In Ovo Peptide YY Administration Improves Growth and Feed Conversion Ratios in Week-Old Broiler Chicks[1]

B. A. COLES,* W. J. CROOM,*[,2] J. BRAKE,* L. R. DANIEL,* V. L. CHRISTENSEN,* C. P. PHELPS,† A. GORE,† and I. L. TAYLOR‡

*Department of Poultry Science, North Carolina State University, Raleigh, North Carolina 27695-7608, †Embrex, Inc., Research Triangle Park, North Carolina 27709, and ‡Department of Medicine, Medical University of South Carolina, Charleston, South Carolina 29425

ABSTRACT The effects of *in ovo* Peptide YY (PYY) administration on growth and feed conversion ratios in a commercial broiler line were investigated. Six hundred Ross male × Cobb female eggs were administered either 0.9% saline (control) or 600 μg/kg egg weight PYY *in ovo* at Day 18 of incubation. On day of hatching, 210 birds from each treatment group were randomly placed by sex into pens. Body weights at placement were not different between treatment groups. Average chick body weight and adjusted pen feed conversion ratios were improved by PYY *in ovo* treatment at 7 d posthatch (165.7 *vs* 170.2 g, $P < 0.02$; and 1.55 *vs* 1.49, $P < 0.04$, respectively). No significant differences between treatments were noted for these parameters at 21 or 42 d of age. These results suggest that *in ovo* treatment of broiler chicken eggs with gastrointestinal hormones that increase intestinal nutrient absorption, such as PYY, may enhance chick performance.

(*Key words*: peptide YY, chick, *in ovo* injection, feed conversion)

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INTRODUCTION

Previous studies have demonstrated that digestive processes are not fully developed at hatch in chicks and turkey poults (Krogdahl and Sell, 1989; Nir *et al*., 1993). The failure of the intestinal tract of hatchlings to fully digest and absorb feed may contribute to increased posthatch mortality and subsequent decreases in performance (Nitsan *et al*., 1991; O'Sullivan *et al*., 1992; Nir *et al*., 1993).

Peptide YY (PYY), a member of the regulatory peptide family that includes neuropeptide Y and pancreatic polypeptide, is present in endocrine cells of the lower intestine and the pancreas of vertebrates (Larhammar, 1996). Peptide YY is a gastrointestinal hormone that can be released by the presence of free fatty acids in the lumen of the distal small intestine (Hallden and Aponte, 1997). Peptide YY has been isolated from chicken intestine and was found to contain 37 amino acid residues rather than the 36 residues found in all other vertebrate pancreatic peptide family members (Conlon and O'Harte, 1992).

Although no data are available concerning the effects of PYY on intestinal nutrient absorption by the broiler chicken, it is possible that *in ovo* administration of PYY may enhance the intestinal absorptive capacity of hatchling broiler chicks, resulting in subsequent improvements in performance. This study was conducted to determine whether *in ovo* administration of PYY results in increased growth and improved feed conversion ratios in broiler chickens.

MATERIALS AND METHODS

Six hundred Ross × Cobb eggs were obtained from Embrex, Inc. and treated in accordance with the guidelines of the North Carolina State University Institutional Animal Care and Use Committee. Eggs were randomly divided into two groups. One group was administered 0.9% saline (0.1 mL) and the other 600 μg human recombinant PYY[3]/kg egg weight dissolved in 0.1 mL of saline into the egg air space on Day 18 of incubation. At hatching, 420 chicks were vent-sexed, wing-banded, weighed, and placed randomly by treatment and sex into 60 pens of 7 chicks each. Pens were located within five adjacent rooms with 12 pens per room. Pens were equipped with nipple drinkers and feeders. Room temperatures were maintained at 30 to 32 C for the 1st wk and then decreased

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[2]To whom correspondence should be addressed: jim_croom@ncsu.edu
[3]Quality Controlled Biochemicals Inc., Hopkinson, MA 01748.

Abbreviation Key: AFCR = adjusted feed conversion ratios; FCR = feed conversion ratio; PYY = peptide YY.

TABLE 1. Effect of *in ovo* ($\bar{x}$ ± SEM) peptide YY (PYY) administration at Day 18 of incubation on BW, feed intake, and adjusted feed conversion ratio (AFCR) in broiler chicks[1]

	BW			Feed intake			AFCR		
Age	Control	PYY	*P*<	Control	PYY	*P*	Control	PYY	*P*
(d)	(g)			(g)			(g:g)		
1[2]	43.72 ± 0.15	43.82 ± 0.20	0.68	. . .	. . .	. . .	. . .	. . .	. . .
7	165.73 ± 1.47	170.17 ± 1.39	0.02	1.32 ± 0.01	1.31 ± 0.02	0.44	1.55 ± 0.02	1.49 ± 0.02	0.04
21	641.10 ± 5.18	645.06 ± 4.94	0.57	5.62 ± 0.07	5.69 ± 0.06	0.42	1.37 ± 0.01	1.38 ± 0.01	0.77
42	2,345.22 ± 34.09	2,374.85 ± 30.97	0.20	22.55 ± 0.41	22.51 ± 0.43	0.94	1.88 ± 0.02	1.87 ± 0.02	0.58

[1]n = 210/treatment.
[2]1 = Time of placement.

gradually to 18 to 20 C by Week 6. The light cycle was 23 h light:1 h dark for the entire experiment. Chicks were allowed *ad libitum* access to water and a starter diet (22% CP) for the first 3 wk and a grower diet (20% CP) for the remaining 3 wk.

Pen feed conversion ratios (FCR) were calculated and individual bird weights were recorded at 7, 21, and 42 d of age. At the end of the experiment, Week 6, all birds were euthanatized with CO_2 gas. The total bird weight of each pen plus the weight of dead birds was used to calculate the adjusted feed conversion ratios (AFCR) of each pen at 7, 21, and 42 d. Data were statistically analyzed using the General Linear Models Procedure of SAS® (1988) with treatment, sex, and room as the main effects. Differences were considered significant at $P < 0.05$.

RESULTS

Although there were significant sex differences for body weight and AFCR, there were no sex by treatment interactions; hence, data from both sexes were pooled by treatment groups. Mortality was 2.86% (6/210) for birds hatched from the saline-treated eggs and 4.29% (9/210) for birds hatched from PYY-treated eggs.

The mean body weights of hatchlings at placement did not differ between treatment groups (43.72 *vs* 43.83 g for control and PYY, respectively; Table 1). At 7 d, hatchlings from PYY-treated eggs were 2.6% heavier than chicks from saline-treated eggs. This difference in body weight did not persist beyond the 1st wk after hatching. Similarly, AFCR (Table 1) was 3.87% lower at 7 d (1.55 *vs* l.49 for control and PYY, respectively) but not at 21 or 42 d for chicks from PYY-treated eggs.

DISCUSSION

Although PYY immunoreactive cells have been identified in the duodenum and jejunum of the mature chicken, its biological activity in the chicken is poorly understood (El Salhy *et al*., 1982). Peptide YY amino acid sequence displays more variability than neuropeptide Y sequences, particularly in mammals and chickens (Larhammar *et al*., 1993). Chicken PYY is approximated 70% homologous to that of the human (Larhammar *et al*., 1993). The results of the present study suggest that human recombinant PYY has biological activity in the chicken embryo.

Peptide YY seems to modify the digestive processes to ensure efficient utilization of ingested food (Hallden and Aponte, 1997). The biological activities of PYY include inhibition of gut motility and gastrointestinal and pancreatic secretions (Savage *et al*., 1987; Hallden and Aponte, 1997), and stimulation of jejunal absorption of glucose in mice (Bird *et al*., 1996). Although nutrient uptake of hatchling broiler chicks was not measured in the present study, enhanced nutrient absorption by the intestinal tract of hatchling chicks is one possible explanation for the observed increased growth rates and improved AFCR during the 1st wk of life (Table 1).

Moran (1985) reported the average turnover of avian intestinal epithelial cells averages 2 d. Hence, the cessation of enhanced growth and the efficiency of FCR after 1 wk posthatch would coincide with the complete turnover of the embryonic epithelial cells affected after *in ovo* administration of PYY. In the present study, PYY was administered on Day 18 of incubation 3 d prior to hatching. We presume that PYY was absorbed by the embryonic membranes of the egg and systemically transferred to the embryo. Peptide YY is known to exert effects on the intestinal tract when administered systemically (Bird *et al*., 1996) and luminally (Hallden and Aponte, 1997).

Kuenzel *et al*. (1987) reported that PYY administered intracerebroventricularly in broiler chicks markedly increased feed intake compared to that of saline-injected control birds. In the present study, however, no differences in feed intake were noted (Table 1). Hence, it is unlikely that the observed differences in chick weight and AFCR at 7 d of age is attributable to differences in nutrient consumption associated with PYY administration.

The results presented herein support indirectly the hypothesis that intestinal absorption may limit growth and performance of the modern broiler chicken (Obst and Diamond, 1992; Croom *et al*., 1998). These conclusions are tentative, however, because no direct measurements of intestinal nutrient uptake were made during the course of the study. We cannot discount the possibility of other undescribed biological effects of PYY that could account for the observed posthatch increase in growth and improvement of performance. Further experimentation, including the posthatch administration of PYY and concomitant measurement of nutrient absorption during a 6-wk growth trial, is needed to fully evaluate the role

of PYY in beneficially altering intestinal function and its subsequent effects on performance.

REFERENCES

Bird, A. R., W. J. Croom, Jr., Y. K. Fan, B. L. Black, B. W. McBride, and I. L. Taylor, 1996. Peptide regulation of intestinal glucose absorption. J. Anim. Sci. 74:2523–2540.

Conlon, J. M., and F. O'Harte. 1992. The primary structure of a PYY related peptide from chicken intestine suggests an anomalous site of cleavage of the signal peptide in prepro PYY. FEBS 313:225–228.

Croom, W. J., Jr., B. McBride, A. R. Bird, Y. K. Fan, J. Odle, and I. L. Taylor, 1998. Regulation of intestinal glucose absorption: A new issue in animal production. Can. J. Anim. Sci. 78:1–13.

El-Salhy, M., E. Wilander, L. Grimelius, L. Terenius, J. M. Lundberg, and K. Tatemots, 1982. The distribution of polypeptide YY (PYY)—and pancreatic polypeptide (PP)—immunoreactive cells in the domestic fowl. Histochemistry. 75:25–30.

Hallden, G., and G. W. Aponte, 1997. Evidence for a role of the gut hormone PYY in the regulation of intestinal fatty-acid-binding protein transcripts in differentiated subpopulations of intestinal epithelial cell hybrids. J. Biol. Chem. 272:12591–12600.

Krogdahl, A., and J. L. Sell. 1989. Influence of age of lipase, amylase, and protease activities in pancreatic tissue and intestinal contents of young turkeys. Poultry Sci. 68:1561–1568.

Kuenzel, W. J., L. W. Douglas and B. A. Davison. 1987. Robust feeding following central administration of neuropeptide Y or peptide YY in chicks, *Gallus domesticus*. Peptides 8:823–828.

Larhammar, D., 1996. Evolution of neuropeptide Y, peptide YY and pancreatic polypeptide. Regulatory Peptides 62:1–11.

Larhammar, D., A. G. Blomqrist, and C. Soderberg, 1993. Evolution of neuropeptide Y and its related peptides. Comp. Biochem. Physiol. 106C:743–752.

Moran, E. T., 1985. Digestion and absorption of carbohydrates in fowl and events through perinatal development. J. Nutr. 115:665–674.

Nir, I., Z. Nitsan, and M. Mahagna, 1993. Comparative growth and development of the digestive organs and of some enzymes in broiler and egg type chicks after hatching. Br. Poult. Sci. 34:523–532.

Nitsan, Z., E. A. Dunnington, and P. B. Siegel, 1991. Organ growth and digestive enzyme levels to fifteen days of age in lines of chickens differing in body weight. Poultry Sci. 70:2040–2048.

Obst, B. S., and J. Diamond, 1992. Ontogenesis of intestinal nutrient transport in domestic chickens (Gallus gallus) and to relation to growth. Auk 109:451–464.

O'Sullivan, N. P., E. A. Dunnington, A. S. Larson, and P. B. Siegel, 1992. Correlated responses in lines of chickens divergently selected for 56-day body weight. 2. Organ growth, deoxyribonucleic acid, ribonucleic acid, and protein content. Poultry Sci. 71:598–609.

SAS Institute, 1988. SAS/STAT® User's Guide. Release 6.03. SAS Institute Inc., Cary, NC.

Savage, A. P., T. E. Adrian, G. Carolan, V. K. Chatterjee, and S. R. Bloom, 1987. Effects of peptide YY (PYY) on mouth to caecum intestinal transit time and on the rate of gastric emptying in healthy volunteers. Gut 28:166–170.