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THE EFFECT OF PARENTERAL IRON SUPPLY ON HEMATOLOGY, HEALTH, GROWTH AND MEAT CLASSIFICATION IN VEAL CALVES

By

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MÖLLERBERG, LARS, TORE EHLERS, STEN-OLOF JACOBSSON, SÖLVE JOHNSSON and INGEMAR OLSSON: *The effect of parenteral iron supply on hematology, health, growth and meat classification in veal calves.* Acta vet. scand. 1975, *16*, 197—204. — Twenty veal calves were fed milk substitute containing 19 mg Fe/kg; ten calves were supplemented with iron in accordance with their requirements and the other 10 were unsupplemented controls. Serum iron (SI), hemoglobin (Hb) and packed cell volume (PCV) were determined at the start of the experiment and then every third week. From 3 weeks after the start to the end of the experiment there were significant differences between SI mean values between treated and untreated calves. In the treated group the Hb mean values were unchanged during the experiment while the untreated group had a significant decrease. The mean PCV values were also decreased. The daily gain was 136 g higher per calf in the treated group. The feed consumption per kg gain was 18 g lower and the carcass weight was 4.2 kg higher per calf in the treated group. The points for color and structure of carcass were 2.5 units higher per calf in the untreated group. The incidence of enteritis was less in the treated calves than in the untreated ones.

veal calves; iron supply; hematology; health.

In a previous investigation it was shown that a parenteral iron supply had a positive effect on Hb (hemoglobin), PCV (packed cell volume), SI (serum iron), the incidence of diarrhea and weight gain, although the iron dosage was not high enough to produce a dark meat at slaughter (*Möllerberg & Jacobsson* 1972).

In Sweden veal calves are mostly recruited from purchased calves, about 10—15 % of which suffer from anemia (*Möllerberg*

& Jacobsson 1970). Many authors, e.g. *Osborne & Davis* (1968), have found decreased resistance to infections during anemic conditions in animals. The dietary requirement of iron in calves is between 30 and 100 mg daily (*Blaxter et al.* 1957, *Matrone et al.* 1957).

The purpose of this investigation was to study the effect of iron supplementation on Hb, PCV, SI, growth rate, the incidence of diarrhea and meat color in veal calves.

MATERIAL AND METHODS

Twenty calves of the Swedish Red and White breed were used. The calves were brought from Farmek Slaughter-house Association in Uppsala at an age of about 3 weeks. The animals were divided at random into 2 groups (controls and supple-

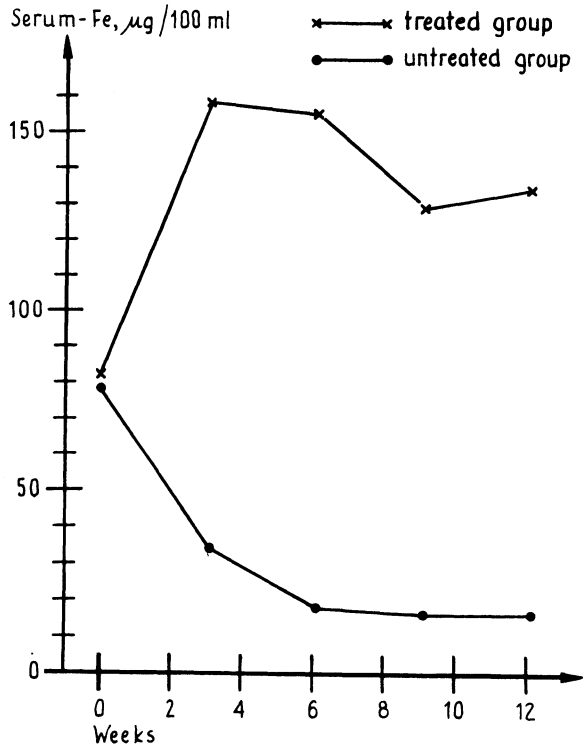

Figure 1. Mean value curves of serum iron concentration (Fe µg/100 ml) in treated group (n=10, 800 mg Fe i.m. at 0 weeks, 900 mg Fe i.m. at 3 weeks and at 6 weeks) and untreated group (n=10).

mented calves). All calves were fed a milk substitute containing 19 mg Fe/kg and 2 mg Cu/kg. The daily ration was increased from 680 g to 2270 g of milk replacer before mixing with water.

On the basis of the iron contents of the milk substitute and the requirement for calves according to *Matrone et al.* (1957), the iron deficit was calculated. During the first 3 weeks' period 800 mg were supplied, and during the second and third periods 900 mg Fe were given by deep intramuscular injection to each calf in the supplemented group. The injected iron was in the form of iron dextrin (Cynemia®, Agricultural Division, American Cyanamid Company, Waine, N.J., USA).

Blood samples were taken for analyses of Hb, PCV and SI on 5 occasions at intervals as indicated in Figs. 1 and 2.

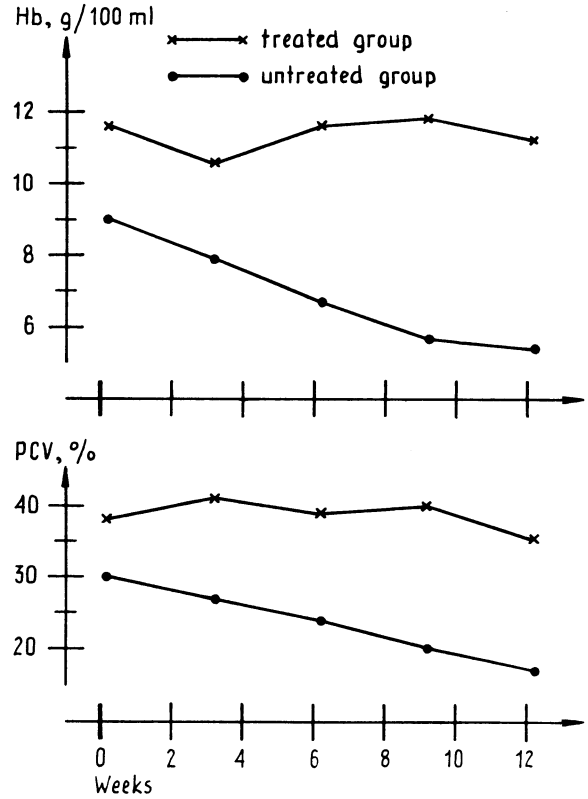

Figure 2. Mean value curves of hemoglobin concentration (Hb g/100 ml) and hematocrit (PCV %) in treated group (n=10, 800 mg Fe i.m. at 0 weeks, 900 mg Fe i.m. at 3 weeks and at 6 weeks) and untreated group (n=10).

Hemoglobin of heparinised whole blood was determined as oxyhemoglobin in an alkaline solution in a Linson Junior photometer (Lars Ljungberg & Co., Stockholm). Hematocrit was determined after centrifugation of heparinised whole blood at 12,000 r.p.m. for 5 min. in a micro hematocrit centrifuge (Hawksley, England). Serum iron was determined according to *Giovanniello et al.* (1967). Serum iron analyses were carried out by Astra AB, Södertälje.

The health of the calves was checked by a technician twice a day, and any signs of illness were noted in a journal. The incidence of enteritis was calculated as a percentage of experimental days. The animals were weighed at intervals indicated in Fig. 3. To obtain an objective estimation of meat color the light re-

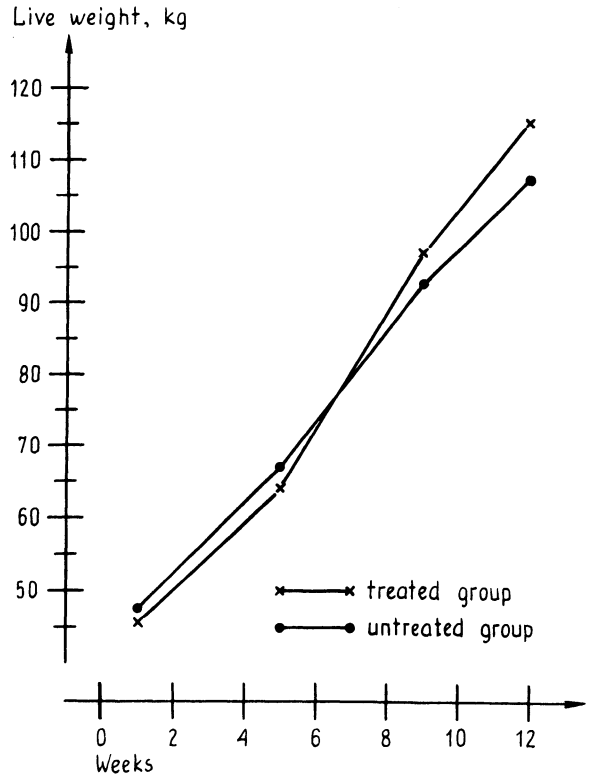

Figure 3. Mean value curves of live weight (kg) in treated group (n=10, 800 mg Fe i.m. at 0 weeks, 900 mg Fe i.m. at 3 weeks and at 6 weeks) and untreated group (n=10).

flection from M. gracilis was measured by remission spectrophotometry. The light reflection is expressed as a percentage of that of a standardised surface.

RESULTS

The results of hematological analyses are shown in Figs. 1 and 2. There was no significant difference in SI between the 2 groups at the start of the experiment. However, Hb and PCV were significantly ($P < 0.05$, $P < 0.01$ respectively) higher in the supplemented than in the control group at the beginning of the experiment.

The mean value of SI in the treated group increased from 82 to 157 μg/100 ml during the first 3 weeks. This rise was almost significant ($P < 0.05$). At 9 weeks the mean value was 129 μg/

Table 1. Days of experiments, feed consumption, growth rate, feed conversion, carcass characteristics and incidence of enteritis. Figures are given as mean values of each group.

	Treated	Control	Statistical test
Number of calves	10	10	
Weight at the beginning of the experiment, kg	45.3	47.4	not signf.
Corrected live weight at the time of slaughter, kg	128.8	121.0	*
Number of experiment days from start to slaughter	86.5	88.6	not signf.
Daily gain, start—slaughter, g	968	832	**
Feed consumption, milk substitutes, start—slaughter, kg	134.5	135.5	not signf.
Milk substitutes per kg gain, start—slaughter	1.62	1.80	*
Carcass weight, kg	70.5	66.3	*
Classification of carcass; points for flesh	5.0	5.3	not signf.
„ „ color and structure	6.0	8.5	***
Measurement of flesh color, % light reflection	12.7	17.0	*
Incidence of enteritis	0.23	2.14	***

* = $P < 0.05$.
** = $P < 0.01$.
*** = $P < 0.001$.

100 ml, which was not significantly different from the values at the start (Fig. 1). In the untreated group SI was significantly lower at all observations after 3 weeks than at the beginning of the experiment. From 3 weeks onwards the treated calves had significantly higher SI levels than those of the controls.

The Hb mean value in the treated group remained at about the same level (10.6—11.7 g/100 ml) on all sampling occasions. In the control group it decreased steadily from 9.0 to 5.4 g/100 ml (Fig. 2). The difference between the groups increased almost significantly ($P < 0.05$) from 2.7 to 5.8 units during the experiment. This was due to a highly significant ($P < 0.001$) decrease in the untreated group.

The PCV mean value in the treated calves remained at about the same level (35—41 %) throughout the experiment. In the controls it decreased from 34 % at 3 weeks to 18 % at 12 weeks. This decrease was significant ($P < 0.01$).

The daily live weight gain, incidence of diarrhea, meat color etc. are shown in Table 1.

DISCUSSION

The results of the serum iron investigations indicate that contents of only 19 mg Fe per kg milk subtsitute were inadequate since values decreased to under 40 μg/100 ml. This is considered to be a critical value (see *Hibbs et al.* 1963 and *Völker et al.* 1972). Such a small iron supplement caused, as indicated by the hematological investigations (Hb and PCV), an anemia condition. On the other hand the calves which received their iron requirements by injections had normal SI, Hb and PCV values.

The significant difference in growth rate between treated calves and the controls was in all probability caused by anemia condition in the control group. This is in accordance with previous reports by *Kirchgessner et al.* (1971). These authors report that calves with Hb values of < 7 g/100 ml demonstrated reduced growth. But even calves with Hb values of < 10 g/100 ml will probably have a higher incidence of illness and reduced growth when they are exposed to violent infections than calves with Hb values of > 10 g/100 ml. *Matrone et al.* (1957) reported normal Hb values for calves of 10—13 g/100 ml. These investigators estimated that the requirement for a calf to grow at the rate of 1 kg daily and to maintain a Hb value of 10 g % is about 17 mg

Fe/day. The absorption of iron is affected by many different factors, including the anemic condition. In this investigation the iron contents in the feed were probably too low, since the growth rate in the control group should have been the same as in the treated group. Obviously the anemic conditions in the untreated animals were so severe that these calves were more susceptible to infection than the supplemented animals which was reflected in a higher incidence of enteritis. *Horváth* (1964) previously reported similar observations in calves and *Osborne et al.* (1968) in pigs.

The treated calves had significantly lower color indexes on carcass classification than the untreated calves. Several workers, e.g. *Kirchgessner et al.*, have reported that iron treatment of calves on an iron deficient ration will increase both the hemoglobin values and the myoglobin contents of the muscles, causing a darker color of the meat.

The results in this trial indicate that calves fed an iron deficient milk replacer common in veal production are affected by severe anemia, decreased growth rate and a higher incidence of enteritis. For this reason it may be questioned if the norms for carcass classification of veal should not be altered so that veal producers are not obliged to work under conditions that may be predisposing for severe anemia among the animals.

REFERENCES

Blaxter, K. L., G. A. M. Sharman & A. M. Macdonald: Iron deficiency anemia in calves. Brit. J. Nutr. 1957, *11*, 234—246.

Giovanniello, T. J., G. Dibenedetto, D. W. Palmer & T. Peters, Jr: Fully automated method for the determination of serum iron and total iron-binding capacity. Techn. Symposium, Automation in Analytical Chemistry, New York. N.Y. Oct. 2, 1967.

Hibbs, J. W., H. R. Conrad, J. H. Vandersall & C. Gale: Occurrence of iron deficiency anemia in dairy calves at birth and its alleviation by iron dextran injection. J. Dairy Sci. 1963, *46*, 1118—1124.

Horváth, Z.: Besonderheiten der Anaemi der Kälber. (Anemia in calves). Nord. Vet.-Med. 1964, *16*, Suppl. 1, 464—465.

Kirchgessner, M., E. Grassmann, J. Krippl & H. L. Müller: Zum Einfluss einmaliger und kontinuierlicher Fe-Zulagen in der Kälbermast auf ernährungsphysiologische Wirksamkeit und Fleishfarbe. (On the influence of unique and continuous Fe supplementation in calf fattening on nutritional efficaciousness and meat colour). Züchtungskunde 1971, *43*, 336—345.

Matrone, G., C. Conley, G. H. Wise & R. K. Waugh: A study of iron and copper requirements of dairy calves. J. Dairy Sci. 1957, *40*, 1437—1447.

Möllerberg, L. & S. O. Jacobsson: Några allmänna synpunkter på järnbristanämi hos kalv. (Some current views on iron deficiency anemia in calf). Svensk Vet.-Tidn. 1970, *22*, 851—854.

Möllerberg, L. & S. O. Jacobsson: The effect of parenteral iron supply on hematology, health and growth in veal calves. Wld Ass. Buiatrics Congress, London 1972.

Osborne, J. C. & J. W. Davis: Increased susceptibility to bacterial endotoxin of pigs with iron-deficiency anemia. J. Amer. vet. med. Ass. 1968, *152*, 1630—1632.

Völker, H., L. Rotermund & E. Müller: Probleme der Intensivmast eisenarm ernährter Kälber zur „Weissfleisch Produktion" im Zusammenhang mit der Eisen- und Hämoglobinbilanz. (Problems in the intensive fattening of iron-deficient calves, with reference to iron and hemoglobin balances). Arch. exp. Vet.-Med. 1972, *26*, 339—347.

SAMMANFATTNING

Effekten av parenteral järntillföresel på hematologi, hälsa, tillväxt och köttklassificering hos gödkalv.

Tjugo stycken gödkalvar utfodrades med ett mjölkersättningspreparat som innehöll 19 mg Fe/kg. Tio stycken kalvar tillfördes järn enligt behov, de övriga tio användes som kontrollkalvar. Serumjärn, hemoglobin och hematokrit undersöktes vid försökets start och sedan var tredje vecka.

Från tre veckor efter försökets start och till dess slut var det signifikant högre medelvärde för serumjärn i försöksgruppen än i kontrollgruppen. Hemoglobinmedelvärdena var oförändrade i försöksgruppen medan de sjönk signifikant i kontrollgruppen. Hematokritvärdena sjönk också i kontrollgruppen. Den dagliga tillväxten var 136 g högre per kalv i försöksgruppen. Foderkonsumtionen var 18 g lägre och slaktvikten 4,2 kg högre per kalv i försöksgruppen. Poäng för färg och struktur var 2,5 enheter högre per kalv i kontrollgruppen. Frekvensen av enteriter var mindre bland kalvarna i försöksgruppen än bland de obehandlade.

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