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NUTRITIVE EVALUATION OF AZOLLA AS LIVESTOCK FEED

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ABSTRACT

Present study was undertaken to explore the nutritive potential of *Azolla pinnata* as an animal feed. For this *Azolla* was cultivated in water trough, harvested and sundried. Sundried *Azolla* sample was analysed 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 22.48 percent crude protein, 4.5 percent ether extract, 14.7 percent crude fiber, and 40.98 percent nitrogen free extract. The total Ash content was 17.34 percent. 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, 2.71% Potassium and 0.34% Phosphorus and other minerals in trace levels. Thus *Azolla* can be considered as potential unconventional feed for livestock.

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1 Introduction

Azolla is an aquatic free floating fern belonging to the family Salviniaceae. Nutritive value of Azolla is well documented which shows that it is a good source of protein with almost all essential amino acid required for animal nutrition (notably lysine). Furthermore, it also provides macronutrients like calcium, magnesium, potassium and vitamins like vitamin A (precursor beta-carotene) and B12. All these facts suggested that Azolla can be used as unconventional feed with protein supplement for many species including ruminants, poultry, pigs and fish (Hossiny et al., 2008). Due to ease of cultivation, high productivity and good nutritive value it is used as a beneficial fodder supplement by various researchers (Singh & Subudhi, 1978; Prabina & Kumar, 2010).

Azolla pinnata tried as a feed for broiler chicken (Alalade & Iyayi, 2006; Balaji et al., 2009; Dhumal et al., 2009; Bolka, 2011), goats (Samanta & Tamang, 1993) and buffalo calves (Indira et al., 2009). *Azolla filiculoides* was also used in diets for sows (Leterme et al., 2010) and as partial replacement of protein source for growing fattening pigs (Duran, 1994; Becerra et al., 1995). Furthermore, it was also tried as a protein supplement for Rabbits (Gualtieri et al., 1988; Wittouk et al., 1992, Sreemannaryana et al., 1993; Abdella et al., 1998; Sadek et al., 2010). In view of the above facts, the present experiment, the nutritional value of *Azolla pinnata* was undertaken.

Plate 1: Sun drying of azolla.

2 Materials and Methods

Present study has been carried out at the department of Livestock Production and Management, Bangalore Veterinary College, Karnataka

2.1 Cultivation of Azolla in Water Troughs

Three water troughs with even bottom and 10 sft. capacity were taken for the study. All the roots and other unwanted particles were removed from the floor and sealed the bottom with cement and the same level in order to maintain a uniform

water level. Any thin layer of 10-15 cm made up of fine soil were spread and then, the water tank filled with water and maintain the constant level of the water. About 1.5 kg of cow dung dissolves in 3.5 liters of water and spread evenly in the water trough. Preparation once completed, the water tank injected with fresh azolla culture of 300 g / m² on it. Once in every 15 days, application of 1.5 kg dung, 0.2g super phosphate and 0.2g of mineral mixture was done to obtain continuous growth of azolla and to avoid nutrient deficiency and also check the pH. In the case of pits contaminate with insects and contaminates, a fresh pure culture was added.

2.2 Collections and storage of azolla

Azolla multiplied rapidly and covered the complete pits within 7 days. Fully grown azolla (Plate 2) was harvested every week from the water trough. Harvesting azolla was cleaned and thoroughly washed and sundried for 2-3 days and dried till crispy dried and stored in air tight aluminium foils.

Table 1 Chemical composition of azolla.

Nutrients	Azolla
Dry matter	4.70
Organic matter	82.66
Crude Protein	22.48
Ether extract	4.50
Crude fibre	14.70
Total ash	17.34
NFE	40.97
NDF	54.85
ADF	36.57
ADL	24.05

2.3 Chemical evaluation of azolla

The DM content of collected azolla samples were analysed by drying to a constant weight in a forced hot air oven at 105°C. The ash content in the samples was estimated as residue after incineration of samples at 600°C for 3 hours. Crude protein (N X 6.25) was analysed using Gerhardt digestion and distillation unit (AOAC, 2005). The Ether extract (EE) content in the sample was analysed after extraction with petroleum ether using the procedure of AOAC (2005). The fiber fractions were determined according to the methods described by Van Soest et al. (1991). Mineral profile of Azolla was analysed by inductively coupled plasma-atomic emission spectrophotometer and amount was calculated by below given formula.

$$\mu\text{g} / \text{g} =$$

$$\text{Concentration of mineral in sample solution (mg / L) } \times \frac{\text{Volume made (ml)}}{\text{Weight of sample (g)}}$$

Plate 2 Azolla (*Azollapinnata*) grown in water trough

Parameters were analyzed by analysis of variance with using GraphPad Prism version 5.1. Individual differences between means were tested using Tukey's Multiple Comparison Test when treatment effect was significant.

3 Results and Discussion

The results of proximate analysis of sun dried azolla (Plate 1) sample are presented in the Table 1. The values were Total dry matter 4.7 per cent, 82.66 per cent of the organic matter, 22.48 per cent crude protein, 4.5 percent of the ether extract, 14.7 per cent of crude fiber, 17.34 percent of total ash and 40.98 per cent of nitrogen free extract.

The chemical composition of sun dried azolla as presented in the table 2 revealed that dry matter content was 4.7 which are in agreement with the findings of Giridhar et al. (2012) and Kavya (2014) whereas, Parashuramulu et al. (2013) reported almost double (8.9%) of DM content. Though the DM content in the fresh azolla was slightly less, but can be used as a supplement to meet the DM requirements in livestock feeds.

The result of crude protein were in agreement with the findings of Basak et al. (2002), Lukiwati et al. (2008), Prasanna et al. (2011), Bolka (2011), Chatterjee et al. (2013) and Kavya (2014), those have reported crude protein values ranged from 21.0 (Kavya, 2014) to 25.8 (Basak et al., 2002). High protein content azolla suggests that it's a potential natural protein source.

The crude fibre content was close agreement with the values obtained by Balaji et al. (2009) and Cheryl et al. (2014), respectively. On the contrary Singh & Subudhi (1978) reported less value and it ranged between 9.1 to 13.07 percent while

Alalade & Iyayi (2006) was reported 12.7 per cent CF. Further the higher range of CF values from 15.17 to 19.85 was recorded by Bolka (2011) and Kavya (2014). Slight variations in the contents of CF in azolla was observed in the present study, when compared to other research workers which might be due to changes in the dry matter content of azolla used for CF estimation.

Nitrogen-free extract obtained was comparable to the findings of Kavya (2014). The higher values 47 and 47.4 percent were observed by Samanta & Tamang (1993) and Alalade & Iyayi (2006) respectively.

Table 2 Mineral profile of *Azollapinnata* (on per cent DMB).

Minerals	Percentage	Ppm
Calcium	1.64	
Phosphorus	0.34	
Potassium	2.71	
Copper		9.1
Manganese		2418
Zinc		325
Iron		1569
Cobalt		8.11
Chromium		5.06
Boron		31
Nickel		5.33
Lead		8.1
Cadmium		1.2

Total Ash in this study were similar with values of Balaji et al. (2009), Prasanna et al. (2011), Bolka (2011), Chatterjee et al. (2013) Parashuramulu et al. (2013) and Kavya (2014) whose values were in the range from 16.21 percent was reported by Prasanna et al. (2011) and 19.47 percent by Chatterjee et al. (2013). Whereas Subudhi & Singh (1978) reported 10.50-15.82 percent of TA in dried azolla. The higher value (24.26) of TA was reported by Cheryl et al. (2014) while this value was 28.7 percent were also reported by Lukiwati et al. (2008). The large variation in the values of TA in azolla might be due to mineral inputs in the ingredients added for cultivation of azolla.

From the study it was revealed that the ether extract was 4.5 percent, the results are in agreement with findings (3.38-4.41%) of other researchers Basak et al. (2002), Balaji et al. (2009), Bolka (2011) and Kavya (2014). The lower values of 2.73 and 3.27 percent were reported by Tamang et al. (1993) and Chatterjee et al. (2013) respectively. Slight variation was observed in the content of EE can be attributed to the nutrient inputs used to cultivate the azolla.

The NDF content of azolla is in close agreement with the value reported by Parnerkar et al. (1986), Kavya (2014) but higher than the values reported by Buckingham et al. (1978), Taklimi (1990); Ali & Leeson (1995) and Alalade & Iyayi (2006).

The ADF content of azolla is almost similar to the value reported by Khatun et al. (1996). The ADL content of azolla obtained in present study is almost similar to the value reported by Ramesh (2008) Kavya (2014) but higher than the value reported by Tamang et al. (1993).

The mineral profile of azolla obtained in the present study is almost similar to the values reported by Anand & Geetha (2007), Kavya (2014). Calcium content of azolla is similar to the reports of Tamang et al. (1993). Magnesium content of azolla obtained in the present study is similar to the value reported by Alalade & Iyayi (2006). Higher level of heavy metals like nickel, lead, cadmium was also obtained in the sample of azolla used for the present study indicating bioaccumulation of heavy metals by azolla. Padmavathiamma & Li (2007) studied the absorption of iron, copper, cadmium, nickel, lead, zinc, manganese, and cobalt by *Azolla pinnata* indicating bioaccumulation of heavy metals by azolla.

Yield of Azolla was reported around 120 g/m²/day fresh weight per water trough which is similar to Duran (1994) those who reported 120-200 g/m²/day of fresh azolla production can be harvested and Gerek (2001) reported that 1122 g/m² of fresh azolla can be harvested after 15 days from the inoculation of fresh weight of 300 g/m² azolla.

Azollapinnata differences in nutrient composition may be due chemical composition of soil nutrients and also may be due to differences in environmental conditions such as respond to heat, light intensity and its resulting impact on their growth, morphology. Moreover, epiphytic algal contamination resulted in affect the chemical composition (Sanginga & VanHove, 1989).

Conclusion

Sun dried azolla on chemical analysis showed that rich in crude protein, trace minerals and vitamins and hence it can be used as livestock feed as a unconventional feed

Conflict of interest

Authors would hereby like to declare that there is no conflict of interests that could possibly arise.

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