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Effect of *Azolla pinnata* Feeding on Linear Type Traits and its Relation to Economic Feasibility in Sahiwal Calves

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ABSTRACT

Background: Concentrate is the most vital element in animal diet, prepared primarily from traditional protein sources. All these protein sources are very expensive and responsible for reducing the income. Human beings and animals are competing for protein sources either for consumption or industrial use. Under this context, *Azolla pinnata* can act as best protein replacement source for protein.

Methods: The study was conducted on eighteen female Sahiwal calves for 90 days. The animals were distributed into three groups (T0, T1 and T2). The animals in (T0) group were fed as per ICAR 2013 feeding standard. In the (T1 and T2) group, fresh *Azolla pinnata* was fed by replacing 15% and 30% protein content of concentrate with *Azolla pinnata* on DM basis, respectively.

Result: There was no significant difference in all the parameters used for estimating the linear type traits (LTT). Body weight measured through Schaeffer's formula showed a significant difference between the T0 and T2 groups. The significant difference ($P<0.05$) was obtained for feed cost/kg weight gain in between the T0 and T2 groups. The reduction in the feed cost/kg weight gain in T1 and T2 group as compared to T0 group was Rs. 7.28 and 14.51 respectively. It was concluded that Azolla inclusion at 30% replaced level was the most profitable replacement.

Key words: ADG, *Azolla pinnata,* Economics, Linear type traits, Sahiwal calves.

INTRODUCTION

Most farmers suffer from problem of unavailability of animal health accessing and their growth measurements tools so they make use of linear body measurements for estimating them (Ulutas *et al.,* 2002). Simple linear measuring tools will be easy to manage and will help to pick the animals to become next-generation parents (Essien and Adesope, 2003). Morphometric/Linear type traits (LTT) can be used in farm animals to determine growth rate, body weights, feed use and carcass characteristics. Body measurements can be used in cattle as selection criteria for the growth traits. In addition to increasing their milk production level, enhancement of these (LTT) traits will enhance the herd life of dairy cows (Atkins and Shannon, 2002).

The most expensive part of livestock farming is the feed expense (Goh and Rajion, 2007). Concentrate is the most vital element in animal diet, prepared primarily from traditional protein sources such as groundnut cake, cotton seed cake and soybean meal. All these protein sources are very expensive and responsible for reducing the income and act as a major constraint for poor farmers. Protein is the costliest component of the diet (Mederos *et al.,* 2002). The prices of traditional sources of protein are increasing day by day. Human beings and animals end up competing for protein sources either for consumption or industrial use. Besides this heavy price of these feed resources, their seasonal availability also restricts their inclusion in formulating feed for livestock. Also, Agbede *et al.* (2008) and Agbede *et al.* (2009) indicated that assessing unconventional feed resources in conjunction with other strategies would reduce the load on traditional feed resources and accelerate the achievement of feed safety in tropical animal. Scientists have recently researched more on the use of local protein resources, which have no nutritional and economic value to man. Various research have been done on the use of maggot cassava leaf protein concentrate by Fasuyi (2000), cassava leaf meal Okonkwo *et al.* (2010) cassava peel by Tewe, (1985) winged bean seed by Igene (1999) and Leucaena leaf protein concentrate by Agbede, (2000) at different times to replace conventional protein feed ingredients in the formulation of livestock feeds. Therefore, in order to create dairy farming as a profitable venture for farmers, it is hourly necessary to develop cheap protein feed sources.

With this context, *Azolla pinnata* can act as the best source of protein substitution. So, the present study was conducted with an objective to evaluate the effect of *Azolla pinnata* feeding on different linear type traits (LTT) and to explore the viability and financial feasibility of *Azolla pinnata* as a partial protein substitute for concentrate in Sahiwal calves.

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MATERIALS AND METHODS

The present study has been conducted at Livestock Research Centre (LRC) of National Dairy Research Institute (NDRI), Karnal, Haryana. The experiment was performed to evaluate the different linear type traits (LTT) and evaluate its relationship with cost economy of *Azolla pinnata* feeding in calves by substituting the protein content of concentrate at 15 per cent and 30 per cent level. Sahiwal female calves (n=18) were randomly divided into three treatment groups with six animals in each one. The average weight and age in each groups was 56 kg and 4 months. The research was conducted at LRC, NDRI herd, Karnal.

Azolla was propagated at the Azolla production unit established at NDRI, Karnal. A rectangular pit having dimension of 11.0*4.5 feet (L*B) and 90 cm depth was prepared (total 22 pits). The calves were kept on the adaptation period of two weeks. Afterwards an experiment of 13 weeks (90 days) was carried out during which the groups were fed with three treatments. The animals were fed as per the ICAR feeding standard 2013. The 1st group (T0) was a control group and fed as per ICAR 2013 feeding standard. The 2nd group (T1) was fed by replacing the 15% protein content of the concentrate with the Azolla pinnata and the 3rd group (T2) was fed the same but by replacing the 30% protein content of concentrate with the *Azolla pinnata*. All the groups were fed as per ICAR feeding standard 2013 by balancing the CP intake, TDN intake and DM intake for each animal. The iso-nitrogenous and iso-caloric diets were formulated for all the groups.

Data collection and sampling

Feed intake and body measurements like body length (BL), heart girth (HG), height at withers (HAW), head to shoulder length (HS), chest depth (CD), Hip height (HH) and abdominal girth (AG) were measured fortnightly. The LTT variables were used to measure growth, feed usage and its relationship to economic Azolla feeding. The LTT have been measured using inch tape and represented in centimetres as per the recommended procedures.

The LTT traits were used for estimating the body weight of animals. The body weights at various age groups of calves were estimated by using Schaeffer's formula as outlined below:

$$\text{Live body weight (in pound)} = \frac{\text{Length} * (\text{Girth})^2}{300}$$

Where,
Length and girth is measured in inches.

The resulted body weight in pounds was converted into kilogram (kg) unit for easy assessment and relating it with economic parameters calculation.

Data were collected from the local market about the prevailing price of all the inputs used in the production of *Azolla*. The cost of roughage and concentrate supplied by the fodder section and the cost of cultivating *Azolla* were considered together for calculating the cost of the feed. On cost analysis, feed cost per kilogram weight gain was calculated by multiplying the cost of feed intake by the feed consumed and divide by the weight gain (kg). It is mathematically expressed as:

Feed cost/kg weight gain =

$$\frac{\text{Cost of feed intake/kg} * \text{Avg. feed consumed}}{\text{Avg. weight gain}}$$

The unit cost of Azolla production is calculated as:

Unit cost of *Azolla* production =

$$\frac{\text{Total capital invested for production}}{\text{Total } \textit{Azolla} \text{ yield (kg)}}$$

The percentage reduction in feed cost over control group (%) is calculated as:

Percentage reduction in feed cost of treatment over control group =

$$\frac{\text{Difference in the feed cost/kg gain} * 100}{\text{Feed cost/kg gain in control group}}$$

Statistical analysis

The various LTT traits and body weight measurements at fortnight interval were analysed using the SPSS statistical package (version 20.0) and are presented as means and pooled standard errors (SEM). The dietary treatment effects were explored using a General linear model (GLM) for repeated measures analysis of variance (ANOVA) with dietary treatments (D= T0, T1 and T2) and considering the sampling time (S) as the repeated measure and their interactions (D×S) according to the model:

$$Yik = \mu + Di + (D \times S) + eik$$

Where,
Yik = Dependent variable.
μ = Overall mean.
Di = Effect of dietary treatment (i=3).
(DxS) = Interaction between dietary treatments and sampling time and eik is the residual error.

Post hoc analysis was performed using LSD multiple range test and for all tests, the level of significance was set at 0.05.

RESULTS AND DISCUSSION

Azolla pinnata yield

Azolla has been harvested daily from all the pits. The average yield of Azolla was 0.021 kg/ft²/day. The total

Table 1: Average yield of *Azolla pinnata* from the pits.

Parameter	Value
Area of 1 pit	4.6 m²
Area of 19 pits	87.4 m²
Total Azolla yield (90 days)	1809.10 kg
Azolla pinnata growth period	90 days
Yield of 1 m² (90 days)	20.6 kg
Yield of 1 m²/day	0.229 kg
Average yield per pit/day	1.05 kg
Average yield from 19 pits/day	20.01 kg

Azolla pinnata yield has been presented below in Table 1. The resulting regrading unit cost of production of Azolla was Rs.1.36 which was higher than the values obtained by (Pillai *et al.,* 2002; Cherryl *et al.*, 2013; Sireesha *et al.,* 2017) and the value obtained by them was Rs. 0.65, Rs. 0.56 and 0.66 respectively. This could be due to the inclusion of the silpauline sheet expense as compared to earlier studies that did not include it when measuring the unit cost of production of *Azolla*.

Economics of *Azolla pinnata* production

In the experimental period it was observed that Rs. 2472.79 was the total expenditure required for Azolla production. The amount was determined by adding all expenditures such as the cost of silpauline sheets, cow dung, super phosphate, labour costs, insecticide *etc.* The economics of *Azolla pinnata* production has been presented below in Table 2.

Linear type traits

The mean linear type traits (LTT) of different groups have been presented in the Table 3. Post-hoc analysis revealed that there was no significant difference in height at withers, body length, chest depth, hearth girth, hip height, abdominal girth and head to shoulder length (cm) among all the three groups ($P<0.05$). There was a significant effect of time (trial) but there was no significant interaction between time and variable interaction (LTT Traits) ($P<0.05$). The average heart girth (cm) has shown no significant difference in all the groups in the experiment. In the T2 group, numerically higher value was reported for head to shoulder length (cm), compared to control one. The other LTT parameters like hip height, abdominal girth and head to shoulder length (cm) have shown no significant difference in between the groups. The higher average value for body length was obtained for T2 group in comparison to T0 group. Similar results were obtained by (Paul *et al.*, 2012; Milla *et al.*, 2012; Bhagat *et al.*, 2017). Azolla is rich in essential amino acids, vitamins (vitamin A, vitamin B12, beta carotene), promoters and minerals such as calcium, phosphorus, potassium, zinc, *etc.* (Lumpkin 1984; Bhatt *et al.*, 2020). This may have led to improved growth and thus increased body length. Since Azolla have better mineral profile, growth promoters and contributed to better growth (Lumpkin 1984; Bhatt *et al.*, 2020). The higher value for height at withers (cm) was observed in treatment group in comparison to control one. Since Azolla leaves also contain anthocyanins that have antioxidant property (Katayamaa *et al.,* 2008). All of this may have led to faster growth, better bone and muscle development in *Azolla* fed groups and thus the height was highest in 30 per cent replaced fed groups. Similarly the higher value for body length, chest depth, hearth girth, hip height, abdominal girth and head to shoulder length (cm) was observed in treatment groups. Similar results for various body measurements were obtained by (Otto *et al.*, 1991; Prasad *et al.*, 1994).

Body weight

The body weight of calves (in pounds) at different fortnights has been mentioned in Table 4. The body weight of calves

Table 2: Economics of *Azolla pinnata* production.

Particulars	Cost of item	Quantity (Per pit)	Quantity (19 pits)	Quantity (Whole exp)	Amount (Rs.)
Total cost of silpauline sheet (24 months)	Rs. 35/m^2	5.58 m^2	105.96	105.96	3710.7
Cost of silpauline sheet for 3 months	Rs. 35/m^2	5.58 m^2	105.96	105.96	463.74
Cow dung	Rs. 1/kg	1 kg/2 week	19 kg	133	133
Super phosphate	Rs. 6.5/kg	10 gm/week	190	2470	16.05
Labour charges	Rs. 20.00/hr	-	1 hr	90	1800
Insecticide	-	-	-	-	60
Total cost invested					2472.79
Yield of fresh *Azolla*	-	-	-	1809.1 kg	
Unit cost of *Azolla* production	-	-	-	-	1.36

Table 3: Means±SE body measurements of female sahiwal calves (90 days).

Parameters	T0	T1	T2
Body length (cm)	79.16^a±2.34	81.65^a±3.21	82.22^a±2.73
Height at wither (cm)	83.36^a±2.78	85.82^a±2.59	86.44^a±3.04
Heart girth (cm)	94.55^a±2.99	96.12^a±3.01	95.83^a±2.21
Chest depth (cm)	35.85^a±2.63	37.39^a±2.41	38.91^a±2.88
Head to shoulder length (cm)	37.66^a±1.89	38.28^a±2.51	39.59^a±2.98
Hip height (cm)	91.15^a±3.1	92.27^a±2.9	93.97^a±3.04
Abdominal girth (cm)	94.28^a±2.8	96.05^a±2.87	97.26^a±2.59

Mean±S.D. (n=6). ^{abc} different superscript implies significant difference ($P<0.05$) among treatments.

(in kg) at different fortnights has been mentioned in Table 5. Post hoc analysis using GLM model showed that there was no significant difference in body weights in between the groups at different fortnights. There was a slight significant interaction between time and variables (Body weights) (P<0.05).

Cost economics of *Azolla* feeding

The concentrate ration cost per kilogram used was Rs. 23.4. The cost of ration in T0, T1 and T2 groups with inclusion of *Azolla* as protein substitute with concentrate at 15 per cent and 30 per cent level respectively has been shown in Table 6. The total cost/day/group in different groups that is T0, T1 and T2 group was Rs. 181.86, 174.42 and 165.84 respectively. There was a significant difference observed for total cost/day/group in between the T0 and T2 groups and the non-significant results were obtained for the same between the T0 and T1 and T1 and T2 groups. Compared to the control group, the total feed cost reduction/day in T1 and T2 group was Rs. 7.44 and 16.02 respectively. The total reduction in feed costs in the T1 and T2 group compared to the control group over the whole 90-day period was Rs.669.6 and 1441.8 respectively. All the cost economics of *Azolla pinnata* feeding has been presented below in Table 5. The significant difference was observed for feed cost per day/calf in a 30 per cent substituted group in comparison to control one (P<0.05). Such findings suggested that a total quantity of Rs. 1.24 was saved in T1 groups per day per calf, while a bit higher quantity of Rs. 2.67 was saved in T2 groups per calf compared to control groups. It was concluded that in the T1 groups, the cost of feed was reduced by Rs. 7.44 per day per group. It was also found that in the T2 groups the cost of feed was reduced by Rs. 16.02 per day per group. The significant difference was observed for feed cost per day/calf in T2 group in comparison to control one (P<0.05). Similar results were obtained by (Bhagat *et al.*, 2017; Lupmkin *et al.*, 1984) who found significantly higher values in the Azolla feed groups. Therefore it was concluded that Azolla has a major role to play in lowering feed costs and also being able to fasten the growth of the body due to the growth promoter in them.

Body weight and feed cost analysis

The average initial body weights for different groups were recorded before the start of experiment for grouping and their values has been presented in Table 6. The overall average increase in body weight along with the average daily weight gain (ADG) has been presented in the Table 6. The non-significant results were obtained for the average body weight of different groups at each fortnight. However the average body weight gain was highest in the T2 group

Table 4: Body weight (Means±SE) of animals as per Schaeffer's formula using LTT measurements.

Fortnights	T0 (Lb)	T0 (kg)	T1 (Lb)	T1 (kg)	T2 (Lb)	T2 (kg)
0	120.9	54.95^{a}±2.78	118.81	54.01^{a}±2.46	123.14	55.97 ^{a}±2.41
1	132.4	60.18^{a}±2.93	131.1	59.54^{a}±2.63	135.39	61.54^{a}±3.13
2	144.64	65.74^{a}±3.28	148.2	67.37^{a}±2.78	147.54	67.06^{a}±3.43
3	156.15	70.98^{a}±3.45	151.17	71.44^{a}±2.78	163.86	74.48^{a}±3.05
4	168.9	76.78^{a}±3.60	172.80	78.54^{a}±3.10	175.91	79.96^{a}±2.60
5	183.9	83.20^{a}±3.81	187.01	85.01^{a}±2.81	192.83	87.65^{a}±3.31
6	198.5	90.25^{a}± 3.56	201.1	91.37^{a}±2.76	210.29	95.59^{a}±3.22
Average	157.80	71.73^{a}±2.32	159.43	72.47^{a}±2.27	164.14	74.61^{a}±2.44

mean±S.D. (n=6). ^{abc}different superscript implies significant difference (P<0.05) among treatments.

Table 5: Cost economics of Azolla feeding in Sahiwal calves in different treatment groups.

Parameters	T0	T1	T2
Consumption of conc. mixt/d/calf	0.825	0.706	0.579
Consumption of green fodder/d/calf (kg)	6.5	6.5	6.5
Consumption of *Azolla* /d/calf(kg)	0	1.10	2.20
Consumption of wheat straw/d/calf (kg)	0.3	0.3	0.3
Cumulative fed intake/calf/day (kg)	7.625	8.606	9.579
Cost of conc. mixture (Rs. 23.1/kg)	19.06	16.31	13.37
Cost of green fodder (Rs. 1.5/kg)	9.75	9.75	9.75
Cost of wheat straw (Rs. 5 /kg)	1.5	1.5	1.5
Cost of *Azolla* (1.36/kg)	0	1.51	3.02
Total cost/day/calf	30.31^{a}±0.06	29.07^{ab}±0.04	27.64^{b}±0.08
Total cost/day/group	181.86^{a}±1.17	174.42^{ab}±1.05	165.84^{b}±1.38
Feed cost reduction over control group/ calf	-	1.24	2.67
Feed cost reduction over control group/day	-	7.44	16.02
Feed cost reduction over control group (90 days)	-	669.6	1441.8

Table 6: Body weight and feed cost analysis in different groups.

Parameters	Control (T_0)	Treatment 1 (T_1)	Treatment (T_2)
Initial body weight (kg)	54.95	54.01	55.98
Final body weight (kg)	90.25	91.37	95.59
Body weight gain (kg)	35.3	37.36	39.61
Average daily weight gain (ADG) (kg)	392^{a}±0.02	415^{ab}±0.01	440^{b}±0.01
Total cost/day/calf (Rs)	30.31^{a}±0.06	29.07^{ab}±0.04	27.64^{b}±0.08
Feed cost/kg gain (Rs)	77.32^{a}±0.03	70.04^{ab}±0.01	62.81^{b}±0.02
Reduction in feed cost/kg gain over T0	0	7.28	14.51
Percentage reduction in feed cost over T0 group	0	9.41	18.76

Mean±S.D. (n=6). ^{abc}different superscript implies significant difference (P<0.05) among treatments.

in comparison to the T0 groups. There was a significant difference in the ADG in between the T0 and T2 groups (P<0.05). However, ADG of calves in T1 did not differ significantly from other groups. In the T0, T1 and T2 group, feed cost/kg weight gain was Rs. 77.32, 70.04 and 62.81, respectively. The lowest values for feed cost/kg weight gain were obtained in the T2 groups, reflecting the reduced amount invested for the same body weight gain. The reduction in the T1 and T2 group feed cost/kg weight gain compared to the control group was Rs.7.28 and 14.51 respectively. The percentage decrease in feed costs over control group (per cent) in the group T1 and T2 is Rs 9.41 and 18.76 respectively. The feed cost analysis has been represented in the Table 6. There was a significant difference seen among all the three groups in feed cost/kg gain (Rs). In the T2 group the feed cost/kg gain (Rs) was significantly lower compared to the T0 groups. The percentage reduction in feed costs over the control group (per cent) in T1 and T2 groups is 9.41% and 18.76%. The lowest values for feed cost/kg weight gain were obtained in the T2 groups, reflecting the reduced amount invested for the same body weight gain. There was a significant difference seen among all the three groups in feed cost/kg gain (Rs). In the T2 group the feed cost/kg gain (Rs) was significantly lower compared to the T0 groups. It reflects the low cost of using Azolla as a substitute for the protein concentrate. In the groups treated with Azolla the growth rate was also higher. In the T2 group the feed cost/kg gain (Rs) was significantly lower compared to the T0 groups. It reflects the low cost of using Azolla as a substitute for the protein concentrate. In the groups treated with Azolla the growth rate was also higher. After proper cleaning, Azolla is eaten by animal in desired quantity. So it lowers the cost of feed and increases profit. The feed cost in the T2 group was significantly reduced as compared to control one. This is due to improved Azolla diet adaptability in replacing the concentrate and reducing the cost of raisings.

Conclusion

From the present research, it was found that Azolla has a positive impact on LTT traits. All the parameters were under the normal range and in some cases there was better growth seen. The total feed cost and feed cost per kg gain was less in the Azolla fed groups. Highest profit and growth was seen at 30% replacement level, indicating it has highly economical. Thus in the nearby future, the inclusion of fresh *Azolla pinnata* as an unconventional natural protein source in Sahiwal calves ration up to 30% level will be highly beneficial and recommended.

Conflict of interest

The authors declare that there is no conflict of interest.

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