Effect of dietary mannan oligosaccharide on live performance of broiler chickens given an anticoccidial vaccination followed by a mild coccidial challenge.

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A 42 days pen trial with 720 Ross 308 males chicks evaluating the effects of Paracox-5 vaccination at d 1, dietary mannan oligosaccharide (MOS; Bio-Mos® at 0.5, 1.0 or 2.0 kg/t) and an Eimeria challenge (15 d of age) on animal performance and intestinal lesions was carried out. Thirty chicks were placed per cage with a floor area of 2.1 m2. A 3-phase feeding program was applied: starter (0-15 d), grower (16-22 d) and finisher (23-42 d). Experimental treatments (4) were as follows: 1) without vaccination, dietary MOS, or coccidiosis challenge; 2) without vaccination and dietary MOS but with a 3-strain pathogenic Eimeria challenge; 3) with Paracox-5 vaccination at hatch and Eimeria challenge but no dietary MOS; and 4) with Paracox-5 vaccination at hatch, dietary MOS, and Eimeria challenge. The pathogenic Eimeria sporulated oocysts were supplied at day 15 via feed (100,000 *E. acervulina*; 10,000 *E. maxima*; and 15,000 *E. tenella* per bird). Coccidiosis lesion scores were recorded at 22 d of age (scored as 0, 1, 2, or 3 with increasing severity). Overall mean lesion scores ($P < 0.001$) were higher in challenged birds. Paracox-5 alone improved 15 d BW, and 1-15 and 15-22 d average daily gain among Eimeria challenged broilers ($P < 0.05$). Dietary MOS significantly improved FRC at 15-42 and 22-42 d periods of Paracox-5 vaccinated, Eimeria challenged broilers ($P<0.05$). Mortality varied from 4.4 to 5.8%, with no significant differences between treatments. It was concluded that dietary MOS improved FCR of Paracox-5 vaccinated (d 1), challenged (d 15) broilers from 15-42 d of age.

Key words: broiler; coccidiosis vaccine; lesion scores; mannan oligosaccharide; Paracox-5

Introduction

In recent years with the increased emphasis on non-drug production of broiler chicken, live anticoccidial vaccines have been increasingly substituting chemical and ionophore coccidiostast. Results of broiler trials with Paracox (Schering-Plough Animal Health, UK), a live attenuated anticoccidial vaccine were reported (Williams, et al., 1999). The authors concluded that the use of Paracox vaccine may control clinical coccidiosis. However, some intestinal damage occurs following inoculation with live coccidia strains, and opportunistic clostridia often proliferate in the mucus generated by the damaged intestine (Williams, et al., 2003). Therefore, it is essential that coccidial lesions be minimized and immunity maximized. Dietary supplementation with mannan-oligosaccharide (MOS) may be beneficial, in conjunction with live coccidia vaccines, by acting as a general intestinal immune stimulant. Mannan-oligosaccharide works by adversely affecting clostridia that reside near the intestinal wall and as a binding site for certain pathogenic bacteria (e.g., *E. coli* and Salmonella (Zdunczyk et al., 2005). Mannose residues exposed on glycoproteins present at the gut

epithelial cell surface form important attachment sites for several unfavorable organisms.

Flock health, or more specifically gut health, is the most important contributor to optimal animal performance. A dietary additive such as MOS, which enhances the protective antibody response to enhance disease resistance while at the same time suppressing the acute phase (fever) response, is unique and particularly useful in this regard (Collet, 2005). The objective of the trial was to evaluate the effect of MOS (Bio-Mos, Alltech, Inc., Nicholasville, KY) on coccidial lesion scores and live performance of broiler chickens vaccinated with a live coccidiosis vaccine and challenged with a mixture of 3 pathogenic strains of sporulated Eimeria oocysts. In the case of coccidiosis vaccination followed by pathogenic coccidia challenge, dietary MOS may act to ensure optimal initial gut health, mucosal immune response, *Clostridium perfringens* suppression, increased healing of coccidial and secondary clostridial wounds in the intestinal wall.

Materials and methods

The trial was conducted at the ILVO, Animal Science Unit, Melle, (Belgium) with the approval of the Belgium animal care committee. A total of 720 Ross 308 male broiler chicks, raised in floor pens, were randomly divided over 4 dietary treatments with 6 repetitions each. Thirty birds were housed per pen with a total available floor area of 2.1 m^2 per cage. Experimental treatments were as follows: 1) without vaccination, dietary MOS, or coccidiosis challenge; 2) without vaccination and dietary MOS but with a 3-strain pathogenic Eimeria challenge; 3) with Paracox-5 vaccination at hatch and Eimeria challenge but no dietary MOS; and 4) with Paracox-5 vaccination at hatch, dietary MOS, and Eimeria challenge. Dietary MOS was included at 2 kg/tn in starter, 1 kg/tn in grower and 0.5 kg/tn in finisher. No coccidiostats were included in any of the broiler feeds. A 3-phase feeding program was used: starter (0-15 d), grower (15-22 d), and finisher (22-42 d). At 15, 22, and 42 d (end of each feeding period) body weight, feed conversion ratio (FCR), and mortality, were measured. The feed was based on wheat, corn, soybean meal, and heat-treated full-fat soybeans plus supplemental methionine, lysine, and threonine. Crude protein (%) and metabolizable energy (ME_n, kcal/kg) levels in the 3 feed phases were: starter: 20.9 and 2.770; grower: 20.4 and 2.902 and finisher: 19.5 and 2.997; respectively. Average pen weights were recorded at 1, 15, 22, and 42 d of age. Feed intake (FI) was recorded from 1-15, 15-22, and 22-42 d periods, respectively and averaged daily gains (ADG) and feed conversion ratio (FCR) calculated. A challenge with a mixture of sporulated oocysts of pathogenic strains of Eimeria (100,000 *Eimeria acervulina*; 10,000 *Eimeria maxima*; and 15,000 *Eimeria tenella* per bird) was done on day 15 through the feed (i.e., at the end of the starter period) right after pens weighting and FCR determination. After challenge on d 15, coccidial lesion scoring was carried out on d 22 according to the methodology of Johnson and Reid (1970). On d 22 (i.e., end of the grower period), 3 birds per cage that were randomly selected, weighed, sacrificed and the intestinal tract examined for coccidial damage. Lesion scores were recorded as 0, 1, 2, or 3, from least to most severe, respectively. Lesions typical for each of the 3 types of Eimeria were recorded separately. Mortality and culls were recorded for the entire trial (42d). The performance data were subjected to ANOVA and LSD-multiple range test (Statistica, 1995; Snedecor and Cochran, 1989). Prior to analysis of variance, mortality plus culls and coccidial lesion score data were arcsine-square root transformed by using the following procedure: arcsine degrees = arcsine radians (square root (percent or score/100)) x 180/3.1417.

Results and Discussion

Body weight (BW) results at d 1, 15, 22, and 42, lesion scores at d 22, and 1-42 d total mortality plus culls are summarized in Table 1. The BW at day 15, 1-15 and 15-22 d period AVG was higher for the Paracox-5 vaccinated, pathogenic coccidiosis challenged chicks (Treatment [Trt] 3) than for the unvaccinated, unchallenged or unvaccinated, challenged birds (Trt 1 and 2). At the end of the trial (42d) not significant different in BW between treatments was observed. Total mortality plus culls % ranged from 4.57 to 5.81 and no significantly differences between treatments was observed. These means indicate a mild coccidial challenge (compared to 4.44 % mortality without challenge); figures

are similar to those in the commercial broiler industry. Average daily gain (ADG, g/d) of broiler chickens during various phases of growth are presented in Table 2. The ADG OF 1-15 and 15-22 d periods were higher for the Paracox-5 vaccinated, patho-genic coccidiosis challenged chicks (Trt 3) than for the unvaccinated, unchallenged or unvaccinated, challenged birds (Trt 1 and 2) during the same periods.

Treatments results for FCR are illustrated in Table 3. During 15-42 and 22-42 d in coccidiosis challenged broilers, Paracox-5 vaccination alone (Trt 3) negatively decreased (P<0.05) FCR whereas Paracox-5 plus dietary MOS (Trt 4) brought FCR back in line with the unvaccinated, unsupplemented birds (Trt 2). Therefore, dietary MOS was beneficial in improving FCR of Paracox-5 vaccinated, coccidiosis challenged broilers during the 15-42 d period (compare Trt 3 vs Trt 4). Williams et al. (1999) found that FCR of Paracox vaccinated broilers was 2.01 compared to 1.96 for halofuginone then salinomycin or nicarbazin then monensin medicated birds ($P = 0.025$). This indicates about 0.05 poorer FCR in Paracox vaccinated birds. In the present trial without coccidiostat, 22-42 d old broilers vaccinated with Paracox-5 had 0.057 poorer FCR when challenged (Trt 3) than when unvaccinated and challenged (Trt 2). This is probably due to fact that in the gut damaged wall, the absorption of nutrients is not optimal. In addition, gut wall healing requires energy and protein which can then not be used for growth. Table 4 shows the Coccidiosis lesions scores (0-3, least to most severe). At d 22, lesion scores were significantly different between the coccidiosis unchallenged (Trt 1) and challenged treatments (Trt 2-4) for *Eimeria tenella (P<0.05)*.

Results from the experiment allows to conclude that:1) Challenging broiler chickens at 15 d of age with a mixture of 3 strains of Eimeria significantly worsened 15-22 d average daily gain, 1-22 d and 15-22 d feed conversion ratio (FCR), and 22 d overall coccidiosis lesion scores compared to unchallenged birds. 2) Administering Paracox-5 live attenuated anticoccidial vaccine at d 1 significantly improved BW at d 15, and average daily gain from 1-15 and 15-22 d in Eimeria challenged broilers compared to unvaccinated, challenged broilers. 3) The d 1 Paracox-5 vaccinated, MOS-supplemented, challenged broilers had 15-42 and 22-42 d feed conversion ratios (FCR) significantly better than Paracox-5 vaccinated, un-supplemented, challenged broilers. Dietary MOS (2-1-0.5 kg/ton) can therefore be considered beneficial in combination with Paracox-5 vaccination.

Table 1. Body weight at 1, 15, 22, and 42 d age by experimental treatments.

Treatment[1]				*Body Weight (g)*					
No.	VAC	MOS	CHAL	Day 1	Day 15	Day 22	Day 42	Treat + Culls, %[2]	Mortality[1]
1	--	--	--	45	340b	716	2489	4.44	
2	--	--	+	45.3	347b	630	2382	4.67	
3	+	--	+	45.3	391a	717	2540	4.80	
4	+	+	+	44.9	367ab	693	2552	5.81	

Table 2. Treatments average daily gain of broiler chickens from 1-15, 15-22, 22-42, 1-22, 15-42, and 1-42 d periods.

Treatment[1]				*Average daily gain (g/d)*					
No.	VAC	MOS	CHAL	1-15 d	15-22 d	22-24 d	1-22 d	15-42 d	1-42 d
1	--	--	--	19.7[b]	53.7[a]	88.7	30.5	79.6	58.2
2	--	--	+	20.1[b]	87.6	26.6	75.4	55.6	
3	+	--	+	23.1[a]	91.1	30.5	79.6	59.4	
4	+	+	+	21.4[ab]	92.9	29.5	80.9	59.7	

Table 3. Treatments feed conversion ratios of broiler chickens from 1-15, 15-22, 22-42, 1-22, 15-42, and 1-42 periods.

Treatment[1]				*Feed conversion ratio*					
No.	VAC	MOS	CHAL	1-15 d	15-22 d	22-24 d	1-22 d	15-42 d	1-42 d
1	--	--	--	1.610	1.55[9b]	1.872[ab]	1.570[b]	1.793[b]	1.72
2	--	--	+	1.584	1.888[a]	1.825[bc]	1.727[a]	1.807[b]	1.735
3	+	--	+	1.501	1.876[a]	1.882[a]	1.672[a]	1.855[a]	1.758
4	+	+	+	1.550	1.844[a]	1.815[c]	1.685[a]	1.792[b]	1.706

Table 4. Coccidiosis lesion scores at 22 days of age by treatment and by location (Eimeria species)

Treatment[1]				*Coccidiosis lesion scores*[2]			
No.	VAC	MOS	CHAL	*E. Acervulina*	*E. Maxima*	*E. Tenella*	Overall Mean
1	--	--	--	0.06^{c}	0.22^{c}	0.00^{b}	0.09^{b}
2	--	--	+	1.72^{a}	0.94^{bc}	0.33^{a}	1.00^{a}
3	+	--	+	1.17^{b}	1.39^{a}	0.50^{a}	1.02^{a}
4	+	+	+	1.39^{ab}	1.06^{ab}	0.22^{a}	0.89^{a}

$^{a-b}$ Means in a column with a common superscript do not differ significantly at $P <$ or = 0.05.
[1]There were 6 replicate cage pens (30 birds each) per treatment. VAC is Paracox-5 vaccination on d 1; MOS is Bio-Mos® at 0.5, 1.0, 2.0 kg/ton; and CHAL is mixed pathogenic coccidia challenge via feed on d 15.
[2]Coccidial lesion scores, 0 to 3, least to most severe. Number of birds per treatment and coccidiosis score category was 18 birds sampled (for the overall mean, 54 scores per treatment).
[3]Arcsine transformed data was used for statistical analysis.

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