



## **AZOLLA-EMERGING ANIMAL FEED**

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### **ABSTRACT**

*Azolla is aquatic plant rich in protein, minerals, vitamins etc so used as unconventional feed for ruminants, poultry, swine, fish, laboratory animals and even humans. It is rich in essential aminoacids like lysine which is mostly deficit in plant protein sources along with methionine , arginine and carotene . Moreover,it is easy to cultivate and proliferates rapidly, so when fed to animals reduces cost on feed. In young animals azolla inclusion in diet promotes feed intake, body weight gain and improves the overall health as azolla contains growth promoters. In lactating animals, increase in milk yield and milk fat content has been reported if included in ration of lactating animals. In case of poultry feed intake, body weight are increased in broilers and feed conversion efficiency is increased .In layers more enriched eggs are produced as azolla contains essential aminoacids. Research indicates that azolla can be recommended in poultry ration @5% to improve overall performance of birds. Incorporation of azolla in broiler diet affects haemato-biochemical parameters, dressing %, carcass yield, giblet*

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*% , thigh% , gizzard% and breast% .The cost of rearing animal is reduced as it can be used to replace concentrate and other conventional feeds. There is further scope of including azolla in diet/ration of other animals in scarcity period after processing.*

**Keywords:** Azolla, Fish, Non-Ruminants, Poultry, Production performance, Ruminants

## **INTRODUCTION**

Azolla (also known as green gold, The Super Plant ,mosquito fern) is a free floating aquatic fern of family Azollaceae and order Pteridophyta , nowadays being used as unconventional feed and protein supplement for animals like ruminants ,pigs, poultry and fish[1,2]. Dry flakes of azolla are used as feed in livestock and poultry while fresh azolla for fish. Azolla mostly is also used as mosquito-repellant, biofertilizer and bio-scavenger as it has capability to accumulate heavy metals. Azolla is good source of probiotics, protein(mainly essential aminoacids) with higher lysine, arginine and methionine content, bio-polymers, minerals , chlorophyll and vitamins(Vitamin A, Vitamin B, beta carotene, vitamin B12) while carbohydrate and oil content is low. It is easy to cultivate, moreover gives high production compared to legumes and grasses [3,4]. It is highly digestible in animals because of low lignin and high protein. Azolla also acts as biofertilizer for wetland paddy. Azolla can grow both in wild and controlled conditions. It can be found growing naturally in stagnant water of pond, canal, river and other water sources [5]. Azolla grows well in symbiotic relationship with blue green algae. It usually grows on water surface consisting of alternate leaves with adventitious roots. The fronds of azolla are triangular in shape. Optimum water pH required for growth of azolla is 4.5-7.0(Tolerable pH 3.5-10) and temperature 18-28°C. In world, atleast eight species are known of Azolla,namely Azolla pinnata, Azolla nilotica, Azolla caroliniana, Azolla japonica, Azolla circinata, Azolla microphylla, Azolla rubra and Azolla Mexicana of which most common is Azolla pinnata[6]. In this article compilation of research related to feeding of azolla in various animals has been done along with its nutritional value and method of cultivation.

### ***Nutritive value of azolla***

Nutritional variation in composition have been reported in different species of azolla. Sun dried-azolla meal on an average contains dry matter (89.73%),Organic Matter(75.73-82.66%),Crude Protein(22.48-35.49%),Crude Fibre(14.7%),Ether Extract(3.7-4.5%),Total

Ash(17.34-24.26%),Acid Insoluble Ash(7.94%),calcium(1.64-2.58%),phosphorus(0.26-0.34%) [7-10], potassium (2.71%), Nitrogen Free Extract(40.97%),Neutral detergent Fibre(54.85%),Acid detergent Fibre(36.57%) and Acid detergent Lignin(24.05% ) [7]. On DM basis azolla contains 10% carbohydrates, 10-15% minerals and 7-10% aminoacids, bioactive substances and biopolymers [11,12]. Azolla pinnata on dry matter basis mostly contain trace minerals copper-9.1, Manganese-2418, Zinc-325, Iron-1569, cobalt-8.11, chromium-5.06, boron-31, nickel 5.33, lead-8.1, cadmium-1.2ppm [7]. Research has indicated that Azolla pinnata has ability to bioaccumulate heavy metals [13]. The content of carotene in azolla varies from 206-619mg/Kg [14]. Digestible protein percentage in azolla meal is 56.6% [15]. In another experiment, azolla meal was found to contain lignin (28.24%), cellulose (12.76%), NDF (47.08%) and ADF (36.08%) [16].

### ***Ajmer Model for cultivation of Azolla***

In this method, trench is prepared of 6x1.0x0.2 m under partial shade [6]. Lining of this pit is done with silpauline sheet of 120G. Pucca cement structures can be prepared using bricks (200 in No.), cement, gitti and sand. About 80-100 Kg sieved fertile soil along with 5-7Kg cow dung which is 2-3 days old is mixed with 10-15 litres of water and added in trench. Additional 400-500 litres water is added to keep depth of 10 cm. Mixing of fertile soil and dung is done thoroughly in trench. Inoculation of 2Kg of fresh azolla is done in trench which spreads on surface of water. Half to 1 litre water is sprinkled by hand from top in order to align it and trench is covered with 50% nylon shady net. Harvesting of azolla for animal feeding can be done after 21 days. Certain precautions need to be taken care in this technology i.e. 1. water depth of 10 cm needs to be maintained in trench. 2. Cow dung (5Kg) mixed thoroughly with water needs to be added every month. 3. Superphosphate (20g) every month needs to be added along with cow dung. 4. Azolla is removed periodically and after every three months soil and water needs to be changed with fresh inoculation of azolla seeds. On an average 120-200g fresh azolla can be harvested per day from one metre square area [17]. The nutritional composition of azolla is affected by soil nutrient availability and environmental conditions. Reports indicate that 540 - 720 kg of protein per month can be obtained by cultivation of azolla from 1 hectare area ([18]).

## ***Effect of feeding azolla to Ruminants***

About 1.5-2 Kg Azolla when fed to milch animals after mixing with concentrate in 1 :1 ratio along with adlib sorghum fodder[6] has increased milk production by 20.96% in cows and 16.9% in buffalo. The increase in milk (litres) and fat content (%) was 1-1.5 and 4.3-4.7;1-1.4 and 6.2-6.9 in cows and buffaloes respectively. Commercial feed when fed combined with azolla increased both quantity(10-15%) and quality of milk(increase in fat content) along with improved health of animal[19].[20] reported that azolla if mixed with concentrate in 1:1 with concentrate or fed directly to animals produce extra 15-20% milk and reduces requirement of 20-25% commercial feed, while [21] reported 11.85% increase in milk yield on mixing azolla with concentrate in 1:1 in crossbred cows. [22] has also reported increase in milk and fat % in buffaloes on feeding azolla. The carotenoids, probiotics ,biopolymers and other growth promoters present in Azolla are mainly responsible for increased milk production. Increased growth rate(9%) has been reported in growing calves on feeding azolla 60g/animal/day by [23].[24] revealed that on feeding azolla (700g/animal/day) along with mustard cake (600g/animal/day) there is improved growth rate and increased milk production. Feeding of 2Kg azolla instead of concentrate in crossbred calves reduces milk production cost and feed and labour cost by 18.5 and 16.6% respectively[25] .On replacing concentrate by 5% Azolla pinnata improved growth rate has been noted [26]. [27] reported increased milk yield on inclusion of azolla in daily ration. Azolla was used to replace 15-20% commercial feed which caused changes in milk production. At the same time azolla feeding improved hair coating ,increased eyes brightness, moistened muzzle and helped in keeping animal active. Azolla has also been used as conventional feed upto 35% in lactating cows which did not affect milk yield/fat % [28]. Increase of 10% in milk yield has been reported in lactating buffaloes and crossbred cows on feeding azolla[29,30,31]. In various experiments Azolla pinnata was fed to goats [32]and buffalo calves[33] .Usually azolla is not a preferred feed by goat due to its high moisture content(93%) and cow dung smell. Attempts have been made to feed air dried azolla in Black Bengal goat at 0, 10,20 and 50% level to replace concentrate mixture and study its effect on growth. It was found that azolla can be incorporated in goat ration upto 20% only as if level of inclusion is increased it causes diarrhea and makes animal sick.

### ***Effect of feeding azolla to Non-ruminants:***

Azolla, plant protein and provitamin source is being used in poultry(chicken, ducks, quail) diet[34-38] .Azolla feeding in poultry birds helps in improving the weight of broiler chicken and promotes the egg production in layers [16]. Dried Azolla meal when supplemented@5% in commercial feed of vencobb broiler chicks improves the cumulative feed intake, resulting in higher gain in body weight and feed conversion efficiency[21] without deteriorating health along with economic profit[39]. If azolla is incorporated at 5% in diet of commercial broiler, feed conversion efficiency and energy efficiency are improved significantly ( $P<0.01$ )and feed conversion ratio of 2.06 can be obtained at 2-6 weeks of age[35]. Azolla pinnata can be used to replace 5% of basal ration in quail and this is economic also[38]. Findings of [40,41] indicate that Azolla use in broiler diet upto 15% inclusion does not affect feed consumption. When Nera brown chicks were fed azolla meal @0,5,10 and 15%,weekly per bird feed intake was 286.95, 270.73, 231.28 and 224.38gm,weight gain 95.43, 95.22, 98.62 and 93.44g, and feed conversion efficiency of 3.13,3.05,2.54 and 2.55 in different treatments respectively[16]. On the other side, no changes in production performance of broiler chicken has been reported by [42]on including 4.5% azolla in diet compared to control. In Japanese quail, feed intake of 779.5,777.1,777.7 and 787.5gm ,mean body weight(gm) 177.16,175.42, 169.81 and 164.07and feed conversion ratio of 4.40, 4.43, 4.58 and 4.80 at 6<sup>th</sup> week was noted when azolla was fed at 0, 2.5, 5 and 7.5% respectively[38].When azolla is fed @ 0,5,10 and 15% in male broiler chicks(Cobb-500)the average feed intake(gm/bird)is 118.95,117.79,123.21 , 130.41and body weight gain 60.30, 61.64, 57.58, and 49.46 daily with feed conversion ratio of 1.97, 1.91,2.13, and 2.63 respectively [36] from 1-42days age . High fibre content and tannin in aquatic plants is mainly responsible for poor feed conversion efficiency and decreased nutrient utilization [43]. Studies of [3] indicate that azolla can be used to replace 20% of commercial feed in young chick diet.The palatability in broiler diet is not affected if azolla is included @5% in broiler diet[35] although no mortality was noted at higher levels(10 and 15%) .Azolla pinnata meal has been safely included upto 15% in growing pullets ration with no health issues[44] but 10% level in pullet chick diet has given best performance. Azolla pinnata has been fed to broiler chicken [16,45,46]. [47] reported that dried azolla in Vencobb broilers ration can safely be administered upto 5% without having any deleterious effects but 2.5% azolla inclusion in broiler diet is effective in improving growth parameters and biochemical parameters. When commercial broilers are fed azolla dressing

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percentage is significantly ( $P < 0.01$ ) increased at 5% level of inclusion but giblet percentage at 15% [35]. Best dressing percentage of 72.16 was obtained when azolla was fed at 5% while at 0, 10 and 15% inclusion level it was 69.38, 68.24 and 68.78% respectively. The giblet percent at 15% was 6.44% but in other groups it varied from 5.55-6.01%. Feeding 5% azolla powder significantly ( $P < 0.05$ ) increases carcass yield (%) in male broiler chick (Cobb-500) while lowest percentage was noted in 15% azolla supplemented group [36]. Thigh, breast and gizzard yield (%) followed similar trend. The cost of broiler production is significantly ( $P < 0.05$ ) low if azolla is supplemented @ 5% [35, 36]. Azolla as unconventional nutrient source can be fed upto 10% of basal diet in white Pekin broiler ducks [48]. Moreover azolla fed group in terms of profit/bird shows higher economic efficiency. Feeding of broilers on azolla result in similar body weight and growth like those kept on maize-soybean meal [49]. In an attempt to utilize aquatic plants in swine ration for nutrients and for reducing feed cost *Azolla filiculoides* has been used in sow diet [50] and as partial protein source replacer in growing fattening pigs [17, 37]. Other plants used in ration are water hyacinth, duckweed and *salvinia molesta*. Azolla as a protein source has also been used in laboratory animals like Rabbits [51-55].

### ***Effect of feeding azolla to Fish***

Digested *Azolla pinnata* slurry, which is product of biogas production acts as a fish pond fertilizer [56] and helps in increasing phytoplanktons. Conventional fish feed mixed with digested azolla slurry in 4:1 ratio is helpful in attaining highest growth rate. Supplementation of *Azolla pinnata* in diet of fingerling and adult suppresses the growth in *iletilapia*, *Oreochromis niloticus* L.

### ***Effect of feeding of azolla to Humans***

Different azolla preparations for humans in form of soup are in process but still more trials are needed for justification [57]. Medicinal properties of azolla has been described in book of Li Shi-Zhen. In Tanzania, *Azolla* is used for cough treatment as part of traditional medicine.

## CONCLUSION

It can be concluded that azolla can serve as feed for our stall-fed animals/poultry in near future, if it is processed and preserved properly like hay and silage in lean periods .It's application may be increased to goats by making it more palatable.

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