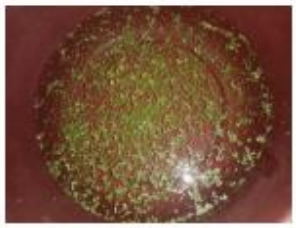
d) Azolla plants develop quickly, creating a green carpet-like mat in the ponds in 14–21 days.

e) Azolla can be produced at regular interval of 21 days during the summer . The azolla plant’s growth rate is slowed

temperature and moisture stress.

As a result throw out this session azolla should be produced 30 days apart. The information presented here is a summary of Rai (2010) [10] (Katole and Colleagues, 2017).

Cultivation of azolla -



NUTRITION CONFORMATION IN AZOLLA

The study's total ash values were comparable to those of Bolka (2011) [22] and Parashuramulu et al. (2013) [23], whilst Prasanna et al. (2011) [20] reported values ranging from 16.21% . According to Subudhi & Singh (1978) [24], dried azolla contained 10.50% 15.82% total ash. Cheeryl et al. (2014) [25] reported a higher value of 24.26 for total ash, but Lukiwati et al. (2008) [26] also claimed a value of 28.7%.

Nutrients	Percentage	ppm	Reference
Crude protein	17.59		(Bhatt et al., 2020) [1]
Crude fiber	16.54		
Total ash	25.28		Balaji et *al.*,(2009) [17]
Calcium	1.67		
Phosphors	0.46		(Kathirvelan et al., 2015) [13]
Iron	0.231		
Manganese	0.205		Chattereji *et al.*,(2013) [18]
Sodium	0.777		
Potassium	2.19		Kavya (2014) [19]
Copper		15.90	Prasanna *et al.*,(2011)[20]
Zinc		46.77	
Magnesium		0.155	Ayyappan (2000) [21]
Moisture		5	

AS NUTRITION SUPPLEMENT FOR LIVE STOCK

Animals such as chickens, ducks, cattle, goats, pigs, fish, and rabbits are fed azolla as a supplement. After conducting an experiment, Seultrope (1967) [27] found that Azolla could be fed to cattle and pigs. Numerous authors have studied the use of azolla as animal feed, and explains how these studies affect growth. Das et al. (1994) [28] found that the digested Azolla slurry residue left over after biogas production could be used as fertilizer for fish ponds. For three months, Murthy et al. (2013) [29] fed the milking cows 2 kg of fresh Azolla daily in place of 50% of concentrate. They found that Azolla preserved good dairy performance while lowering feed labor costs by 16.5% and milk production expenses by 18.5%. According to Parthasarathy et al. (2002) [30], it was safe and profitable to substitute 5% of the broiler feed with dried Azolla in broiler production. In a research conducted by Ali et al. (1995) [31], they fed broiler chicken 10% dried A. pinnata in place of maize and soybean meal. They found that the feed cost dramatically dropped without compromising the amount of meat produced, leading to a higher net return. In an experiment, Rai et al. (2012) [32] found that layer hens given fresh Azolla either developed body weight at 8 weeks or began producing eggs at 40 and 72 days.(TABLE-1)

Sl. No	Fish Name		Habitat	Methods	Time	Remarks	Author/s
	Common	Scientific					
1.	Nile tilapia	*Oreochromis niloticus*	Fresh water	Four isonitrogenous and isolipidic diets were formulated to include 0%, 10%, 20%, and 30% Azolla powder. 375 fish with similar body weight were distributed across 12 Habas, which were fixed in an earthen pond in a random manner, with 25 fish per Haba. The feeding rate was 3% of body weight and the fish were visually fed twice daily.	Feeding trial lasted for 90 days.	• Positive effects on the digestive enzymes, intestinal morphometry, immune functions, and growth rate. • The ideal inclusion from 10 to 20% of the diet.	Magouz *et al.*, 2020[33]
2.	Nile tilapia	*Oreochromis niloticus*	Fresh water	Three isonitrogenous and isocaloric diets containing three levels of azolla 0, 10, and 20, respectively, as a partial substitution of fish meal, were fed to three triplicate ponds of male O. niloticus.	Experimental trial lasted for 90 days.	• Diet with 20% azolla observed similar growth compared with fish fed a diet containing fish meal.	Abou *et al.*, (2008)[34]
3.	Fringed-lipped peninsula carp	*Labeo fimbriatus*	Fresh water	Azolla was used along with spirogyra powder at 4:1 ratio Partial substitute of fish meal at the rate of 0, 25, 50, 75 and 100% were prepared.	The feeding trail was conducted for 60 days	• Can be used for the replacement of fish meal by 25% in the diets.	Sheeno and Sahu, (2006)[35]
4.	Nile tilapia	*Oreochromis niloticus*	Fresh water	For the experimental study three different isonitrogenous diets were formulated by incorporating azolla, lemna, and water hyacinth respectively.	Three groups of juveniles of Oreochromis niloticus	• The inverse relationship was observed between growth and azolla meal levels as per the statistical analysis.	Bag and Mahapatra, (2011)[36]

				and the control diet once daily (Biswas, Jena, & Singh, 2006) at 10% of body weight during the first month, followed by 7% during the second month and 5% during the last 15 days (Jena et al., 2005)			
9.	Thai Silver Barb	*Barbonymus gonionotus*	Fresh water	Five treatments (T1 to T5) were designed to vary in CFF (commercial fish feed) substitution rate of 0%, 25%, 50%, 75%, and 100% with A. pinnata. Twenty fish with an approximate initial size of 3.90 g were transferred into the cages in five separate treatments with three replications. The fish were fed with floating commercial pellet feed.	Experiment lasted for 56 days	• The study suggests that a one-fourth proportion of CFF (commercial fish feed) replacement with fresh *A. pinnata* could be a bearable another option to save the cost of Thai silver barb production and offer high-profit margins.	Mousumi *et al.*, 2018[41]
10.	Rohu	*Labeo rohita*	Fresh water	A basal diet was prepared using groundnut oilcake, rice bran, Soya-bean meal, wheat flour and mineral mixture. For the preparation of experimental diet, Azolla was mixed in basal diet in different quantities.	Experiment lasted for 60 days	• Study indicates a better growth rate, • Specific growth rate, • Food conversion efficiency • High gross conversion efficiency of fingerling fed	Ramesh *et al.*, 2017[42]
11.	Rohu	*Labeo rohita*	Fresh water	The dried Azolla powder was used as a feed ingredient in the diet of Labeo rohita.	The growth of fish was assessed on test diets over a period of 150 days.	• Azolla is a good source of protein and it can be combined upto 25% level in the diet of Labeo rohita safely. • Azolla in fish diets reduces	Suriya Narayana Datta, (2011)[43]

The Impact of Using the Azolla Plant as a Fish Diet on Growth Performance

Fish get longer and heavier as they get bigger. However, a number of variables, including temperature, oxygen levels, feed availability, and water quality, including pH and ammonia, have a significant impact on their growth. Fish need a diet high in protein to survive, unlike animals raised for commercial purposes. Since protein is the most costly ingredient in diet formulae, it is essential to determine the proper amount to support development and survival. Thankfully, Azolla's optimal protein and EAA content make it a superior substitute for conventional fish diets.

Fish such as tilapia [25], redbelly tilapia (Coptodon zillii) [55], catfish [65], fringed-lipped carp (Labeo briatus) [66], calbasu (Labeo calbasu) [67], and Thai silver barb [53] have been fed azolla plants. Numerous investigations on fish growth and survival using raw or dry feed ingredients from Azolla plants have been carried out by researchers [68]. When given diets including Azolla meal, fingerlings and fry stage animals thrive and survive remarkably well [67]. For example, Shiomi and Kitoh [69] reported comparable findings to those of Magouz et al. [25], who observed that tilapia may take up to 20% of Azolla meal. Young fish can be fed 100 g of Azolla meal, whereas mature tilapia can be fed up to 200 g, per studies by El-

Sayed [68] and El-Sayed and Garling [70]. Other researches have discovered that the percentage of Azolla meal in different freshwater fish diets can vary. For instance, 50% can be fed to rohu [71], 25% to Thai silver barb, 40% to fringed-lipped peninsula carp [66], and 30% to carp (L. calbasu) [67]. A research by Das and Rahim [53] looked into how a 25% Azolla pinnata diet affected Thai silver barb growth. Remarkably, their results showed that there were no appreciable differences between the experimental and control groups in terms of average growth rate, net production rate, or specific growth rate ($P>0.05$). It is important to note that, as shown, there were no cases of mortality in the fish treatment groups 2 or 3. Additionally, it was shown that fish fed 25% Azolla had a low feed conversion ratio (FCR), which rose as dietary Azolla levels rose. In tilapia, comparable outcomes were documented [73]. A higher protein efficiency ratio, apparent net protein utilization, apparent net lipid utilization, and apparent net energy consumption are all indicated by a lower FCR. On the other hand, a higher FCR leads to more contaminants in the aqueous environment and less tissue growth [74]. This indicates that whereas stored protein, fats, and energy are transformed into growth, nutrients in Azolla are transformed into muscle [75].Growth of fish after azolla eating in a days

7 days

12 days

20 days

Table 2. Showing the growth performance of two spices –

Azolla diet (%)	Initial weight (g)	Final weight (g)	Survival (%)	Specific growth rate (%/day)	Feed conversion ratio	Protein efficiency ratio
Carp (*Cyprinus carpio* var. *communis*)						
$Diet_1$ (0)	3.51 ± 0.07	12.98 ± 0.41^a	100	1.16 ± 0.07^a	1.91 ± 0.75^d	1.50 ± 0.08^b
$Diet_2$ (10)	3.45 ± 0.06	12.48 ± 0.52^a	100	1.15 ± 0.05^a	1.75 ± 0.48^c	1.63 ± 0.06^a
$Diet_3$ (20)	3.45 ± 0.06	11.55 ± 0.56^b	100	1.07 ± 0.03^b	1.98 ± 0.39^d	1.44 ± 0.07^c
$Diet_4$ (30)	3.45 ± 0.06	10.64 ± 0.48^c	94	0.99 ± 0.04^b	2.40 ± 0.37^c	1.19 ± 0.09^d
$Diet_5$ (40)	3.45 ± 0.06	9.64 ± 0.63^d	92	0.91 ± 0.06^{bc}	2.60 ± 0.29^b	1.09 ± 0.05^c
$Diet_6$ (50)	3.45 ± 0.06	9.06 ± 0.47^d	91	0.87 ± 0.07^c	2.70 ± 0.36^a	1.05 ± 0.07^c
Thai silver barb (*Barbonymus gonionotus*)						
$Diet_1$ (0)	3.90 ± 0.13	30.93 ± 0.4^a	99.33 ± 1.15^a	3.70 ± 0.14^a	0.88 ± 0.09^a	2.98 ± 0.03^a
$Diet_2$ (25)	3.90 ± 0.11	30.68 ± 0.4^a	98.67 ± 1^a	3.68 ± 0.16^a	0.93 ± 0.17^a	2.94 ± 0.02^a
$Diet_3$ (50)	3.90 ± 0.29	24.55 ± 0.45^b	99.33 ± 0.58^a	3.28 ± 0.11^b	1.15 ± 0.12^b	2.26 ± 0.08^b
$Diet_4$ (75)	3.90 ± 0.09	19.81 ± 0.25^c	98 ± 1^a	2.90 ± 0.08^c	1.66 ± 0.15^c	1.75 ± 0.07^c
$Diet_5$ (100)	3.90 ± 0.08	15.20 ± 0.39^d	99.33 ± 0.58^a	2.43 ± 0.18^d	2.64 ± 0.06^d	1.24 ± 0.02^d

Source: Ahmed et al. [72] and Das et al. [53]. The significant differences between the control treatment group and the fish supplemented with Azolla meal are illustrated by a, b, c, d, e, and bc.

The Effects of the Azolla Plant in the Diet of Fish on Immunity

The way the immune system develops and operates is greatly influenced by dietary makeup. As Mendivil [77] pointed out, the feed's chemical and nutritional qualities are very important in this action. The significance of maintaining fish health through optimal feeding is generally acknowledged in contemporary fish farming.According to scientific evidence, dietary additives and supplements help strengthen immune systems and stave against illnesses [78]. Additionally, the ability of high-quality meals to prevent disease and enhance health is marketed [79, 80]. According to van Muiswinkel and Vervoorn-Van der Wal [81], fish have immune systems that are comparable to those of mammals and birds. They belong to the vertebrate class and have a sophisticated intrinsic defense system that they use to protect themselves in their surroundings [83] as well as innate and adaptive immunity [82]. Fish inhabit a variety of watery environments and make good use of their defense mechanisms there. However, the infection pressure is noticeably higher in farms since aggressive culture techniques are widely used.

Challenges in Using the Azolla Plant as a Fish Feed

Analyzing the growth performance, immunity, and mortality rate of fish is essential when utilizing plant-based protein as a feed ingredient. The effect of amino acid imbalances on fish health brought on by antinutritional factors (ANFs) found in plant ingredients must also be taken into account. Because plant protein sources contain varying amounts of ANFs (protease inhibitors, phenolic compounds, phytates, lectins, and oligosaccharides), it is required to eliminate them before introducing them to aquafeeds. Plant components are deficient in certain EAAs, less appealing, and have lower nutritional digestibility due to their high concentration of nonsoluble carbohydrates like fiber and starch. It is essential to remove these antinutritional components before adding them to aquafeeds because fish are more vulnerable to them than terrestrial animals**.**

CONCLUSION

Using recent research publications, this review explores the effects of dietary Azolla meal components on fish. High amounts of crude protein, EAAs, vitamins, and minerals found in azolla meal have been demonstrated to promote the growth and development of aquatic species. Literature claims that tilapia species can eat up to 20%, common carps up to 15%, Barbary-mus gonionotus up to 25%, and L. calbasu up to 30%. Additionally, it may lessen the negative effects that conventional fishmeal manufacturing has on the environment. Nevertheless, overall findings suggest that farmers could benefit from lower feed costs if Azolla meal is used in aquafeed in place of fishmeal, either entirely or partially.

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