Animal Feed Science and Technology 204 (2015) 52–61

Contents lists available at ScienceDirect

Animal Feed Science and Technology

journal homepage: www.elsevier.com/locate/anifeedsci

Ileal amino acid digestibility in egg from hyperimmunized-hens fed to weaned pigs and piglet response to diets contain egg products☆

J.M. Heo[a,b], T.A. Woyengo[a,1], R.K. Kahindi[a], E. Kiarie[a,2], P.K. Maiti[c], C.M. Nyachoti[a,*]

[a] Department of Animal Science, University of Manitoba, Winnipeg, MB, Canada R3T 2N2
[b] Department of Animal Science and Biotechnology, Chungnam National University, Daejeon 305-764, South Korea
[c] Nutratech/J.H. Hare and Associates, Winnipeg, MB, Canada R3Y 1M5

ARTICLE INFO

Article history:
Received 2 October 2014
Received in revised form 12 March 2015
Accepted 14 March 2015

Keywords:
Amino acids
Digestibility
Pig
Egg products

ABSTRACT

Two experiments were conducted to determine the nutritive value of egg obtained from hens immunized with *E. coli* K88 antigens (EGG), and EGG-exchange (an egg product containing 4.0 g/kg EGG, 646.0 g/kg normal egg and 350.0 g/kg inulin; EGG-X) fed to weaned pigs. In experiment 1, 12 ileal-cannulated barrows (initial BW of 17 kg) were fed four diets over two 7-d periods to determine standardized ileal digestibility (SID) of amino acids (AA) in EGG and EGG-X. In period 1, pigs were fed three diets in a completely randomized design to give four replicates per diet. The three diets were a cornstarch-based diets with EGG, EGG-X, or spray dried porcine plasma (SDPP) as the sole source of crude protein (CP). In period 2, a low-casein diet was fed to all pigs to determine endogenous AA losses for calculation of SID of AA. Titanium dioxide (3.0 g/kg) was added in all diets as an indigestible marker. In experiment 2, 96 piglets (initial body weight (BW) of 5.9 kg) weaned at 21 days (d) and housed in 24 pens (4 pigs per pen) were fed four diets in a completely randomized design (6 pens per diet) to investigate the effects of including EGG and EGG-X in diets for weaned pigs on growth performance, pancreas weight, intestinal histomorphology, and blood parameters. The four diets were a corn-soybean meal-based (CON; no antimicrobial agents added), CON + 3.0 g/kg EGG, CON + 50 g/kg EGG-X, and CON + 50 g/kg SDPP. Pigs were fed the test diets for 14 d (phase I) and then a common commercial diet for another 11 d (phase II). Growth performance was determined in both phases I and II whereas the rest of the response criteria were determined in phase I. The EGG and EGG-X were similar in SID of indispensable AA, which ranged from 6.50 g/kg (for histidine in EGG) to 7.96 g/kg

Abbreviations: AA, amino acid(s); ADG, average daily gain; ADFI, average daily feed intake; ANOVA, analysis of variance; BW, body weight; CD, crypt depth; CON, a corn-soybean meal-based diet; CP, crude protein; d, day(s); CSID, coefficients of standardized ileal digestibility; DM, dry matter; DMI, dry matter intake; EGG, egg obtained from hens immunized with *E. coli* K88 antigens; EGG-X, an egg product containing 4.0 g/kg EGG, 646.0 g/kg normal egg and 350.0 g/kg inulin; ETEC, enterotoxigenic *Escherichia coli*; GE, gross energy; GLM, general liner model; h, hour(s); ME, metabolizable energy; N, nitrogen; PUN, plasma urea nitrogen; SEM, standard error of mean; SD, standard deviation; SDPP, spray dried porcine plasma; SID, standardized ileal digestibility; VH, villous height.

☆ A part of the results and data (i.e., SID of AA) in this manuscript has been published in an international symposium entitled "12th Digestive physiology of Pigs": Standardized ileal amino acid digestibility in egg from hyperimmunized-hens fed to nursery pigs, p. 87.

* Corresponding author. Tel.: +1 204 474 7323; fax: +1 204 474 7628.
E-mail address: Martin.Nyachoti@umanitoba.ca (C.M. Nyachoti).

[1] Present address: University of Alberta, Edmonton AB, Canada T6G 2P5.
[2] Present address: DuPont Industrial Biosciences-Danisco Animal Nutrition, Marlborough, Wiltshire SN8 1XN, UK.

http://dx.doi.org/10.1016/j.anifeedsci.2015.03.006
0377-8401/

(for arginine in EGG-X). The SDPP had higher (P<0.05) SID of indispensable AA than EGG or EGG-X. The EGG reduced plasma urea nitrogen (PUN); and increased average daily feed intake (ADFI; P<0.05) by 23% and tended to increase (P<0.10) average daily gain (ADG) by 28% in phase II. The EGG-X did not affect growth performance of pigs, but increased (P<0.05) pancreas weight relative to BW. The SDPP increased (P<0.05) ADG, and reduced (P<0.05) PUN. The results show that EGG and EGG-X can be sources of AA in pig diets, and their AA digestibility values could be considered when formulating pig diets using the same. Inclusion of EGG in diets for weaned pigs can result in improved growth performance of the pigs. The EGG-X did not affect growth performance of the weaned pigs likely due to increased metabolic activity in the pancreas as evidenced by the increased pancreas size due to the EGG-X.

1. Introduction

Piglet weaning transition is stressful event that is associated with increased susceptibility to gut infections, especially colibacillosis (Kiarie, 2008). Antibiotics can be used to prevent or treat the infections, but their use is being discouraged because they cause anti-microbial resistance. Thus, there has been a need to develop alternatives to antibiotics have been to manage the gut health.

Egg yolk antibodies from chickens immunized against gut infections with such colibacillosis have been considered as alternative anti-microbial agents in the animal production industry. Several studies showed that early-weaned pigs challenged with *Escherichia coli* (*E. coli*), but fed a diet supplemented with egg-yolk antibody against enterotoxigenic *Escherichia coli* (ETEC) that causes colibacillosis had reduced diarrhea (Owusu-Asiedu et al., 2003a), reduced inflammatory responses (Kiarie et al., 2009a) and improved intestinal morphology (Kiarie et al., 2009b). Whole egg from hens hyperimmunized with ETEC can also be used as an alternative anti-microbial agent (Maiti and Hare, 2010). In addition to EGG, inulin has been shown to improve gut health and digestive capacity of weaned pigs (Awad et al., 2013). Thus, addition of inulin to EGG-containing diets for weaned pig diets may result in further improvement in gut health and digestive capacity of the weaned pigs. A product containing both EGG and inulin (EGG-X) for improving gut health and hence performance of weaned pigs has been developed. However, there is lack of information on effects of including EGG and EGG-X in diets for weanling pigs on growth performance and indicators of health of weaned pigs and on the availability of AA in EGG and EGG-X fed to weanling pigs. The objectives of the present study were to determine; (i) SID of AA of EGG and EGG-X; and (ii) growth performance, intestinal morphology, and blood parameters of weaned pigs fed diets containing EGG and EGG-X.

2. Materials and methods

The experimental protocols used in the present studies were reviewed and approved by the Animal Care Committee of the University of Manitoba and animals were cared for according to the guidelines of the Canadian Council on Animal Care (CCAC, 2009).

The evaluated EGG and EGG-X were obtained from Nutratech/J.H. Hare & Associates Ltd. (Winnipeg, MB, Canada). The EGG, which is commonly known as HYPER-EGG® K-88, was produced as described by Maiti and Hare (2010) and contained specific polyclonal antibodies against ETEC K-88 with an antibody titers of 1:256,000. The EGG-X, which is commonly known as HYPER EGG-X change, contained contained 4.0 g/kg HYPER-EGG (with an antibody titers of 1:166,400), 646.0 g/kg normal egg and 350.0 g/kg inulin. The SDPP was obtained from Farmlands Proteins Plant (Maquoketa, IA), and was included in the study for comparison. The pigs used in both experiments were Genesus (Yorkshire-Landrace female × Duroc male), and were obtained from the Glenlea Swine Research Unit, University of Manitoba.

2.1. Experimental design, animals, housing and diets for experiment 1

The experiment was conducted to determine the coefficients of standardized ileal digestibility (CSID) of AA in EGG and EGG-X fed to weaned pigs. Twelve barrows (initial BW of 17 ± 1 kg), fitted with a T-cannula at the distal ileum (Nyachoti et al., 2002) were housed individually in plastic-covered expended metal floor pens (1.47 × 1.14 m) in a temperature controlled room (20 ± 2 °C). Each pen was equipped with a feeder and a nipple drinker, which allowed pigs to have unlimited access to water at all times.

The experimental diets included a cornstarch-based diet with either 300.0 g/kg EGG, 429.0 g/kg EGG-X, or 165.0 g/kg SDPP as the sole source of CP and AA; a diet containing 55.0 g/kg casein was fed to estimate basal endogenous AA losses for determining SID of AA (Table 1). During the initial 7 d, four pigs were randomly assigned to each of the EGG-, EGG-X or SDPP-containing diets and during the next 7 d all pigs were fed the casein diet ($n = 12$). During each period, pigs were adapted to the diets for 5 d followed by a 2-d digesta collection period (12 h per day). Daily feed allowance was set at 4% BW at the beginning of each period and offered in two equal portions at 08:00 and 16:00 h as a dry mash. Ileal digesta were collected in