

Effects of oral iron supplementation on haematocrit, live weight gain and health in neonatal dairy calves

Mohri, M. * ; Sarrafzadeh, F. and Seifi, H. A.

Department of Clinical Sciences, School of Veterinary Medicine, Ferdowsi University of Mashhad, Mashhad, Iran

*Correspondence: M. Mohri, Department of Clinical Sciences, School of Veterinary Medicine, Ferdowsi University of Mashhad, Mashhad, Iran. E-mail: mohri@ferdowsi.um.ac.ir

Summary

Forty neonate calves were used in this study. The animals were divided into two treatment (n = 20) and control (n = 20) groups. In the treatment group, oral iron as ferrous sulphate was supplemented to each calf at the dose of 150 mg/day for 28 days, from the birthday. Blood sampling was taken from jugular vein immediately after birth and on days 7, 14, 21 and 28 after birth. Significant differences in haematocrit (PCV) levels were found between two groups on days 14, 21 and 28 ($P < 0.05$). Total gain, mean daily gain and weight gain during 4th week of life was significantly higher in the treatment group than control group ($P \leq 0.05$). Chi-square test proved no significant difference between the two groups regarding the incidence of diseases.

Key words: Haematocrit, Health, Iron, Neonatal dairy calves, Performance

Introduction

Iron is the second most abundant metal and fourth most common element on Earth. Unfortunately, this element is chemically unstable and easily oxidized to an insoluble ferric form. Ferric iron is unavailable for most biological systems. All living organisms, with the possible exception of lactobacillus, require iron for their metabolism (Smith, 1989).

Iron is an essential element in all living cells and participates in numerous metabolic pathways. The dependence of all forms of life on iron may be related to the ease with which iron is reversibly oxidized and to its abundant presence, virtually in all soils and waters (Fairbanks and Beutler, 1990).

Iron deficiency is usually primary and most likely to occur in newborn animals whose sole source of iron is the milk of the dam, which is usually poor in iron. Deposition of iron in the liver of newborn is sufficient to maintain normal haemopoiesis for more than 2-3 weeks (Radostits *et al.*, 2000).

Iron requirement in domestic animals are influenced by age, growth rate, availability of dietary iron source and the criteria of adequacy. Definite iron requirement for most domestic species has not been determined.

Most recommendations are just estimation (Smith, 1989). The general opinion is that iron level is sufficient in the diet of calf in heifer replacement system. Anemia should not be used to determine iron adequacy, because use of dietary iron for haemoglobin synthesis can take precedence over demands for other iron compounds, iron is preferentially shunted from other iron pools to haemoglobin synthesis. Thus, haemoglobin may be the last pool to show the effects of iron inadequacy (Andrews and Smith, 2000). This study was performed to determine whether iron supplementation in neonatal dairy calves (heifer replacement system) fed roughage and concentrates could promote PCV, performance and health in non-anemic calves.

Materials and Methods

The study was conducted in a dairy herd belonging to College of Agricultural Sciences, Ferdowsi University of Mashhad, Iran, with approximately 110 calves per year. This herd consists of pure bred animals of Holstein breed. The herd was totally confined in free-stall housing without access to pasture. Milk yield cows were divided into 2 groups: A- high milk yield cows that were fed by alfalfa silage (20 kg), alfalfa hay (4

kg), concentrate (10 kg), cotton seed meal (1.5 kg), sugar beet pulp (2.5 kg) and molasses (0.5 kg) and B- low milk yield cows were fed alfalfa silage (20 kg), alfalfa hay (3 kg), straw (1 kg), sugar beet pulp (1 kg) and molasses (1 kg) daily.

Cows were dried two months before the expected parturition time and transferred to a separate stall. As the time of parturition approached, the cows were moved to straw bedded maternity pens. Prompt assistance was assigned to cows for dystocia. Following parturition, the calf was weighed and transferred to individual well-painted metal pen. Within first six hrs of life, calf was fed with 4 kg of dam's colostrums using nipple bottle. Then, whole milk was replaced for feeding twice daily (2 kg every 12 hrs) until 10th day of life. After this time concentrate, high quality alfalfa (contained 210 and 310 ppm of iron DM basis, respectively) and water offered free choice. The calves were weaned at 45 days. The heifer calves were mainly used as herd replacements.

Forty calves were paired during September (1998) to March (1999) according to the sex and parity of dams. The calves were divided into 2 groups: treatment (n = 20) and control (n = 20). In the treatment group oral iron as ferrous sulphate (Darou Pakhsh Pharmaceutical, Tehran, Iran) was supplemented to each calf at a dose of 150 mg/day for 28 days. The calves in two groups received similar diet during the study except iron supplementation in the treatment group.

Body weight, height and length; total weekly and daily weight gain were also recorded according to Larson *et al.*, (1977). The health of the calves was checked by a technician twice a day and any signs of illness, treatment (if needed) and duration of illness were recorded. The incidence of

diseases was calculated as a percentage of experimental days (28 days). Haematocrit (PCV) was determined by micro-haematocrit method.

The SPSS package was used for data analysis. After testing normal distributions of data, parametric independent t-test and paired t-test were used to investigate significant difference between and within groups, respectively. Chi-square test was used for comparison of disease incidence between groups. $P \leq 0.05$ was considered as significant.

Results

The results are showed in Table 1. There were significant differences in PCV levels on days 14, 21 and 28 between groups ($P < 0.05$). In the treatment group, there were significant differences in PCV levels between days 7 (35.95 ± 0.82), 14 (37.7 ± 0.94), 21 (39.5 ± 0.89) and 28 (40.85 ± 0.81) with first sampling (34.01 ± 0.86 , $P < 0.05$). In control group, paired t-test revealed significant differences in PCV between day 14 (33.5 ± 1.42) and first sampling (35.15 ± 1.26 , $P < 0.05$).

Our results showed that the difference of increasing pattern of weight gain became significant during 4th week of life and higher level was seen in the treatment group ($P < 0.05$). Total weight gain and mean daily weight gain were significantly higher in the treatment group than control group ($P < 0.05$). Length and height did not show significant differences between the trial groups.

During this study, in the treatment group, 3 cases of diarrhea and 2 cases of pneumonia were recorded. In control group also, 4 cases of diarrhea and one case of pneumonia

Table 1: Mean (\pm SE) of measured parameters with statistical comparisons for the two groups

	PCV1 (%)	PCV2 (%)	PCV3 (%)	PCV4 (%)	PCV5 (%)	TWG (Kg)	ADG (gr)	WG1 (Kg)	WG2 (Kg)	WG3 (Kg)	WG4 (Kg)
Treatment	34.01 (0.86)	35.95 (0.82)	37.70 (0.94)	39.5 (0.89)	40.85 (0.81)	10.05 (0.53)	352.73 (18.93)	1.55 (0.21)	2.45 (0.20)	2.55 (0.18)	3.50 (0.3)
Control	35.15 (1.26)	34.65 (1.27)	33.50 (1.42)	34.8 (1.21)	35.60 (1.25)	8.50 (0.42)	298.18 (14.7)	1.41 (0.20)	2.32 (0.17)	2.23 (0.18)	2.55 (0.21)
P-value	NS	NS	0.02	0.003	0.001	0.034	0.034	NS	NS	NS	0.017

PCV: packed cell volume; TWG: total weight gain; ADG: average daily gain; WG: weekly gain; 1: 24-48 hrs; 2: 7 days; 3: 14 days; 4: 21 days; 5: 28 days and NS: non-significant difference occurred. Chi-square test showed no significant difference between groups for the incidence of diseases.

Discussion

There are various reports concerning better performance and weight gain in veal calves supplemented with iron (Mollerberg *et al.*, 1975; Geisser *et al.*, 1991; Gygax *et al.*, 1993; Knaus *et al.*, 1997). Correlation between iron and RBC parameters with performance has been clarified (Little *et al.*, 1977; Sarkozy *et al.*, 1984; Reece and Hotchkiss, 1987; Steinhardt and Thielscher, 2000). Ceppi *et al.*, (1994) studied the various parameters in iron deficient veal calves. They reported that in calves with iron deficiency, insulin like growth factor 1 (IGF-1) and its response to exogenous somatotropin (GH) are reduced. They believed that the increased disappearance rate of GH, seen even in mild iron deficiency which may contribute to reduced GH levels and IGF-1 response to GH in severe iron deficiency (Ceppi *et al.*, 1994; Hugi and Blum, 1997). Ceppi and Blum (1994) also suggested that food intake, average daily weight gain and growth reduced in iron deficient calves. Even when calves were fed by hay and grain in addition to milk, there was a marked growth response to the administration of iron (Radostits *et al.*, 2000).

In our study, calves in the control group had lower performance and weight gain than those in the treatment group although anemia was not a serious problem. Thus, iron content of diet in the control calves was not completely sufficient for maximum normal performance. Bunger *et al.*, (1979) reported significant differences between anemic and non-anemic calves for body weight gain. It seems that sufficient iron is needed for normal appetite, secretion of IGF-1 and tri-iodothyronine and glucose utilization (Reece and Hotchkiss, 1987; Ceppi and Blum, 1994; Ceppi *et al.*, 1994). Decreased weight gain and performance in iron deficiency could also increased infections partially, particularly respiratory and gastrointestinal tract (Mollerberg *et al.*, 1975). On the other hand, Bostedt *et al.*, (2000) revealed that there is no difference in body weights of the treated (iron supplemented) and control groups of calves.

Iron is a nutrient related to health and immunity (Brock, 1994). Apart from anemia

prevention, the role of iron in maintaining health is not still completely clear. Hershko (1993) showed an optimal immune responsiveness at physiological normal levels of iron in human blood. Sipahi *et al.*, (1998) showed that in the iron deficient child the production of IL-2 was significantly lower than in non-deficient child.

Various studies have reported the higher prevalence of infectious diseases in iron deficient veal calves (Mollerberg *et al.*, 1975; Bunger *et al.*, 1986; Lliescu and Bazilescu, 1986; Gygax *et al.*, 1993). Bunger *et al.*, (1979) reported that there were significant differences between anemic calves and non-anemic calves in performance and incidence of infection. Gygax *et al.*, (1993) reported that cell-mediated immunity, number of neutrophils with phagocytic capacity, activity of the Fe- containing enzyme myeloperoxidase, blood serum IgG concentration and the number and diameter of germinal centers in cervical superficial lymph nodes in veal calves fed 10 mg Fe/kg MR were significantly reduced when compared with calves fed 50 mg Fe/kg MR. In our study anemia does not observed in control calves and incidence of diseases was not significantly different between trial groups. Since an increase as well as a decrease in blood iron levels had negative effects on immune responsiveness and performance (Jenkins and Hidioglou, 1987; De Sousa *et al.*, 1991; Brock, 1994), our results indicated that iron supplementation at a dose of 150 mg/day not only had no adverse effects on health and weight gain but also improved RBC production and performance in neonatal dairy calves fed roughage and concentrates.

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