Development of an oxidative stress model in weaned piglets highlighting plasma biomarkers specificity to different stress inducers

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Introduction

Weaning is a key period involving different stress components (nutritional, immune and behavioral stress) which induce oxidative stress. Oxidative stress is defined as an imbalance between the production of free radicals and antioxidant defenses, in favor of the former and is closely related to immune system and inflammatory status. Piglet at weaning is therefore an interesting reproducible model of oxidative stress, required to further evaluate different nutritional strategies to limit the use of antibiotics on farms and to enhance immune system and animal health.

Objective

The purpose of this study was to determine the effects of vaccination, heat stress and dietary antioxidant concentration on zootechnical performance (Average Daily Gain, ADG and Average Daily Feed Intake, ADFI) and some blood biomarkers (general indicator: resistance of blood to a controlled free radical attack, terminal oxidation product: lipid peroxides, marker of inflammation: haptoglobin and activity of an antioxidant enzyme: glutathione peroxidase) as an effective model of oxidative stress for starter pigs.

Materials and methods

LOCATION : IFIP Experimental unit, Villefranche-de Rouergue (France)

TREATMENTS AND ANIMALS: 360 starter pigs (8.7 ± 1.6 kg) weaned at 28 days were affected to eight groups in a 2×2×2 factorial design. 3 factors were investigated:
- vaccination at weaning against circovirus type II and swine influenza, or not.
- antioxidant supplementation (AOX) from weaning to day 14 (phase 1 period):
  - low antioxidant level: NRC (2012) levels for vitamin E and selenium: 0.3 ppm total selenium (0.1 ppm in mineral form), 16 mg/kg α-tocopherol acetate (vitamin E)
  - high antioxidant level: 0.5 ppm total selenium (0.2 ppm in organic form: selenium yeast ALKOSHEL®), Lallemand Animal Nutrition, Canada, 100 mg/kg α-tocopherol acetate (vitamin E) and 30 mg/kg MELOPHERM® (melon freeze-dried juice concentrate) had high levels of Superoxide Dismutase
- heat stress at days 9-10, 23-24 and 37-38 (37°C over 2x6h periods), or not.

DURATION: from weaning to day 41 after weaning (phase 1 period: 0-14 days, phase 2 period divided into 2 periods: 14-28 days and 28-41 days)

RESULTS:

Vaccination and heat stress decrease ADFI and ADG during phase 2 period (14-28 days and 28-41 days)

Heat stress decreases half-haemolysis time of whole blood and RBC at W+40d

AOX increases GPx activity and half-haemolysis time of whole blood and RBC and decreases the level of lipid peroxides

Vaccination induces higher haptoglobin and lipid peroxide concentrations and decreases GPx activity

Conclusion

A double vaccination at weaning against circovirus type II and swine flu and the repetition of heat stress periods by increasing the room temperature appear to be effective means to develop a model of oxidative stress. Piglets zootechnical performance (ADG and ADFI) were negatively impacted by heat stress and vaccination during phase 2 period. Moreover, the results show a specificity of plasma biomarkers to different stress inducers: resistance of whole blood and red blood cells to a controlled free radical attack is decreased by heat stress, while vaccination decreases GPx activity and increases haptoglobin and lipid peroxide concentrations.

Extra antioxidant supplementation with vitamin E, organic selenium and SOD-rich melon pulp concentrate has a positive effect on the resistance of blood and oxidative status (increased antioxidant enzyme GPx activity and decreased lipid peroxides). This model could be therefore be used to evaluate nutritional strategies to prevent or limit oxidative stress.

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