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Effect of a direct-fed microbial (Eubios 1090) in the presence of antibiotics (Carbadox or CTC-Denagard) on post-weaning pig growth performance and immune response

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ABSTRACT

A study was conducted to determine the effects of a probiotic (Eubios 1090), in the presence of two different antibiotics, on performance in nursery pigs. A total of 216 pigs were weaned at an average of 21 d, blocked by initial body weight (BW = 6.79 kg), and distributed into 32 pens of 6 to 7 pigs per pen in an offsite nursery facility. Pens were randomly assigned to 1 of 4 dietary treatments (8 pens per treatment) that were fed throughout post-weaning phase 1 (day (D) 0 to 10), phase 2 (D 10 to 20), and phase 3 (D 20 to 34). Dietary treatments were: 1) Carbadox without Eubios 1090; 2) Chlortetracycline + Tiamulin (CTC-Denagard) without Eubios 1090; 3) Carbadox + Eubios 1090; and 4) CTC-Denagard + Eubios 1090. There was no interaction observed between the two antibiotics and addition of the probiotic. There was a tendency for greater gain to feed ratio (G:F) in phase 2 when nursery pigs received Carbadox compared to CTC-Denagard ($P = 0.08$), and a tendency for greater average daily feed intake (ADFI) in the overall nursery period when pigs were fed CTC-Denagard compared to Carbadox ($P = 0.10$). Pigs that received the non-Eubios 1090 diets had greater average daily gain (ADG), G:F, and body weight (BW) during phase 2 compared to pigs that received diets containing Eubios 1090 ($P = 0.05$). In phase 3, pigs receiving the Eubios 1090 diet had increased ADG and G:F ($P = 0.05$). Between the Carbadox diet and the CTC-Denagard diet, the diet containing CTC-Denagard increased ADFI throughout the 3 phases. In summary, probiotic supplementation demonstrated negative effects in phase 2 and positive effects to growth performance in nursery pigs during the latter part of early post-weaning (phase 3).

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MEET THE STUDENT-AUTHOR

Kimberly Santos

I grew up as the daughter of a United States Army infantryman and have lived in seven different states. After graduating from Shawnee High School in Shawnee, Oklahoma, I accepted a four-year Army Reserve Officer Training Corps scholarship along with other numerous departmental and third-party scholarships at the University of Arkansas. I decided to study Animal Science and Equine Science in preparation for veterinary school. In doing so, I have fulfilled my goal in being involved on campus, in the College of Agricultural, Food and Life Sciences, and in the Army Reserve Officer Training Corps. I have been a member of the Meat Science Quiz Bowl, Block and Bridle, and the Poultry Science Club. Also, I have served as the secretary and president for the Pre-Veterinary Club and completed an internship at the Royal School of Veterinary Studies at the University of Edinburgh in Scotland. Honor societies that I am a member of and have held officer positions are Golden Key, Alpha Zeta, and Gamma Beta Phi Arkansas Chapter.

As a contracted scholarship cadet, I have spent my time as the color guard commander at university athletic events and community events, the captain and member of the Arkansas Ranger Challenge Championship team, and the president and competitor of the Pershing Rifles Marksmanship Association. Throughout my achievements, I earned the position as the Razorback Battalion Cadet Commander and became the national recipient of the General George C. Marshall Award.

During my time volunteering then working at the University Swine Research Farm, my interest for studying nursery pigs grew. The pig's performance and health concerned me as well as motivated me to conduct research in the field. Upon graduation, I will be commissioned as a second lieutenant in the United States Army Veterinary Corps. I would like to give special thanks to Dr. Charles Maxwell, Dr. Jason Frank and Benjamin Bass for their ongoing support over the past two years.

INTRODUCTION

Early weaning is a common procedure causing physiological stress due to abrupt changes in diet and environment (Dybkjær et al., 2006). The pigs' transition from the diet of sow's milk to solid feed is usually associated with poor average daily feed intake (ADFI) during the first week after weaning (Spring, 1999). This can cause an adverse impact on the gastrointestinal microflora that can lead to the nursery pigs becoming more susceptible to high numbers of potentially pathogenic bacteria such as *Escherichia coli* and a decline in favorable lactobacilli (Bolduan, 1999). To ensure the gut has sufficient numbers and species of microbes that can benefit growth performance of the early-weaned pig, diets may contain probiotics, a direct-fed microbial (DFM) supplement. Direct-fed microbial supplements can result in a positive effect on the gastrointestinal microflora and subsequent growth performance of the animal.

A probiotic is a feed additive containing bacterial organisms that contribute to the health and balance of the intestinal tract when ingested (Roselli et al., 2005). It has been reported that probiotic factors inhibit adhesion and viability of known enteric pathogens. This suggests that probiotics could be a rich source of new antipathogenic compounds (Howarth, 2009). Research indicates that dietary probiotics may serve as a partial replacement for dietary antibiotics (Roselli et al., 2005). The mechanisms by which dietary antibiotics or probiotics improve growth performance have not been completely clarified, but have been studied at the University of Arkansas. It was concluded that the supplementation of phosphorylated mannans (yeast cell wall) to the newly weaned pig can serve as a growth-enhancing diet additive (Davis et al., 2004a). Because direct-fed probiotics have the ability to alter gastrointestinal microflora, this study was conducted to further evaluate the effect of Eubios 1090 (a probiotic) in nursery diets containing Carbadox or Chlorotetracycline + Tiamulin (CTC-Denagard). Carbadox is an antibiotic product that was approved in the 1970s to prevent and treat dysentery in swine and to maintain weight gain during periods of stress, such as weaning. In a previous study, it was found that Denagard Plus Chlortetracycline, an antibiotic premix, caused an increase in average daily gain (ADG), with Carbadox also improving ADG (Davis et al., 2004b). In recent studies at the University of Arkansas, probiotic supplementation with a *Bacillus* combination diet devoid of antibiotics resulted in improved final body weight (BW) at the end of the nursery period (Novartis Animal Health., 2007).

Probiotics and Antibiotics. One reason for the use of probiotics, instead of antibiotics, is to replace banned uses for antibiotics, such as the recent, April 2007, removal of fluoroquinolones from poultry production in the United States and the removal of growth-promotant use in many European countries (Singer and Hofacre, 2006). Another reason is the voluntary reduction in growth-promotant uses of antibiotics by some of the major poultry production companies and restaurant chains (Singer and Hofacre, 2006). The major driving force influencing these recent changes in antibiotic usage in poultry has been the perceived public health risks associated with this practice. There is a notion that antibiotic uses in agriculture may pose a risk to public health and animal health (Singer and Hofacre, 2006).

Probiotics are a major focus in today's society. They are live microorganisms that may produce a beneficial effect on the health of the animal. Probiotics replace harmful microbes with useful ones (Howarth, 2009). Recently, there has been a growing commercial interest in the probiotic food concept. Weaned pigs are usually chosen to carry out this concept because of the development phases they undergo (O' Hare and Wood, 2003). Because usual weaning procedures are accompanied by a general weakening of the immune system, implementing probiotics into the young pig's system at this time may help stabilize the microflora in the intestinal tract. Probiotic supplementation has been suggested to benefit the host animal by stimulating appetite and improving intestinal microbial population balance, digestion and growth performance of the animal (Dybkjaer et al., 2006).

There has been previous research studying the effects of antibiotics and probiotics on suckling pig and weaned pig performance to determine the effects of a probiotic on growth performance. The results of the study suggest that there is value to routinely administering a probiotic (*lactobacillus* and *streptococcus*) to neonatal pigs to improve pre-weaning performance. Under the conditions of their nursery study, the probiotic (*lactobacillus* and *streptococcus*) tended to enhance ADG and feed consumption in pigs that were weaned into pens with non-littermates (Estienne et al., 2005).

This study will further evaluate the effect of the probiotic, Eubios 1090, with antibiotics (Carbadox or CTC-Denagard) by measuring growth performance parameters in post-weaned pigs.

MATERIALS AND METHODS

Animals and Housing. A total of 216 pigs from the University of Arkansas Research Swine Farm were transported to the University of Arkansas Offsite Nursery Facility. The pigs averaged 21 d of age at weaning and weighed an average of 6.79 kg ± 0.01. Pigs were individually weighed and divided into 5 weight blocks with stratification by sex and litter. Pens were randomly assigned to treatments and pigs were further subdivided into 32 pens with 6 to 7 pigs per pen. Housed in an environmentally controlled nursery, the pigs had *ad libitum* access to feed and water from a 3-head feeder and two nipple waterers.

Diets. Four dietary treatments were arranged as a 2 × 2 factorial and were randomly assigned to pens (8 pens per treatment). Treatments included: 1) 50 g/ton of Carbadox antibiotic added to a basal diet; 2) 400 g/ton of Chlortetracycline antibiotic and 35 g/ton of Tiamulin antibiotic (CTC-Denagard) added to a basal diet; 3) 50 g/ton of Carbadox antibiotic and 0.45 kg/ton of Eubios 1090 probiotic added to a basal diet; 4) 400 g/ton of Chlortetracycline antibiotic, 35 g/ton of Tiamulin antibiotic, and 0.45 kg/ton Eubios 1090 probiotic added to a basal diet. The Eubios 1090 was obtained from Agtech Products, Inc. (Waukesha, Wis.). Pigs were fed the same dietary treatment throughout phase 1 (days 0 to 10), phase 2 (days 10 to 20), and phase 3 (days 20 to 34). Diets were formulated to meet or exceed the dietary nutrient requirements for nursery pigs as determined by the National Research Council (NRC, 1998).

Data Collection. Individual body weight was recorded on days 0, 10, 20, and 34. Feed disappearance was measured for each pen at the end of each phase. These measurements were used to calculate ADG (body weight ÷ number of days), ADFI (weight of feed disappearance ÷ number of days), and G:F (body weight gained to weight of feed disappearance) for each phase. Analyses of data were performed using the PROC GLM procedure of SAS with block and treatment in the model. The P value or probability is significant when ≤0.05, and the P value has a tendency to be significant when ≤0.10.

RESULTS AND DISCUSSION

There were no interactions observed between the antibiotic and probiotic diets. Therefore, only the main effect of antibiotic inclusion and main effect of Eubios 1090 inclusion will be compared as shown in Table 1. There were no differences observed in ADG and BW between the Carbadox diet and the CTC-Denagard diet. In phase 1, ADFI was greater ($P = 0.001$) in pigs fed diets containing CTC-Denagard compared to those that were fed the diet containing Carbadox. During phase 2, there were tendencies for increased ADFI ($P = 0.08$) when nursery pigs were fed diets containing CTC-Denagard compared to those fed a diet containing Carbadox but reduced G:F ($P = 0.08$). Overall, there was a tendency for greater ADFI ($P = 0.10$) when pigs were fed diets containing CTC-Denagard compared to diets containing Carbadox. Inclusion of Eubios 1090 had no effect on ADFI. During phase 2, pigs fed the non-Eubios 1090 diet had greater ADG ($P = 0.02$) and G:F ($P = 0.03$) compared to the pigs fed the diet containing Eubios 1090. Pigs fed the non-Eubios 1090 diet were also heavier ($P = 0.02$) at the end of phase 2. However in phase 3, pigs fed the Eubios 1090 diet had an increased ADG ($P = 0.04$) and G:F ($P = 0.04$).

This tendency for increased ADFI is similar to previous experiments evaluating the effectiveness of Carbadox and CTC-Denagard. Novartis Animal Health reported that pigs fed diets containing CTC-Denagard had increased ADG and ADFI (Novartis Animal Health, 2007). There was a negative effect in pigs fed diets containing Eubios 1090 at an earlier age (phase 1 and 2) when compared to pigs fed diets without Eubios 1090, but once the pigs reached phase 3 their ADG and G:F was greater. One speculation could be that the developing gastrointestinal microflora reacted with Eubios 1090. This concurs with previous research that reported benefits from the addition of Eubios 1090 only during the last 14 days of post-weaning, increasing ADG and G:F (Estienne et al., 2005). However, for the entire 34 day post-weaning period, there was no effect of Eubios 1090 supplementation to pigs in this study.

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Table 1. Nursery pig growth performance in response to four dietary treatments.

	Antibiotic		Probiotic			*P*-value	
	Carbadox	CTC-Denagard	Non-Eubios 1090	Eubios 1090	Standard Error of the Mean	Antibiotic	Probiotic
Average Daily Gain (ADG), g							
Phase 1	110	124	121	113	6.7	0.15	0.39
Phase 2	389	397	409	378	9.3	0.54	0.02
Phase 3	620	625	607	638	10.4	0.73	0.04
Overall	401	409	404	406	6.6	0.41	0.83
Average Daily Feed Intake (ADFI), g							
Phase 1	194	215	207	201	4.1	0.001	0.30
Phase 2	518	545	541	521	11.0	0.08	0.20
Phase 3	872	887	874	884	14.8	0.46	0.63
Overall	568	588	579	577	8.4	0.10	0.87
Gain to Feed Ratio (G:F)							
Phase 1	0.568	0.577	0.585	0.560	0.029	0.83	0.53
Phase 2	0.752	0.728	0.755	0.725	0.009	0.08	0.03
Phase 3	0.708	0.699	0.691	0.716	0.008	0.44	0.04
Overall	0.707	0.695	0.698	0.703	0.006	0.14	0.51
Body Weight (BW), kg							
Initial wt	6.80	6.79	6.79	6.79	0.01	0.37	0.86
Phase 1	7.90	8.03	8.00	7.92	0.07	0.17	0.39
Phase 2	11.79	12.01	12.10	11.70	0.12	0.20	0.02
Phase 3	20.49	20.76	20.61	20.63	0.22	0.37	0.96

Phase 1 = day (D) 1 to 10; Phase 2 = D 10 to 20; Phase 3 = D 20 to 34.