

# Nutritional Anemia in Pigs

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**N**UTRITIONAL anemia in pigs has been responsible for considerable economic loss to the swine producers of this country for many years. It is hard to estimate the losses from this condition alone as nutritional deficiencies are often complicated by various forms of enteritis, commonly occurring in our swine herds, as well as heavy parasitic infestations. These two conditions may result in a severe depletion independent of a primary nutritional deficiency and produce symptoms and pathologic changes similar to those associated with nutritional anemia. While the direct loss due to the death of swine is considerable from nutritional deficiencies it does in no way compare with the tremendous economic loss due to the retarded growth and development of the young pigs. Under ordinary conditions we most commonly experience symptoms of nutritional anemia in young pigs from three to six weeks of age. After the pigs begin to consume foods other than the sow's milk, its occurrence is not so frequent. During the past few years of drought conditions in various part of Iowa nutritional deficiencies have been more prevalent, especially in the older swine.

An extensive review of the literature on this subject will not be made but reference to some of the work done by previous investigators which have a direct bearing on the various phases of this work will be included. The observations which we have made over a period of years both at the Research Institute and in the field will be presented and the various environmental conditions affecting pigs will be discussed.

## **Blood Picture**

Unfortunately the blood picture alone has been the basis for the diagnosis of anemia in swine disregarding entirely the clinical picture which is invariably mani-

festated in this condition. Very little consideration has been given to such wide variations found in the blood constituents of young pigs and the effect of environmental conditions on apparently healthy pigs. For a clear understanding of a condition of this nature it is necessary to become familiar with some of the blood constituents of swine in general, considering variations which may exist under certain physiologic and environmental conditions. Scarborough (7) published a comprehensive review of various investigations on the hematology of swine. While this contribution contains much significant data; such factors as size, weight, age and environmental conditions have not been taken into consideration. These factors were known from more recent studies and experience have definite influences on the blood composition. Some of the earlier investigators recognized the influence of the age of an animal on the various blood constituents. The variations in comparable age groups are quite significant. Reports on studies of the hemoglobin content of the blood of pigs at birth were reported by von Falck (2) as 15.6 grams per 100 cc. Doyle (1) reports variations in groups from 13.8 to 9.2. Hamilton, Hunt, Mitchell and Carroll (3) found hemoglobin values from less than 9 to almost 15 grams per 100 cc. averaging 10.75. Hart, Elvehjem, Steenbock, Bohstedt and Farge (4) report the average figure for the majority of new born pigs as about 8.0 grams per 100 cc. It can readily be seen from these reports that there is considerable variation in the hemoglobin content of pigs' blood at birth, probably influenced by various factors including environmental conditions. It was also found that wide variations are reported in the literature on comparable age groups. Kernkamp (5) proposed definite ranges in blood cell counts and hemoglobin values for various age groups, as the result

of his extensive blood studies in swine. He recognizes the wide variation which exist both in the number of erythrocytes and leucocytes as well as hemoglobin values in apparently normal swine.

Extensive hemoglobin studies were carried on here at the Research Institute over a period of years to determine variations occurring between litters and litter mates from birth to six weeks of age under different environmental conditions. Studies were also made on groups of pigs over a period of six months comparing the hemoglobin variations found in pigs raised under the average farm conditions and those farrowed and raised in confinement on concrete floors in our barns. The pigs which were raised and maintained under the average farm conditions were farrowed in small individual hog houses located in large lots and allowed to run with the sow until they were weaned at about eight weeks of age. At that time the sows were removed and the pigs were raised in these pens during the course of study. The pigs which were raised in confinement were farrowed and kept in large pens in a concrete barn. The concrete floors were well drained and the only litter provided was clean oat straw. The sows were confined to the barn seven to twelve days before farrowing.

Table I shows the variation in hemoglobin values between litters of pigs raised under average farm conditions. Records of only a few of the litters made in these studies will be included in this table. All litters were raised under identical conditions.

in the field where other factors have definite influences. Some of these will be considered later. The majority of the pigs show lower hemoglobin values for the first few weeks after birth and then show a progressive rise until they reach fairly uniform values. Many individual pigs and litters that have unusually low hemoglobin values at birth show a progressive rise until they reach the average level.

Table II shows the hemoglobin values among litters of pigs farrowed and raised in our barns on concrete floors.

These litters of pigs showed considerable variations in hemoglobin values at birth. The average of a large number of litters raised under these environmental conditions was considerably lower than that of the litters farrowed and raised under the average farm conditions. The decrease in hemoglobin values in the first few weeks after birth is far more significant than that of the group shown in Table I. In spite of the low averages recorded in some of these litters there was no evidence of any pathologic condition and no losses were experienced.

Table III shows clearly the variation of individuals within a litter of apparently normal pigs raised under the average farm conditions and a group raised in barns up to six weeks of age. The highest and lowest hemoglobin values within the litter at birth are compared with the litter average.

Thus the hemoglobin variations between litter mates at birth may be compared with the litter average when pigs are farrowed and raised under the average farm condition, and when they are farrowed

TABLE I

Number of Pigs in Litter	Birth	Age in Weeks					
		1	2	3	4	5	6
9	9.3	8.2	10.8	11.6	11.9	12.2	12.0
6	10.4	8.8	10.9	12.4	12.0	12.4	12.2
8	6.0	7.8	11.0	11.2	11.7	12.0	11.9
4	13.5	11.7	11.6	12.6	12.2	12.2	12.4

Hb values in gms. per 100 cc.

It appears that in many instances the large litters have lower hemoglobin values than the smaller litters. However, there are many exceptions observed especially

and raised in confinement. Our records on these litters for six weeks show that the pigs having the highest and lowest hemoglobin values at birth usually approach

the litter average as they increase in age and size.

A wide variation was found in the numerical counts of erythrocytes and leucocytes taken the same time at which the hemoglobin determinations were made. It suffices to say that sometimes the numerical blood cell counts decrease as does the hemoglobin during the first few weeks of life. However, there is no close correlation between the variations in the numbers of erythrocytes, leucocytes and hemoglobin values. In apparently healthy young pigs the hemoglobin content of the blood may become quite low without any appreciable decrease in the number of red or white cells.

a mean or normal range for blood constituents in the various age groups of pigs. Many changes observed in the blood composition of young pigs the first few weeks following birth are apparently physiological. The wide range of hemoglobin values and blood cell counts reported by various investigators in the literature confirm such an opinion.

### Etiology

The fundamental cause of nutritional anemia in swine may be defined as a deficiency in all or part of the nutritive constituents and accessory factors necessary for normal growth and development. However, various deficiencies in

TABLE II

Number of Pigs in Litter		Birth	Age in Weeks					
			1	2	3	4	5	6
9	5.3	4.7	3.5	3.6	3.8	4.5	6.8	
8	10.8	4.6	4.2	4.0	4.9	5.3	6.0	
6	10.3	6.5	5.4	6.0	7.8	8.0	10.5	
9	4.2	4.4	4.6	5.2	6.8	7.0	8.2	

Hb values in gms. per 100 cc.

Our experimental data show that there is considerable variation in the blood composition of young pigs as individuals and as litter groups when farrowed and raised under identical conditions. The blood of pigs farrowed and raised entirely in barns show definite tendencies to develop a low hemoglobin content in the first few weeks of life which progressively increases to approach the average of those raised under farm conditions.

It is impossible to attempt to establish

swine are frequently observed without showing any clinical symptoms or indications of anemia.

In discussing some of the more important factors contributing to nutritional deficiencies in pigs, it might be well to start with some of those which influence the condition of the pigs at birth, and are in many instances overlooked or ignored in the field by veterinarians as well as livestock owners. The condition of the breeding herd is probably one of the most

TABLE III

Litter Raised Under Average Conditions				Litter Raised in Confinement		
Age in Weeks	Highest Individual	Lowest Individual	Litter Average	Highest Individual	Lowest Individual	Litter Average
Birth	15.8	6.2	12.6	10.2	7.5	9.2
1	12.5	8.8	8.5	8.5	5.2	6.0
2	12.6	10.7	9.2	6.0	4.0	4.6
3	12.8	11.8	12.2	4.8	4.2	4.6
4	11.9	12.2	12.0	5.9	5.4	6.2
5	11.0	11.5	11.8	7.0	6.8	6.6
6	11.8	10.2	12.4	7.2	8.1	8.4
8 pigs in litter				9 pigs in litter		

important considerations in the management and production of swine. The breeding stock should be strong and healthy. They should be properly fed, should receive plenty of exercise, preferably in a good pasture where an ample supply of green feed and sunlight are available. A constant supply of good fresh water should be available at all times. However, the breeding stock should not be too fat. Difficulties in breeding and parturition are often experienced in sows which are excessively fat. Sows that are maintained in good condition at the time of breeding and during the gestation period usually produce good litters of strong healthy pigs. It is only reasonable to expect that breeding stock which suffers from nutritional deficiencies during the gestation period will be apt to produce pigs with similar deficiencies, or at best, pigs which have little or no reserves. Strong healthy pigs apparently have reserves which will carry them through until they are old enough to consume food substances to supplement the sow's milk. Our breeding stock at the Research Institute is fed well balanced rations and maintained in good condition. The pigs farrowed and raised both under average farm conditions and confined to the barns up to six months of age showed no clinical indications of nutritional deficiencies. On the other hand we have observed cases in the field where the breeding stock was not properly maintained. This resulted in the production of litters having individuals which developed well defined clinical symptoms of nutritional anemia.

### Observations

It might be appropriate at this time to briefly summarize our observations on two groups of pigs from birth to six months of age. Weekly hemoglobin determinations were made on the two groups of pigs. Pigs in Group 1 were farrowed and raised under average farm conditions. The hemoglobin values represent the average of the group which included 10 litters consisting of 84 individuals. The pigs in Group 2 were farrowed and raised in confinement in barn pens with concrete floors. Group 2 included 10 litters con-

sisting of 82 individuals.

The average hemoglobin value for Group 1 at birth was 10.2 gms. per 100 cc. blood. There was a slight drop in hemoglobin content the first week to 9.7 gms., which was the lowest average value that occurred in this group during the course of the study. A steady increase occurred in the next two weeks which reached the maximum of 12.8 gms. at three weeks of age. It was the highest average hemoglobin value obtained for this group. This average at 8 weeks of age was considerably higher, reaching 11.0 gms. There were minor fluctuations in the weekly hemoglobin values during the following period, attaining an average of 11.5 gms. at six months of age.

The average hemoglobin values for Group 2 farrowed and raised under barn conditions was somewhat lower than that of Group 1 at birth being 8.8 gms. The decrease was very rapid for the following two weeks, attaining the lowest average of 4.8 gms. at 21 days of age. The rise in hemoglobin values was rather gradual up to 11 weeks at which time the average was 7.8 gms. This was followed by a slight decrease of 0.5 gms. on the eighth week. There was a gradual increase with few significant variations up to six months of age, showing an average of 10.4 gms. hemoglobin per 100 cc. blood at that time. The pigs in Group 2 which were raised in confinement, were slightly retarded in development from the second to the ninth week compared with the development of the pigs in Group 1. After the ninth week Group 1 showed a progressive improvement in growth and condition up to the close of the experimental study. Even though the hemoglobin values in Group 2 decreased to a very low level, none of the pigs showed any indications of a pathologic condition or nutritional deficiency. Apparently the pigs in Group 2 were strong, healthy pigs having ample reserve and resistance to develop even under rather unfavorable environmental conditions.

### Suckling Pigs

Nutritional anemia is most commonly observed in pigs from two to four weeks

of age. At this time the young pigs' nutrition is entirely dependent upon the sow's milk. This period is considered by some to be the most critical age for young pigs from the standpoint of nutritional anemia. Apparently sow's milk is rather low in some necessary food constituents, particularly the mineral content. The margin of safety for the young pig at this time is small, especially when they are housed under unfavorable conditions. Deficiencies in both quality and quantity of the milk available to the young pigs are therefore of prime importance. Consideration should be given to the condition of the sow prior to and during the gestation period. If the sow has developed a nutritional deficiency prior to farrowing, the pigs are likely to incur a corresponding deficiency. The milk produced by such a sow might be deficient in those nutritive factors. An insufficient quantity of milk produced by the sow for the maintenance and development of the young pigs causes a serious condition of malnutrition in a very short time. In this connection it should be noted that successful stockmen select breeding stock not only for conformation and ability to produce large and healthy litters of pigs regularly, but they consider the sow's ability to produce a sufficient quantity of milk necessary for the rapid growth and development of the young pigs.

Nutritional anemia in suckling pigs is more often observed in the largest and fastest growing individuals of the litter. This no doubt is due to the faster depletion of the reserves caused by the rapid growth and development. When the young pigs reach an age where they are able to consume food to supplement the sow's milk, the danger of nutritional deficiencies are greatly diminished.

#### **Effect of Drought**

During recent years severe drought conditions were experienced in Iowa. Various manifestations of nutritional deficiencies were encountered, some of which resulted in the development of clinical symptoms of nutritional anemia often accompanied by well defined nervous disturbances. In many localities where severe drought

caused complete crop failures, pastures were also depleted. Under these conditions swine were often inadequately nourished. The breeding stock which in many instances was undernourished for a considerable time showed the effects of a general nutritional disturbance. The additional depletion caused by farrowing and nursing of the litter resulted in the development of an anemic condition both in the breeding stock and in the suckling pigs. In regions where feed had to be shipped great distances, it was a common practice to buy only corn to feed to the hogs. As corn is not very rich in protein, many cases of protein deficiencies were observed. On the other hand under conditions where there is a lack of grain and concentrates, the swine are fed excessive amounts of watery feeds. This results in edema and dropsical developments such as are often encountered in protein and vitamin deficiencies. Many nutritionists believe that undernourishment is wholly responsible for this condition. Pigs raised under these conditions may develop clinical symptoms of nutritional anemia.

#### **Mineral Deficiencies**

Mineral deficiencies have attracted the most widespread attention of nutritionists, veterinarians and livestock producers. Oftentimes many other factors which have been discussed previously in this paper and equally important, have been entirely overlooked. The margin of safety, especially in the necessary mineral constituents, is very small for suckling pigs unable to supplement their diet of sow's milk. The minerals which are most commonly found to be deficient include calcium, phosphorus, iron and copper. Anemic conditions have been observed in the field and produced under experimental conditions as the result of mineral deficiencies. The lack of minerals in grain and plants grown under drought conditions or on mineral deficient soils may cause nutritional disturbances in swine. In the northwestern states and western Canada disturbances in metabolism are not uncommon because of iodine deficiency.

#### **Role of Vitamins**

The role vitamins play in nutritional

anemia is not well understood at the present time. An insufficiency of vitamins retards the growth and development of pigs and no doubt has a definite effect on metabolism.

Environment and local conditions may have a definite influence on the health and development of young pigs. Confinement in cold wet barns and the absence of sunlight are contributing factors to nutritional anemia. Mathews et al (6) found that sunlight was effective under certain conditions, in preventing anemia, but that ultra-violet irradiation indoors was ineffective. In our studies on the effect of confinement on young pigs, we found that even though the hemoglobin content of the blood reached extremely low levels for several weeks after birth in pigs farrowed and raised in our barns, no clinical symptoms of anemia developed. These pigs when removed from the barn to pasture at five and six weeks of age showed a remarkable improvement in condition and within one week the hemoglobin content of the blood reached a level comparable to that of the pigs raised under average farm condition. Other factors such as exercise and bits of food picked up in the pasture probably contributed to this improved condition. Pigs that are raised in regions where the soil has definite mineral deficiencies often show symptoms of anemia.

Parasitic infestations and enteritis may be contributing factors in nutritional anemia. Heavy parasitic infestations deplete the natural reserves in young pigs seriously retarding digestion and absorption. Various forms of enteritis also affect the digestion and assimilation of food. It must always be kept in mind that healthy pigs from strong healthy sows usually have ample reserves to withstand a temporary deficiency and are therefore less susceptible to nutritional anemia.

### Symptoms

Clinical symptoms in nutritional anemia, as a rule, develop rather slowly. One or two individuals of a litter of suckling pigs will develop a dry rough skin. The hair soon becomes more or less erect and matted in places. Oftentimes the largest and

fastest pigs are the first to show clinical symptoms. Gradually the pigs seem to lose their vigor and appear rather listless and indifferent to their surroundings. This is followed by languor and fatigue as the results of ordinary locomotion. After violent exertion or prolonged exercise the pigs may sway and often fall to the ground. The head is no longer held erect, the eyelids may droop and the tail and ears hang listlessly. Progressive weakness, loss of appetite and emaciation are often observed. An edematous condition frequently develops subcutaneously in the region of the shoulder and neck, later in the forearm, thigh and legs. The skin becomes thickened, rough, wrinkled and in some instances cracks. Crusts may form on the skin as the result of serious exudates. The mucous membranes become blanched. Respirations may become accelerated and superficial accompanied by a very rapid heart action and a weak pulse.

### Blood Changes

There may be definite changes in the constituents of the blood. Commonly there is a distinct reduction in the number of erythrocytes which may or may not be accompanied by a reduction in the number of leucocytes. The hemoglobin content usually drops to a very low level, often reaching a level of 2.0 gms. per 100 cc. in fatal cases. The decrease in hemoglobin may or may not be accompanied by a corresponding decrease in erythrocytes. It must be kept in mind, however, that all pigs showing clinical symptoms of anemia do not show significant reductions in either the number of erythrocytes or hemoglobin content of the blood.

### Pathologic Changes

Fatal cases of anemia may show severe emaciation. This condition may be masked in a large percentage of cases by large quantities of edematous exudate. The hair coat is dry, coarse, rough and often matted, especially in cases where extreme weakness and emaciation develop. The skin, frequently rough and scaly, may fold and wrinkle about the neck, shoulders and thighs. The apparent swelling in the region of the pharynx and ventral sur-

faces of the neck are the result of edema.

Large quantities of watery fluid are often found in the thoracic and abdominal cavities. The heart usually is pale in color, soft and flabby and may be considerably enlarged. In the subacute and more chronic cases the heart may be covered with a fibrinous exudate. The lungs are sometimes edematous and may show evidence of pneumonia in the more chronic cases. The liver is usually enlarged, pale in color and may be mottled. The degeneration of the liver tissue may be extensive resulting in a yellowish appearance. The kidneys usually are very light in color as the result of degenerative changes. The muscles and tissues in general appear pale and often are quite edematous. The blood usually is much lighter in color than is found in normal swine, but there are frequently exceptions especially in older animals.

#### **Treatment**

The success in treatment of nutritional anemia depends primarily on the accurate determination on the part of the veterinarian of the deficiency responsible for the condition, and the subsequent correction of it. In growing pigs the deficiency is frequently found to be a lack of protein. Growing pigs should receive at least 13% digestible protein. Usually 10% tankage with the protein in the other feeds will be sufficient to secure rapid growth and development. After pigs have reached 100 pounds they may be finished on a fattening ration with little danger of developing a protein deficiency. Other feeds which can be used to supply protein constituents are dried skimmed milk which contains from 30 to 33% digestible protein; alfalfa containing from 10 to 12% and dried yeast which contains 40% or more protein. Because of the bitter taste of yeast it is not advisable to use quantities greater than 10% of the concentrate mixture.

Mineral deficiencies can be corrected without great cost to the owner. Some elaborate commercial mineral mixture, if properly administered, will correct such deficiencies, but a few simple mineral supplements will be quite as effective and can

be secured at much less cost to the owner. It must always be kept in mind that following unusual weather conditions such as drought, especially over a period of years, we may experience definite mineral deficiencies. Calcium deficiencies may be corrected by adding ground limestone to the ration and phosphorus may be supplied by the addition of ground bone meal. In cases where deficiencies of copper and iron occur, addition of copper sulphate and iron citrate have been found to be efficient. It has been observed that iron supplements accompanied by small amounts of copper are much more effective in correcting this deficiency than iron supplement alone. The other mineral requirements essential for normal growth and development are usually supplied in sufficient quantities in the various food constituents.

Where anemic conditions develop in pigs that are confined to buildings the beneficial effects of sunlight, exercise and liberty in pasture cannot be overemphasized. This is especially true where the sanitary conditions of the barns and buildings are not good.

#### **Summary**

The variations in the hemoglobin and cellular content of the blood of young pigs were found to be great in individuals, litters and in litter mates. The effect of confinement in barns causes a definite decrease in the hemoglobin content of the blood. The variations were found to be so great in apparently healthy pigs that any attempt to diagnose nutritional anemia from the blood picture alone is not to be recommended.

The various deficiencies in nutritive constituents, accessory factors and conditions which influence the normal development of pigs resulting in nutritional anemia were discussed. Means of preventing anemia, especially in young pigs by proper nutrition and management of the breeding stock, cannot be overemphasized. The effects of various environmental conditions on the growth and development of pigs were considered. The effect of prolonged drought conditions on feeds and pastures with the possible development of

nutritional deficiencies in livestock should not be overlooked.

The symptoms and pathologic changes described, together with the blood picture, should be the guide for diagnosis of nutritional anemia.

The most common deficiencies occurring in swine have been described and effective means of correcting these deficiencies have been discussed. Certain supplements to inadequate rations have been suggested relative to certain specific deficiencies. However, the changes in feed should be gradual as a radical change might cause a severe digestive disturbance which might prove detrimental to pigs showing clinical symptoms of anemia.

Certain infectious diseases and parasitic infestations resulting in loss of appetite and generalized toxemia are factors favorable to the development of nutritional anemia.

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## Book Reviews

**Animal Pathology.** Russel A Runnells, D.V.M., M.S. Associate Professor of Veterinary Pathology, Iowa State College. 1st Edition. 480 pages, 125 plates. Collegiate Press, Inc., Ames, Iowa. 1938. Price \$6.00.

This is the first American text to adequately cover the field of animal disease from the standpoints of General Pathology, Systemic Pathology and the Special Pathology of the Specific Infectious Diseases. The veterinarian and the veterinary student feel the need for text and reference books just as much as do the physician and the medical student. The relatively small number of veterinarians and veterinary students make publication a difficult problem to the business management of a publishing house. This explains, at least in part, the relative scarcity of books on animal disease.

Doctor Runnells and his publisher have produced a clearly written, attractively printed and bound volume with excellent half-tone illustrations. When used as a teaching text it should obviate the tedious

note-taking so necessary in the past. Animal Pathology may now be taught on a recitation-discussion basis to the profit of both student and instructor. Its adoption as a required text by all the veterinary colleges in North America will insure the necessary revision that keeps any text alive and up-to-date.

Errors in printing are surprisingly few and there are no seriously objectionable interpretations of the process of disease as viewed in the light of our present inadequate knowledge of certain of them.

The brevity of the text may appear as a disadvantage, but the reference at the end of each chapter are intended to provide the more advanced reader with sufficient source material. This keeps the cost of the book within reason.

—E. A. Benbrook

#### A Vitamin Deficiency

Absence of Vitamin A, rather than any poisonous substance in the meal itself, is back of the so-called cotton seed meal "poisoning" which quite often develops in dairy herds and in beef cattle on feed.