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Azolla pinnata as a Sustainable Protein-Rich Feed Supplement for Poultry Nutrition

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Abstract: The growing demand for sustainable and cost-effective poultry feed has increased interest in Azolla pinnata, a fast-growing aquatic fern with high nutritional value and a low environmental footprint. Containing up to 25% protein along with essential amino acids, vitamins, and minerals, Azolla pinnata offers a promising alternative to traditional feed ingredients such as soybean meal and fishmeal. This study evaluates its nutritional composition, effects on growth performance, and practical applicability in poultry diets. Biochemical analyses and controlled feeding trials with broiler chickens and ducks were conducted, assessing parameters including weight gain, feed conversion ratio (FCR), and overall health. The findings demonstrate that partial replacement of conventional feed with Azolla enhances growth performance and reduces feed costs, underscoring its potential as a sustainable and eco-friendly super feed for the poultry industry.

Keywords: Azolla pinnata, Protein, Protein-Rich, Poultry Nutrition, Aquatic fern, Growth performance, Poultry diets, Feed conversion ratio, FCR, Poultry industry.

I. INTRODUCTION

The increasing cost of commercial poultry feed has encouraged researchers and farmers to explore natural, low-cost, and nutrient-rich feed alternatives. Poultry production demands high-quality protein sources, traditionally procured from soybean meal, groundnut cake, and fishmeal. These ingredients are not only expensive but also environmentally taxing due to land use, water consumption, and greenhouse emissions associated with their production. In contrast, Azolla pinnata, a floating fern found in tropical and subtropical regions, offers an attractive alternative because of its exceptional growth rate and ability to double its biomass within 2–3 days under optimal conditions.

Figure 1: Cultivation of Azolla

Cultivation of Azolla

Azolla pinnata is well known for its symbiotic relationship with the nitrogen-fixing cyanobacterium Anabaena azollae, which allows it to accumulate high levels of protein, micronutrients, and bioactive compounds. With a nutritional profile that includes 25–30% crude protein, essential amino acids such as lysine and methionine, and minerals like calcium, magnesium, and iron, Azolla

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serves as an excellent supplement for poultry diets. This study aims to evaluate the nutritional composition of Azolla pinnata and assess its practical effects on poultry growth and performance.

II. PROPOSED METHODOLOGY

The research methodology combines nutritional analysis, controlled feeding trials, and comparative evaluation against conventional poultry feed ingredients. Fresh Azolla pinnata was cultivated in lined outdoor tanks under controlled conditions to maintain a consistent nutrient profile. Samples were collected for biochemical analyses to determine crude protein, fiber, lipid content, ash percentage, and micronutrient concentrations using standard techniques, including Kjeldahl nitrogen estimation, Soxhlet extraction, and atomic absorption spectrophotometry.

To assess its effectiveness as a feed supplement, feeding trials were conducted on broiler chickens and ducks. The study followed a systematic approach involving Azolla cultivation, nutrient analysis, formulation of experimental diets, and evaluation of poultry performance. Azolla biomass was harvested and either dried for laboratory analysis or administered fresh to the poultry. The experimental design included two groups: a control group fed conventional feed and a treatment group receiving a diet supplemented with 10% fresh Azolla. Observations were recorded over a 45-day period, focusing on parameters such as feed intake, feed conversion ratio (FCR), egg-laying rate, plumage condition, and overall health.

Cultivation Setup and Sample Preparation

Figure 2: Cultivation Setup and Sample Preparation

Azolla Cultivation

Although not hardware-intensive, Azolla cultivation requires a well-constructed setup to maintain cleanliness and nutrient stability. A series of shallow cement tanks measuring 2 m × 1 m × 0.3 m were prepared as Azolla beds. The tanks were layered with a mixture of soil, cow dung slurry, and superphosphate to promote rapid growth. Water levels were maintained at 5–7 cm throughout

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the cultivation cycle. A shade net structure protected the beds from direct sunlight, preventing thermal stress and maintaining favorable growth conditions. Regular maintenance included removal of contaminants, monitoring pH (kept between 5.5 and 6.5), and ensuring adequate dissolved nutrients. The tanks were maintained under partial shade to prevent thermal stress, as Azolla thrives within a temperature range of 20–28°C. Harvesting was carried out every two days to ensure that the plants remained in the active growth phase. After collection, the samples were washed, sun-dried, and ground into powder form, making them suitable for incorporation into poultry rations. This cultivation methodology ensured high biomass yield and consistent nutrient content required for accurate feeding trials.

III. EXPERIMENTAL PROCEDURE

After establishing stable Azolla biomass, fresh samples were collected daily, washed thoroughly to remove dirt, and weighed before feeding. The treatment group received fresh Azolla mixed with commercial feed, while the control group consumed only commercial feed. Nutritional analysis of the Azolla was conducted using standard proximate analysis methods to determine crude protein, crude fiber, ash content, and moisture percentage. Atomic absorption spectroscopy was used for mineral profiling, while vitamin content was assessed through high-performance liquid chromatography (HPLC). Poultry performance indicators were recorded weekly.

Practical Experimentations

Figure 3: Broiler Chickens Feeding Azolla

Broiler Chickens Feeding Azolla

The implementation phase consisted of integrating the prepared Azolla powder into poultry feed formulations. The control group received a standard commercial broiler or duck starter and finisher diet, while the experimental groups received feed in which Azolla replaced a portion of the protein sources. The birds were housed under uniform environmental and management conditions to minimize external influences on the experimental outcomes. Daily feed intake and weekly weight gain were recorded, and the health status of the birds was monitored through behavioral observations and veterinary examinations. Blood samples were taken at the end of the trial to evaluate hematological and biochemical parameters, assessing potential health benefits or adverse effects associated with Azolla supplementation.

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IV. RESULTS AND DISCUSSION

The nutritional analysis revealed that Azolla pinnata contained approximately 25.4% crude protein, 13.2% crude fiber, 16.8% ash, and valuable micronutrients including calcium (1.9%), iron (0.38%), and phosphorus (0.67%). Vitamins A, B12, and beta-carotene were present in significant quantities. These findings confirm the nutrient density of Azolla and support its classification as a super feed.

Table 1: Nutritional Composition of Azolla pinnata

Parameter	Value	Method Used
Moisture (%)	85.2	Oven drying method
Crude Protein (%)	25.4	Kjeldahl method
Crude Fiber (%)	13.2	Fiber estimation apparatus
Ash Content (%)	16.8	Muffle furnace method
Calcium (%)	1.90	Atomic Absorption Spectroscopy (AAS)
Phosphorus (%)	0.67	Colorimetric method
Iron (%)	0.38	Atomic Absorption Spectroscopy (AAS)
Vitamin A (mg/kg)	4.8	HPLC
Vitamin B12 (µg/kg)	65	Microbiological assay
Beta-carotene (mg/kg)	180	HPLC

Table 2: Performance Comparison of Poultry (Control vs. Azolla-Supplemented Group)

Parameter	Control Group	Azolla Supplemented Group	Remarks
Average Daily Feed Intake (g/day)	118	112	Slight decrease due to higher nutrition density
Feed Conversion Ratio (FCR)	2.15	1.91	Improved FCR by ~11%
Average Body Weight Gain (%)	100% (baseline)	112%	Higher growth rate
Egg Production (%)	78	86	Increase due to improved nutrient availability
Egg Yolk Color Score (Roche scale)	6	9	Increased pigmentation from carotenoids
Overall Health & Plumage Quality	Normal	Improved	Better feather sheen and vitality
Mortality Rate (%)	2	1	Slight improvement in survivability

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The treatment group demonstrated notable improvements in feed efficiency, with an 11% reduction in FCR compared to the control group. Egg yolk color in the treatment group exhibited a deeper pigmentation due to the natural carotenoids present in Azolla. Furthermore, birds fed with Azolla showed improved feather sheen, reduced stress behavior, and better overall health. No adverse effects on digestion or feed intake were observed. These results align with previous studies, reinforcing the idea that Azolla serves as a sustainable, cost-effective feed supplement that can significantly reduce feed expenses while enhancing poultry performance.

V. CONCLUSION

The study concludes that Azolla pinnata is a highly nutritious, sustainable, and cost-effective supplementary feed for poultry. Its high protein content, essential amino acids, minerals, and natural pigments contribute to enhanced poultry health and productivity. With its ease of cultivation, low input requirements, and rapid biomass production, Azolla represents a viable alternative to conventional feed ingredients. Incorporating Azolla into poultry diets can lower feed costs, promote eco-friendly farming practices, and improve the nutritional quality of poultry products. The successful integration of Azolla supports sustainable livestock production and environmental conservation by reducing dependence on resource-intensive feeds. Future research could focus on determining optimal inclusion levels, evaluating effects across different poultry breeds, and assessing long-term economic benefits.

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