Depletion-repletion of dietary iron increases total muscle and liver iron contents, but not aerobic capacity, in pigs

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Current iron (Fe) levels in fresh pork are below requirements to claim for a source of Fe (Anonymous, 2013). Dietary studies to increase muscle Fe in pork have generally failed, although an increase in muscle redness, associated with increased haem Fe, was observed (Apple *et.al* 2007). Under normal feeding conditions about 10% of dietary Fe is absorbed, however this value increases markedly under Fe deficiency (West and Oates 2008). This study tested the hypothesis that feeding lower levels of dietary Fe (depletion) followed by feeding higher levels of dietary Fe (repletion) to pigs will increase muscle Fe levels.

A total of 48 female pigs was allocated to one of two grower-stage diets differing in Fe content (High; 239 ppm or Low; 50 ppm) at 10 kg and fed *ad libitum* for 8 weeks; eight pigs per group were then slaughtered. The remaining 32 pigs were allocated to a cross-over design during the finisher period. Half of the High pigs were fed a high Fe diet (248 ppm; High-High) while the other half were fed a low Fe diet (71 ppm; High-Low). The same design was applied to the Low pigs (Low-High and Low-Low treatments). Pigs were slaughtered after another 7 weeks of supplementation. Liver, heart and muscle samples (*m.longissimus dorsi*-LD; *m.rectus femorus*-RF) were collected. Myoglobin (Mb) and haem Fe were measured in both muscles, and redness in the LD only. Data were analysed using the GLM procedure (SAS®; USA).

Table 1. *Least-square means for iron (Fe) and myoglobin (Mb) concentrations in the* m. longissimus dorsi, m. rectus femoris *and liver (Fe only).*

Dietary Treatments	High	Low	High-High	High-Low	Low-Low	Low-High	SE
m.longissimus dorsi							
Fe (mg/kg)	4.7^{ab}	4.3^{ab}	5.1^{a}	4.3^{ab}	4.0^{b}	4.2^{ab}	0.39
Mb (mg/g)	0.9^{ab}	0.8^{a}	1.7^{d}	1.4^{cd}	1.2^{bc}	1.3^{cd}	0.12
m.rectus femorus							
Fe (mg/kg)	7.0^{ab}	5.5^{a}	7.2^{ab}	8.5^{b}	7.1^{ab}	9.3^{b}	0.94
Mb (mg/g)	1.9^{ab}	1.4^{b}	2.8^{a}	2.9^{a}	2.1^{ab}	2.4^{ab}	0.35
Liver							
Fe (mg/kg)	169.4^{b}	54.1^{a}	294.4^{d}	198.5^{b}	181.5^{b}	247.3^{c}	15.38

[a,b] Significant differences between treatments within rows ($P<0.05$); SE, standard error.

Muscle Fe levels in the Low-High treatment were of a level high enough to be considered a source of Fe (>8.8 mg/kg), but only in the RF, thus partially supporting our hypothesis. Muscle Fe levels in the LD did not change ($P>0.05$) during the finisher period compared to levels in the grower pigs. Liver Fe levels increased ($P<0.05$) during the finisher period; pigs in the Low-High group deposited almost 5-fold more Fe during the finisher period. Heart Fe levels were maintained ($P>0.05$) across all treatments (data not presented). The Mb levels in finisher pigs across both muscles were similar ($P>0.05$), however finisher pigs from the High grower treatment generally trended towards higher Mb levels. Redness was increased in High-High samples (data not presented; $P<0.05$).

Muscle Mb increases with age and with high dietary Fe supplementation, from grower to finishing. The liver acts as a sink for Fe, and it appeared that absorption of Fe was increased by the depletion of body Fe, as observed in the Low-High pigs. Because heart Fe did not differ between treatments, this suggests that the liver will continually supply Fe to tissues with an absolute requirement. These data also suggest that more oxidative muscles (RF) responded in a greater manner to the dietary manipulations tested. Assuming Mb is a measure for oxidative capacity and is correlated with total muscle redness (Lindahl *et al.,* 2001), this dietary depletion/repletion model did not increase total muscle oxidative capacity nor did it detrimentally affect meat redness. Thus, dietary depletion/repletion offers a method for increasing free Fe and keeping pork the 'other white meat'. However, further investigations to optimise these responses are required.

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Supported in part by Australian Pork Limited and Pork CRC Limited Australia.