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Incidence of iron deficiency in crossbred cow calves reared on *pucca* floor

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Iron deficiency in cow calves lead to clinical or subclinical anaemia, poor growth and increased susceptibility to enteric and respiratory diseases (Radostits *et al*. 2000). A study to investigate the iron requirement of calves recorded gradual increase in total iron binding capacity and a fall in serum iron concentration thus suggesting the essentiality of iron (Atyabi *et al*. 2006). Diet and environment of the calf are important determinants of iron intake. The calves raised on *kucha* floor get more iron because of their access to soil. During the past few decades, there has been change in the calf rearing management system. Calves are being reared on the *pucca* floor. Such calves are more likely to develop iron deficiency anaemia, because of obvious reason of less access to soil and low iron in milk. However, studies seem to be lacking on iron status and its effect on the hemogram of calves reared on *pucca* floor under Indian conditions. The present study was planned to record the incidence of iron deficiency anaemia in crossbred cow calves reared on *pucca* floor and to evaluate the treatment in iron deficient calves.

A baseline survey was conducted to record incidence of iron deficiency anaemia in 115 crossbred cow calves in the age group of 1–3 months reared on *pucca* floor. Calves were sampled from dairy farms located in the periphery of Ludhiana city, parts of Moga and Sangrur districts. The blood samples were collected from each cow calf in heparinised mineral free screw capped glass vials (15–20 ml) and in disodium EDTA containing vials (2–3 ml). Blood samples were analyzed for haematological parameters, viz. hemoglobin, packed cell volume (PCV), total erythrocytic count (TEC) as per Jain (1986). Erythrocytic indices, viz. mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC) were calculated. Giemsa stained peripheral blood smears were examined for red cell morphology, viz. size, shape and staining characteristics. Plasma was analyzed for total plasma Fe and total iron binding capacity (Caraway 1962) and % transferrin saturation was calculated. Faecal samples were processed by floatation and sedimentation methods for detection of ova/cyst. For the calculation of appropriate therapeutic dose of iron in anaemic calves, a target normal value of Hb was taken as 9.6 g/dl (cut off limit for anaemia in calves as reported by Bunger *et al*. 1987, Katunguka *et al*. 1987). The total dose of iron was calculated @ 3.4 mg/g of hemoglobin increase as recommended by Fraser (1986). A total dose of 400 mg of iron dextran was computed to restore the Hb concentration to 9.6 g/dl. This total dose was subdivided into 2 doses.

Nine iron deficient anemic crossbred cow calves (4–8 weeks age) were treated with 200 mg of iron dextran deep intramuscularly weekly with 2 injections each. Response of treatment trial was assessed by determination of Hb, PCV, TEC, plasma Fe, TIBC and per cent transferrin saturation on 0, 7th and 15th day of treatment given.

As a convention, anaemia in calves is defined when Hb concentration falls below 9.6 g/dl or PCV value is below 30% (Bunger *et al*. 1987 and Katunguka *et al*. 1987). Considering this index of anaemia, Hb and PCV was low in 52.2 and 62.6% of crossbred calves respectively (Table 1). Anaemia was of moderate degree (Hb 6.0–9.6 g/dl) in 51.3% of calves. Moderately low PCV (20–30%) and very low PCV (< 20%) was found in 54.9% and 7.80% of calves, respectively. Low TEC (< 5×10^6 ml^{-1}) was, however observed only in 4.34% of calves. Mean value of corpuscular volume was below the normal range (40–60 fl) as suggested by Radostits *et al*. (2000). Anaemia was microcytic-normochromic, microcytic-hypochromic, normocytic-hypochromic and normocytic-normochromic in 69.2, 19.2, 5.75 and 5.75% calves with low plasma Fe concentration, respectively. Mean values of plasma Fe, total iron binding capacity (TIBC) and plasma transferrin saturation (PTS) are given in Table 1. Plasma Fe concentration was low (< 100 mg/dl), in 45.1% of crossbred calves and TIBC was above 500 mg/dl in 46.9% calves. While, percent transferrin saturation was less than 10% in 18.2% calves. Prevalence of iron deficiency was 45.1% in crossbred cow calves reared on *pucca* floor.

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Table 1. Mean values and number (%) of low values of some blood components in crossbred cow calves (n=115) (mean±SE)

Parameter	Crossbred cow calves (n=115)	Low values**	Number	Percentage (%)
Hb (g/dl)	9.60±0.19 (4.80–14.5)	9.60	60	52.2
PCV (%)	27.9±0.51 (14.0–40.0)	30.0	72	62.6
TEC (10^6 /ml)	7.86±0.17 (4.01-12.1)	5.00	5	4.34
MCV (fl)	35.9±0.44 (31.4–48.8)	–	–	–
MCH (pg)	12.4±0.15 (8.87–16.3)	–	–	–
MCHC (%)	34.2±0.35 (25.1–45.6)	–	–	–
Plasma iron (mg/dl)	101.3±3.74 (21.2–203)	100	52	45.2
Total iron binding capacity (mg/dl)	486.8±21.3 (187.6–1309.7)	500	54	46.9
Percent transferrin saturation (%)	28.4±1.93 (1.97–53.9	10	21	18.2

Figures in parentheses show range. (n) refers to number of calves; low values** = values equal or below those listed below.

Concurrently low Hb and low plasma Fe concentrations (iron deficiency anaemia) were present in 27.8% of calves. Low plasma Fe concentration and normal Hb was observed in 17.3% of calves. Plasma Fe concentration was low (< 50 mg/dl) in 80% and in the range of 50–100 mg/dl in 20% of calves manifesting microcytic-hypochromic anaemia and iron deficiency. Total erythrocyte count was not as markedly affected as Hb concentration in iron deficiency anaemia in the present study as reported by Getty *et al*. (1968). Jain (1986) also quoted that haemoglobin synthesis was more deficient than erythrocyte production in iron deficiency. Iron deficiency in the present study was principally characterized by microcytic-hypochromic and microcytic-normochromic anaemia. Earlier studies showed microcytic-hypochromic or microcytic-normochromic anaemia in clinical iron deficiency of calves (Getty *et al.* 1968, Van Hellemond and Sprietsma (1979). In laboratory and field experiments, Blaxter *et al*. (1957) recorded microcytic normochromic anaemia in iron deficiency of cow calves.

Reece and Hotchkiss (1987) observed microcytic-hypochromic in cow calves fed milk replacer containing iron content below 25 ppm iron. Stockham and Scott (2002) cited that microcytic-hypochromic anaemia was feature of iron deficiency, while microcytic-normochromic was a feature of early iron deficiency in calves (Jain 1986).

Prevalence of iron deficiency anaemia was 27.8% in crossbred cow calves reared on *pucca* floor. A survey of 60 farms in Romania reported a higher incidence (42.6%) of iron deficiency anaemia in cow calves (Iliescu and Bazilescu 1986) compared to present study. The difference could be due to difference in management practices and type of feeding. In the present study the calves were maintained on milk and roughages at the time of sampling. Previous studies have shown that the iron deficiency in calves was associated with feeding of milk replacer (Van Hellemond and Sprietsma 1979, Reece and Hotchkiss 1987, Gygax *et al.* 1993), whole milk diet (Bunger *et al.* 1982, Radostits *et al.* 2000) and defatted or butter milk or milk powder (Lindt and Blum 1994). No study on incidence of iron deficiency anaemia in calves in India was encountered in scientific literature. Triad of low plasma Fe concentration, high TIBC values and low per cent transferrin saturation accompanied iron deficiency anaemia in calves (Table 1).

As from the results, iron deficiency was detected in 45.2% of calves, of which 27.8% showed iron deficiency anaemia and 17.4% calves had latent iron deficiency. It might be extrapolated from these results that iron supplementation was necessary for calves (< 3 months of age) under the prevalent management and feeding practices. In addition to anaemia, there were reports of growth failure, susceptibility to diseases and high mortality rate in Indian cow calves (Chavai *et al.* 2001) which was also the consequence of iron deficiency (Underwood and Suttle 1999). It may therefore be inferred that iron supplementation should form an integral part in the present feeding and management system of young cow calves**.** The results of the present study on cow calves also showed that anaemia in 24.4% of calves were detected in the absence of low plasma Fe. It therefore seemed rationale to also consider the other causes of anaemia in calves. As a part of study, it was found that 75.6% (86/115) calves were shedding (+++) ova of *Toxocara vitulorum*. Therefore, infection of ascarids cannot be overlooked as one of the etiological factor in the calves of the present study; this was recorded by Pandey and Mishra (1985) in cow and Devi *et al.* (2000) in buffalo calves.

Mean values of red cell parameters recorded before and during treatment are presented in Table 2. Mean values of Hb and PCV increased significantly from 0 day to 15th day of treatment. Concentration of Hb showed an increment of more than 1 g/dl in four, equal or less than to 1 g/dl in rest of the 5 calves during initial 7 days of treatment. Similarly, PCV values were higher by more than 2% in 3 and less than or equal to 2% in remaining 6 iron deficient calves during first week of treatment. Increase in Hb values was more than 1.2 g/dl in 7 and less than or equal to 1.2 g/dl in remaining 2 iron deficient calves during second week. Packed cell volume also increased by more than or equal to 5% in 7 and less than 5% in 2 of the treated calves. Thus increase in Hb and PCV was comparatively more during 7–15th day of treatment period.

Table 2. Alterations in haemato-biochemical parameters following iron dextran injection in iron deficient anemic calves (n=9) (mean±SE)

Parameter	Pretreatment	7 days	15 days
Hb (g/dl)	7.62±0.22^{a} (7.16–8.09)	8.57±0.22^{b} (8.10–9.03)	9.88±0.22^{b} (9.39–10.32)
PCV (%)	23.3±0.33^{a} (22.6–24.0)	25.4±0.33^{b} (24.7–26.1)	28.6±0.33^{b} (27.9–29.3)
TEC (10^6 /ml)	7.36±0.27^{a} (6.78–7.93)	7.80±0.27^{ac} (7.23–8.38)	8.62±0.27^{c} (8.04–9.19)
MCV (fl)	31.8±0.86^{a} (30.1–33.6)	32.8±0.86^{a} (31.0–34.6)	33.4±0.86^{a} (31.6–35.2)
MCH (pg)	10.4±0.30^{a} (9.7–11.0)	11.0±0.30^{ab} (10.4–11.6)	11.4 0.30^{b} (10.8–12.1)
MCHC (%)	32.6±0.74^{a} (31.1–34.2)	33.6±7.42^{a} (32.1–35.1)	34.35±0.74^{a} (32.8–35.8)
PI (mg/dl)	45.5±11.0^{a} (22.7–68.4)	99.5±11.0^{b} (76.7–122.3)	144.8±11.0^{c} (122.0–167.7)
TIBC (mg/dl)	1002.5±51.6^{a} (895.8–1109.1)	835.8±51.6^{b} (729.2–942.5)	535.6±51.6^{c} (429.0–642.2)
PTS (%)	4.67±2.65^{a} (0.8–10.1)	12.6±2.65^{b} (7.15–18.0)	28.5±2.65 (23.1–34.0)

Means with different superscripts in row differ significantly ($p < 0.05$). Figures in parentheses show range. (n) refers to number of calves treated.

Comparatively, increase in TEC was less pronounced. Total erythrocyte count increased only by 0.44×10^6 /ml on seventh day and by 0.82×10^6 /ml during 7–15 days of treatment period and mean TEC value was significantly higher on 15th day. Erythrocytic indices were less affected by the treatment. Elevation in MCV and MCHC value was non-significant whereas mean MCH value increased significantly by 15th day.

As expected, plasma Fe showed a significant and progressive rise till 15 th day. The increment was of the order of more than 50 mg/dl in five and less than 50 mg/dl in rest of 4 calves by 7 th day. Increase during second week was of more than 50 mg/dl in four calves and less than 50 mg/dl in 5 calves. Thus, increase in plasma Fe was relatively more pronounced during first week of treatment. Values of TIBC showed significant and progressive fall and percent transferrin saturation followed reverse trend during the treatment period (Table 2).

Haematology and iron biochemistry values demonstrated that low iron status in the calves caused microcytic-normochromic anaemia. This etiology of anaemia was further substantiated by the improvement in red cell parameters and iron metabolism analytes following treatment with parenteral iron supplementation.

Previously, a therapeutic study in calves by oral as well as parenteral iron supplements revealed more effect on Hb and PCV as compared on TEC from 7 to 31 weeks of age (Getty *et al.* 1968). On the contrary, Ramakrishna *et al.* (1992) observed increase in Hb and PCV alongwith TEC in experimentally induced haemorrhagic anemic calves from 11th day of treatment with oral and parenteral supplementation of iron. The difference in results on TEC could be difference in etiology and course of anaemia. Classically all the erythrocytic indices were said to decrease in iron deficiency anaemia of calf (Smith 1997). In the present study however, MCH showed a significant increase on 15th day of treatment. No significant effect was observed on MCV and MCHC value in the present study as also reported by (Getty *et al*. 1968). Significant increase in plasma Fe concentration following iron supplementation was similar to the findings of Getty *et al.* (1968) and Ramakrishna *et al.* (1992).

The dose regimen selected in the treatment trial effectively raised red cell parameters, plasma Fe and percent transferrin saturation. Getty *et al.* (1968) injected two doses of 500 mg of iron dextran at 7 th and 21 day in cow calves with marginal iron status. A study by Mohri *et al*. (2009) demonstrated that a single injection of 1 g iron dextran to calves at 2 days of age increased PCV, red cell count gradually compared to control group without affecting MCH, MCHC and plasma Fe concentration. The improvement in red cell parameters was less pronounced between treated and untreated calves compared to the present study. On comparing the results of the present study with earlier treatment trials, it seemed plausible to suggest that parenteral iron supplement at low dose rate were probably more effective than 2 injections at high dose rate, in treatment of iron deficiency anaemia. This treatment trial confirmed iron deficiency anaemia and its alleviation by treatment with iron dextran.

SUMMARY

A total of 115 crossbred cow calves (1–3 months age), reared on *pucca* floor, in and around the Ludhiana, Moga and Sangrur districts of Punjab, were sampled to record the prevalence of iron deficiency. Hemoglobin concentration and PCV was low in 52.2 and 62.6% of crossbred calves respectively. Plasma iron concentration was low in 45.2% of calves. Prevalence of iron deficiency and iron deficiency anaemia was 45.2 and 27.8% respectively, in calves reared on *pucca* floor. Iron deficiency anaemia was substantiated by a treatment trial of iron dextran on 9 iron deficient anemic cow calves of 4–8 weeks age, which were administered 2 injections of iron dextran @250 mg by deep intramuscular route weekly. Mean values of Hb, PCV, plasma Fe concentration and percent transferrin saturation increased significantly by the day 15th of treatment. Total

iron binding capacity showed significant decrease on the day 7th and 15th of treatment. It was concluded that 2 injections of iron dextran @250 mg at weekly interval were effectie in ameliorating the anaemia in crossbred cow calves. It was hypothesized from this study that iron deficiency is common in cow calves of 1–3 months of age and they should be supplemented with iron orally of parentraly.

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