Reduction of intestinal viscosity, liver bacterial translocation and rachitogenic effect of a rye-based diet in neonate chickens consuming a *Bacillus*-based Direct-Fed microbial. By J. Latorre[1], G. Tellez[1], and B. M. Hargis[1], [1]*Department of Poultry Science, University of Arkansas, Fayetteville, AR 72701*

Introduction

Exogenous enzymes such as xylanase are used in poultry diets to reduce anti-nutritional effects caused by the presence of non-starch polysaccharides (NSP). It has been proposed that the mechanism by which xylanases exert their effect is through reducing intestinal viscosity within the broiler digestive tract (1, 2, 3). Additionally, rye feeding has been related to a reduction in bone mineralization and leg problems that could be related to an increment in bile acid deconjutagion, leading to inefficient absorption of fat soluble vitamins such as Vitamin D_3 (4, 5, 6). Moreover, the viscous nature of the rye diets have showed to increase microbial activity in the intestine due to presence of unabsorbed nutrients, which at the end can provoke inflammation and dysbacteriosis (7, 8). Previously, we have reported that dietary inclusion of selected *Bacillus* Direct-Fed Microbial (DFM) candidates that produce exogenous phytase, lipases, proteases, cellulases and xylanases in NSP diets significantly reduced both digestive viscosity and *C. perfringens* proliferation when compared with control diets without the DFM *in vitro*. Therefore, the objective of the present study was to evaluate the effect of the dietary inclusion of the *Bacillus*-based DFM *in vivo* on intestinal physiological and microbiological responses together with bone parameters in neonate chickens consuming a rye-based diet.

Material and Methods

In the present study, starter rye-soybean-based diets with or without DFM were administered ad libitum to one-day-old broiler chickens in two independent experiments (n=12 per group). At day 10, all chickens in both groups were weight and humanely killed. Liver sections were aseptically collected to determine CFU/gram of coliforms on McConkey agar plates. Intestinal contents from duodenum to cloaca were collected and centrifuged to determine viscosity of the digesta using a cone-plate viscometer (1). Bone ash determination was done using the left tibia following the A.O.A.C method of analysis (2000) and bone strength was measured using an Instron 4502 material testing machine with a 100 kg load cell (9).

Results and Discussion

In both experiments, a significant reduction ($P<0.05$) in the total number coliforms in the liver as well as intestinal viscosity was observed in the group of chickens fed the rye-base diet with DFM when compared with the control non-treated diet. In the case of bone composition and bone strength, the inclusion of the DFM improves bone mineralization leading to a higher concentration of calcium and phosphorus in bone ash which was also reflected in superior bone strength. Impaired gut epithelial integrity due to alterations in tight junction proteins may be the pathological mechanism underlying bacterial translocation. Bacterial overgrowth, diet ingredients, immune dysfunction, alteration of the luminal factors, and altered intestinal permeability are all involved in bacterial translocation and its complications. The results of the present study suggest that the NSP from rye-based diets can both enhance bacterial translocation, intestinal viscosity and decrease bone mineralization. However, as observed in the present study, these adverse effects can be prevented by the inclusion of selected DFM candidates. Studies to evaluate the possible inflammatory effects of the NSP in rye-base diets as well as the morphological changes in different sections of the gastrointestinal tract, performance parameters and microbial profiles are currently being evaluated.

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Table 1. Evaluation of body weight, intestinal viscosity and liver bacterial translocation in neonate broiler chickens fed with a Rye-based diet with/without DFM in experiment 1 and 2.

	Experiment 1		
Diet	**Body Weight (g)**	**Intestinal Viscosity (cP Log_{10})**	**Bacterial Translocation (CFU Log_{10})**
Rye-Soybean	110.69 ± 5.21^{a}	8.42 ± 0.57^{a}	1.35 ± 0.45^{a}
Rye-Soybean + DFM	137.67 ± 4.94^{b}	5.42 ± 0.57^{b}	0.27 ± 0.27^{b}
	Experiment 2		
Diet	**Body Weight (g)**	**Intestinal Viscosity (cP Log_{10})**	**Bacterial Translocation (CFU Log_{10})**
Rye-Soybean	140.89 ± 5.21^{a}	8.72 ± 0.83^{a}	2.40 ± 0.73^{a}
Rye-Soybean + DFM	167.66 ± 6.94^{b}	5.22 ± 0.77^{b}	0.36 ± 0.57^{b}

[a-b]Superscripts within columns indicate significant difference at $p < 0.05$

Data is express as Mean ± SE

Intestinal viscosity is expressed in Log_{10} (in centipoise, cp = 1/100 dyne sec/cm^2) from 5 chickens.

Liver bacterial translocation (expressed in cfu Log_{10}/gram of tissue) from 12 chickens

Table 2. Evaluation of bone strength and bone composition in neonate broiler chickens fed with a Rye-based diet with/without DFM in experiment 1 and 2.

Diet	Tibia strength load at yield (kg/mm^2)	Tibia diameter (mm)	Total ash from tibia (%)	Calcium (% of ash)	Phosphorus (% of ash)
			Experiment 1		
Rye-Soybean	1.58 ± 0.01^b	1.61 ± 0.28^b	34.87 ± 0.35^b	18.48 ± 0.27^b	13.15 ± 0.12^b
Rye-Soybean + DFM	2.68 ± 0.01^a	3.61 ± 0.28^a	54.87 ± 0.39^a	36.48 ± 0.87^a	26.15 ± 0.82^a
			Experiment 2		
Diet	**Tibia strength load at yield (kg/mm^2)**	**Tibia diameter (mm)**	**Total ash from tibia (%)**	**Calcium (% of ash)**	**Phosphorus (% of ash)**
Rye-Soybean	2.58 ± 0.03^b	1.82 ± 0.78^b	30.87 ± 0.75^b	21.32 ± 0.46^b	15.67 ± 0.29^b
Rye-Soybean + DFM	3.25 ± 0.09^b	2.91 ± 0.28^a	56.57 ± 0.45^a	40.28 ± 0.21^b	29.75 ± 0.1^b

Tibias from twelve chickens were collected to evaluate bone qualities. Data is expressed as Mean ± SE.

[a-b] Superscripts within columns indicate significant difference at $p<0.05$.