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Iron Requirement of Pigs Farrowed in Metal Farrowing Stalls

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IRON REQUIREMENT OF PIGS FARROWED IN METAL FARROWING STALLS

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TABLE OF CONTENTS

CHAPTER		PAGE
I.	INTRODUCTION	1
II.	REVIEW OF LITERATURE	4
III.	MATERIALS AND METHODS	10
	Field Study	10
	Laboratory Analysis	15
	Statistical Analysis	15
IV.	RESULTS AND DISCUSSIONS	16
	Hemoglobin	16
	Birth	16
	Four Days	16
	Six Days	18
	Two Weeks	18
	Five Weeks	21
	Weight	21
	Two Weeks	21
	Five Weeks	21
V.	SUMMARY	22
LITERATURE CITED		24

LIST OF TABLES

TABLE PAGE

1. Mean values for hemoglobin in pigs as determined by Miller et al (1961) 9

2. Mean hemoglobin levels for each treatment at birth, 4, 6, 14 and 35 days of age (gm./100 ml.) 17

3. Mean weight for each treatment at 14 and 35 days of age 17

4. Combined means for all treatments at birth, 4, 6, 14 and 35 days of age 20

LIST OF FIGURES

FIGURE		PAGE
1.	Pigs chewing on metal farrowing stall	2
2.	Metal farrowing stalls utilized in study	12
3.	Pricking ear vein for blood sampling	14
4.	Drawing blood into a 20-lambda micro pipette	14
5.	Hemoglobin levels at various ages for pigs on 3 treatments	19

ABSTRACT

Pigs farrowed and reared in metal farrowing stalls were studied to determine the need for iron. Three treatments were studied, namely--T-0 (pigs given no iron injection), T-1 (pigs given 1 iron-dextran injection at 2 days of age) and T-2 (pigs given 2 injections of iron-dextran, the first at day 2 and the second at day 7). Hemoglobin levels were analyzed to determine the incorporation of iron in the bloodstream in the form of hemoglobin. Pig weights were used as a measure of production.

The hemoglobin levels did not differ ($p > 0.1$) among the 3 treatments at birth, 4 days, 6 days, 2 weeks and 5 weeks of age. However, birth values were higher ($p < 0.01$) than either 4 or 6 day values. In addition, 2 week values were higher ($p < 0.01$) than 4 and 6 day values, but lower than birth values. Five week values were the highest ($p < 0.01$) of all values measured. Weights did not differ among treatment groups at 2 and 5 weeks of age ($p > 0.1$).

Results of this study indicate that pigs farrowed and reared in metal farrowing stalls neither benefit in iron level or production from iron-dextran injections.

CHAPTER I

INTRODUCTION

Pigs are the only farm animal in which iron deficiency anemia occurs to any extent. Pigs that are reared in open lots or houses with no flooring, conditions similar to the natural habitat in which domestic pigs have evolved, have little or no problem with iron deficiency anemia. Pigs farrowed in confinement with flooring do not have access to the soil from which they can derive the necessary iron. Dams do not provide sufficient iron in the milk to maintain normal hemoglobin levels, thus iron supplements are necessary. Of the many methods of iron supplementation, intramuscular injections of iron-dextran have been found most effective in preventing anemia.

In recent years metal farrowing stalls with metal partitions and metal slatted flooring have been utilized. The question has subsequently arisen regarding the possibility that piglets may ingest sufficient iron from the slats and/or partitions of the stalls to eliminate the need for further iron supplementation. Pigs are frequently observed chewing on the farrowing stall and the pen partitions and rooting on the metal slats (Fig. 1).

Fig. 1. Pigs chewing on the metal farrowing stall.

If iron supplements are not necessary, the cost of the syringes and iron-dextran solution could be saved; and the farmer's time could be more efficiently utilized in other activities. More importantly, however, stress and handling of the pig would be reduced. Therefore, the purpose of these investigations was to determine if iron supplements are necessary to maintain a normal hemoglobin level in baby pigs farrowed and reared in metal pens with metal slatted floors and partitioning.

CHAPTER II

REVIEW OF LITERATURE

One constituent of hemoglobin, the oxygen-carrying protein in the blood, is iron. This iron exists in the heme form in hemoglobin and also in certain enzymes. A sufficient level of iron is thus necessary for hemoglobin formation and subsequently very important for growth and maintenance in animals.

The weight of a baby pig is expected to double in the first week and quadruple within 2 weeks. Therefore, after only 2 weeks the need for oxygen, and subsequently hemoglobin, is increased 400% (Talbot and Swenson, 1970). If the iron level is not sufficient to meet this increased need then the baby pig becomes anemic. Matrone et al (1960) stated that the iron requirement is primarily a function of growth rate and red blood cell turnover. Consequently, fast growing animals require more iron than slow growing animals.

Iron deficiency anemia rarely occurs in pigs farrowed on the ground. The practice in recent years of confinement for farrowing sows caused baby pig anemia to be both a common and important problem. McGowan and Crichton (1923) discovered that this anemic condition was a result of iron deficiency. Doyle (1932) and Kernkamp (1935) found that the occurrence of anemia was greatly reduced when the pigs had access to soil. Zimmerman et al (1959) showed that placing two pounds of fresh soil in the baby pigs' pen each day was just as effective against anemia as any iron supplement which was available.

The problem of anemia was first approached by an attempt to supplement more iron through the milk of the dam. Elvehjem et al (1926) using cattle and goats found that the iron content of the milk could not be increased by increased iron content of the dam's feed.

Prepartum feeding of iron to the dam in an attempt to increase the stored iron in the pig prior to birth also failed. Hart et al (1929), McGowan and Crichton (1923) and Venn et al (1947) administered large oral doses of iron salts during late gestation in an attempt to create an iron store in the fetus. Pigs from dams given iron salts had no higher hemoglobin values than pigs from dams given no iron salts.

Since more than one half of the iron in the animal body is incorporated in hemoglobin, the hemoglobin levels are traditionally used to indicate the iron level of the body. A popular and accurate method of determining hemoglobin is the cyanmethemoglobin method of Crosby et al (1954). In much swine hematology research blood samples were taken from a vein in the ear (Zimmerman et al, 1959; Wahlstrom and Juhl, 1960; Miller et al, 1961; Matrone et al, 1960; Rydberg et al, 1959b).

Oral administration of iron was first found as an effective method of maintaining normal hemoglobin levels. Ullrey et al (1959) learned that orally administered iron in the form of ferrous iron in milk in the quantity of 125 ppm maintained hemoglobin levels sufficient to avoid anemia. Hart et al (1929), Doyle (1932) and Kernkamp (1935) found that anemia could be minimized by administering iron and copper salts orally. The major disadvantage to this was that oral doses must be continued for several weeks to maintain hemoglobin levels. In addition, in many instances the oral doses were coughed up and never utilized.

London and Twiggy in 1952 developed an iron-dextran complex which was found successful in treating iron deficiency anemia in humans when injected intramuscularly. This treatment was investigated for use in swine (McDonald et al, 1955; Barber et al, 1955: Brownlie, 1955; Kernkamp, 1957; Ullrey et al, 1957) and found successful when injected in the ham. Zimmerman et al (1959) found that 2 ml of iron-dextran administered within 24 hours of birth provided for maximum growth and hemoglobin until 3 weeks of age. An additional 2 ml injected on the 21st day insured maximum hemoglobin until 8 weeks in nursing pigs. Other investigations (Barber et al, 1955; Kernkamp, 1957; Dale and Mackay, 1958; Doornenbal, 1959; Maner et al, 1959; Rydberg et al, 1959; Ullrey et al, 1959; Zimmerman et al, 1959; Wahlstrom and Juhl, 1960) have determined that an injection of iron-dextran at 3 days of age caused hemoglobin levels to increase to a sufficient level to avoid anemia and to remain at this level for about 4 weeks.

Treatments of oral iron and injected iron-dextran were compared to determine if one method was more effective than the other. Wahlstrom and Juhl (1960) found that pigs injected with iron-dextran had higher hemoglobin levels and heavier weights than pigs given an oral iron pill. Maner <u>et al</u> (1959), Zimmerman <u>et al</u> (1959) and Rydberg (1959) also concluded that intramuscular iron-dextran was more effective in maintaining high hemoglobin levels than oral iron treatments such as iron pastes, iron pills and daily spraying of the dam's udders with a ferrous sulfate solution.

Investigations by Maner <u>et al</u> (1959) showed that 2 iron-dextran injections given at days 3 and 10 produced pigs with significantly higher hemoglobin levels than those given only 1 shot at 3 days of age.

This initiated research into the methods of absorption and utilization of iron by pigs. Granick (1946) found that iron was almost entirely retained by the body once it was absorbed. His research also showed that absorption was controlled by ferritin. Iron entered the mucosa and united with apoferritin which resulted in ferritin formation. When ferritin reached an equilibrium with stored iron a "Mucosal Block" inhibited further iron absorption. Indications were that iron was stored both in the liver and bone marrow.

Miller *et al* (1961) established normal hemoglobin values for pigs from birth to maturity (Table 1). His findings revealed that hemoglobin values for new born pigs were similar to adult values. In addition, values did not seem to be influenced by sex. Miller *et al* (1960) and Wahlstrom and Juhl (1960) agreed that hemoglobin values decreased approximately 25% the first 2-3 days regardless of treatment. Rydberg *et al* (1959) theorized that the hemoglobin level must reach a certain minimum value before activation of the hemopoietic center to replace hemoglobin occurs. This slump in hemoglobin could only be reversed by administration of iron.

Table 1. Mean values for hemoglobin in pigs as determined by Miller et al (1961).

Age	Hemoglobin gm./100 ml. Male	Female
Birth	12.6 ± 0.2	12.5 ± 0.2
1 Day	11.3 ± 0.2	11.5 ± 0.2
2 Days	9.7 ± 0.2	10.3 ± 0.2
3 Days	9.2 ± 0.1	9.3 ± 0.1
7 Days	9.7 ± 0.1	9.9 ± 0.1
10 Days	11.2 ± 0.2	10.7 ± 0.3
3 Weeks	10.3 ± 0.1	10.6 ± 0.1
5 Weeks	9.3 ± 0.1	9.5 ± 0.1

CHAPTER III

METHODS AND MATERIALS

This study was conducted at Bowling Green, Kentucky in January, February and March of 1976. The swine herd, farrowing house and laboratory facilities of the Department of Agriculture, Western Kentucky University, were used for the study.

Field Study

The dams chosen for this study were registered Yorkshire sows. The same registered Yorkshire boar was used to sire all the pigs. The sows which farrowed closest together were used for the study. No sow with fewer than 3 pigs was included.

During gestation the dams were maintained on a basic ration of 3 pounds corn and 1 pound of commercially prepared 34% protein supplement fortified with vitamins and minerals. On cold days (atmospheric temperature below 50°F) the dams were fed an additional 1-2 pounds/head/day of corn. Two weeks prior to farrowing the sows were placed on 8-10 pounds/head/day of a standard ration. This ration consisted of 1200 pounds of corn, 400 pounds of the commercially prepared 34% protein supplement and 400 pounds of wheat bran. After farrowing the sows were fed the same ration in the following amounts:

Days after farrowing	1	2	3	4	5	6
Pounds of ration	5	6	7	8	9	10

The sows were maintained in a 1-acre pasture lot with open front shelters until approximately 1 week prior to farrowing at which time they were moved into the farrowing house. The sows and pigs remained in the farrowing house until the pigs were 6 weeks of age.

The farrowing house was a Thrive Center Building purchased from the Huskee-Bilt Division of Tractor Supply. The stalls, partitions between stalls and the slatted floors were made from hot rolled steel (Fig. 2). Each stall was equipped with a Fairfield feeder and waterer. When the pigs were two weeks old a creep feeder was placed in each stall. The creep ration was Central Soya Primer 1 Baby Pig Pre-starter. This ration contained 16% protein, 9% crude fat, 2.5% crude fiber and ASP-250. The ration was fed until 4 weeks of age. Following 4 weeks a 3:1 corn to Central Soya 42% Pig Master Concentrate plus ASP-250 was fed.

The author was present at each farrowing at which time each pig was randomly assigned an identification number and ear notched by the conventional ear notch system. Initial blood samples were also collected at this time.

The treatments were arranged in a completely random design in which the pigs were randomly assigned to treatments at birth. The 3 treatments were: (1) T-0, pigs

Fig. 2. Metal farrowing stalls utilized in study.

given no iron supplements; (2) T-1, pigs given 1 intramuscular injection of iron-dextran at day 2; (3) T-2, pigs given 2 intramuscular injections of iron-dextran, the first on day 2 and the second on day 7. Each injection consisted of 1 ml of iron-dextran containing 100 mg of iron.

Blood samples were taken using a 20-gauge needle to prick an ear vein (Fig. 3). Blood was then drawn into a graduated 20-lambda micro pipette (Fig. 4). Then the 0.02 ml of blood was transferred to a pre-labeled 7 ml vacutainer. This vacutainer contained 10.5 mg of disodium edetate, an anticoagulant, and 5 ml of cyanmethemoglobin solution. The vacutainer was shaken immediately to thoroughly mix the anticoagulant, blood and reagent. This agrees with the cyanmethemoglobin technique of Crosby et al (1954). Blood samples were taken at birth, 4 days, 6 days, 2 weeks and 5 weeks of age. Pig weights were taken and recorded at 2 and 5 weeks of age using a Hanson milk scale equipped with a styrofoam container in which to place the pig.

Laboratory Analysis

The method used to determine hemoglobin was the cyanmethemoglobin technique as described by Crosby et al (1954). The cyanmethemoglobin reagent was prepared using 3 vials of cyanmethemoglobin dry pak and 3 liters of distilled water. The reagent was transferred to a brown glass bottle and stored at room temperature in a dark

Fig. 3. Pricking ear vein for blood sampling.

Fig. 4. Drawing blood into a graduated 20-lambda micro pipette.

cabinet. Five ml of the reagent was placed in each prelabeled vacutainer within 24 hours before the samples were to be taken. After preparing the cyanmethemoglobin reagent, certified standard solutions were used to prepare a curve showing the relative percent transmittances with corresponding hemoglobin levels.

All blood samples were analyzed within 2 hours after sampling. A small portion of the blood-reagent solution was used to rinse a clean cuvette. The remaining solution was poured into the cuvette. The cuvette was then placed in the Shimadru Spectrophotometer QV-50 for reading the percent transmittance. The spectrophotometer was set for 540 nm wavelength and 0.02 mm slit. At each analysis a fresh cyanmethemoglobin standard was prepared to zero the spectrophotometer. Using a chart prepared from the percent transmittance curve the hemoglobin level corresponding to each percent transmittance was recorded.

Statistical Analysis

The analysis of variance was conducted as suggested by Steele and Torrie (1960). In unequal replications of a treatment, individuals were randomly eliminated to provide equal replication. F values were tested for significance at the 0.1, 0.05 and 0.01 levels.

CHAPTER IV

DISCUSSION

Hemoglobin values for the treatments are given in Table 2. Weights for the treatment groups are in Table 3.

Hemoglobin

Birth

Average hemoglobin values at birth were 12.8, 13.3 and 13.4 gm/100 ml respectively for T-0, T-1 and T-2 (Table 2). No differences at the 0.1 level among the treatments were observed. This was to be expected since all 3 groups had been treated alike to this point. These values were slightly higher than the average birth values as reported by Miller et al (1961) in Table 1.

Four Days

Treatments T-1 and T-2 had received an intramuscular injection of iron-dextran at day 2. T-0 had received no iron supplementation.

Average hemoglobin values at day 4 were 10.3, 10.6 and 10.7 gm/100 ml respectively for the treatment groups T-0, T-1 and T-2 (Table 2). No differences were found among treatments ($p > 0.1$). All hemoglobin values showed highly significant decreases ($p < 0.01$) from birth to 4 days of age. These values were higher than the values reported by Miller

Table 2. Mean hemoglobin levels for each treatment at birth, 4, 6, 14 and 35 days of age. (gm./100 ml.)

Age	T-0	T-1	T-2
Birth	12.8	13.3	13.4
4 Days	10.3	10.6	10.7
6 Days	10.7	10.6	10.3
2 Weeks	11.4	12.3	12.2
5 Weeks	14.8	14.7	15.5

Table 3. Mean weight for each treatment at 14 and 35 days of age.

Age	T-0	T-1	T-2
2 Weeks	8.2	8.1	7.8
5 Weeks	18.4	17.5	17.5

et al (1961) for 3 days of age. Miller et al (1961) and Wahlstrom and Juhl (1960) reported that hemoglobin levels decreased an average of 25% the first 2-3 days postpartum. This research showed that hemoglobin values decreased an average of 20% with the following specific decreases: T-0, 19%; T-1, 20%; and T-2, 20% (Fig. 5).

Six Days

The average hemoglobin values at 6 days of age were 10.7, 10.6 and 10.3 gm/100 ml for treatment groups T-0, T-1 and T-2 respectively (Table 2). Again no differences were found among treatments ($p > 0.1$). The values were still depressed as compared to birth hemoglobin as follows: T-0, 16%; T-1, 20%; and T-2, 23% (Fig. 5). This again agrees with Miller et al (1961) who found that 6 days of age was too early for an increase in hemoglobin values to occur. These values were not different ($p > 0.1$) from the 4 day hemoglobin values. However, the values were lower than the birth values ($p < 0.01$) as seen in Table 4. These 6 day values were only slightly higher than the values reported by Miller et al (1961) for 1 week of age (Table 1).

Two Weeks

The average hemoglobin values at 2 weeks of age were 11.4, 12.3 and 12.2 gm/100 ml respectively for the treatment groups T-0, T-1 and T-2 (Table 2). No differences were found among treatments ($p > 0.1$). These values were found to be higher than 6 day hemoglobin values ($p < 0.01$) as seen in Table 4. These 2 week values were higher than

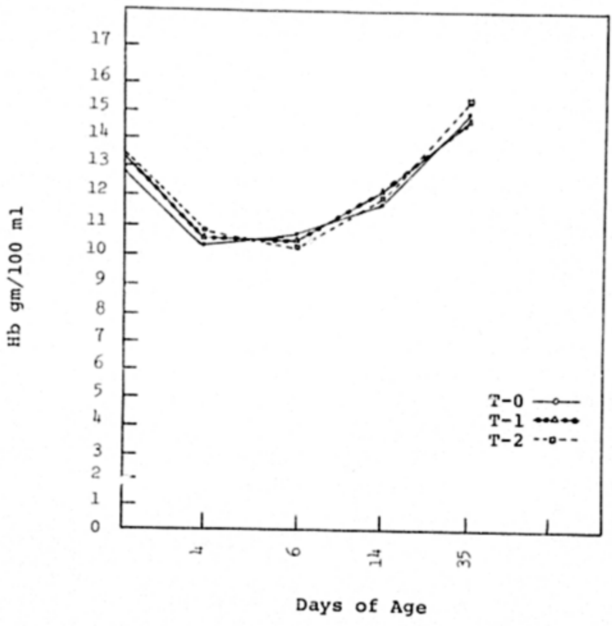

Fig. 5. Hemoglobin levels at various ages for pigs on 3 treatments.

Table 4. Combined means for all treatments at birth, 4, 6, 14, and 35 days.

Age	Hemoglobin gm./100 ml.
Birth	13.37 c
4 Days	10.53 a
6 Days	10.67 a
2 Weeks	12.04 b
5 Weeks	14.77 d

Means followed by the same letter showed no differences ($p > .1$). Means followed by different letters showed significant differences ($p < .01$).

either the 10 day or 3 week values reported by Miller et al (1961) in Table 1.

Five Weeks

The average hemoglobin values at 5 weeks were 14.8, 14.7 and 15.5 gm/100 ml for treatment groups T-0, T-1 and T-2 respectively (Table 2). No differences were found among treatments ($p < 0.1$). The 5 weeks values were higher ($p < 0.01$) than the 2 week values (Table 4). These hemoglobin values were much higher than the values Miller et al (1961) reported as average for this age (Table 1).

Weight

Two Weeks

The average pig weights for the T-0, T-1 and T-2 treatment groups at 2 weeks of age were 8.2, 8.1 and 7.7 pounds respectively (Table 3). No differences were observed among treatments ($p > 0.1$).

Five Weeks

The average pig weights for the T-0, T-1 and T-2 treatment groups at 5 weeks of age were 18.4, 17.5 and 17.5 pounds respectively (Table 3). No differences were observed among treatments ($p > 0.1$).

CHAPTER V

SUMMARY

Hemoglobin values and weights of pigs farrowed and reared in metal farrowing stalls were studied. The farrowing house, swine herd and laboratory facilities of the Department of Agriculture, Western Kentucky University, were utilized. The study was performed in January, February and March of 1976.

The treatments compared in this study were: T-0, pigs given no iron supplement; T-1, pigs given 1 iron-dextran injection at day 2; and T-2, pigs given 2 injections of iron-dextran, the first at day 2 and the second at day 7.

No differences ($p > 0.1$) in hemoglobin values were observed among treatments at birth, 4 days, 6 days, 2 weeks and 5 weeks of age. However, birth values were higher ($p < 0.01$) than either 4 or 6 day values. In addition, 2 week values were higher ($p < 0.01$) than 4 and 6 day values, but lower than birth values. Five week values were the highest ($p < 0.01$) of all values measured. These results concerning hemoglobin levels indicate that there is no reason to supplement iron to pigs farrowed and reared in metal farrowing stalls.

No differences ($p > 0.1$) were observed among treatment

groups for pig weights at 2 and 5 weeks of age. This indicated that there is no reason to supplement iron for increased production when pigs are farrowed and reared in metal farrowing stalls.

The results of this study indicate that pigs farrowed and reared in metal farrowing stalls with metal partitions and metal slatted floors maintained hemoglobin levels comparable to similar pigs receiving intramuscular injections of iron-dextran.

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