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**Review Article**

# Iron deficiency anemia in piglets and molecular mechanisms involved in iron metabolism: A review

S. Sawhney[1*], G. Sarkar[2], S. Begum[1] and A. K. De[1]

[1]Animal Science Division, ICAR- Central Island Agricultural Research Institute, Port Blair- 744 101, Andaman and Nicobar Islands, India; [2]Department of Veterinary Pathology, ICAR- Indian Veterinary Research Institute, Bareilly- 243 122, Uttar Pradesh, India

## Abstract

**Iron deficient anemia (IDA) is the major cause of death of piglets in swine industry. Newborn piglets suffer from iron deficiency anemia (IDA) after few days of birth. During birth, piglets possess approximately 50 mg of iron store which gets exhausted very quickly as the daily iron requirement is 7-15 mg. In addition, sow milk is deficient in iron and provides minimal quantity of iron to newborn piglets. Therefore, newborn piglets suffer from iron deficiency anemia (IDA) after few days of birth if not supplemented with iron from outside. Intensive rearing makes the condition worse as piglets kept in pens are not in contact with soil. Anemia is the first sign of IDA, and it affects both humans and animals. In swine farms, iron supplementation is given to meet the daily requirement of iron. Single or two doses of intramuscular iron injection is generally practiced to avoid IDA in piglets. Moreover, oral iron supplementation in the form of paste applied to the sow's udder or in the form of feed supplementation is also practiced. There are various hematological and reticulocyte indices which are generally used for the diagnosis of IDA in piglets. The most commonly used diagnostic approaches are measurement of blood hemoglobin, serum iron, total iron binding capacity, serum ferritin and serum transferrin saturation. The current review deals with different aspects of iron deficiency anemia in piglets and molecular mechanism involved in iron metabolism.**

**Keywords:** Anemia, Hemoglobin, Iron deficiency, Iron metabolism, Piglet

## Highlights

- This review article narrates different aspects of iron deficiency anemia (IDA) in piglets.
- This article provides information on iron metabolism and homeostasis.
- It gives significant details about laboratory diagnosis of IDA in piglets.
- The review also discusses different measures, especially iron supplementation, to prevent and control IDA in piglets.

## INTRODUCTION

Iron is a crucial micronutrient for the survival of all kinds of life forms, yet it is the most commonly deficient micronutrient worldwide (McLean *et al*., 2009; Starzyñski *et al*., 2013). The importance of iron in health and medicine has been recognized since antiquity (Guggenheim, 1995; Beard and Dawson, 1997). Our body contains iron in different forms, with about 60-70% of the body's iron as hemoglobin (Hb) in circulating erythrocytes, about 20-30% as mobilizable iron store, about 3-7% as myoglobin found in muscle tissues and about 1% in various other enzymes (Ponka *et al*., 1998; Abbaspour *et al*., 2014; Svoboda *et al*., 2017). Adequate quantities of iron are required to enable RBCs to carry oxygen in the blood through Hb and store it in muscle cells through myoglobin. It also participates in heme production, cell division and various enzymatic reactions including electron transfers and oxidation reductions (Suttle, 2010; Pantopoulos *et al*., 2012).

Neonates require nutrition which has a vital impact on their growth and development during early stages of life. Iron is one such trace

*Corresponding Author, E-mail: snehasawhney88@gmail.com

element available abundantly, yet its deficiency is seen in infants, young children, pregnant women and people of all age groups worldwide. Infants may face this nutritional challenge, and its impact can be severe, long-lasting and sometimes irreversible (Turawa *et al.*, 2021). When the body's iron reserve is depleting, or the body is not receiving enough iron or sometimes losing out iron, then the body cannot produce enough Hb and develops iron deficiency, if left untreated, will eventually result in iron deficiency anemia (IDA) (Kessy *et al.*, 2019). It was observed that during IDA, the quantity of red blood cells (RBC), hemoglobin concentration (Hb) and/or packed cell volume (PCV) reduced than their normal levels (Szudzik *et al.*, 2018). IDA is classified as microcytic and hypochromic anemia where there is a decrease in red cell volume and Hb in RBC (Perri *et al.*, 2016).

Almost one-quarter of the world's human population is being affected by IDA (WHO, 2015). Although people of all age groups are vulnerable, children between the age group of 0-5 years of age (42%) and pregnant women (40%) are at a higher risk of developing it (McLean *et al.*, 2009; WHO, 2017; Turawa *et al.*, 2021). In humans, risk of getting IDA occurs mostly during infancy and early childhood and pigs are the only mammalian species which suffer from neonatal anemia (Szudzik *et al.*, 2018) and the first case was reported in 1872 (Boussingault, 1872). All pig breeds suffer from this disorder, but the condition becomes severe in high performance breeds (Perri *et al.*, 2016). If piglets suffer from IDA, they may experience chronic diarrhea as well as appear pale, feeble with stunted growth and short of breath, and if it is not treated, animal may die eventually (Miller and Ullrey, 1997). IDA causes animal's immunity to deteriorate, as well as poor weight gain and in extreme situations, piglet mortality, resulting in economic losses in pig production (Chaud and Alvaro, 2019).

Piglets get iron from sow's milk, soil and feed. Sow's milk provides very minimal amount of iron, and iron supplementation becomes necessary in such situation. In extensive or semi-intensive system of management, piglets get iron from soil, whereas in intensive system of management, as piglets do not have access to soil, chances of developing IDA increases (Antonides *et al.*, 2016). Although, IDA is extremely prevalent in piglets of all breeds, its severity varies and its genesis is unrelated to the piglet rearing or sows feeding practices (Bhattarai *et al.*, 2019). The present review narrates the etiology, symptoms, signs and diagnosis of IDA and measures to control IDA.

## Etiology of IDA in neonatal piglets

**Iron stores in newborn piglets:** At birth, piglets have only 50 mg of hepatic iron store in their body (Venn *et al.*, 1947). The body needs minerals and trace elements for growth, but at the same time iron reserve in the liver begins to run out shortly after birth. As they are rapidly growing, they require 8-16 mg iron daily; therefore, the iron store is exhausted in 3-5 days (NRC, 2012; Wilcock and Walk, 2016). It is understood that without iron supplements in the first 48 hrs of their lives, piglet's reserves will get exhausted (Svoboda *et al.*, 2017).

**Large litter size and rapid growth rate:** Due to large litter size and rapid growth rate, the iron stores get exhausted very quickly after birth. If unmet, it may result in severe iron deficiency during neonatal, weaning or post-weaning period and can affect piglet survival rate, as the animal is not receiving the necessary amount of iron required for growth and development (Hamilton *et al.*, 1933; Perri *et al.* 2016; Kim *et al.* 2018). A 30% increase in plasma volume is also seen in growing nursing piglets which reduces the concentration of iron-containing Hb within the body, preventing the production of healthy RBCs, resulting in lack of oxygen in the blood and affecting other metabolic processes, eventually leading to anemia (Miller and Ullrey, 1997).

**Low iron content in sow's colostrum and milk:** Neonates are always at a higher risk of developing iron deficiency anemia because the sow's colostrum and milk contain insufficient iron for the piglets (Fransson and Lönnerdal, 1980; Csapó *et al.*, 1996). Iron level in sow's milk varies from 1.4 to 2.6 mg/L (Szudzik *et al.*, 2018). Piglets require 7 mg of iron daily; however, when they consume 0.5-1 L of milk, which contains 60-90% iron, they receive only 1 mg iron daily (NRC, 1968). As the litter size increases, milk and iron accessible to individual pigs decreases, and high milk production may lower the iron level in the milk (Stojanac *et al.*, 2016). Close and Cole (2004) proposed that depletion of sow's body iron reserves would be more compelling in hyperprolific sows because iron demand for a larger number of fetuses and milk production would continue to rise in modern breeding herds. Notably, attempts have been made to increase the iron content in sow's milk by feeding them with high iron diets or by supplementing iron dextran during late gestation and lactation but mostly remain unsuccessful (Pond *et al.*, 1961).

**Removal of contact with iron-containing soil:** In commercial farms, piglets do not have contact with soil, which is a natural provider of iron (Pal and Chakravarty, 2020). McGowan and Crichton (1923) described that litters raised in concrete pens were more likely to develop anemia during second or third week of birth. This condition can be prevented or cured by administering exogenous iron supplementation (oral or parenteral method) to the piglets within first week after birth (Svoboda and Píšťková, 2018).

## Symptoms of IDA

Iron deficiency anemia has different stages, such as chronic anemia and acute anemia. In chronic anemia, pallor and wrinkled skin, absence of pink snout and ears, rough hair coat, listlessness and poor growth rate are observed, whereas in acute anemia, spasmodic respiration and in extreme cases death occurs (Ullrey *et al.*, 1959; Zimmerman *et al.*, 2019). It is also observed that piglets cannot absorb iron supplemented through oral route due to their immature duodenum; hence iron dextran (ferric hydroxide and dextran) or gleptoferron (beta-ferric oxyhydroxide and dextran glucoheptonic acid) based injections are generally recommended to control IDA in piglets (Egeli and Framstad, 1999; Sperling *et al.*, 2018). In some cases, split iron supplementation technique is also followed where 200 mg of iron dextran injection is administered at 3-6 days of age, followed by oral iron supplementation either in paste form or mixed with drinking water till 28 days (Loh *et al.*, 2001).

**Hb levels and iron stores in sows:** In sow, the normal range for Hb is 10-16 g/dL, and less than 10 g/dL indicates anemia (Noblett *et al.*, 2021). Hb level tends to drop during early lactation, and anemia is more common, whereas, during late lactation, Hb levels start to rise (Noblett *et al.*, 2021). A linear fall in average Hb levels from 11.7 g/dL to 10.8 g/dL with increasing parity in hyper prolific sows has been recorded, indicating that the sow's were incapable to replenish their iron levels between parities (Auvigne *et al.*, 2010). Hematologic variables in sows and piglets were unaffected by iron therapy given to mid-gestating sows at farrowing. The reason could be due to low iron stores and increased blood volume during pregnancy. Currently, iron supplementation recommended for pregnant sows is 80 mg/kg in the dry feed (NRC, 2012), which was recommended four decades ago (NRC, 1979).

During late pregnancy, iron requirement of the sow increases rapidly as its erythrocyte mass increases which supply iron to the developing fetuses (Mahan and Shields, 1998; Mahan *et al.*, 2009). Sow parity is crucial for piglets' nutrition; piglets breastfed by multiparous sows between the age of 28-144 days have a lower mortality rate than those breastfed by primiparous sows. After reaching parity 3, sow's iron reserves decline steadily and then remain low for the rest of their lives. The hemoglobin levels remain lower than 10 g/dL in above three parity sows (Gannon *et al.*, 2011); as parity increases, the body iron stores decrease (Peters and Mahan, 2008).

It was also observed that parenteral iron dextran injections to gestating sows or feeding large doses of iron to sows during late gestation didn't improve the iron levels in nursing piglets (Ducsay *et al.*, 1984). There have been few initiatives to raise Hb levels and improve sows' hematological health (Wei *et al.*, 2005). A negative correlation was found between piglet birthweight and piglet Hb level which showed that heavier piglets might have lower Hb levels (Hollema *et al.*, 2020). The current trend of increasing the number of hyper prolific sows in the commercial breeding herd is another risk factor for development of IDA in piglets.

## Iron metabolism and homeostasis

Iron is absorbed mostly at duodenum and jejunum of intestine and there are two forms of iron, that is heme and non heme iron (Milto *et al.*, 2016). Heme iron is obtained from myoglobin and Hb found in meat, seafood, poultry etc. and is easily absorbed by enterocytes via heme carrier protein 1 (HCP1). Non heme iron is found in plant-based foods and has divalent iron $Fe^{2+}$ and trivalent iron $Fe^{3+}$. Divalent metal ion transporter (DMT1) found on duodenal brush border membrane transports $Fe^{2+}$ which is reduced by duodenal cytochrome b reductase (Dcytb), which has ferric reductase activity useful for dietary iron absorption (McKie, 2008). This ferrous iron form either gets absorbed and stored as ferritin or transferred across the apical membrane of enterocytes by divalent metal transporter (DMT1).

The liver, which stores iron either as ferritin or hemosiderin is the largest stores of non-functional iron (Harvey, 2008; Saito, 2014). The heme iron is absorbed through a different system called heme carrier protein 1 (HCP1) (Kim *et al.*, 2018). $Fe^{2+}$ is converted to $Fe^{3+}$ with the help of hephaestin and is exported by basolateral ferroprotein to extracellular space, where it is bound to transferrin in the plasma and transported to the target organ for use (Al-Hassi *et al.*, 2021). The role of transferrin is to chelate iron by reducing the solubility. It also protects iron from forming reactive oxygen species and helps transporting into cells. Iron metabolism proteins such as DMT1, ferritin, ferroportin etc. are regulated by post transcriptional feedback mechanism to maintain cellular iron homeostasis (Mims and Prchal, 2005; Ding *et al.*, 2020) (Fig. 1).

The molecular machinery which is involved in intestinal absorption of iron is immature in newborn piglets. This may be a leading factor in the development of IDA in piglets. Few studies on rodents also suggested that system of iron absorption is well established in adult animals but is not completely functional in early life (Leong *et al.*, 2003).

Ferroportin is strongly regulated by hepcidin levels, as this is the only efflux route of iron from cells. When there are elevated levels of iron, hepcidin is produced by hepatocytes which is a regulatory hormone that strongly controls the transportation of iron from enterocytes into circulation via ferroportin. Hepcidin prevents macrophages from recycling iron by lowering the total iron flux into the circulation and keeping iron homeostasis and hence limits iron toxicity. Its expression is down-regulated when increased erythropoietic activity is seen and/or in case of hypoxia or in iron deficiency (Ganz, 2013). Internalization and degradation of ferroportin restrict iron transport in the presence of hepcidin. If there is an excess of iron in the enterocytes, it is excreted out when they reach the villi's tip (Waldvogel-Abramowski *et al.*, 2014).

Increased expression of DMT1 in epithelial cells of duodenal villi (Slc11a2) is linked with high demand of iron in the body (Canonne-Hergaux *et al.*, 1999). Both mRNA and protein level expression of Slc11a2 gene was found higher in iron deficient piglets as compared to iron-supplemented piglets (Canonne-Hergaux *et al.*, 1999). Staroñ *et al.* (2017) observed that RBC indices and plasma iron were lower in oral iron-supplemented piglets when compared to FeDex injected piglets. On the other hand, bovine hemoglobin supplementation resulted in recovery of severe IDA piglets without affecting hepcidin expression levels. Expression levels of heme oxygenase 1 (HO1) (encoded by the Hmox1 gene) in the duodenal enterocytes were three-fold higher in hemoglobin-supplemented piglets than FeDex-injected piglets and anemic piglets. HO1 is an inducible heme degrading enzyme which increases the levels of ferritin (Staroñ *et al.*, 2017). Timely and precise iron administration to piglets is very important as the nutrient supply helps in intestinal development, nutrition absorption, secretion of digestive juices and enzymes (Ding *et al.*, 2020).

## Iron toxicity

Excess iron is toxic and can cause oxidative damage to cells. Iron dextran is normally non-toxic to piglets, but occasional adverse effects like shortness of breath, tremor and paralysis have been reported (Süveges and Glavitis, 1976). Süveges and Glavitis (1976) and Hirayama and Yasutake (1998) observed inflammation at the site of injection and symptoms developed after 6 hrs of iron injection. The free radicals produced by iron can be harmful for the tissues and cell components. Also, iron toxicity is mostly seen in piglets which are deficient in vitamin E and selenium (Mahan and Vallet, 1997). Few arthritis cases in piglets were also reported on administration of iron dextran, and could be reduced by supplementation of oral iron (Holmgren, 1996; Rantzer *et al.*, 2010). Antioxidants levels should be considered when administering iron dosages, which can reduce the side effects of overdose of iron and affects the immune system (Holmgren, 1996).

Iron stores in the body are tightly regulated to avoid developing toxicity, as body lacks a mechanism to excrete excess iron from the body. Its balance in the body is maintained through absorption in intestine by enterocytes and regulation of iron export from cells (Fig. 1). At cellular level, homeostasis is tightly controlled by iron efflux which is regulated by hepcidin, a crucial hormone of iron metabolism (Lane *et al.*, 2015). Hepcidin is released when iron reserves are high and binds to ferroportin to cause its internalization and destruction. This causes absorbed dietary iron to stay in the

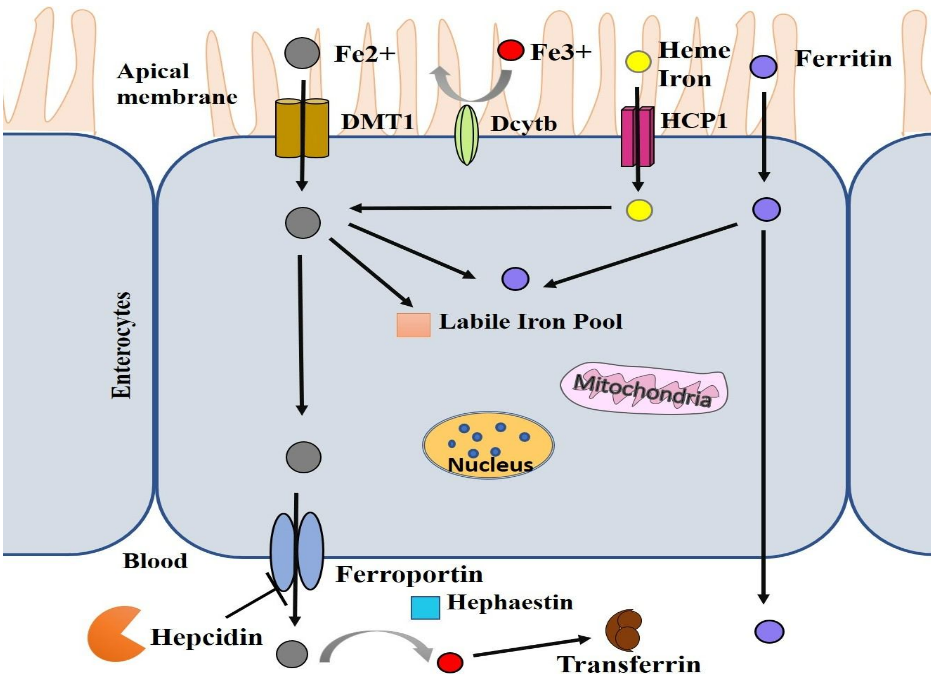


**Fig. 1. Mechanism of intestinal iron absorption**

enterocytes and is subsequently removed by enterocyte shedding. But when iron stores go down, iron efflux from enterocytes to blood increases by suppressing the production of hepcidin (Harvey, 2008; Naigamwalla *et al.*, 2012). Understanding iron metabolism and iron status of sows and piglets on commercial farms can be helpful in the development of effective strategies to reduce the risk of IDA.

## Laboratory diagnosis of IDA in piglets

IDA in piglets is generally detected by measurement of blood hemoglobin level as 80-90% of iron present in the body is utilized in Hb formation (Cook, 2005). Hb values below 9 g/100 mL is known as borderline anemia and requires iron supplementation before it reaches below 8 g/100 mL, which is declared as anemic (Noblett *et al.*, 2021). If the Hb level is 10 or more, it is considered normal. The growth rate is affected when Hb levels falls to 7 g/100 mL. Hb values below 6 g/dL is regarded as severe anemia, while levels below 4 are associated with increased mortality (Zimmerman *et al.*, 2019). According to Bhattarai and Nielson (2015a), Hb concentration below 110 g/L indicates IDA, whereas below 90 g/L indicates anemia. Wei *et al.* (2005) used Hb concentration below 60 g/L as an indicative of severe anemia, whereas, Svoboda and Drabek (2005) suggested Hb concentrations below 80 g/L as indicative of anemia. Besides Hb concentration, other hematological parameters like RBC count, total and differential leukocyte count, platelets count, hemocrit (Hct), hemoglobin distribution width (HDW), mean corpuscular Hb concentration (MCHC), mean corpuscular hemoglobin (MCH), mean corpuscular volume (MCV) and red blood cell distribution width (RDW) are considered for detection of IDA in piglets. Reticulocyte parameters like reticulocyte count (absolute and relative), reticulocyte hemoglobin content (CHr), mean reticulocyte corpuscular Hb concentration (CHCMr), reticulocyte cellular volume (MCVr), reticulocyte red cell distribution width (RDWr) and reticulocyte Hb distribution width (HDWr) are also indicators of iron status in the body (Svoboda and Drabek, 2005; Bhattarai and Nielsen, 2015a; Perri *et al.*, 2016). In case of iron deficiency, low ferritin and iron levels in blood serum and high levels of transferrin and TIBC were recorded. Hepcidin levels in plasma and urine of pigs indirectly help to understand iron status (Starzyñski *et al.*, 2013; Staroñ *et al.*, 2015).

## Iron supplementation to control IDA in piglets

An external iron supply is necessary to control IDA, either orally or by injection (intramuscular or subcutaneous). Iron injection administered within 24 hrs in newborn piglets resulted in a higher growth rate at weaning than untreated piglets, which implies that iron treatment at early stage may enhance their growth rate (Peters and Mahan, 2008). High growth rate of newborn piglets demands large amount of hemoglobin (Hb) carrying RBCs; however, due to low amounts of iron reserves, presence of little iron in sow's milk and restricted access to soil which contains comparatively abundant iron (20-40 g per kg), piglet growth is hampered (Egeli and Framstad, 1999; Colombo *et al.*, 2014).

During the first three days of life, neonates require exogenous iron supplementation to compensate with limiting iron available in their body and prevent them from developing iron deficiency and anemia (Hart *et al.*, 1929; Lipiñski *et al.*, 2010). Iron injection in the form of FeDex (polynuclear iron hydroxide with dextran) and oral iron supplements such as iron salts, carbonyl iron and iron chelate are mostly used (Szudzik *et al.*, 2018).

In commercial pig farms, a 100-200 mg/piglet intramuscular iron dextran injection is administered within 1-7 days of age (Svoboda and Drabek, 2005), which has been followed for many years and has a positive impact on pig's health when administered subcutaneously or intramuscularly or intraperitoneally to piglet's ham or neck muscles (Miller and Ullrey, 1997).

Intramuscular iron supplementation methods should be monitored to prevent iron deficiency and anemia in piglets, as their iron status is not often evaluated. Also, sometimes piglets with sufficient iron may face suppressed immune system and increased chances of infections and morbidity (Svoboda and Drabek, 2005; Wei *et al*., 2005). It was found that when newly weaned piglets were given high amount of zinc oxide to prevent *Escherichia coli* infection, it hampered the absorption of iron from the feed (Perri *et al*., 2016). Despite iron administration, a portion of piglets had anemia with Hb levels below 90 g/L during weaning and post weaning (Perri *et al*., 2016). This could be due to updated management practices used today in commercial swine farms as piglets with fast growth rate are at higher risk of developing anemia.

However, two recent investigations have found that a single dosage of iron given within 48 hrs of birth is insufficient to avoid iron shortage and anemia in newborn pigs (Bhattarai and Nielsen, 2015b; Perri *et al*., 2016). It was also noted that in some pigs, the prevalence of anemia during early nursery phase was higher (Perri *et al*., 2016). Sometimes a second dose of iron of 200 mg on 21 day or 100 mg at 10 day of age is also given to correct the iron status in piglets and to improve the Hb concentrations and iron levels (Jolliff and Mahan, 2011)

**Parenteral iron supplementation:** Rapidly growing pigs need to be supplied with exogenous iron to support their growth rate as they lack Hb in blood at the time of birth. Sperling *et al*. (2018), suggested that the two iron-containing products, i.e., gleptoferron ($C_{13}H_{25}FeO_{15}$) iron and iron dextran are used to prevent in IDA in suckling piglets, have increased the iron uptake by improving the Hb levels in piglets from day 2 to day 31. In 1952, piglets were given an intramuscular iron dextran injection for the first time to treat IDA (McDonald *et al*., 1955). Later, many studies were carried out using iron dextran and found useful in controlling anemia in piglets (Ullrey *et al*., 1959; NRC, 2012). Intramuscular iron dextran injection showed to have fast and high absorption rate when administered in anemia piglets (Martin *et al*., 1955).

A single 200 mg dose was administered within 24-48 hrs after birth. Gleptoferron (Forceris) treated piglets were noted to have higher level of Hb, MCV, haematocrit, Hb concentrations, as well as higher plasma iron and transferritin saturation and a poorer TIBC than iron dextran (Uniferon) treated piglets. Both medications were safe and efficient in preventing IDA in piglets (Sperling *et al*., 2018). According to Morales *et al*. (2018), onetime dose of gleptoferron of 200 mg exhibited greater blood iron concentrations from 2 h to 72 h post treat-ment and its effectiveness was more than the iron dextran-supplemented group (Morales *et al*., 2018).

Currently, large doses of intramuscular injection of iron dextran (FeDex) on 3 to 6 days postpartum is in practice (Egeli and Framstad, 1999; Svoboda and Drabek, 2005) and has improved the hematological values of piglets in comparison to a single injection of 100 to 200 mg of iron (generally applied dosages) which seems doubtful in efficiently getting metabolized and detoxified from the body (Mahan and Shields, 1998). Stojanac *et al*. (2016) found that newborn piglets which received iron dextran complex subcutaneously, intramuscularly and iron in form of micro-encapsulation showed to have higher Fe and Hb levels when compared to control group.

**Mode of action of parenteral iron supplementation:** The iron dextran and gleptoferron injections are high molecular complex forms as they are bound to stabilizer. When iron dextran is administrated, reticulo histiocytic system gets activated, and within seven days, it is utilized from the injection site (Sladic-Simic and Cvetkovic, 1978; Katkiewicz *et al*., 1986). Dextran is decomposed down by the lysosomal enzymes as phagocytes break down the complex, and iron is then stored as ferritin (Katkiewicz *et al*., 1986). When iron is released, it will bind to transferrin and migrate to the desired area. After 24 hrs of injection, iron content of erythrocytes increases, and after four days, improvement is seen in the levels of Hb, PCV and MCV (Vrigazov and Dilov, 1976; Svoboda *et al.*, 2017). Whereas piglets supplemented with inorganic iron were absorbed rapidly within 2 hrs from gut for Hb production than injected iron dextran (Braude *et al.*, 1962).

**Oral supplementation:** There are many methods by which iron can be administered orally to piglets. Soil is the basic source of iron, and if soil is provided in pen frequently, it will provide natural iron to the piglets. However, providing soil in pen frequently is a laborious method (Miller and Ullrey, 1997; Friendship *et al.*, 2021). Painting of sow's udder with saturated ferrous sulphate solution for 4-6 weeks of lactation is another option which aids in the iron uptake by suckling piglets (Miller and Ullrey, 1997). Iron salts mixed with syrups may be given to the suckling piglets for prevention and control of IDA. Iron containing preparations such as iron blocks mixed with sweetened energy source, kept in creep area are also found to be helpful (Szudzik *et al.*, 2018). Friendship *et al.* (2021) found that iron salts mixed with peat moss was an effective source of iron to the piglets. Iron fortified peat moss was found to be as effective as second intramuscular injection of 200 mg of gleptoferron during suckling period. However, oral iron supplements showed slower response than iron-dextran injection (Ullrey *et al.*, 1959).

## Conclusion

Newborn piglets suffer from IDA during their early stages of life. The iron stored in their body is insufficient to meet their daily iron demand, and this needs to be treated immediately. Parenteral and oral are the two ways of iron supplementation by which IDA can be prevented in neonates. The most preferred method is administering iron in injection form. Oral supplementation has also proved to be meeting iron demand of piglets; however, timely check of Hb or Hct levels will avoid the iron deficiency. Serum iron, TIBC, serum ferritin and serum transferrin saturation are some of the important parameters when diagnosing the levels of iron stored in the body. Sometimes single dosage of iron is not sufficient for the rapidly growing piglets, and during 3rd or 4th week, another dose of iron may be required. Over dosages of iron should be avoided as the piglets have immature metabolism, it may cause toxicity and lead to many other side effects which can be prevented by supplying antioxidants to the piglets. Split iron technique may eliminate the risk of iron overdosing as small doses are easily metabolized and may support in overall development of the newborn. High performance breeds are at a greater risk of developing IDA, which should be well examined. Early diagnosis and treatment are helpful in reversing the Hb levels to normal and severe complications can be avoided.

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