Indian Journal of Animal Sciences **85** (11): 1270–1272, November 2015/Short communication
https://doi.org/10.56093/ijans.v85i11.53321

Change in plasma trace mineral profile of nondescript cattle by replacing mustard oilseed cake from azolla meal

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Received: 7 July 2014; Accepted: 7 May 2015

Key words: Azolla meal, Economics, Non-descript cows, Strategic supplementation, Trace mineral

Livestock production is backbone of Indian economy and source of employment in rural areas for centuries. As per 18th livestock census (2007), ratio of rural to urban cattle in India is 19.3:1. Among many factors, feeding accounts for more than 60–70% of the total recurring cost. Azolla is a free-floating water fern that fixes nitrogen in association with a specific species of cyanobacteria, and can be mass produced on the farm like blue-green algae. It is a good source of nitrogen and on decomposition, a source of various micronutrients as well. It also has the ability to multiply fast.

Study was conducted in 22 villages of Jabalpur district in Madhya Pradesh state of central India. Survey was done to assess the feeding regime and health status of animals in the villages. Randomly, 18 nondescript cattle were selected for the study. Cattle were taken for grazing in the morning for 8–10 h and hand-milked twice daily. The feed samples collected during the survey were analyzed for different trace minerals using atomic absorption spectrometry.

Feed intake was recorded by weighing feed offered and left over feed. Thus, nutrient and mineral intake were estimated using nutritive values of feed and feed intake. Intake of grasses through grazing was calculated as per Coleman (2005).

Nutrients supplied were compared with their respective requirements given by ICAR (1998). Net deficiencies of trace minerals were supplied in the form of concentrate mixture using mustard oil seed cake and azolla meal (test feed).

Blood collection was carried out 4 times i.e. 0, 2nd, 4th, and 6th month of study. Blood was collected from jugular vein aseptically in a sterilized plastic tubes containing anti-coagulant heparin solution (0.2 mg/ml of blood). Blood samples thus centrifuged for separating the plasma. Trace minerals like zinc, iron, copper, manganese and cobalt were estimated in different feed stuffs and blood plasma using atomic absorption spectrophotometry.

Economics of milk production was calculated before and after study based on the expenditure on feeds and return from the milk production of animals. The data were analyzed as per Snedecor and Cochran (1994).

Feed intake of the animals before start of experiment: Average body weights of animals and feed intake before start of experiment is presented in Table 1. Different feed ingredients used for the feeding of animals in GC, GS and GA groups were wheat straw (dry stalks of *Triticum aestivum*), grass (*Cynodon dactylon*), *arhar chuni* (agro-industrial byproduct of *Cajanus cajan*), wheat bran (agro-industrial byproduct of *Triticum aestivum*), gram husk (outer coat of *Cicer arietinum*) and mustard oilseed cake (*Brassica campestris*).

Table 1. Mean values (kg) for daily feed intake and body weight before start of experiment

	Latin Name	Control	Mustard oilseed cake	Azolla
Body weight	-	137±3.63	141±6.84	148±9.41
Wheat straw	*Triticum aestivum*	2.45±0.34	1.33±0.49	2.36±0.30
Grass	*Cynodon dactylon*	3.33±2.10	6.66±2.10	1.66±1.66
Arhar chuni	*Cajanus cajan*	0.07±0.06	0.10±0.07	0.36±0.14
Wheat bran	*Triticum aestivum*	0.07±0.06	0.07±0.06	0.20±0.08
Gram husk	*Cicer arietinum*	0.01±0.01	0.01±0.01	0.05±0.02
Mustard oilseed cake	*Brassica campestris*	0.01±0.01	0.01±0.01	0.05±0.02

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Per cent excess or deficiency of nutrients: Per cent excess and deficit of nutrients were obtained by subtracting the total nutrients offered and total nutrients requirement (Table 2). DM was marginally higher in all the 3 groups, which was usually fulfilled by wheat straw. Deficiency of nutrients and minerals (except Fe and Mn) was observed in different groups i.e. GC, GS and GA.

Trace mineral profile of animals before and after supplementation: Cobalt (Co), copper (Cu), zinc (Zn), manganese (Mn) and iron (Fe) were estimated in the plasma of cattle before and after supplementation (Table 3). Manganese was in excess by 19.63% because most of the available feeds contained adequate level of Mn. Similar findings were also reported by Garg *et al.* (2003). Trace minerals were finally estimated at 6th month of supplementation in all the experimental animals. In the present study, Co concentration in animals of all the 3 experimental groups before supplementation was below the minimum critical level (1.5 ppm) as reported by Mpofu *et al*. (1999). In the present study, Cu concentration before supplementation in all the 3 groups were lower than the normal critical level (0.67–0.80 ppm) as also reported by Gadberry *et al.* (2003). After supplementation significant increase in Cu concentration was observed in azolla supplemented group. Alalade and Iyayi (2006) observed that azolla contained 16.74 ppm Cu, this was in agreement with our results.

Change in the concentration (Table 4) was calculated in all the 3 groups. Changes in concentration of Co and Zn were found to be highly significant ($P \leq 0.01$). Concentration in the 3rd group i.e. GA changes in concentrations of cobalt and zinc were having high significant differences ($P \leq 0.01$) while, changes in Cu concentration were significant ($P \leq 0.05$).

Zn concentration analyzed in the area of study ranged between 0.64 to 0.70 ppm before supplementation which was lower than the critical level (1.08 ppm) as reported by Gadberry *et al*. (2003). Similarly, Ramana *et al.* (2001) also reported lower level of Zn (0.66 ppm) in the blood plasma of dairy cattle. Maximum increase in Zn concentration was observed in azolla supplemented group as Zn content in azolla was 87.59 ppm (Alalade and Iyayi 2006). Manganese concentration in the cattle before supplementation was within the normal range (0.45–0.50 ppm) as reported by the Suttle (2010). Tiwary *et al.* (2010) reported Mn 0.45–0.53 ppm in lactating cattle, which was in agreement with the present

Table 2. Excess or deficit (%) of nutrients in the ration of ND cattle

	DM(kg)	CP (g)	TDN (kg)	Ca (g)	P(g)	Fe(mg)	Cu(mg)	Zn(mg)	Mn(mg)	Co(mg)
Control										
Excess/ Deficit (-)	0.27	–211	–0.2	–0.7	–4.7	105	–11.8	–93.8	20.4	–0.04
Def/ Ex (%)	9.81	–61.9	–14.1	–6.9	–50.6	21.0	–42.9	–68.4	18.6	–14.8
Group 2 (*Mustard oilseed cake*)										
Excess/ Deficit (-)	0.2	–177	–0.2	5.9	–3.1	235	–8.5	–73.0	14.6	0.02
Def/ Ex (%)	7.8	–51.5	–10.1	54.6	–33.3	41.7	–30.0	–51.8	12.9	6.4
Group 3 (*Azolla meal*)										
Excess/ Deficit (-)	0.2	–197	–0.4	–0.8	–3.8	36.3	–10.3	–93.7	32.3	–0.04
Def/ Ex (%)	5.7	–50.9	–20.7	–6.8	–36.6	6.1	–34.7	–63.4	27.3	–12.9

Table 3. Plasma mineral profile of the animals before and after supplementation

Trace mineral (ppm)	GC		GS		GA	
	Before	After	Before	After	Before	After
Co	1.16±0.04	1.21±0.08	1.20±0.03	1.72±0.04	1.18±0.03	1.75±0.04
Cu	0.61±0.06	0.67±0.03	0.76±0.09	1.01±0.11	0.69±0.06	1.04±0.08
Zn	0.70±0.03	0.76±0.05	0.68±0.05	0.97±0.05	0.64±0.04	1.02±0.08
Mn	0.44±0.04	0.45±0.02	0.45±0.03	0.53±0.02	0.44±0.04	0.50±0.02
Fe	1.59±0.17	1.57±0.09	1.80±0.10	2.03±0.13	1.68±0.13	1.97±0.09

Table 4. Overall change in trace minerals concentration (%) of animals

Group	Co (%)	Cu (%)	Zn (%)	Mn (%)	Fe (%)
GC	4.39±3.78	16.43±13.97	9.86±11.16	8.14±11.04	5.08±14.22
t value	1.01^{NS}	0.90^{NS}	0.84^{NS}	0.46^{NS}	0.11^{NS}
GS	44.99±7.86	37.43±17.89	45.99±12.44	22.43±14.39	13.08±6.66
t value	6.63**	2.30^{NS}	4.73**	1.33^{NS}	2.11^{NS}
GA	49.17±4.69	57.55±15.84	60.60±11.42	20.72±11.51	21.63±11.83
t value	12.72**	3.36*	5.32**	1.71^{NS}	1.44^{NS}

Superscript ** high significant difference ($p<0.01$), * significant difference ($p<0.05$) & ^{NS} non-significant difference.

Table 5. Net increase in the profit during 180 day in the supplemented groups

Group	Net increase in milk production with control group (lit)	Cost of milk* (₹)	Cost of feed per kg milk (₹)	Net increase in profit during 180 days (₹)
GS	66.9	1338	600.1	737.9
GA	159.3	3186	1502.2	1683.8

*Cost of milk in villages was @ 20 ₹/liter during period of study.

study. Manganese content in azolla was also very high (174.42 ppm) as reported by Alalade and Iyayi (2006).

Iron concentration in all the three groups of study before supplementation varied from 1.59 to 1.80 ppm, which was adequate to the minimum critical level (1.69 ppm) as reported by Gadberry *et al.* (2003). After supplementation, Fe concentration had nonsignificantly (P>0.05) increased in supplemented groups above the normal critical level. Iron content in azolla was high (755.73 ppm) as reported by Alalade and Iyayi (2006). Iron contents were higher in forages as compared to concentrates in which it was comparatively low therefore, animals reared mainly on forage diets were not deficit in Fe content. Tiwary *et al.* (2010) observed normal plasma Fe content of lactating cattle as 0.5–1.62 ppm which was in support to the present study.

Net increase in the profit (Table 5) to farmers' in supplemented groups for the whole period of 180 days was ₹ 737.9 and 1,502.2 in GS and GA group. Net increase in the profit is calculated and presented in Table 5. Results in the present study were in accordance with Olfadehan and Adewumi (2008).

The plasma Zn concentration (ppm), Cu concentration (ppm) and Co concentration (ppm) of non-descript cattle increased significantly (P<0.05) after supplementation of SNS as 0.66 ppm vs 0.99 ppm; 0.72 ppm vs 1.02 ppm; 1.19 ppm vs 1.73 ppm, respectively. Concentration of Zn, Cu and Co was below critical level before supplementation while, increased significantly after supplementation.

The dietary deficiency also reflected blood plasma mineral concentrations of the non-descript cattle as were found below their respective critical levels.

SUMMARY

Survey was conducted to assess the feeding regime and health status of animals in 22 villages of Jabalpur district from Madhya Pradesh state of India. Non descript cattle (18) were randomly divided into three groups GC (control) as per farmers' practice; GS, strategic nutrient supplement (mustard oilseed cake as protein source); and GA, strategic azolla supplement (mustard oilseed cake was replaced from azolla meal isonitrogenously). Overall change in the concentration of Co, Cu, Zn, Mn and Fe in GC were 4.39, 16.43, 9.86, 8.14 and 5.08%, respectively. In GS group change in Co was 44.99%, Cu 37.43%, Zn 45.99%, Mn 22.43% and in Fe 13.08%. In azolla supplemented (GA) group Co, Cu, Zn, Mn and Fe concentration varied by 49.17, 57.55, 60.60, 20.72 and 21.63%, respectively. Net increase in the profit to farmers in supplemented groups was ₹ 737.9 and 1,502.2 in GS and GA groups. Though, change in the concentration of Co and Zn was significantly higher in supplemented groups than control while Cu concentration varied significantly only in GA group.

ACKNOWLEDGEMENT

I acknowledge my advisor Dr R P S Baghel for providing me moral and financial support during the period of my study. I also want acknowledge AICRP under which I am working as a Senior Research Fellow for the period of 4 years of my Doctorate degree.

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