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The Influence of Iron and Copper on Hematologic Values and on Body Weight of Range Calves

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SUMMARY

The hemoglobin (Hb) concentrations and packed cell volume (PCV) of Hereford range calves were determined at birth and at 3, 6, 15, and 25 weeks of age. The Hb values were highest at birth and significantly decreased to 15 weeks of age, after which time they leveled off. Packed cell volume was lowest at birth and significantly increased through the trial.

Copper glycinate injection of calves at birth and at 3 weeks of age did not significantly change their Hb or PCV patterns. Iron dextran injections significantly increased or maintained Hb concentrations and PCV in calves up to 6 weeks of age, after which time they followed the pattern of the control animals. Neither copper nor iron, alone or in combination, had any effect on rate of gain under the conditions of this experiment.

The heifer calves had significantly higher Hb concentrations and PCV than the steer calves. This difference was maintained through the 25-week period.

INTRODUCTION

Considerable research has been reported on the hematology of newborn dairy calves and newborn pigs. However, little work has been reported on newborn range beef calves. The performance of the beef calf is generally attributed to the milking and mothering ability of its dam. Anemia in young calves does not seem to be as prevalent as with pigs. However, several reports of anemia in dairy calves given an exclusive milk diet are available.[4, 5, 7, 8]

Several investigators have shown that milk alone does not contain sufficient quantites of iron and copper to support the formation of normal amounts of hemoglobin in growing animals. Supplementing milk diets with iron alone; with iron and copper; or with iron, copper, and cobalt prevented anemia.[4, 5, 7, 8] These workers also reported growth stimulation accompanied the increase in Hb.

Knoop *et al.*[4] reported that dairy calves on an exclusive milk diet developed anemia, as evidenced by unthriftiness, retarded growth, and low Hb concentrations. Oral supplementation of 400 mg. of inorganic iron and 40 mg. of inorganic copper prevented anemia in these calves. Thomas *et al.*[8] maintained red blood cell count and Hb levels by feeding 100 mg. of iron per day to calves that were moderately anemic. Iron alone or iron in combination with copper, cobalt, and manganese eliminated anemia in these young calves; whereas, copper, cobalt, and manganese fed alone were ineffective in treating anemia. Matrone *et al.*[5] reported increased gains and Hb concentrations from adding iron to the milk diet of dairy calves.

Previous work at this station [3] indicated that range calves in eastern Oregon were marginal or submarginal with respect to anemia. Calves given 10 ml. of an iron dextran preparation at birth had significantly higher Hb concentrations at 3 weeks of age than control animals. Packed cell volumes and rates of gain, while not significant, followed the same trend. By the fourth week, these differences were not as apparent.

The purpose of this research was to determine the normal hemoglobin and packed cell volume of range calves from birth to weaning and to observe the effect of iron and copper treatments on these factors and on rate of gain.

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Materials and Methods

Seventy-two newborn calves were randomly allotted to treatment in a 3 by 3 by 2 factorial design to study the effect of iron and copper on male and female calves (Table 1). The treatments were set up to compare the effects of one and two injections of either copper and iron alone, or in combination, with control calves given no injections. There were equal numbers of male and female animals in each group. There were four replications. Each replication was filled with calves born within a three-day period or less. The calves were from good quality, uniform Hereford range cows. The general health status of the herd was good with no evidence of diarrhea, leptospirosis, or other disturbances in the calves.

TABLE 1—Experimental Design; Effect of Iron and Copper on Hemoglobin Level, Packed Cell Volume, and Rate of Gain in Hereford Calves

No. of copper injections (0.5 ml.)	Sex	No. of iron injections (10 ml.)		
		0	1	2
0	Male	4	4	4
0	Female	4	4	4
1	Male	4	4	4
1	Female	4	4	4
2	Male	4	4	4
2	Female	4	4	4

The calves were weighed and blood samples obtained within three days of birth and the iron or copper was injected at that time. Calves given second injections of iron or copper were so treated at 3 weeks of age. Copper was given as a 0.5 ml. subcutaneous injection of copper glycinate.* The iron used was an iron-dextran ** preparation and was given as a 10.0-ml. intramuscular injection. These doses were recommended by the manufacturers of the respective products.

The calves were kept with their dams on native hay meadows until they were about 6 weeks old, after which time the herd was moved to sagebrush-bunchgrass-type summer range. The study was terminated at weaning time, when the calves averaged 25 weeks of age. No attempt was made to prevent the calves from eating forage during the experimental period.

Body weight and blood samples were obtained at birth, 3, 6, 15, and 25 weeks of age. The Hb and PVC were determined immediately after blood samples were obtained. Hemoglobin determinations were made in duplicate by a direct photometric method,[2] using a photoelectric colorimeter. Packed cell volume determinations were made by centrifuging 10 ml. of blood for one hour at 3,000 r.p.m. in graduated conical centrifuge tubes.

The data were statistically analyzed using a split-plot analysis with time interval as the subplot.[6]

Results and Discussion

Body Weight Changes.—The average daily gain of all the calves was 1.64 lb. (Table 2). Treatments had no significant effect on rate of gain. The effect of age interval on rate of gain was significant as was gain of each sex with respect to time. Up to 15 weeks of age, the steer calves gained consistently from 0.13 to 0.25 lb. more per day than the heifer calves. During the period from 15 to 25 weeks of age, the heifers made slightly higher gains than the steers. The severe drop in rate of gain after 15 weeks of age cannot be attributed to treatment, but rather to a lowering of quality in the range forage resulting in a decrease in milk production.

The body weight gains of the calves on the experiment followed the same pattern and magnitude as is average for calves under this type of management. Calves nursing cows that are grazing on native sagebrush-bunchgrass range generally drop off in rate of gain after the middle of July.

* Provided by Cutter Laboratories, Berkeley, Calif.
** Provided by Armour Pharmaceutical Co., Kankakee, Ill.

TABLE 2—Average Daily Gain of Calves Given Copper or Iron Injections

Treatment*	No. of injections	No. of animals	Av. daily gain (lb.) at following age intervals				
			Birth to 3 wk.	3 wk. to 6 wk.	6 wk. to 15 wk.	15 wk. to 25 wk.	Birth to weaning
Copper	0	24	1.63	1.75	1.82	1.46	1.66
Copper	1	24	1.68	1.92	1.79	1.40	1.65
Copper	2	24	1.61	1.84	1.78	1.38	1.63
Iron	0	24	1.69	1.77	1.77	1.42	1.64
Iron	1	24	1.65	1.86	1.80	1.39	1.64
Iron	2	24	1.59	1.88	1.82	1.42	1.66
Male	..	36	1.72	1.96	1.86	1.39	1.69
Female	..	36	1.56	1.71	1.73	1.43	1.60
Average	..	72	1.64	1.84	1.80	1.41	1.64

* Calves treated with copper and iron were given the first injections of 0.5 ml. and 10.0 ml., respectively, at birth and the second injections at three weeks of age. Data represent main effects only and not the interactions.

TABLE 3—Average Hemoglobin Values of Calves Given Iron or Copper Injections

Treatment*	No. of injections	No. of animals	Av. Hb values (Gm./100 ml.) at					
			Birth	3 wk.	6 wk.	15 wk.	25 wk.	Av.
Copper	0	24	11.30	10.93	10.80	10.08	10.02	10.63
Copper	1	24	11.93	10.93	10.90	9.75	10.02	10.51
Copper	2	24	11.39	11.05	11.13	9.93	9.79	10.66
Iron	0	24	11.76	10.35	10.45	10.02	9.98	10.51
Iron	1	24	11.00	11.32	10.93	9.92	9.98	10.67
Iron	2	24	10.88	11.26	11.43	9.81	9.98	10.67
Male	..	36	11.10	10.77	10.86	9.70	9.87	10.46
Female	..	36	11.32	11.18	11.02	10.13	10.02	10.73
Average	..	72	11.21	10.98	10.94	9.92	9.94	10.60

* Calves treated with copper and iron were given the first injections of 0.5 ml. and 10.0 ml., respectively, at birth and the second injections at three weeks of age. Data represent main effects only and not the interactions.

This date corresponds with the 15-week age of calves in this study. This drop in rate of gain is associated with the milk production of the dam. By the middle of July, this forage has become quite dry and the crude protein content has fallen to the point where it is merely supplying enough to maintain the cow; consequently, milk production falls off sharply.

Hematology.—The average Hb value for each group and treatment are shown (Table 3). The average value for all the calves at birth was 11.21 Gm./100 ml. with a range from 9.3 to 13.4 Gm./100 ml. Hubbert and Wallace [3] reported average Hb values of 14.2 Gm./100 ml. at birth. The blood was collected within 24 hours after birth, whereas the values reported in this study were from calves up to 3 days of age. At each age period after birth, the Hb values averaged slightly lower, but the ranges were of the same magnitude. This decrease in Hb level with age was significant at the 1% probability level. Thomas *et al.*[8] reported similar results with dairy calves. His data show that Hb levels of calves start to decline shortly after birth and reach their minimum value at 40 to 60 days of age, after which time Hb concentrations tend to increase. The calves in this experiment reached their minimum Hb level at about 105 days and then tended to level off rather than increase. This change in rate of decline is probably due to the change in feed at this time. Thomas reported that the time the levels increased coincided with the time that the calves started consuming large quantities of alfalfa; whereas, range-managed calves, such as the animals in this study, are getting their nourishment from milk and a very low quality forage at this time.

The copper and iron injections had no significant effect on the Hb values. The interaction of iron and time was significant. The Hb level on those calves given one injection of iron increased at 3 weeks of age over that of birth and then started declining, while the Hb of those given two iron injections increased up to 6 weeks of age before it declined.

The heifer calves had consistently higher Hb levels than the steer calves, with the heifers averaging 10.7 Gm./100 ml. and the steers 10.4 Gm./100 ml. for the season. These differences were significant ($P < 0.05$) and are in agreement with those reported by Anderson *et al.*[1] and

TABLE 4—Average Packed Cell Volume of Calves Given Iron or Copper Injections

Treatment*	No. of injections	No. of animals	Av. PCV (%) at					
			Birth	3 wk.	6 wk.	15 wk.	25 wk.	Av.
Copper	0	24	37.9	38.9	38.5	42.7	40.1	39.6
Copper	1	24	36.9	38.5	38.9	39.0	40.8	38.8
Copper	2	24	38.2	38.7	40.0	40.9	40.5	39.7
Iron	0	24	39.6	36.5	37.2	41.7	40.5	39.1
Iron	1	24	36.7	40.0	38.9	41.5	40.7	39.6
Iron	2	24	36.7	39.5	41.2	39.4	40.3	39.4
Male	..	36	37.0	37.8	38.7	39.5	39.9	38.6
Female	..	36	38.4	39.6	39.6	42.3	41.1	40.2
Average	..	72	37.7	38.7	39.1	40.9	40.5	39.4

* Calves treated with copper and iron were given the first injections of 0.5 ml. and 10.0 ml., respectively, at birth and the second injections at three weeks of age. Data represent main effects only and not the interactions.

Thomas *et al.*[8] (who reported higher Hb values for female dairy calves than for males). However, Thomas reported that these differences remained only up to 75 days of age, while the heifers in this study had higher Hb concentration than the steers at 175 days.

The PCV values followed the opposite trend from the Hb. These data are summarized (Table 4). The PCV at birth ranged from 28.9 to 43.4% with an average of 37.7%. These values increased with the age of the animal up to 9 or 15 weeks of age, after which time they leveled off or declined slightly. Packed cell volume increased with age more rapidly in those calves given iron than in the controls. This interaction of iron and time was significant ($P < 0.01$). Copper appeared to have no effect on PCV. Hubbert *et al.*[3] reported a decrease in PCV of calves from birth to 4 weeks of age; whereas, the PCV of calves in this study increased from birth to 3 weeks and at each blood-sampling date thereafter. This occurred in the controls as well as in the treated animals.

The heifers had higher PCV values than the steers, as was the case with Hb. The average PCV of the heifers was 40.2% compared with 38.6% for the steer calves. This difference was significant ($P < 0.01$).

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SUMMARIO IN INTERLINGUA

Le Influentia de Ferro e de Cupro Super le Valores Hematologic e le Peso Corporee de Vitellos in Pastura

Le concentrationes de hemoglobina e le volumine de cellulas paccate de vitellos Hereford in pastura esseva determinate a nato e a etates de 3, 6, 15, e 25 septimanas. Le valores del hemoglobina esseva le plus alte al nascentia e declinava usque al etate de 15 septimanas, post qual tempore illos cercava un plateau. Le volumine de cellulas paccate esseva le plus basse al nascentia e montava significativemente durante le periodo total del studio.

Injectiones de glycinato de cupro in vitellos a nato e a 3 septimanas de etate non alterava significativemente le comportamento de lor hemoglobina o de lor volumine de cellulas paccate. Injectiones de dextrano a ferro augmentava significativemente o manteneva le concentration de hemoglobina e le volumine de cellulas paccate in vitellos de etates de usque a 6 septimanas. Post iste etate, le hemoglobina e le volumine de cellulas paccate se comportava como in le animales de controlo. Ni cupro ni ferro—sol o in combination—habeva ulle effecto super le ganio de peso sub le conditiones del experimento.

Le vitellos feminin habeva significativemente plus alte concentrationes de hemoglobina e significativemente plus alte volumines de cellulas paccate que le vitellos masculin. Iste differentia esseva mantenite usque al fin del periodo de 25 septimanas.