



Comparing the Effects of Supplementary Antibiotic, Probiotic, and Prebiotic on Carcass Composition, *Salmonella* Counts and Serotypes in Droppings and Intestine of Broiler Chickens

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Abstract

The effects of antibiotic, probiotic, and prebiotic as dietary feed additives on carcass composition as well as *Salmonella* counts and its serotypes in droppings and intestine of broiler chickens on days 1, 28, and 56 of experiment were investigated. Dietary treatments were 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). From an initial total of 190 day-old Arbor acres broiler chicks, two birds were randomly selected from each treatment and sampled for *Salmonella*. The remaining 180 birds were randomly allotted to the five dietary treatments with three replicates of 12 birds each. Feed and water were supplied *ad libitum*. The results indicated that breast, neck, drumsticks and liver yields significantly affected by the inclusion of feed additives ($P < 0.05$). Significant differences were observed in average *Salmonella* counts in both the intestines and droppings of broiler chickens at different days of experiment ($P < 0.05$). *Salmonella* Gallinarum and *Salmonella* Typhi were serotypes identified in the droppings and intestine of broiler chickens. Our findings reveal that the inclusion of prebiotic oligomanno or probiotic GRO-UP as antibiotic substitutes in diets of broiler chickens can rapidly reduce some *Salmonella* serotypes and aid to the control *Salmonella* organisms.

Introduction

The benefits of broiler production cannot be over emphasized in the face of rising demand for animal protein in many developing countries. To maximize production, broilers must be free from diseases and fed appropriate diets that meet their nutritional requirements for optimal production (Tannock, 1998). Antibiotics are

widely used in animal feed to boost animal performance and productivity. Tetracyclines (oxytetracycline and chlortetracycline) are arguably the most commonly used therapeutic antibiotics in food animal production (Fairchild *et al.*, 2005).

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Oxytetracycline (OTC) is a broad spectrum antibiotic known as tetracyclines which were developed to enhance the control of bacterial infections (Alam, 2000). Stutz and Lawton (1984) showed that using 55 ppm OTC improved growth performance and reduced the ileum weight of chicks. Zulkifli *et al.* (2000) demonstrated that chicks given diets supplemented with 50 mg/kg OTC during 21-42 days of age increased body weight gain (BWG) but the antibody produced against Newcastle disease virus (NDV) was not affected. Talabi *et al.* (2013) also documented the use of OTC powder in feed of broiler chicks at 0.05 g/kg as a growth promoter. However, at low levels of antibiotic administration, resistant microbial cells survive and develop resistance (Huyghebaert *et al.*, 2011; Toghyani *et al.*, 2011).

As a result, other feed additives such as prebiotics and probiotics have been suggested for animal feeding. They are increasingly adopted as antibiotic substitutes to improve performance and gut health in poultry and pigs (Higgins *et al.*, 2008; Marković *et al.*, 2009). Probiotics are live microbial feed supplements that enhance intestinal health (Fuller, 1989). Prebiotics are indigestible food ingredients that selectively induce growth and/or activity of one or more bacterial population in the colon (Gibson and Roberfroid, 1995). Mohammadi Gheisar *et al.* (2016) concluded that the inclusion of prebiotic (e.g. lactulose) improves growth performance and alters excreta microbial populations with no adverse effect on broiler chickens. Nonetheless, more work is needed to establish useful relationships in prebiotic and probiotic supplementation and poultry performance. The objective of the current study is to compare the effects of prebiotic, probiotic, and antibiotic supplementation on carcass composition, and *Salmonella* counts and their serotypes in droppings and intestine of broiler chickens.

Materials and Methods

Experimental location

The experiments were conducted at the Poultry Unit of the Directorate of University Farms (DUFARMS) of the Federal University of Agriculture, Abeokuta, Ogun State, Nigeria. The

area lies within the rainforest zone of South-Western Nigeria (7°10'37"N, 3°26'58"E) at an altitude of 173 m above sea level. The climate is humid with a mean annual rainfall of 1037 mm. The mean annual temperature and humidity are 34.7°C and 82%, respectively (Google Earth, 2013).

Animal management and experimental diets

All procedures used in this study were approved by the Animal Management Committee of the Federal University of Agriculture, Abeokuta and in accordance with the guidelines for care and use of animals in research (FASS, 2010). A total of 190 day-old broiler chicks (Arbor acres strain) were sourced from a reputable hatchery in Abeokuta, Ogun state, Nigeria. The birds were weighed and randomly allotted to five 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 three replicates of 12 broiler chickens. Two birds were randomly selected from each treatment group and sampled for *Salmonella*. The chicks were subjected to standard brooding in a deep litter system. At the starter phase (0-4 weeks), birds were fed with formulated broiler starter diet (23.01% CP and 2856 ME Kcal/kg) while at finisher phase (5-8 weeks), they were fed with broiler finisher diet (20.71% CP and 2911 ME Kcal/kg). Fresh water and feed were supplied *ad libitum*. Routine vaccination and medications were administered to the birds accordingly.

Probiotic GRO-UP™ was supplied by Bio Ingredients Ltd., Lagos, Nigeria with the composition of *Saccharomyces cerevisiae*: 1.5×10^{11} cfu/kg, *Lactobacillus sporogenes*: 3×10^7 cfu/kg and fortified with phytase phosphorus, proteins, calcium and carbohydrates. Prebiotic oligomanno® (Mannan oligosaccharide) was supplied by Yonichi Chemical Institute Co., Ltd. Machikita 9-25, Moriyama-Ku, Nagoya, Japan and composed of hydrolyzed Guar gum fiber. The composition of the experimental basal diet is presented in the Table 1.

Table 1. Ingredients and chemical composition of basal diet (as - fed basis)

Ingredients (%)	Starter (Weeks 0-4)	Finisher (Weeks 4-8)
Corn	50.66	55.00
Wheat offal	5.00	6.00
Fish meal (72% CP)	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
<i>Calculated analysis</i>		
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

*Each kg premix contains Vit. A: 10000000 IU, Vit. D₃: 2500000 IU, Vit. E: 20000 mg, Vit. K₃: 3000 mg, Vit. B₁: 30000 mg, Vit. B₃: 3000 mg, Vit. B₂: 7000 mg, Vit. B₆: 5000 mg, Vit. B₁₂: 25 mg, Panthotenic acid: 10000mg, Folic acid: 800 mg, Biotin: 50 mg, 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.

Sample collection

Bird droppings were collected from two birds per replicate three times (on days 1, 28 and 56 of experiment) by collecting from the cloaca using a sterile glass rod. Intestines scrapings were also collected from two birds per replicate after slaughtering. Both droppings and intestinal scrapings were analyzed for Salmonella isolation/screening and population studies.

Salmonella count

2 g of each sample was homogenized in 20 mL of Selenite F broth and 1 mL of the homogenate was added to 9 mL of Selenite F broth. 9 mL of Selenite F broth was then placed in six sterile tubes and serial diluted to 10⁻⁶-fold. 1 ml of the final diluent was spread on a dried Xylose Lysine Desoxycholate (XLD) Agar and incubated at 37 ± 1°C for 24 hrs. Colonies identified as Salmonella were counted and estimated as follows:

Let **X** be total number of colonies counted.

Weight of sample ~ 2 g; Volume used for culture ~ 2/20 = 1/10; Dilution used for culture ~ 10⁻⁶

Total colony forming unit (cfu) = $X \times 10^{-1} \times 10^6 = X \times 10^5$ cfu/mL

Since, 2g of sample was put into 20 mL of peptone water = 2/20 = 0.1g/mL.

Then, 0.1 g = $X \times 10^5$ cfu of isolates

$$1 \text{ g} = \frac{X \times 10^5 \times 1}{0.1} = X \times 10^6$$

Pre-enrichment, Salmonella isolation and screening

Salmonella isolation and screening were carried out at the Veterinary Microbiology Laboratory of the College of Veterinary Medicine, Federal University of Agriculture, Abeokuta, Nigeria. The representative samples (droppings and intestine) were transferred separately into a non-selective medium (Buffered Peptone Water, BPW agar) for pre-enrichment, then incubated at 37°C ± 1°C for 16-20 hours (Hendriksen, 2003).

Selective enrichment

0.1 mL of the pre-enriched sample was transferred into 10 mL of Rappaport-Vassiliadis R10 Broth with soya peptone (RVS) medium and incubated at 41.5 ± 1°C for 24 ± 3 hrs. The sample was then inoculated with a sterile loop onto plates containing Xylose Lysine Desoxycholate (XLD) Agar and Brilliant Green Agar (BGA) so that colonies were well isolated. The inoculated petri dishes were inverted and transferred to an incubator at 37 ± 1°C for 24 ± 3 hrs. Typical colonies of Salmonella grown on XLD had a black centre and a lightly transparent zone of

reddish colour due to the colour change of the indicator. Typical colonies of *Salmonella* on BGA appeared pink measuring 1 mm to 2 mm in diameter and caused the colour to change to red. Suspected colonies were streaked onto pre-dried nutrient agar plates and incubated at $37 \pm 1^\circ\text{C}$ for 24 ± 3 hrs and the cultures were further used for confirmatory tests (Rappaport *et al.*, 1956; Vassiliadis *et al.*, 1978; Peterz *et al.*, 1989).

Identification of *Salmonella* serotypes

Motility test

Motility test was carried out to determine the motility of the *Salmonella* organisms (i.e. motile or non-motile).

Biochemical test

Serotypes were biochemically identified using a kit (Oxoid microbat 24E). The Oxoid microbat 24E kit contains the following reagents:

H_2S (hydrogen sulphide gas), to determine the ability of the *Salmonella* organisms to produce H_2S ; glucose, to determine the ability of the *Salmonella* organisms to ferment glucose and consequently producing acid and gas; mannitol, to determine the ability of the *Salmonella* organisms to ferment mannitol; O-Nitrophenyl- β -D-galactopyranosidase, to determine the presence of enzyme β -galactosidase by utilizing O-Nitrophenyl- β -D-galactopyranosidase to differentiate late lactose fermenting *Salmonella* organisms from non-lactose fermenting organisms; xylose, to determine the ability of the *Salmonella* organisms to ferment xylose sugar; indole test, to determine the ability of *Salmonella* organisms to split indole from tryptophan present in peptone water; and urease test, to determine the ability of *Salmonella* organisms to produce enzyme urease as this will split urea to form ammonia and CO_2 (Hendriksen, 2003; Collins *et al.*, 2004; Park *et al.*, 2009; Nataro *et al.*, 2011; PHE, 2015).

Carcass yield evaluation

At week eight of the experiment, 30 birds (2 birds per replicate) were randomly selected, weighed, and slaughtered. Scalding was done at 60°C following standard commercial procedures (Jensen, 1984), then evisceration. Dressed weight was determined. Parts such as head, neck, shank, thigh, drumstick, back, breast weight and visceral organs (gizzard, intestines, liver, heart and kidney) were weighed. The weights of the various parts were expressed as percentage of

the live weights.

Statistical analysis

Data obtained 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

The effects of dietary feed additives on carcass composition of broiler chickens are presented in Table 2. There were significant ($P < 0.05$) differences in the weights of breast, neck, drumsticks, and liver. Breast and drumstick weights were similar between the control, OXYT, and GRO-UP treatments. Birds in both MOS-500 and MOS-1000 groups had the lowest ($P < 0.05$) breast weight and drumsticks. Birds fed OXYT and GRO-UP diets had the greatest neck weights while the lowest weight was found in birds fed MOS (500 ppm) diets. Birds fed OXYT diets had the highest ($P < 0.05$) liver weight while birds fed the control diet had the lowest. However, there was an insignificant difference between dressing percentage of treatments.

Salmonella counts in droppings of broiler chickens were significantly different between dietary treatments at different intervals ($P < 0.05$; Table 3). The initial count in all droppings ranged from 5.50 to 6.50 cfu $\times 10^6/\text{g}$ though there was a reduction in colony counts in all treatments over time. The total colony counts of *Salmonella* in the droppings of birds fed the control diet were higher ($P < 0.05$) than other treatments. *Salmonella* counts in droppings of birds fed OXYT, GRO-UP and MOS (1000 ppm) diets were lower than other treatments during the first four weeks of rearing. The highest ($P < 0.05$) count in droppings and the lowest percentage reduction (15.38%) was recorded in birds fed control diet. During the second four weeks, the lowest ($P < 0.05$) count in droppings and highest percentage reduction (95.45%) was recorded for birds fed MOS (1000 ppm) diets while the lowest percentage reduction (18.18%) was recorded for birds fed control diet. Overall, birds fed diets with MOS (1000 ppm) had the highest percentage reduction in average *Salmonella* counts (98.18%), followed by MOS (500 ppm) (92.31%), while birds fed the control diet had the lowest percentage reduction in *Salmonella* counts (30.77%).

Table 2. Effects of dietary feed additives on carcass composition of broiler chickens (% live body weight)

Parameters	Control	OXYT	GRO-UP	MOS (500 ppm)	MOS (1000 ppm)	SEM	P-Value
Live weight (g)	2234.67	2107.00	2184.93	2114.8	2079.87	27.16	0.11
Dressing	68.03	62.90	64.45	66.73	64.51	0.84	0.24
Head	2.49	2.47	2.49	2.70	2.44	0.04	0.71
Shank	4.97	4.24	4.85	4.64	4.71	0.11	0.16
Thigh	10.74	11.09	11.54	10.62	10.06	0.22	0.45
Breast	18.95 ^{ab}	19.54 ^{ab}	21.00 ^a	18.15 ^b	18.19 ^b	0.41	<0.001
Back	17.35	16.20	15.99	17.05	17.12	0.31	0.72
Wings	8.83	9.18	8.98	8.46	8.87	0.12	0.33
Neck	3.16 ^{bc}	4.74 ^a	4.24 ^{ab}	2.86 ^c	3.52 ^{bc}	0.24	0.01
Drumsticks	10.78 ^{ab}	10.25 ^{ab}	11.52 ^a	10.10 ^b	9.94 ^b	0.21	0.03
Heart	0.44	0.53	0.44	0.54	0.48	0.02	0.58
Liver	1.97 ^c	2.70 ^a	2.46 ^{ab}	2.04 ^{bc}	2.00 ^{bc}	0.09	<0.001
Gizzard	1.76	2.24	2.01	2.08	1.75	0.08	0.75
Spleen	0.15	0.15	0.11	0.14	0.16	0.01	0.41
Lungs	0.54	0.63	0.56	0.58	0.52	0.24	0.23
Kidney	0.35	0.58	0.48	0.48	0.39	0.36	0.22

^{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).

Table 3. Effects of dietary feed additives on average Salmonella counts (cfu/g $\times 10^{-6}$) in droppings of broiler chickens at different intervals

Treatments	Control	OXYT	GRO-UP	MOS (500 ppm)	MOS (1000 ppm)	SEM	P-Value
Week 0	6.50 ^a	6.25 ^b	5.60 ^d	5.85 ^c	5.50 ^d	0.10	0.01
Weeks 0-4	5.50 ^a (15.38)	2.25 ^c (64)	2.30 ^c (58.93)	2.50 ^b (57.26)	2.20 ^c (60)	0.34	0.00
Weeks 4-8	4.50 ^a (18.18)	0.70 ^c (68.89)	1.10 ^b (52.17)	0.45 ^d (82)	0.10 ^e (95.45)	0.43	0.04
Reduction in colonization (%) (Weeks 0-8)	30.77	88.89	80.35	92.31	98.18		

^{a-e}Means on the same row having different superscripts are significantly different ($P < 0.05$).

Values in brackets indicate percentage reduction.

Control (No additive); OXYT: Oxytetracycline (antibiotic); GRO-UP (probiotic); MOS: Mannan oligosaccharide (prebiotic).

Table 4 shows the effects of dietary feed additives on Salmonella serotypes present in the droppings of broiler chickens at different time intervals. The results revealed that *Salmonella* Gallinarum and *Salmonella* Typhi were identified across all treatments. In the droppings of birds fed the control diet, *Salmonella* Gallinarum was present at weeks 0 and 4 but absent at week 8 while *Salmonella* Typhi was present throughout the experiment. In the droppings of birds fed OXYT diets, *Salmonella* Gallinarum was present throughout the experiment while *Salmonella* Typhi was absent throughout the experiment. In the droppings of birds fed GRO-UP supplemented diet, *Salmonella* Gallinarum was present at weeks 0 and 8 but absent at week 4 while *Salmonella* Typhi was present at weeks 0 and 4 but absent at week 8 of the experiment. In

the droppings of birds fed MOS-500 and MOS-1000 diets, *Salmonella* Gallinarum was present throughout the experiment while *Salmonella* Typhi was present at week 0 but absent at weeks 4 and 8 of the experiment.

There were significant ($P < 0.05$) differences in average Salmonella counts between dietary treatments in the intestine of broiler chickens at different intervals (Table 5). The initial count across all treatments ranged from 6.65 to 7.80 cfu $\times 10^6$ /g. However, there was a reduction in colony counts in all treatments by weeks 4 and 8. The total colony counts of Salmonella in the intestine of birds fed OXYT diets was higher ($P < 0.05$) than other treatments. By the end of week 4, the Salmonella counts in the intestine of birds fed OXYT and MOS (500 ppm) diets were lower than other treatments ($P < 0.05$). The highest ($P <$

0.05) count in the intestine and the lowest percentage reduction (17.29%) was observed in birds fed control diet. By the end of week 8, *Salmonella* counts in the intestine of birds fed diets with feed additives were statistically similar and significantly lower than the control ($P < 0.05$). The highest percentage reduction was recorded for birds fed MOS (1000 ppm) diets

(60%) followed by MOS (500 ppm) (50%), while the lowest percentage reduction was recorded for birds fed control diet (14.55%). Overall, birds fed diets with MOS (1000 ppm) had the highest percentage reduction in the *Salmonella* counts (86.11%), followed by MOS (500 ppm) (83.01%), while the control diet had the lowest percentage reduction in *Salmonella* count (29.32%).

Table 4. Effects of dietary feed additives on *Salmonella* serotypes present in the droppings of broiler chickens at different intervals

Treatments	Week 0		Week 4		Week 8	
	<i>S. Gallinarum</i>	<i>S. Typhi</i>	<i>S. Gallinarum</i>	<i>S. Typhi</i>	<i>S. Gallinarum</i>	<i>S. Typhi</i>
Control	+	+	+	+	-	+
OXYT	+	-	+	-	+	-
GRO-UP	+	+	-	+	+	-
MOS (500 ppm)	+	+	+	-	+	-
MOS (1000 ppm)	+	+	+	-	+	-

+: present; -: absent;

Control (No additive); OXYT: Oxytetracycline (antibiotics); GRO-UP (probiotics); MOS: Mannan oligosaccharide (prebiotics).

Table 5. Effects of dietary feed additives on average *Salmonella* counts (cfu/g $\times 10^{-6}$) in the intestine of broiler chickens at different intervals

Treatments	Control	OXYT	GRO-UP	MOS (500 ppm)	MOS (1000 ppm)	SEM	P-Value
Week 0	6.65 ^d	7.80 ^a	7.65 ^b	6.80 ^d	7.20 ^c	0.13	0.04
Weeks 0-4	5.50 ^a (17.29%)	2.25 ^d (71.15%)	2.80 ^b (63.40%)	2.30 ^d (66.18%)	2.50 ^c (65.28%)	0.34	0.00
Weeks 4-8	4.70 ^a (14.55%)	1.35 ^b (40%)	1.60 ^b (42.86%)	1.15 ^b (50%)	1.00 ^b (60%)	0.38	0.01
%reduction in colonization (Weeks 0-8)	29.32	82.69	79.08	83.09	86.11		

^{a-d} Means on the same row having different superscripts are significantly different ($P < 0.05$).

Values in brackets indicate percentage reduction.

Control (No additive); OXYT: Oxytetracycline (antibiotics); GRO-UP (probiotics); MOS: Mannan oligosaccharide (prebiotics).

Table 6. Effects of dietary feed additives on *Salmonella* serotypes present in the intestine of broiler chickens at different intervals

Treatments	Week 0		Week 4		Week 8	
	<i>S. Gallinarum</i>	<i>S. Typhi</i>	<i>S. Gallinarum</i>	<i>S. Typhi</i>	<i>S. Gallinarum</i>	<i>S. Typhi</i>
Control	+	+	+	+	-	+
OXYT	+	+	-	+	-	+
GRO-UP	+	+	-	+	-	+
MOS (500 ppm)	+	-	+	-	-	-
MOS (1000 ppm)	+	-	+	-	-	-

+: present -: absent

Control (No additive); OXYT: Oxytetracycline (antibiotics); GRO-UP (probiotics); MOS: Mannan oligosaccharide (prebiotics).

Table 6 shows the effects of dietary feed additives on *Salmonella* serotypes present in the intestine of broiler chickens at different time intervals. *Salmonella* Gallinarum and *Salmonella* Typhi were identified across all treatments. In the intestine of birds fed control diet, *Salmonella* Gallinarum was present at week 0 and 4 but absent at week 8 of the experiment, while

Salmonella Typhi was present throughout the experiment. In the intestine of birds fed OXYT diets, *Salmonella* Gallinarum was present at week 0 but absent at weeks 4 and 8 of the experiment, while *Salmonella* Typhi was present throughout the experiment. In the intestine of birds fed GRO-UP diets, *Salmonella* Gallinarum was present at week 0 but absent at weeks 4 and 8 of

the experiment, while *Salmonella* Typhi was present throughout the experiment. In the intestine of birds fed MOS (500 ppm) and MOS (1000 ppm) diets, *Salmonella* Gallinarum was present at weeks 0 and 4 but absent at week 8 of the experiment, while *Salmonella* Typhi was absent throughout the experiment.

Discussion

The relative weights of breast, neck, drumsticks and liver (but not dressing) were significantly affected by dietary supplementation of feed additives. The addition of MOS had no effect on body weight at any age. Mathis (2000) found that the combination of certain antibiotics with MOS could lead to additive or synergistic benefits on broiler performance, compared to using antibiotics alone. The lowest drumsticks and breast meat yield recorded were in birds fed MOS at 500 ppm and 1000 ppm contrasts the report of Clementino Dos Santos *et al.* (2002) who stated that dietary MOS (0.1%) significantly increased breast yield as a percentage of dressed carcass. Mohammed *et al.* (2008) did not observe any significant effects of prebiotic and probiotic supplements on the relative weights of dressing, liver, heart, and gizzard. Similarly, Midilli *et al.* (2008) did not observe any impact of MOS on carcass traits and relative weights of internal organs in broiler chickens. Dosage, method of preparation, and animal condition may be responsible for such inconsistencies. Growth stimulants as feed additives are added to poultry diet to enhance growth rate and economic meat production (Bunyan *et al.*, 1997). The observed effects of feed additives on some of the carcass traits could point to the growth-promoting effects of these dietary additives in relation to improved gut environment and a stable intestinal flora (Eltazi, 2014).

Previous studies demonstrated that prebiotics can moderate the gut environment by increasing the number of beneficial microbes and hindering rapid multiplication of intestinal pathogens (Patterson and Burkholder, 2003; Higgins *et al.*, 2008). Dietary prebiotics reduced *Salmonella* population in the intestine of chickens (Bailey *et al.*, 1991; Pascual *et al.*, 1999; Stern *et al.*, 2001) and supported competitive exclusion and immune modulation (Jin *et al.*, 1997; Simon *et al.*, 2001). The observation that feeding broiler chickens diets supplemented with Mannan oligosaccharide (MOS at 500 ppm

and 1000 ppm) reduced *Salmonella* counts in the droppings and intestine support the argument of the active prebiotic function that mannan oligosaccharide (MOS) performs in the gut of broiler chickens. A similar trend was observed by Mohammadi Gheisar *et al.* (2016) with the prebiotic lactulose. Spring *et al.* (2000) noted a significant reduction in caecal *Salmonella* counts in chickens that received 4000 ppm of dietary MOS. Oyofe *et al.* (1989) found that dietary inclusion of 2.5% mannose reduced *Salmonella* colonization and 0.1% mannose decreased shedding, and colonization of caecal and liver after infection with 2×10^7 cfu of *Salmonella enteritidis* in 2-week old chickens (Fernandez *et al.*, 2000; Agunos *et al.*, 2007).

The beneficial activity of GRO-UP and MOS against *Salmonella* spp observed in the present study was supported by Courtin *et al.* (2008) who found that feed additives increase the number of bifidobacteria in the caecum of chickens. *Salmonella* Gallinarum and *Salmonella* Typhi were identified in the droppings and intestine of broiler chickens at different time intervals. This result agrees with Davies and Wray (1993) who reported that *Salmonella* bacteria are more closely associated with poultry than their ubiquitous distribution deserves. *Salmonella* bacteria may not exist as single entities but in a huge range of serotypes, including poultry-specific pathogens like *Salmonella* Gallinarum and *Salmonella* Typhi. The serotype distribution at different time intervals in droppings and intestine of broiler chickens is of high economic interest.

Conclusion

Carcass composition was not adversely affected by the inclusion of feed additives in broiler diets. There was a higher percentage reduction in *Salmonella* colonization in birds fed diets with prebiotics and probiotics. At the end of week eight, broiler chickens fed diets with mannan oligosaccharide (1000 ppm MOS) had the highest percentage reduction in overall *Salmonella* count, followed by birds fed 500 ppm MOS. Birds fed the control diet had the lowest percentage reduction in *Salmonella* counts in the droppings and intestine. The inclusion of MOS (both 500 or 1000 ppm) or GRO-UP as antibiotic substitutes in diets of broiler chickens can control and eradicate some *Salmonella* serotypes.

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مقایسه اثرات مکمل آنتی‌بیوتیک، پروبیوتیک، و پری‌بیوتیک بر ترکیب لاشه، بر جمعیت و سوتیپ باکتری‌های سالمونلا در فضولات و روده جوجه‌های گوشتی

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چکیده

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در این آزمایش اثرات افزودنی‌های آنتی‌بیوتیک، پروبیوتیک، و پری‌بیوتیک بر ترکیب لاشه و همچنین جمعیت و سروتیپ باکتری‌های سالمونلا در فضولات و روده جوجه‌های گوشتی در روزهای ۱، ۲۸ و ۵۶ بررسی شد. تیمارهای غذایی عبارت بودند از جیره‌ی شاهد (جیره‌ی پایه بدون افزودنی)، جیره‌ی اکسی‌تتراسایکلین (جیره‌ی پایه با ۶۰۰ پی‌پی‌ام آنتی‌بیوتیک اکسی‌تتراسایکلین)، جیره GRO-UP (جیره‌ی پایه بعلاوه ۵۰۰ پی‌پی‌ام پروبیوتیک)، و جیره‌های MOS-500 یا MOS-1000 (به ترتیب، جیره‌ی پایه بعلاوه ۵۰۰ یا ۱۰۰۰ پی‌پی‌ام پری‌بیوتیک مانان الیگوساکارید). از تعداد اولیه ۱۹۰ جوجه گوشتی یکروزه آربورایکرز، تعداد ۲ قطعه بطور تصادفی از هر تیمار انتخاب و برای شمارش سالمونلا مورد استفاده قرار گرفتند. تعداد ۱۸۰ پرنده باقیمانده به طور تصادفی به پنج تیمار آزمایشی با ۳ تکرار حاوی ۱۲ پرنده در هر تکرار اختصاص یافتند. آب و خوراک بطور آزاد در اختیار پرندگان قرار داشت. نتایج آزمایش نشان داد که راندمان سینه، گردن، ران و کبد بطور چشمگیری تحت تاثیر تیمارهای آزمایشی قرار گرفت ($P < 0.05$). اختلافات چشمگیری در جمعیت باکتری‌های سالمونلا در روده و همچنین فضولات جوجه‌های گوشتی در روزهای مختلف آزمایش مشاهده شد ($P < 0.05$). سروتیپ‌های سالمونلا گالی‌ناروم و سالمونلا تیفی در فضولات و روده جوجه‌های گوشتی مشاهده شدند. یافته‌های آزمایش ما نشان داد که افزودن پری‌بیوتیک الیگومانان یا پروبیوتیک GRO-UP به عنوان جایگزین آنتی‌بیوتیک در جیره‌ی غذایی جوجه‌های گوشتی می‌تواند به سرعت سبب کاهش سرتیپ‌های سالمونلا شود و به کنترل سالمونلا کمک کند.

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