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Effects of Antibiotic, Probiotic and Prebiotic Supplementation in Broiler Diets on Performance Characteristics and Apparent Nutrient Digestibility

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ABSTRACT: A total of 180-day-old Arbor Acres broiler chicks were used to determine the effects of antibiotic, probiotic and prebiotic supplementation in broiler diets on performance characteristics and apparent nutrient digestibility in an 8-week feeding trial. The birds were randomly allotted to 5 dietary treatments including control diet (basal diet without additives), OXYT diet (basal diet with 600 ppm of the antibiotic oxytetracycline), GRO-UP diet (basal diet with 500 ppm probiotic), and MOS-500 or MOS-1000 diets (basal diet with 500 or 1000 ppm mannan oligosaccharide prebiotic, respectively) with 3 replicates of 12 birds each. No significant difference (P>0.05) was observed in the performance of broiler chickens except for reduction in mortality in the birds fed with feed additives. There were significant (P<0.05) differences in the apparent nutrient digestibility at the end of weeks 4 and 8. Inclusion of dietary prebiotic and probiotic had no significant effect on broiler performance but reduced mortality rate and enhanced apparent nutrient digestibility.

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Nutrition plays an important role in maintaining animal health and prevention of various diseases (Surai, 2002). Feed additives are products used in animal nutrition for purposes of improving the quality of feed and the quality of food from animal origin or to improve the animal performance and health (Hashemi and Davoodi, 2010). Antibiotics as feed additives have been used for many years in poultry diets (Engberg *et al*., 2000). Due to the potential of bacterial resistance and antibiotic residues in animal products (Nasir and Grashorn, 2006), attempts are being made to replace them with prebiotics and probiotics (Goodarzi and Nanekarani, 2014). Probiotics have been reported to have favourable effects on performance (Santin *et al*., 2001). Their mode of action includes competitive exclusion (Berchieri *et al*., 2006), microbial antagonism (Mountzouris *et al*., 2006) and immune modulation (Lan *et al*., 2005). Prebiotics are food ingredients that stimulate selective growth and activity of beneficial microorganisms in the gut and thereby benefit health (Cummings and Macfarlane, 2002).

They also enhance digestibility and performance parameters by creating favourable conditions for beneficial bacteria (Steiner, 2006). Supplementation with probiotics and prebiotics can improve the performance of broiler chickens (Bozkurt *et al*., 2014). However, there are still indications that the results of using probiotic and prebiotic in poultry diets are quite inconsistent. Hence, the current study is to determine the effects of antibiotic, probiotic and prebiotic supplementation in broiler diets on performance characteristics and apparent nutrient digestibility.

MATERIALS AND METHODS

The experiment was conducted at the Poultry Unit of Directorate of University Farms, Federal University of Agriculture, Abeokuta, Nigeria.

One hundred and eighty day-old Arbor Acres broiler chicks obtained from a commercial hatchery were weighed and randomly divided into five dietary treatments with three replicates of 12 birds each. Five experimental diets were formulated at starter and finisher phases to include control diet (basal diet without additives), OXYT diet (basal diet with 600 ppm of the antibiotic oxytetracycline), GRO-UP diet (basal diet with 500 ppm probiotic), and MOS-500 or MOS-1000 diets (basal diet with 500 or 1000 ppm

mannan oligosaccharide prebiotic, respectively). The birds were reared intensively on deep litter housing system and brooding was done for 2 weeks. Temperature was maintained at a stable ambient condition of 30.2°C after brooding and throughout the study period.

Table 1: Ingredients and chemical composition of basal diets (As-fed basis)

Ingredients (%)	Starter (Weeks 0-4)	Finisher (Weeks 4-8)
Maize	50.66	55.00
Wheat offal	5.00	6.00
Fish meal (72%)	3.00	2.00
Soybean meal	24.24	18.00
Groundnut cake	10.00	13.00
Palm kernel cake	3.00	-
Bone meal	2.00	2.00
Oyster shell	1.00	2.75
Lysine	0.10	0.20
Methionine	0.25	0.30
*Premix	0.50	0.50
Salt (NaCl)	0.25	0.25
Total	100.00	100.00
Calculated analysis		
Metabolizable energy (Kcal/kg)	2856	2911
Crude protein (%)	23.01	20.71
Lysine (%)	1.30	1.20
Methionine (%)	0.60	0.60
Methionine + Cystine (%)	1.00	0.97
Available phosphorus (%)	0.50	0.50
Calcium (%)	1.20	1.80

*A kilogramme premix contains Vit. A: 10000000 IU, Vit. D_3: 2500000 IU, Vit. E: 20000 mg, Vit. K_3: 3000 mg, Vit. B: 30000 mg, Vit. B_3: 3000 mg, Vit. B_2: 7000 mg, Vit. B_6: 5000 mg, Vit. B_{12}: 25mg, Panthotenic acid: 10000mg, Folic acid: 800 mg, Biotin: 50mg, Manganese: 80000 mg, Iron: 40000 mg, Zinc: 60000 mg, Copper: 8000 mg, Cobalt: 250 mg, Iodine: 1000 mg, Selenium (1%), 150 mg, Choline: 200000 mg and Antioxidant: 100000 mg.

The composition of the experimental basal diets is presented in Table 1. Data on performance was collected weekly. At the end of weeks 4 and 8, four birds per replicate (making a total of 12 birds per treatment) were selected and arranged in clean, separate and disinfected metabolic cages. Three days of acclimatization were allowed prior to digestibility study. A known weight of feed, which matched previous daily feed intake, was fed during the metabolic trial. Excreta were collected daily for a period of three days. The daily excreta voided for each bird was dried overnight (at 55°C) while total collections per bird were pooled at the end of the 3-day metabolic trial. Dried excreta samples were grounded and analyzed to determine the proximate composition according to the method of AOAC (1990).

Statistical analysis: Data obtained from the trial were subjected to Analysis of Variance (ANOVA) in a Completely Randomized Design (CRD) using SAS (2003). Significant means among variables were separated using Duncan's Multiple Range Test.

RESULTS AND DISCUSSION

The effects of antibiotic, probiotic and prebiotic supplementation in broiler diets on performance are presented in Table 2. Mortality was lowest (P<0.05) in the birds fed MOS (500 and 1000 ppm) while those fed on GRO-UP recorded the highest (P<0.05) mortality. At the finisher phase, the average final weight of birds fed diets supplemented with OXYT, GRO-UP and MOS (500 ppm) compared favourably (P>0.05) with that of control. Mortality was lowest (P<0.05) in birds fed OXYT, GRO-UP and MOS (1000 ppm).

Table 2: Effects of antibiotic, probiotic and prebiotic supplementation in broiler diets on performance characteristics

Parameters	Control	OXYT	GRO-UP	MOS (500 ppm)	MOS (1000 ppm)	SEM
Weeks 0-4						
Initial weight (g/bird)	37.43	37.33	37.58	36.79	37.83	0.36
Final weight (g/bird)	766.67	728.00	798.00	753.00	737.33	10.32
Weight gain (g/bird)	729.24	690.67	760.42	716.21	699.50	10.35
Total feed intake (g)	1711.84	1597.29	1662.13	1751.72	1736.42	23.30
Feed conversion ratio	2.35	2.31	2.19	2.46	2.48	0.05
Mortality (%)	5.56^{b}	5.56^{b}	8.33^{a}	2.78^{c}	2.78^{c}	1.36
Weeks 4-8						
Initial weight (g/bird)	766.67	728.00	798.00	753.00	737.33	10.32
Final weight (g/bird)	2466.67^{a}	2366.67^{ab}	2400.00^{ab}	2366.67^{ab}	2266.67^{b}	26.67
Weight gain/bird (g/bird)	1700.00	1638.67	1602.00	1613.67	1529.34	24.73
Total feed intake (g)	5644.33	5305.67	5424.33	5518.67	5519.02	53.94
Feed conversion ratio	3.34	3.25	3.39	3.43	3.61	0.06
Mortality (%)	8.33^{a}	2.78^{c}	2.78^{c}	5.56^{b}	2.78^{c}	0.13

$^{a-d}$Means on the same row having different superscripts are significantly different (P<0.05). Control (No additive); OXYT: Oxytetracycline (antibiotics); GRO-UP (probiotics); MOS: Mannan oligosaccharide (prebiotics); SEM: Standard error of mean

The effects of antibiotic, probiotic and prebiotic supplementation in broiler diets on apparent nutrient digestibility are shown in Table 3. At week 4, the control group had the lowest dry matter, crude protein, ash and nitrogen free extract contents when compared to the feed additive groups. At week 8, birds fed OXYT, GRO-UP and MOS (500 ppm) supplemented diets had statistically similar value (P<0.05) for dry matter while birds fed MOS (1000 ppm) supplemented diets had the least dry matter. Crude protein was highest in birds fed GRO-UP and MOS (500 ppm). Diet supplemented with MOS

(1000 ppm) had the highest crude fibre. GRO-UP and MOS (1000 ppm) diets had the highest nitrogen free extract when compared to other treatments. The performance of birds fed with feed additives did not differ significantly from the control throughout the study which agrees with the report of Ravangard *et al*. (2017) who observed similar trend. In contrast, Murshed and Abudabos (2015) found that dietary inclusion of probiotic and prebiotic had beneficial effects on body weight gain and feed conversion ratio during the first two weeks of age.

Table 3: Effects of antibiotic, probiotic and prebiotic supplementation in broiler diets on apparent nutrient digestibility

Parameters	Control	OXYT	GRO-UP	MOS (500 ppm)	MOS (1000 ppm)	SEM
Week 4						
Dry matter (%)	80.45^{c}	84.16^{ab}	85.78^{ab}	87.11^{a}	82.92^{b}	0.67
Crude protein (%)	74.51^{c}	78.34^{a}	79.93^{a}	79.93^{a}	78.19^{b}	0.82
Ether extract (%)	78.49	79.13	77.32	78.52	78.12	0.38
Ash (%)	70.16^{b}	74.93^{ab}	74.01^{ab}	76.14^{a}	76.32^{a}	0.94
Crude fibre (%)	61.53	60.15	61.94	59.74	62.13	0.85
Nitrogen Free Extract (%)	73.11^{c}	80.11^{a}	82.34^{a}	79.32^{ab}	76.14^{b}	0.82
Week 8						
Dry matter (%)	83.22^{ab}	87.13^{a}	86.68^{a}	85.75^{ab}	80.78^{b}	0.86
Crude protein (%)	72.50^{b}	74.33^{b}	81.11^{a}	81.43^{a}	73.77^{b}	0.94
Ether extract (%)	79.30	80.25	82.33	78.60	81.05	0.46
Ash (%)	63.14	73.33	70.53	71.68	73.14	0.69
Crude fibre (%)	60.14^{c}	61.53^{c}	61.07^{c}	63.06^{b}	69.30^{a}	0.67
Nitrogen Free Extract (%)	77.44^{b}	78.13^{b}	80.44^{a}	79.91^{b}	80.06^{a}	0.91

$^{a-c}$Means on the same row having different superscripts are significantly different (P<0.05). Control (No additive); OXYT: Oxytetracycline (antibiotics); GRO-UP (probiotics); MOS: Mannan oligosaccharide (prebiotics); SEM: Standard error of mean

The results of using probiotics and prebiotics in poultry diets are inconsistent. Well-nourished healthy chicks may not respond to growth promoting supplements when they are housed in clean, disinfected conditions and at a moderate stocking density (Botsoglou *et al*., 2004). Mortality was lowest in birds fed diets with MOS 500 and 1000 ppm at the starter phase which agrees with the report of Hooge (2003) that MOS has mortality lowering ability. The reduction in mortality observed at the finisher phase in birds fed dietary feed additives may be attributed to boost in body defense against diseases and gut microbial balance. The observed improvement in apparent nutrient digestibility in diets supplemented with feed additives at the starter phase agrees with the finding of Yang *et al*. (2008) who reported that feed additives could affect nutrient utilization of birds. However, at the finisher phase, diets with MOS-1000 had the lowest dry matter, highest crude fibre and both GRO-UP and MOS-1000 diets, had the highest nitrogen free extracts. Kumprecht and Zobac (1997) showed that total tract digestibility of fibre was increased by MOS, but the digestibility of nitrogen free extract was not affected.

Conclusion: Inclusion of dietary prebiotic and probiotic had no significant effect on broiler performance but reduced mortality rate and enhanced apparent nutrient digestibility.

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