Effect of dietary addition of iron sulfate in broilers diet on water-soluble phosphorus excreted, minerals digestibility and bone mineralization

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Introduction

❖ Runoff and soil erosion can carry excess phosphorus (P), especially Water-Soluble Phosphorus (WSP), applied to land causing eutrophication (Moore et al., 1999).

❖ Phosphates are commonly removed from municipal and industrial wastewater by precipitation with multivalent metals, such as Fe^{3+} and Al^{3+} (Metcalf et al., 2003).

Background

In a previous trial, it has been shown that the addition of Fe sulfate encapsulated in fat matrix to broiler diet can reduced up to 24% the excretion of WSP in excreta without modifying P retention and growth performance (Floradin and al., 2017).

Objective

The aim of this trial was to evaluate the effect of iron encapsulated or not using a spray-chilling method in terms of growth performance, apparent ileal (AID) digestibility of calcium (Ca), Fe, P and phytic P (PP), kidneys and liver Fe content, and bone mineral content (BMC) of tibia (DXA, Discovery W; Hologic Inc., Waltham, MA, USA) and WSP excretion in litter.

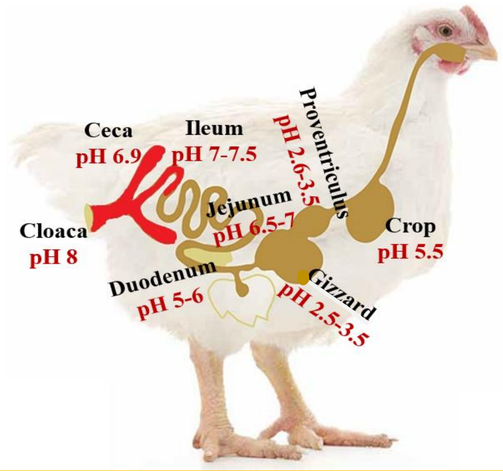
Materials and methods

❖ Three-phases feeding program (0-10, 10-21, 21-34 days) and 5 diets:
- A positive control (PC) (analyzed Fe =300 ppm)
- PC + 2 levels of Fe sulfate (33 , and 60 ppm Fe) encapsulated (FeE1 and FeE2)
- PC + 2 levels of Fe sulfate (33 and 60 ppm Fe) non-encapsulated (FeNE1 and FeNE2).

❖ 2700 males Cobb 500, 45 birds per pen, litter was collected at d 35.

❖ Data were analyzed as a randomized complete block design by PROC MIXED of SAS using contrast (PC+ vs. Fe, FeE vs. FeNE, FeE1 vs. FeE2 and FeNE1 vs. FeNE2).

Target zone for optimal release Fe^{2+} and formation insoluble complexes.



Results and discussion

A really important point to consider is dietary Fe in PC was really higher than expected with 300 ppm

❖ Overall ADG was reduced by iron addition (PC vs other, P = 0.05) except in birds receiving FeE1 (FeE1 vs FeE2, P < 0.05).

❖ A significant increase in AID of P (P <0.001), PP (P = 0.01; Fig 1), Ca (P <0.001) and Fe (P <0.001) was observed with the addition of Fe (PC vs other).

❖ High Fe diets increase Fe concentration in the liver (FeE1 vs FeE2, P =0.003), but kidneys content were not affected (PC vs other, P=0,59).

❖ BMC was reduced with Fe addition (C+ vs other, P = 0.02) except in FeE1 (FeE1 vs FeE2, P =0.009).

❖ Iron did not significantly affect total P litter, but increase WSP in the litter (P <0.001).

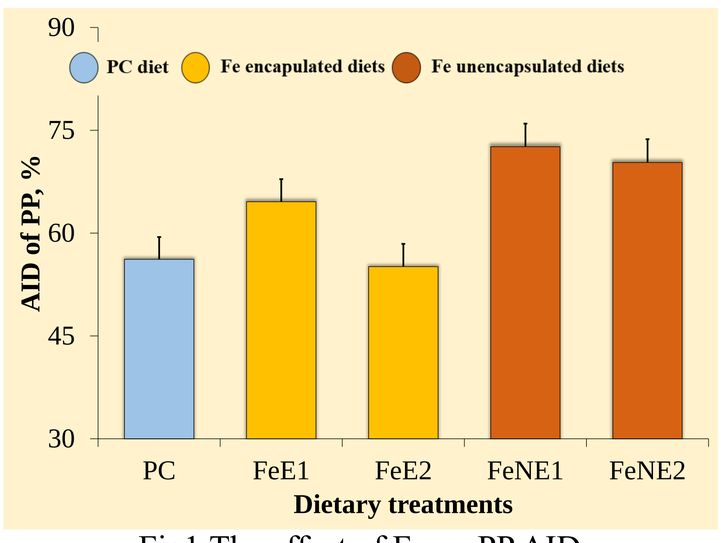


Fig1.The effect of Fe on PP AID

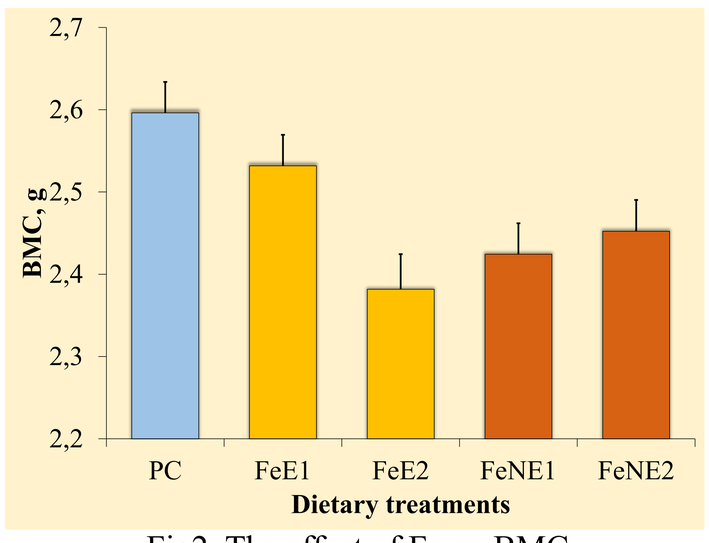


Fig2. The effect of Fe on BMC

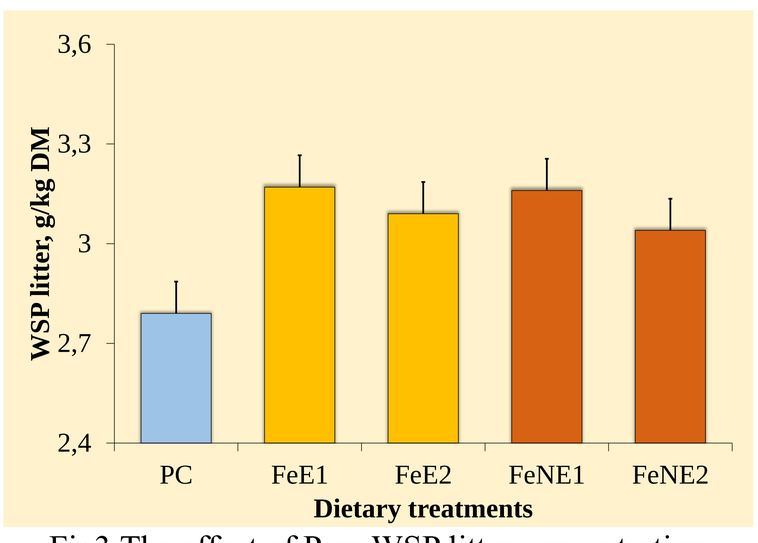


Fig3.The effect of P on WSP litter concentration

Fe complexes P inducing a P deficiency that leads to higher hydrolysis of PP (*Applegate et al., 2003)*

Adverse effect of high Fe concentration on bone mineralization and remodeling (*Tsay et al., 2010; Jia et al., 2012)*, perhaps inducing an increase in urinary excretion of P.

Conclusion and perspectives

❖ Fe addition encapsulated or not reduces growth performance and does not insolubilize the P in the litter.

❖ Fe diets are effective to improve the digestibility of total P and Ca by an increase of hydrolysis of phytic P.

❖ The increase of P digestibility with Fe addition needs further investigation.

References

❖ Applegate et al. 2003 Poult. Sci. 82:1024–1029; Floradin P. (2017). PSA; Jia et al. 2012 J. Orthop. Res. 30:1843–1852 Metcalf, E. E., and Eddy, H. P. (2003). Wastewater engineer treatment disposal, reuse. New York; Moore et al., 1999. Poult. Sci. 78: 692-698;Tsay et al. 2010 Blood, 116:2582–2589.