Impact of Nursery Diet Protein Quality and Fish Oil Supplementation on Immune Response of Pigs

S. Hooda, N. Richmond, D. Wey, J. Zhu, N. A. Karrow and C.F.M. de Lange*
Dept. of Animal and Poultry Science, University of Guelph, Guelph, Ontario, N1G 2W1
*Corresponding author: cdelange@uoguelph.ca

Introduction

Feeding low cost and less complex nursery diets reduces growth performance during the nursery phase only, but does not affect growth performance up to market weight and carcass quality at slaughter (Skinner et al., 2013). However, the immune response – indicator of overall resistance to infectious diseases – was compromised in nursery pigs fed less complex diets (Levesque et al., 2013). Thus, the efficacy of less complex nursery diets appears limited during an immune challenge. Fish oil that has well proven immunomodulatory effects may be included in less complex diets to improve the pig’s immunological status.

Thus, this study was conducted to evaluate the effect of including 5% fish or corn oil in low and high protein quality starter diets on various aspects of the immune responses (e.g. antibody and cell-mediated) of starter pigs.

An immunization protocol was carried out using the antigens albumin chicken egg white (OVA) and Candida albicans (CAA). Vaccination with these antigens stimulates the acute phase response (e.g. secretion of the hepatic acute phase protein haptoglobin, Hp), antibody-mediated immune response (AMIR; e.g. production of IgG1 and IgG2), and cell-mediated immune response (CMIR; e.g. dermal hypersensitivity response).

Materials and Methods

The study was conducted at the Arkell Swine Research Station (University of Guelph, Guelph, ON). One hundred and twenty Yorkshire pigs (60 barrows and 60 gilts) were weaned at a mean body weight of 6.25 kg and 21 days of age, and assigned to 1 of 4 dietary treatments in a 2 × 2 factorial arrangement based on diet protein quality (High vs. Low) and 5% oil (Corn vs. Fish) supplementation. Nursery diets were provided in a 3-phase feeding program with Phase I, II, and III diets fed for 7, 14, and 21 d, respectively. High diets contained plasma protein, soybean isolate (highly digestible purified protein), fishmeal, and crystalline amino acids. Low diets included mainly soybean meal as a source of protein. All pigs were fed a common grower diet thereafter for 14 d. On d 6 post-weaning, 12 pigs (6 per gender) were vaccinated per treatment using intramuscular injections of different antigens (0.5 g OVA; 0.5 g killed CAA; 0.5 mg Quil A adjuvant in 1 ml saline). On the same days, 6 pigs per treatment were injected with saline to serve as controls. Blood samples were collected on d 20 (primary AMIR) and d 34 (secondary AMIR) for determination of total anti-OVA IgG and OVA-specific isotypes IgG1 and IgG2, and on d 22 and 28 for Hp concentration. On d 17 and d 48 post-weaning, all vaccinated and saline injected pigs were given intradermal injection 100 μg OVA dissolved in 50μL of saline in one ear and 100 μg CAA dissolved in 50μL of saline in another ear to measure the dermal hypersensitivity response; in each ear, 50 μL of saline was also injected as a control. Skin fold thickness (SFT) measurements were taken before injection and 6, 24 and 48h post-injection using a skin-fold caliper. Results were considered significant at $P < 0.05$ and tendencies reported $P < 0.10.$

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Results

Anti-OVA antibody secondary (d 34) responses were significantly greater ($P < 0.001$) than primary (d 20); however neither starter diet protein quality nor oil inclusion affected anti-OVA total IgG response. However, IgG1 and IgG2 at d 34 were lower ($P < 0.05$) in pigs fed Fish oil (Figure 1). At d 17 post-weaning, pigs fed Low diet had greater ($P < 0.01$) CMIR to OVA and CAA than pigs fed on High. At d 48, High and Fish oil fed pigs tended to lower ($P < 0.10$) local immune response than pigs that had Low and Corn diets. The vaccination protocol increased ($P < 0.05$) serum Hp levels and Fish oil reduced ($P < 0.05$) Hp level on d 2 and d 6 post-injection in both vaccinated and saline injected pigs as compared to pigs that were fed Corn diets (Figure 2).

![Figure 1](image1.png)

**Figure 1.** Effect of nursery diet protein quality (High vs Low) and 5% oil (Corn vs Fish) supplementation on anti-OVA IgG1, and IgG2.

![Figure 2](image2.png)

**Figure 2.** Effect of 5% oil (Corn vs Fish) supplementation on serum Haptoglobin concentration in control (Saline) and vaccinated (Vaccine) pigs. Within d after vaccination, values with different super scripts differ ($P<0.05$).
Discussion and Implications

Antibody-mediated and cell-mediated immune responses were measurable in all vaccinated pigs, which indicate that the vaccination protocol was efficacious. Fish oil supplementation seems to affect immune response more than starter diet protein quality. Fish oil supplementation in starter diets attenuated the AMIR and CMIR indicated by IgG1 and IgG2, and SFT measurements, respectively. Inclusion of fish oil in starter diets also lowered early stages of the host acute phase response as indicated by serum concentration of Hp. However, the net benefit of fish oil in severe and natural disease challenges should be evaluated in future studies. In addition, maternal feeding and dose-dependent effects of fish oil on immune response should be explored.

References