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Dietary nucleotide supplementation reduces occurrence of diarrhoea in early weaned pigs ☆

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Abstract

In the weaning period, transition from sow's milk to the post-weaning diet causes the withdrawal of important nutrients as milk nucleotides, which are known to be determinant for the development of the gastrointestinal tract and immune function. The objective of these investigations was to study the effect of including these nucleotides in solid diets for piglets. Nucleotide composition of sow's milk was analyzed using 5 sows at 21 days of lactation. The average free nucleotide concentration was 102.8±9.16 μmol/100 mL. Two experiments were performed to assess the effect of a product based on this composition (Nucleoforce Piglets®) on digestive adaptation and incidence of diarrhoea of nursery piglets. In Exp. 1, three groups of 6 piglets were weaned at 21 days of age and fed with a diet supplemented with 0 (control), 1000 or 2000 ppm of nucleotides, and a fourth group of 6 piglets was maintained in lactation. Seven days after weaning, piglets were euthanized and samples of jejunal mucosa were processed for histological measurements. Villus height decreased from 448 μm in un-weaned pigs to 275 μm in the control group 7 days after weaning. Although there were no differences in feed intake among groups, the reduction in villous height was less pronounced ($P<0.001$) in nucleotide supplemented groups showing a villous height of 351 and 378 μm with the doses of 1000 or 2000 ppm respectively. In Exp. 2, 384 early weaned pigs were fed during 14 days with a diet supplemented with 0 (control), 750 and 1000 ppm of nucleotides. ADG and ADFI were not modified by the treatment, but nucleotide supplementation reduced the number of pigs treated with antibiotic as a result of diarrhoea (15.63% vs 3.13% and 1.56%; for control, 750 and 1000 ppm; $P<0.001$). These results suggest that dietary supplementation with nucleotides from yeast might help to prevent post-weaning diarrhoea in piglets.

Keywords: Weaning pig; Dietary nucleotides; Diarrhoea

1. Introduction

Weaning is a crucial phase in the current pig production systems. Early weaning is commercially advantageous but is generally accepted as a stressful event and is often associated with a period of underfeeding (Le Dividich and Herpin, 1994). This may cause a strong reduction in the length of intestinal villi, which consequently reduces the gut digestive as well as

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absorptive capacities causing poor performance and often diarrhoea (Nabuurs, 1991).

Nucleotides are milk micronutrients of particular interest. Although they can be synthesized endogenously, some tissues such as the lymphoid tissue or the intestines have a low biosynthetic capacity, and are probably dependent on an exogenous supply (van Buren and Rudolph, 1997). Dietary nucleotides have a key nutritional role for maturation of these tissues in periods of intensive development (Sanchez-Pozo and Gil, 2002), such as the lactation period. This might explain why the mammal's milk is specially rich in nucleotides (Schlimme et al., 2000). Nucleotides are usually present in commercially available post-weaning diets, but their content may be insufficient to allow proper intestinal maturation.

The objective of the present experiment was to study the effect of nucleotide supplementation on intestinal morphometry of post-weaned pigs, and its impact on productive performance and incidence of diarrhoea.

2. Materials and methods

The nucleotide composition of sow's milk was studied and a yeast concentrate (Nucleoforce Piglets®, Bioiberica, Palafolls, Spain) was designed to be included in the post-weaning diets providing the same amount of nucleotides per day than sow's milk, considering an estimated daily milk intake of 1 kg per day (Pluske et al., 1997) and a post-weaning feed intake of 250 g/d. The effect of nucleotide supplementation was determined on intestinal morphometry (Experiment 1) and on productive performance and occurrence of diarrhoea under practical conditions (Experiment 2).

Mammary secretions of five multiparous sows at day 21 of lactation were collected from all functional teats within 12 h post-weaning. Samples were collected by hand-stripping the mammary glands. A total of 30 mL of milk was collected from every sow and stored at −20 °C. Nucleotide extraction and analysis were carried out in duplicate following the method of Ferreira et al. (2001). Samples were analyzed for 5′monophosphate nucleotides using a Waters (Milford, MA) 2695 HPLC system with ultraviolet λ variable WATERS 2488 detector.

2.1. Experiment 1

Twenty-four piglets (Landrace × Large White × Duroc) from six litters were selected and randomly divided in 4 groups ($n=6$) according to body weight, sex and litter in a randomized complete block design. Three groups were weaned at 21 days of age and housed in 1.2 m × 1.8 m pens with woven-wire floors and controlled environment. Piglets were fed ad libitum a standard post-weaning diet (2600 kcal ME/kg; 193 g CP/kg; 13 g lys/kg) supplemented with 0 (control), 1000 or 2000 ppm of Nucleoforce Piglets®. The remaining group of 6 piglets was maintained in lactation without access to creep feed. Seven days after weaning, feed intake was recorded and piglets were weighed and killed by an intravenous Na-thiobarbital injection (200 mg kg^{-1} LW). Immediately thereafter, the abdomen was opened and the whole gut was excised. A portion of approximately 20 mm in length of the distal jejunum (2 m from ileocecal junction) was fixed by immersion in 100 g L^{-1} phosphate-buffered formalin. Tissue samples for the morphometric study were dehydrated and embedded in paraffin wax, sectioned at 4 μm and stained with haematoxylin and eosin. Villous height and crypt depth were measured in 10 well oriented villi in each sample using Leica DMLS2 microscope with Leica IM500 software.

2.2. Experiment 2

A total of 384 piglets were weaned at 21 days of age, and randomly allocated to 16 replications of 3 dietary treatments (128 pigs/treatment) according to body weight, sex and litter in a randomized complete block design and housed in 1.75 m × 1.20 m pens (8 pigs/pen) with woven-wire floors and controlled environment. Piglets were fed ad libitum during 2 weeks with a standard post-weaning diet (2503 kcal ME/kg; 200 g CP/kg; 13 g lys/kg) supplemented with 0 (control), 750 or 1000 ppm of Nucleoforce Piglets®. Piglet body weight and feed intake were recorded weekly per pen. Piglets with clinical signs of diarrhoea were treated with marbofloxacin (Marbocyl® 2%: 2 mg/ kg BW, im). Percentage of i.m. antibiotic injections and mortality as a result of diarrhoea were also recorded.

2.3. Statistical analysis

Antibiotic treatments and mortality were calculated as the percentage of animals treated with antibiotic injections and the percentage of casualties, of the total number of animals. These data were analyzed by chi-square test of FREQ procedure of SAS statistic package (SAS Institute, INC. 8.1, Cary, NC) using dietary treatment as factor. Other data were analyzed by ANOVA, with dietary treatment as classification factor, using the general linear model (GLM) procedure of SAS. Pen was used as the experimental unit in productive performance analysis, while pig was the experimental unit in morphometric data.