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Effect of an Oral Starter Dose of Iron on Haematology and Weight Gain in Piglets Having Voluntary Access to Glutamic Acid-chelated Iron Solution

By *A. K. Egeli* and *T. Framstad*

Department of Reproduction and Forensic Medicine, Norwegian College of Veterinary Medicine, Oslo, Norway.

Egeli AK, Framstad T: Effect of an oral starter dose of iron on haematology and weight gain in piglets having voluntary access to glutamic acid-chelated iron solution. Acta vet. scand. 1998, 39, 359-365. – Six litters of Norwegian Landrace piglets were included in the study. The day after birth (day 1), half of the piglets (split litters) were given 52 mg glutamic acid-chelated Fe (4 ml of a 50% solution of *Super* Fe-MAX®) perorally. All the piglets had free access to a 3% solution of *Super* Fe-MAX® from this day until weaning at 5 weeks. The piglets were weighed and blood samples collected on days 1, 4, 7, 14, 21 and 35, and weighed only on days 28 and 49. The production of erythrocytes and haemoglobin was greater in the first week after birth in piglets given extra iron perorally on day 1, compared to those with voluntary access to iron. The extra peroral iron administration did not prevent some of the piglets from becoming anaemic later. Weight gain was similar in the 2 groups.

amino acid-chelated iron; peroral iron supplementation.

Introduction

In Norway, oral Fe supplementation in piglets has been a routine practice for many years, and a wide range of products is available for this purpose. Because it is considered that the voluntary consumption by piglets of such products during the first week of life will be inadequate, the practice of administering an oral dose directly into the mouth in new-born piglets has been employed. Following this method *Holmgren & Framstad* (1996) found no effect on weight gain and haemoglobin concentration in 20 days old Swedish cross-breed piglets. The weight gain was, however, lower than earlier found in Norwegian Landrace piglets (*Egeli & Framstad* unpubl.). The aim of the present study was to investigate the effect of an oral starter dose given the day after birth of 52 mg Fe as glutamic acid-chelated Fe (*Super* Fe-MAX®) on haematological parameters and weight gain in fast growing Norwegian Landrace piglets, compared with only voluntary access to a 3% solution of *Super* Fe-MAX® (0.78 mg Fe/ml) from the same day.

Materials and methods

The study took place in a commercial herd. The litters were kept with the sows in farrowing crates on a concrete floor covered with saw dust until weaning. The piglets were not subjected to castration or tail docking. None of the piglets died, nor were any given medical treatment. All

the investigations and treatments were performed by a veterinarian.

Altogether 53 piglets (6 litters) of the Norwegian Landrace breed were divided randomly into 2 groups (split litters) (Groups 1 and 2). The design involving split litters minimised the effect of the sow and the need of treating all piglets on a fixed time after birth. Twenty-four to 48 h after birth, the piglets in Group 1 were each given 52 mg glutamic acid-chelated Fe in a water solution (4 ml of a 50% solution of *Super* Fe-MAX® (Borregaard Industries Ltd., Sarpsborg, Norway) directly into the mouth, and free access to a 3% solution of *Super* Fe-MAX® (containing 0.78 mg Fe/ml) from a separate drinking unit from the same day. They were given free access to pelleted food from 7 days of age. The piglets in Group 2 were not dosed, but otherwise had free access to the Fe solution and pelleted food from the same time as Group 1. All piglets were weighed, and one ml blood was collected by the method described by *Framstad et al.* (1988), using ethylene diaminetetra-acetic acid (EDTA) as anticoagulant before treatment on the morning of the day after birth (day 1) and on the mornings of days 4, 7, 14, 21 and 35. The piglets were also weighed on day 28 and 2 weeks after weaning (day 49). One blood sample taken on day 1 and one on day 21 had to be excluded because of coagulation. Three piglets observed to be bleeding from the navel in Group 2 were also excluded.

The erythrocyte count (RBC), haemoglobin concentration (HGB), mean cell volume (MCV), erythrocyte distribution width (RDW) and haemoglobin distribution width (HDW) were measured using an automated blood analyser; Technicon H*1® (Technicon Instruments Corp., Tarrytown, N.Y.). RDW is the coefficient of variation of the RBC volume histogram, and HDW is the standard deviation of the haemoglobin concentration histogram.

Comparison of 2 means between groups was done using the *t*-test. Differences in haematological parameters within groups at different occasions were examined using a paired *t*-test.

Results

Fig. 1a: The mean birth weight (± SD) was 1.77 kg (± 0.33) in Group 1 and 1.80 kg (± 0.34) in Group 2, the mean weight on day 35 being 11.01 kg (± 1.92) in Group 1 and 11.22 kg (± 1.64) in Group 2.

Fig. 1b: HGB decreased from day 1 to day 4 in Group 1 ($p<0.001$), and from day 1 to day 7 in Group 2 ($p<0.001$). From then on, i.e. day 4 in Group 1 and day 7 in Group 2, HGB increased to weaning ($p<0.001$). Group 1 had higher HGB than Group 2 on day 4 ($p<0.01$) and day 7 ($p<0.001$).

Fig. 1c: RBC decreased from day 1 to day 4 in Group 1 ($p<0.001$), and from day 1 to day 7 in Group 2 ($p<0.01$), before again increasing in both groups to day 35 ($p<0.001$). Group 1 had higher RBC than Group 2 on day 7 ($p<0.001$).

Fig. 1d: MCV increased from day 1 to day 7 in Group 1 ($p<0.001$), while in Group 2 no significant changes in MCV between sampling times were observed until the period between day 14 and day 21. MCV decreased from day 7 in Group 1 and from day 14 in Group 2 to day 35 ($p<0.001$). MCV was higher in Group 1 than in Group 2 on day 4 ($p<0.05$) and day 7 ($p<0.001$).

Fig. 1e: RDW increased from day 1 to day 4 in Group 1 ($p<0.001$), and from day 1 to day 14 in Group 2 ($p<0.001$). RDW decreased from day 4 to day 7 in Group 1 ($p<0.001$), but increased from day 7 to day 21 ($p<0.05$). RDW decreased from day 14 to day 35 in Group 2 ($p<0.001$). While Group 1 had a higher RDW than Group 2 on day 4 ($p<0.001$), Group 2 had the higher RDW on day 7 ($p<0.01$).

Fig. 1f: HDW decreased in both groups from the first to last blood sampling ($p<0.001$), except in Group 1 between day 14 and 21, when it

Fig. 1a

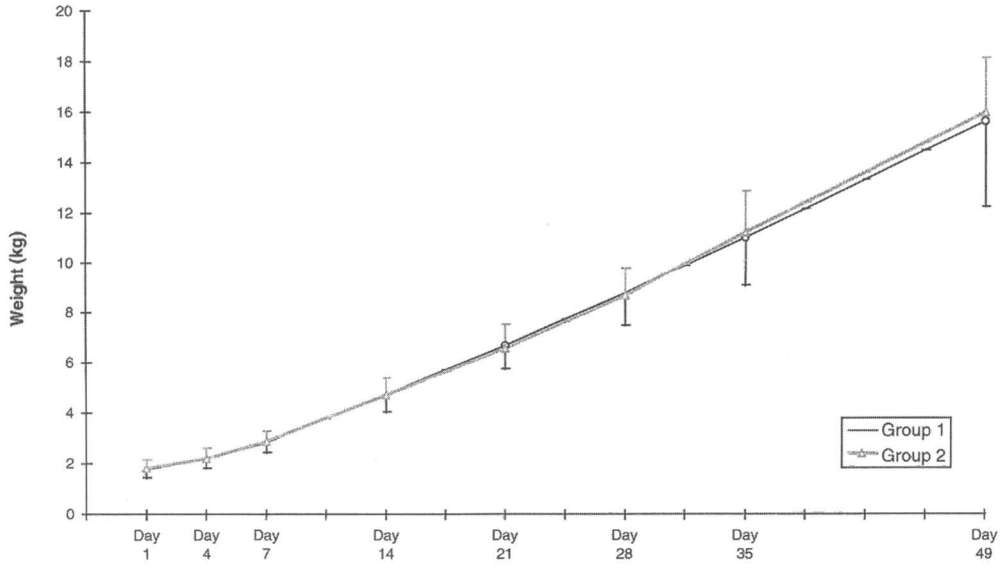
Weight (kg)
20
18
16
14
12
10
8
6
4
2
0
Day 1
Day 4
Day 7
Day 14
Day 21
Day 28
Day 35
Day 49
Group 1
Group 2

Fig. 1b

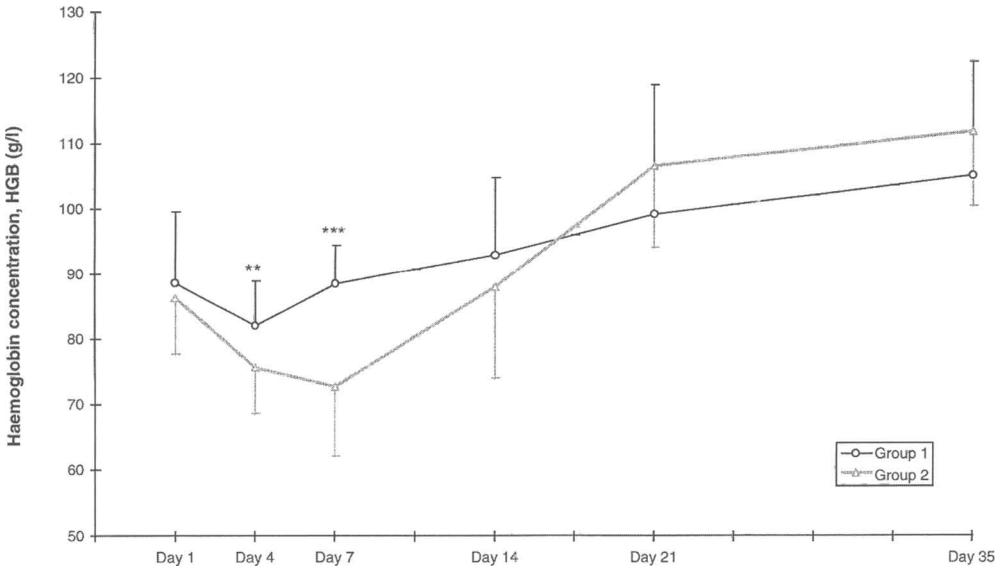
Haemoglobin concentration, HGB (g/l)
130
120
110
100
90
80
70
60
50
**
***
Day 1
Day 4
Day 7
Day 14
Day 21
Day 35
Group 1
Group 2

Fig. 1c

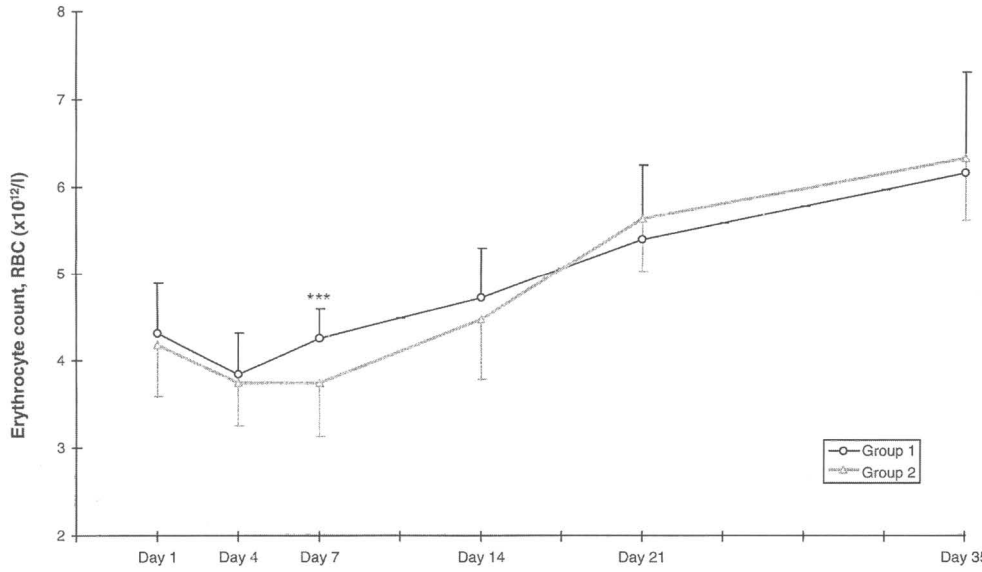
Erythrocyte count, RBC (x10¹²/l)
8
7
6
5
4
3
2
***
Group 1
Group 2
Day 1
Day 4
Day 7
Day 14
Day 21
Day 35

Fig. 1d

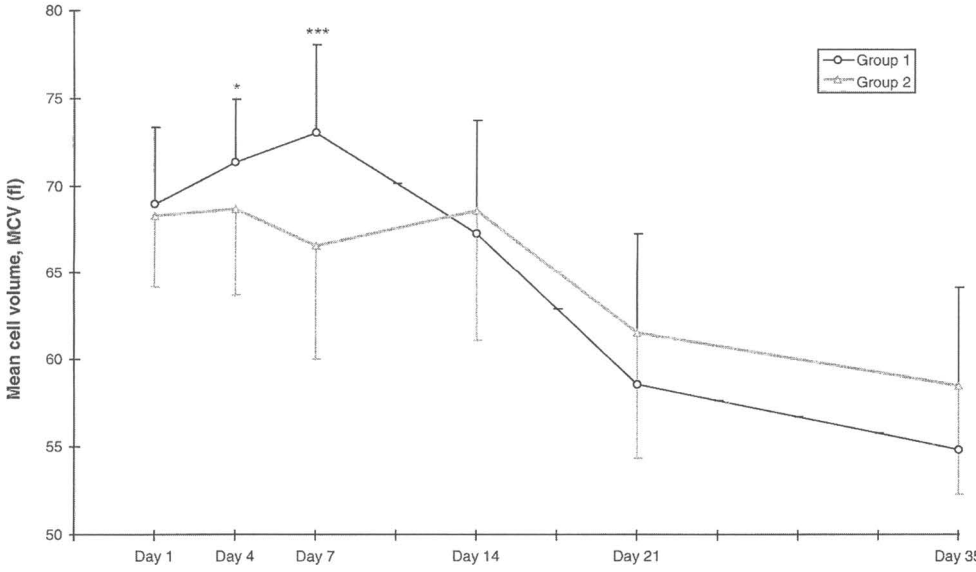
Mean cell volume, MCV (fl)
80
75
70
65
60
55
50
*
***
Group 1
Group 2
Day 1
Day 4
Day 7
Day 14
Day 21
Day 35

Fig. 1e

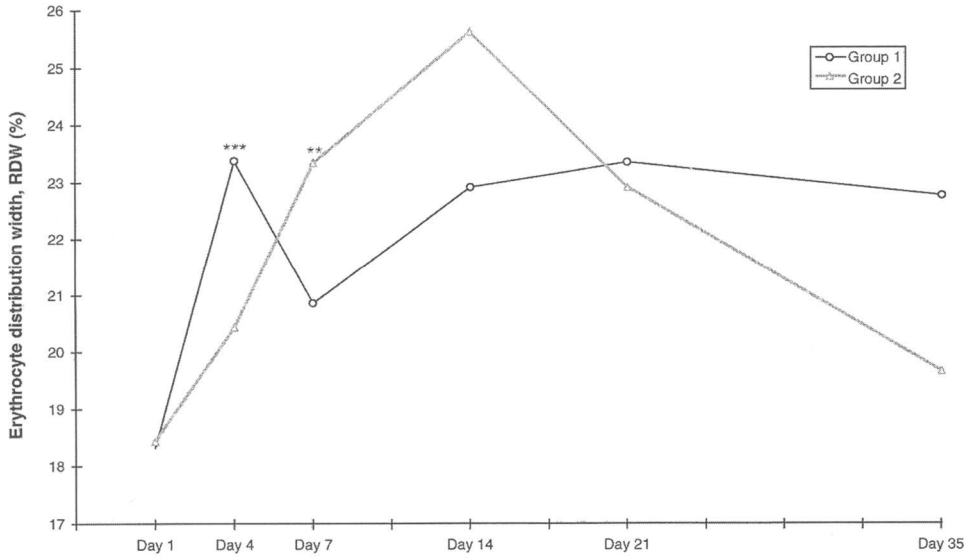

Fig. 1f

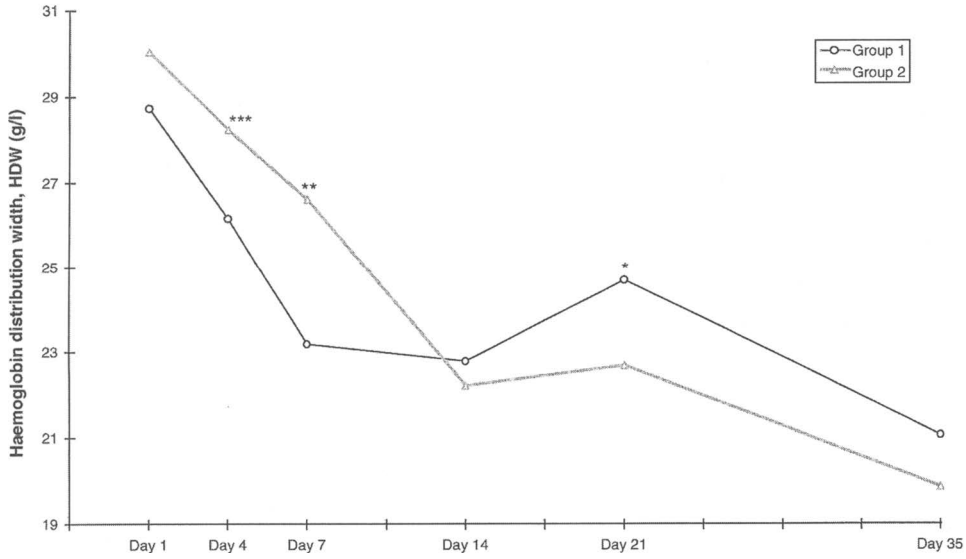

Figure 1a-f. Evolution of haematological parameters and weight during the first 5 (7) weeks of life in Norwegian Landrace piglets (Mean (SD). Group 1 was given 52 mg iron in 50% *Super* Fe-MAX® solution on day 1. Both groups had free access to 3% *Super* Fe-MAX® solution from day 1. * = $p<0.05$, ** = $p<0.01$, *** = $p<0.001$ between groups.

showed an increase ($p<0.01$). While Group 2 had a higher HDW than Group 1 on day 4 ($p<0.001$) and 7 ($p<0.01$), Group 1 had the higher HDW on day 21 ($p<0.05$).

Discussion

Haematological parameters were influenced by the individual peroral administration of a dose of 52 mg glutamic acid-chelated Fe on day 1, as can be seen by comparison with the blood picture in the piglets which were only given voluntary access to the Fe solution from the same day. From Fig. 1, it can be seen that piglets in Group 1 had significantly higher HGB, MCV, RDW values and lower HDW than piglets in Group 2 on day 4. On day 7, RBC was also higher in Group 1 than in Group 2. MCV increased in Group 1 from day 1 to day 7, but not in Group 2. MCV and RDW have both been found to be sensitive indicators of active erythropoiesis in piglets (*Holter et al.* 1991, *Egeli & Framstad* 1997). A rise in MCV and RDW indicates active production of new erythrocytes, with greater numbers of large immature cells being released into the circulation. This took place to a greater extent in Group 1 than in Group 2 during the first week. RDW has been found to be even more sensitive than MCV in detecting a new population of erythrocytes in response to Fe treatment in Fe-deficiency anaemic kittens (*Jain* 1993). This seemed also to be the case in the present study. Changes in RDW occurred more rapidly than changes in MCV, as shown in Fig. 1d and e. RDW was higher on day 7 in Group 2 than in Group 1 indicating a higher erythrocyte production in Group 2 at that time. The curves for HGB, RBC and MCV in the 2 groups crossed between days 14 and 21, which gave numerically higher values in Group 2.

In a previous study, in which all piglets were treated with Fe either orally or by injection on day 1, HDW was found to decrease from day 1 to weaning (*Egeli & Framstad* 1997). HDW increased from day 14 to day 21 in Group 1, Group 1 then having a higher HDW than Group 2. At this time the 2 RDW curves again crossed, giving numerically higher values in Group 1. RDW will increase with the production of both microcytic and macrocytic cells, and will be especially high in a reactive Fe deficiency anaemia. These findings indicate that the Group 1 piglets on average produced more haemoglobin and erythrocytes during the first week after birth than those in Group 2 but less later on in the preweaning period. *Bollwahn et al.* (1972) found that HGB levels in 7 days old piglet injected with iron-dextran immediately after birth were no higher than in 7 days old piglets injected 3 days after birth. A possible explanation for the obvious positive effect in haematology on day 4 found in the present trial could be that peroral Fe is available for haemoglobin synthesis sooner after administration than injected Fe-dextran (*Framstad et al.* 1997). The average weight on the day after birth of Norwegian Landrace and cross-breed Yorkshire piglets has been found to be between 1.5-1.9 kg in different trials. Breeding for high weight gain may also have influenced the Fe reserves and demands for Fe soon after birth causing the early utilisation of the administrered Fe seen in the present trial.

There was no difference between groups in weight gain. Group 1 had higher variation in weight on days 35 and 49 and HGB on days 21 and 35 than Group 2. This is due to a few more anaemic piglets in Group 1. Four of the piglets in Group 1 had HGB at or below 80 g/l, which is generally acknowledged to cause growth retardation on every sample occasion. On day 7, HGB in these piglets was satisfactory compared with the other piglets, but later in the preweaning period they showed low HGB, RBC and MCV, and high RDW and HDW, indicating the presence of a microcytic hypochromic anaemia.

The 52 mg glutamic acid-chelated Fe given directly per os on day 1 had a positive effect on haematology on days 4 and 7, but was too little an amount to prevent the subsequent development of Fe deficiency in those piglets which apparently failed to voluntarily consume enough Fe solution. The higher HGB on days 4 and 7 in Group 1 did not improve the weaning weight compared to the other group.

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Sammendrag

Effekten av en oral startdose av jern på hematologi og tilvekst hos grisunger som har frivillig tilgang til glutamin syre-chelatert jern- oppløsning.

Seks kull av Norsk landsvin grisunger ble inkludert i undersøkelsen. Dagen etter fødsel (dag 1) ble halvdelen av grisungene (splittet kull) gitt 52 mg glutamin syre-chelatert jern (4 ml av en 50% løsning av *Super* Fe-MAX®) peroralt. Alle grisungene hadde fri tilgang på en 3% løsning av *Super* Fe-MAX® fra denne dag til avvenning ved 5 uker. Grisungene ble veid og tatt blodprøver av på dag 1, 4, 7, 14, 21 og 35, og bare veid på dag 28 og 49. Produksjonen av erythrocytter og hemoglobin var høyest i første leveuke hos grisunger som ble gitt ekstra jern peroralt på dag 1, sammenlignet med de som bare hadde frivillig tilgang på jern. Denne ekstra perorale jernbehandlingen forhindret ikke at noen grisunger seinere ble anemiske. Tilveksten var lik i begge grupper.

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Reprints may be obtained from: A.K. Egeli, Department of Reproduction and Forensic Medicine, Norwegian College of Veterinary Medicine, P.O. Box 8146 Dep. N-0033, Oslo, Norway. E-mail: A.K.Egeli@veths.No, tel: +47 22 96 48 74, fax: +47 22 59 70 83.