International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2018; 6(3): 2031-2033

Received: 04-03-2018
Accepted: 06-04-2018

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Chemical composition and pellet quality of *Azolla pinnata* grown in semi-arid zone of India

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Abstract
Present experiment was undertaken to explore the nutritive potential of *Azolla pinnata* as an animal feed. For this Azolla was cultivated on high-density polyethylene (HDPE) Azolla bed and grounded pits and harvested, dried and incorporated in the pelleted complete feed. Sundried Azolla sample was analyzed for proximate principles. The dry matter content of Azolla was 4.7 percent. Analysis of dry matter revealed the presence of total 82.66 percent organic matter. Among these includes 21.67 percent crude protein, 3.27 percent ether extract, 12.38 percent crude fiber, and 43.35 percent nitrogen free extract. The total Ash and acid insoluble ash content were found 19.33 and 3.64 percent, respectively. NDF, ADF and hemicellulose in Azolla (*Azolla pinnata*) were found to be 41.84%, 28.56% and 13.28%, respectively. The chemical analysis proves that Azolla is a rich source of crude protein, trace minerals and vitamins. The mineral profile of Azolla indicates 1.64% Calcium and 0.34% Phosphorus and other minerals in trace levels. Thus Azolla can be considered as potential unconventional feed for livestock.

Keywords: *Azolla*, proximate, composition, evaluation, dry matter

1. Introduction
Azolla is a free-floating aquatic macrophyte consisting of a short, branched, floating stem, bearing roots that hang down in water, containing 28% crude protein and has a potential to be used as a protein supplement in ruminants (Ahirwar and Leela, 2012) [2]. Floating species are generally not dependent on soil or water depth. Due to rapid growth, aquatic macrophytes come to invade gaps and cause various problems so many authors have considered them as pest. However, if we properly use their power, they can be utilized as animal feed. It exhibits ability to absorb or concentrate metals, nutrients and other compounds, which make them a useful tool in the treatment of pollutant water. It has been also known as "green gold mine" because of its high nutritive value and multifaceted uses such as human food, animal feed, medicine, production of biogas, hydrogen fuel, water purifier, weed control, reduction of ammonia volatilization, and super plant due to its fast growth (Wagner, 1997; Indira *et al.*, 2009) [25,]. It is good source of protein and it contains almost all essential amino acids, minerals such as iron, calcium, magnesium, potassium, phosphorus, manganese etc, apart from appreciable quantities of vitamin A precursor beta-carotene and vitamin B_{12}. It is also found to contain probiotics and biopolymers (Pillai *et al*., 2002) [16]. In view of the above facts, the present study, the nutritional value of *Azolla pinnata* was undertaken.

2. Materials and Methods
Present experiment was conducted at ICAR-National Research Centre on Camel, Bikaner.

2.1 Cultivation of Azolla
Azolla (*Azolla pinnata*) had been produced at the Azolla Production Unit established at Livestock Feed Resources Management and Technology Centre, Rajasthan University of Veterinary and Animal Sciences, Bikaner and ICAR-NRCC, Bikaner. High-density polyethylene (HDPE) Azolla beds and grounded pits methods were used for Azolla production. HDPE Azolla beds of size 12X6X1 feet were used. Similarly, pits of 3MX2MX0.2 M sizes were dug and covered with silpauline sheet. The outer edges of sheets were fixed with help of mud. Sheets were uniformly covered by fertile soil. Water was poured into pit to reach a level of about 10cm. Slurry of cow dung about 2-2.5Kg and 50mg Super Phosphate was mixed in water and it was repeated weekly. Fresh and pure culture of Azolla was inoculated in

the pit at the rate of 500g to 1Kg per square meter. Azolla grew and spread all over the bed within a fortnight and appeared as a thick mat like structure. About 25 to 30% water was replaced to avoid nitrogen build up and prevent micro nutrient deficiency, once in 10 days and 5 kg of bed soil was replaced with fresh soil once in 30 days.

2.2 Collections and storage of Azolla

Azolla multiplied rapidly and covered the complete pits within 7 days. Fully grown Azolla was harvested daily from Azolla producing units, it was washed with water thoroughly to remove dung using a wire mesh, air dried overnight and sundried later and used on the next day for mixing in the complete feed mixture and pelleting. Three type of feed pellet were prepared with 0% Azolla, 2% Azolla and 4% Azolla inclusion using cactus as a binder agent.

2.3 Chemical evaluation of Azolla

The feed and faeces samples were analysed for proximate constituents according to AOAC (2016) [1]**.** Moisture, dry matter and total ash of samples were analyzed by standard conventional procedure. Ether extraction and crude fibre of feed and faeces were estimated by using Soxhlet's apparatus and Fibre-E-Tek machine, respectively. Estimation of total nitrogen of feed, residue and faeces were done by standard Kjeldahl's method using Kel Plus Semi-Automatic Nitrogen Analyzer (Pelican Equipment). Nitrogen free extract was estimated by using standard conventional Weende's method. Fibre fractions (NDF, ADF, hemicellulose) were determined using by method of Van Soest (1991) [24]. Mineral profile of Azolla was estimated using inductively coupled plasma optic emission spectrophotometer (ICP-OES). Pellet diameter was analysed by vernier calliper and density was calculated by below given formula

Density (g/cu.cm) = weight of sample/ volume

3 Results and Discussion

The proximate analysis of *Azolla pinnata* was carried out to determine dry matter, organic matter, crude protein, ether extract, nitrogen free extract, crude fiber, total ash and acid insoluble ash content and minerals. The values have been presented in Table 1. Whereas pellet quality was presented in Table 2.

The crude protein, ether extract, crude fibre, nitrogen free extract, total ash, acid insoluble ash, NDF, ADF and hemicellulose in Azolla (*Azolla pinnata*) were found to be 21.67%, 3.27%, 12.38%, 43.35%, 19.33%, 3.64%, 41.84%, 28.56% and 13.28%, respectively.

The results of CP value obtained in the present study was found to be similar to values reported by Querubin *et al.*, (1986) [17] in *A.microphylla* (23.40%) and Alalade and Lyayi (2006) in *A.pinnata* (21.40%). However, Becerra *et al.*, (1995) and Indira *et al.,* (2009) reported higher CP content 26.7% in *Azolla microphylla* and 28.24% in *Azolla pinnata*, respectively. Whereas, Tamang and Samanta (1992) [19] and Kumar *et al.*, (2014) reported the CP content was found to be 15.4% in sun-dried Azolla and 17.3% in *Azolla microphylla* which was lower than the present investigation. The possible reason of variability in CP content is the response of Azolla strains to environmental conditions like temperature, light intensity, water availability and soil nutrients which affect chemical composition.

The crude fibre content on % DM basis in *A.Pinnata* was found to be 12.38%. Similar results were recorded by Arvindraj (2012) [4], Sharma (2013) [10] and Kumar *et al.,* (2014) found to be 12.45%, 12.63% and 12.02% CF in *A. microphylla*, respectively. CF values recorded by Becerra *et al.,* (1995) in *Azolla microphylla* and Ghodake *et al.,* (2012) in *Azolla pinnata* were 11.2% and 9.07%, respectively which was lower than the present investigation.

The ether extract (% on DM) values (3.27%) recorded in present investigation was similar to the findings reported by Querubin *et al.,* (1986) [17], Basak *et al.,* (2002) [7], Alalade and Lyayi (2006), Ghodake *et al.,* (2012), Kumar *et al.,* (2012) [14], Chatterjee *et al.,* (2013) [10], Sharma (2013) [13] and Kumar *et al.,* (2014). However, Buckingham *et al.,* (1978) [9], Becerra *et al.,* (1995) and Arvindraj (2012) [4] recorded higher values of crude fibre i.e. 5.05%, 4.6% and 4.06% in *A. microphylla*, respectively.

The total ash content in *A. pinnata* was found to be 19.33%. Indira *et al.,* (2009), Arvindraj (2012) [4] and Kumar *et al.,* (2014) recorded values 20.21% in *A. pinnata*, 19.87% in *A. microphylla* and 20.31% in *A. microphylla*, respectively which is comparable with the result of present study. In the present investigation nitrogen free extract content of *Azolla pinnata* was found to be 43.35%, collaborate with findings of Balaji *et al.,* (2009) [6], Arvindraj (2012) [4], Chatterjee *et al.,* (2013) [10], Sharma (2013) [13] and Khare (2014) [13].

Acid insoluble ash content recorded in the present study was 3.64% which is comparable to results recorded by Arvindraj (2012) [4] and Sharma (2013) [10]. However, Bloka (2011) recorded value 7.19% of AIA which was higher than present study. The possible reason of difference in AIA content is difference in extent of washing during harvest of Azolla. The low acid insoluble ash with high value of total ash content of Azolla indicates that it may be a micronutrients rich source.

In the present investigation neutral detergent fiber content of *Azolla pinnata* was found to be 41.84% which was comparable with the values recorded by Chatterjee *et al.,* (2013) [10], Sharma (2013) [10] and Kumar *et al.,* (2014) in *A. microphylla*. However, Querubin *et al.,* (1986) [17] in *A. microphylla*, Indira *et al.,* (2009) in *A. pinnata* and Arvindraj (2012) [4] in *A. microphylla* recorded higher NDF values of 67.8%, 72.05% and 68.43%, respectively.

Table 1: Proximate composition of *Azolla Pinnata*

Parameters	Quantity (%)
DM	94.40
OM	80.67
CP	21.67
EE	3.27
CF	12.38
NFE	43.35
TA	19.33
NDF	41.80
ADF	28.56
HC	13.28
Ca	0.98%
P	0.59%

In the present investigation acid detergent fiber content of *Azolla pinnata* was found to be 28.56% which was similar to values reported by Buckingham *et al.,* (1978) [9], Seyed and Mozafar (1990), Chatterjee *et al.,* (2013) [10], Sharma (2013) [10], Kumar *et al.,* (2014) and Roy *et al.,* (2016) [18].

Hemicellulose content of *Azolla pinnata* recorded in the present study was 13.28%, which was comparable with results of Querubin *et al.,* (1986) [17], Samanta *et al.,* (1992) and Sharma (2013) [10] i.e. 13.3%, 15.6% and 12.30%, respectively.

In the present investigation calcium and Phosphorous were found to be 0.98% and 0.56%, respectively which was similar to earlier reports of Sujatha *et al.,* (2013) [23] Shamna *et al.*, (2013) [21].

Volume and density were found to be 3.45, 3.15 and 3.57 cubic cm and 1.02, 0.97 and 1.01 g/cubic cm at level of 0% Azolla, 2% Azolla and 4% Azolla inclusion, respectively. Volume and density were found significantly differ and also comparable to each other.

Table 2: Pellet Quality of Azolla included complete feed

	Pellets			
Parameters	**0% Azolla**	**2% Azolla**	**4% Azolla**	**SEM**
Volume	3.45^{b}	3.15^{a}	3.57^{b}	0.099228
Density	1.02^{b}	0.97^{a}	1.01^{ab}	0.010814

Conclusion

It is concluded that Azolla is rich source of protein and macronutrients. It can be used as unconventional feed with protein supplement for many species including ruminants, poultry, pigs and fish. Pelleting of Azolla feed is easy to handle and transportation.

References

1. AOAC. Official method of analysis, 20th edition, Association of Official Analytical Chemists, Washington, D.C. 2016; 5(2):137-141.
2. Ahirwar MK, Leela V. Nutritive value and *in vitro* degradability of *Azolla pinnata* for ruminants. Indian Veterinary journal. 2012; 89(4):101-102.
3. Alalade OA, Lyayi EA. Chemical composition and the feeding value of Azolla (*Azolla pinnata*) meal for egg-type chicks. International Journal of Poultry Science. 2006; 5:137-141.
4. Arvindraj N. Chemical composition and nutritional evaluation of *Azolla microphylla* as a feed supplement for cattle. M.V.Sc. Thesis to NDRI, Kalyani, West Bengal, India. 2012.
5. Bacerra M, Preston TR, Ogle B. Effect of replacing whole boiled soya beans with Azolla in the diets of growing ducks. Livestock Research for Rural Development. 1995; 7:1-11.
6. Balaji K, Jalaludeen A, Churchil RR, Peethambaran PA, Senthil kumar S. Effect of dietary inclusion of Azolla (*Azolla pinnata*) on production performance of broiler chicken. Indian Journal of Poultry Science. 2009; 44(2):195-198.
7. Basak B, Pramanik AH, Rahmnan MS, Taradar SU, Roy BC. Azolla (*Azolla pinnata*) as a feed ingredient in broiler ration. International Journal of Poultry Science. 2002; 1:29-34.
8. Bolka PC. Nutritional evaluation of Azolla (*Azolla pinnata*) in broilers and layers. Ph.D. Thesis submitted to Karnataka Veterinary, Animal and Fisheries Sciences University, Bidar. 2011.
9. Buckingham MKW, ELA SW, Moris JG, Goldman CR. Nutritive value of the nitrogen-fixing aquatic fern Azolla filiculoides. Journal of Agricultural and Food Chemistry. 1978; 26:1230-1234.
10. Chatterjee A, Sharma P, Ghosh MK, Mandal M, Roy PK. Utilization of *Azolla Microphylla* as Feed Supplement for Crossbred Cattle. International Journal of Agricultural Science and Technology, 2013; 4(3):207-214.
11. Ghodake SS, Fernandes AP, Darade V, Zagade BG. Effect of different levels of azolla meal on feed intake of Osamanabadi kids. Veterinary Science Research Journal, 2011; 2(1, 2):22-24.
12. Indira D, Ravi A. Feeding value of Azolla (*Azolla pinnata*) in buffalo calves. International Journal of Food, Agriculture & Veterinary Sciences. 2014; 4(2):22-27.
13. Khare A, Baghel RPS, Gupta RS, Nayak S, Khare V, Patil A. *et al*. production of indigenous cattle fed supplements of mustard oil cake or Azolla meal (*Azolla filiculoides*). Livestock Research and Rural Development, 2014; 26(4):1-5.
14. Kumar DS, Prasad RMV, Kishore KR, Rao ER. Effect of Azolla (*Azolla pinnata*) based concentrate mixture on nutrient utilization in buffalo bulls. Indian Journal of Animal Research, 2012; 46(3):268-271.
15. Kumar R, Tripathi P, Chaudhary UB, Tripathi MK. Nutrient composition, *in vitro* methane production and digestibility of Azolla (*Azolla microphylla*) with rumen liquor of goats. Indian Journal of Small Ruminants, 2015; 21(1):126-128.
16. Pillai KP, Premalatha S, Rajamony S, Azolla-A sustainable feed substitute for livestock. *Leisa India*. 2002; 4:15-17.
17. Querubin LJ, Alcantara PF, Princesa AO. Chemical composition of three Azolla species (*A. caroliniana, A. microphylla and A. pinnata*) and feeding value of Azolla meal (*A. microphylla*) in broiler ration. Philippine Agriculturist (Philippines). 1986; 69:479-490.
18. Roy D, Kumar V, Kumar M, Sirohi R, Singh Y, Singh JK. Effect of feeding *Azolla pinnata* on growth performance, feed intake, nutrient digestibility and blood biochemicals of Hariana heifers fed on roughage based diet. Indian Journal of Dairy Science. 2016; 69(2).
19. Samanta G, Tamang Y. Feeding value of Azolla (*Azolla pinnata*) in goats. *Annales de zootechnie*. 1995; 44(1):62-62.
20. Seyed M, Seyed M, Taklinci, Goudh, Deve, CV, Reddy GG, Ventarami BS, Umakanth U. Utilization of *Azolla microphylla* in broiler feeding. MVSc. Thesis submitted to U. A. S., Bangalore, 1990.
21. Shamna TP, Peethambaran PA, Jalaludeen A, Leo Joseph Muhammad Aslam MK. Broiler characteristics of japanese quails (*Coturnix coturnix japonica*) at different levels of diet substitution with *Azolla pinnata*. Animal Science Reporter. 2013; 7(2):75-80.
22. Sharma. Comparative nutritional evaluation and effect of supplementation of *Azolla microphylla* on milk yield and composition in crossbred cattle. M.V.Sc. Thesis submitted to NDRI, Karnal, Haryana, India. 2013.
23. Sujatha T, UdhayakumarI D, Kundu A, Jeyakumar S, Jai sundar Kundu MS. Utilization of raw Azolla as a natural feed additive for sustainable production in nicobari fowl. Animal Science Reporter. 2013; 7(4).
24. Van Soest PJ, Robertson JB, Lewis BA, Methods for dietary fibre, neutral detergent fibre and non starch polysaccharides in relation to animal nutrition. Journal of Dairy Science. 1991; 74(10):3583-3597.
25. Wagner GM. Azolla: a review of its biology and utilization. The Botanical Review, 1997; 63(1):1-26.