

Evaluation of *Ocimum gratissimum* and *Ocimum canum* as natural growth promoters on the growth performance, intestinal microbiota and villi morphometry of broiler chickens

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Abstract

The study was carried out to evaluate the performance of broiler chickens fed diets containing *Ocimum gratissimum* and *Ocimum canum* as an alternative to antibiotic growth promoters (AGPs). A total of 396, one day-old Cobb 500 broiler chicks were randomly allotted to six dietary treatments each replicated thrice with 22 birds per replicate in a completely randomized design. Six treatment diets were formulated containing 0g of experimental materials as control, 400 and 800g of *O. gratissimum* (T2 and T3), 400 and 800g of *O. canum* (T4 and T5) while oxytetracycline as recommended by the manufacturer was used as positive control. Data were collected on growth parameters: initial weight, final weight, weight gain, feed intake and feed cost per kg gain at both the starter and finisher phases. All data collected were subjected to analysis of variance and significant differences among treatment means were compared using Tukey procedures. Growth performance result showed that final weight, weight gain, feed conversion ratio and feed cost per kg gain were significantly higher ($p < 0.05$) for birds fed diets containing *O. gratissimum* and *O. canum* at 800g per 100kg diets at both the starter and finisher phases. The population of *Bacillus* and *Lactobacillus* spp. were increased while the concentration of *Escherichia coli*, *Clostridium* spp., *Salmonella* spp., *Enterobacteriaceae* and *Pseudomonas* spp were significantly ($p < 0.05$) reduced by the inclusion of *Ocimum* spp. Villi area, villi perimeter, height, width, crypt depth and villi height/crypt depth ratio were higher ($p < 0.05$) for birds fed dietary supplement of 400g of *O. gratissimum*, 400g and 800g of *O. canum* and AGP (Oxyteracycline) than the control. Addition of *O. gratissimum* and *O. canum* in broiler chickens' diets significantly improved growth performance, intestinal microbiota and villi morphometric. Farmers and feed millers can use *O. gratissimum* and *O. canum* at 800g/100kg diets for improved performance.

Keywords: Antibiotics, Phytobiotics, Microbiota, Nutrient Absorption, Essential Oil.

Introduction

Antibiotics growth promoters (AGPs) have been used for about 50 years to enhance growth performance (Dibner and Richards, 2005). It has been used widely not only to prevent and treat poultry diseases, but also for the improvement of meat and egg production (Ogle, 2013). However, repeated use of antibiotics in poultry diets resulted in severe problems like resistance of pathogen to antibiotics, accumulation of

antibiotics residue in their products and environment, imbalance of normal microflora and reduction in beneficial intestinal microflora (Barton, 2000). The use of these feed antibiotics and some other antimicrobial compounds as performance enhancers became the target of increasing public criticism and a topic of political controversy which led the European Union (E) to place a total ban on the use of feed antibiotics in January 2006 (Broz and

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Paulus, 2015). Natural growth promoters (NGPs) such as prebiotics, probiotics, synbiotics, enzymes and plant extracts can be used to feed the broilers without any adverse effect on the performance of birds (Akhtar *et al.*, 1984). Beneficial properties of bioactive plant constituents in animal nutrition may comprise the stimulation of appetite and feed intake, the enhancement of endogenous digestive enzyme secretion, stimulation of **immune responses** and antibacterial, antiviral and antioxidant action (Al-Sultan, 2003; Al-Amin *et al.*, 2006; Al-Mashhadani, 2015). Several types of herbal products and their oil extracts have enhanced broiler performance and resulted in growth-promoting effects. These may serve as environmental friendly alternatives to the antibiotic growth promoters commonly used in animal and poultry feed. The proposed mode of action of herbal products is attributed to their antimicrobial properties (Lambert *et al.*, 2001; Burt, 2004); oxidative-resistant activity, enhancement of the immune system and consequently, improvement in poultry performance (Dorhoi, *et al.*, 2006). Scent leaf (*Ocimum gratissimum*) and curry leaf (*Ocimum canum*) as NGPs can be used as an alternative to common artificial growth promoters like antibiotics. Scent leaf (*O. gratissimum*), the African variety of basil (*Ocimum sp.*), is widely grown as a perennial herb in tropical Africa, South East Asia, India and Hawaii. Ijeh *et al.* (2004) noted that scent leaf is rich in alkaloids, tannins, phytates, flavonoids, oligosaccharides, terpenoids, thymol and saponin, with tolerable cyanogenic content. The proximate composition shows a crude protein of 4.7%, 10.8% crude fibre, and ash content of 12.24% (Mensah *et al.*, 2008). The essential oil (eugenol) present in scent leaf possesses antimicrobial activities against pathogenic strains of gram negative and gram positive bacteria and pathogenic

fungus (Matasyoh *et al.*, 2007). Curry leaf (*O. canum*) is a small strong smelling perennial shrub commonly found in forests as undergrowth (Sinha *et al.*, 2012; Verma *et al.*, 2012; Priya *et al.*, 2014). The essential oil from the plant is reported for anti-microbial and antioxidant role (Rao *et al.*, 2011; Satish and Gopu, 2015). These aromatic leaves have been reported to retain their flavor and other qualities even after drying (Mandal *et al.*, 2010). The study was undertaken therefore to evaluate the essential oil of *Ocimum gratissimum* and *Ocimum canum* leaves as potential sources of natural antibiotics in broiler chickens production as replacement for synthetic antibiotic growth promoters on growth performance, intestinal microbes and villi morphometric.

Materials and methods

Experimental site

The experiment was conducted at the Poultry Unit of the Department of Animal Science Teaching and Research farm, Ahmadu Bello University, Zaria, Kaduna State. Zaria is in the Northern Guinea Savannah zone, located on longitude 11° 09' 01.78" N and 7° 39' 14.79" E 671m above sea level. The climate is characterized by a well-defined dry and wet seasons. The climate is relatively dry with a mean annual rainfall of 700-1400mm (IARMS, 2019).

Experimental design and management of birds

Three hundred and ninety-six, one day old Cobb 500 broiler chicks were allotted to six dietary treatments with 3 replicates of 22 birds each in a completely randomized design (CRD). The birds were housed in deep litter pens and managed with all necessary routine management practices. Feed and water were provided *ad libitum* throughout the experimental period.

Experimental diets

Six treatment diets were formulated as

shown in Tables 1 and 2 for the starter and finisher phases respectively. Scent and curry leaves were added as follows:

- Diet 1: Standard diet without experimental materials (Control)
- Diet 2: Standard diet with scent leaf feed additive 400g/100kg
- Diet 3: Standard diet with scent leaf feed

- additive 800g/100kg
- Diet 4: Standard diet with curry leaf feed additive 400g/100kg
- Diet 5: Standard diet with curry leaf feed additive 800g/100kg
- Diet 6: Standard diet with Oxytetracycline as feed additive (as recommended by manufacturer).

Table 1: Composition of broiler starter diets

Ingredients (%)	0	Inclusion of experimental materials (g/100kg Diet)				Oxytet
		<i>Ocimum gratissimum</i>		<i>Ocimum canum</i>		
		400	800	400	800	
Maize	56.75	56.35	55.95	56.35	55.95	56.75
Soya cake	28.00	28.00	28.00	28.00	28.00	28.00
Groundnut cake	11.00	11.00	11.00	11.00	11.00	11.00
Scent leaf	0.00	0.40	0.80	0.00	0.00	0.00
Curry leaf	0.00	0.00	0.00	0.40	0.80	0.00
Bone Meal	3.00	3.00	3.00	3.00	3.00	3.00
Limestone	0.50	0.50	0.50	0.50	0.50	0.50
Common Salt	0.25	0.25	0.25	0.25	0.25	0.25
Methionine	0.20	0.20	0.20	0.20	0.20	0.20
Lysine	0.05	0.05	0.05	0.05	0.05	0.05
Vit-min Premix ^A	0.25	0.25	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00	100.00	100.00
Calculated Analysis						
ME (Kcals/Kg)	2,923	2,916	2,910	2,918	2,912	2,923
Crude Protein (%)	23.07	23.04	23.01	23.03	23.01	23.07
Crude Fibre (%)	3.66	3.68	3.70	3.67	3.69	3.66
Ether Extract (%)	3.24	3.37	3.40	3.35	3.39	3.24
Calcium (%)	1.32	1.32	1.32	1.32	1.32	1.32
Phosphorus (%)	0.87	0.86	0.86	0.86	0.86	0.87
Methionine (%)	0.50	0.50	0.50	0.50	0.50	0.50
Lysine (%)	1.28	1.28	1.28	1.28	1.28	1.28
	118.10	121.10	124.10	121.10	124.10	121.60

^A Vitamin- mineral premix provide per kg of diet: Vit. A, 10,000,000 IU; Vit. D₃, 2, 000,000 IU; Vit. E, 40,000mg; Vit. K₃, 2000mg; Vit. B₁, 1,500mg; Vit. B₂, 5,000mg, Vit. B₆, 4,000mg; Vit. B₁₂, 20mg; Niacin, 40,000mg; Calpan, 10,000mg; Folic acid, 1,000mg; Biotin, 100mg; Choline Chloride, 30,000mg; Manganese, 80,000mg; Iron, 40,000mg; Zinc, 60,000mg; Copper, 80,000mg; Iodine, 800mg; Cobalt, 300mg; Selenium, 200mg. Oxytet = Oxytetracycline.

Growth study

Initial and final weights of birds were taken at the beginning and at the end of both starter and finisher phases. Weight gain and feed intake were measured weekly while feed/gain ratio and cost per Kg gain were computed for both phases. Mortality was recorded as they occur.

Intestinal microbial study

At the end of the experimental period,

bacterial cell species and numbers in the ileum and caecum were determined using one chicken per replicate that is three chickens per treatment. This was carried out at the Department of Veterinary Microbiology, Ahmadu Bello University, Zaria. The total bacteria load, and isolation of *Salmonella*, *Staphylococcus* and *Escherichia coli* from the samples were done using different selective media for

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Table 2: Composition of broiler finisher diets

Ingredient	Inclusion of experimental materials (g/100kg Diet)					
	0	<i>Ocimum gratissimum</i>		<i>Ocimum canum</i>		Oxytet
		400	800	400	800	
Maize	58.00	57.60	57.20	57.60	57.20	58.00
Soya cake	20.00	20.00	20.00	20.00	20.00	20.00
Groundnut cake	11.00	11.00	11.00	11.00	11.00	11.00
Scent leaf	0.00	0.40	0.80	0.00	0.00	0.00
Curry leaf	0.00	0.00	0.00	0.40	0.80	0.00
Maize offal	6.80	6.80	6.80	6.80	6.80	6.80
Bone meal	3.00	3.00	3.00	3.00	3.00	3.00
Limestone	0.35	0.35	0.35	0.35	0.35	0.35
Salt	0.25	0.25	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25	0.25	0.25
Lysine	0.10	0.10	0.10	0.10	0.10	0.10
Vit-min Premix ^A	0.25	0.25	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00	100.00	100.00
Calculated Analysis						
ME (Kcals/Kg)	2,923	2,920	2,917	2,920	2,917	2,923
Crude Protein (%)	20.09	20.06	20.08	20.05	20.07	20.09
Crude Fibre (%)	4.07	4.12	4.17	4.10	4.14	4.07
Ether Extract (%)	4.55	4.63	4.71	4.65	4.73	4.55
Calcium (%)	1.27	1.27	1.27	1.27	1.27	1.27
Phosphorus (%)	0.57	0.57	0.57	0.57	0.57	0.57
Methionine (%)	0.55	0.55	0.55	0.55	0.55	0.55
Lysine (%)	1.04	1.04	1.04	1.04	1.04	1.04
Feed Cost (₦/kg)	105.10	108.10	111.10	108.30	111.30	109.10

^A Vitamin- mineral premix provide per kg of diet: Vit. A, 10,000,000 IU; Vit. D₃, 2,000,000 IU; Vit. E, 40,000mg; Vit. K3, 2000mg; Vit. B1, 1,500mg; Vit. B2, 5,000mg, Vit. B6, 4,000mg; Vit. B12, 20mg; Niacin, 40,000mg; Calpan, 10,000mg; Folic acid, 1,000mg; Biotin, 100mg; Choline Chloride, 30,000mg; Manganese, 80,000mg; Iron, 40,000mg; Zinc, 60,000mg; Copper, 80,000mg; Iodine, 800mg; Cobalt, 300mg; Selenium, 200mg. Oxytet = Oxytetracycline.

isolation of bacteria groups and characterization based on sugars fermentation using Microbact 12E kit and conventional biochemical methods. The media used were Eosin Methylene Blue Agar, Mannitol Salt Agar and Salmonella Shigella Agar (OMP, 2015).

Villi morphometric

Intestinal segment samples (approximately 2cm in length) were taken from birds used for carcass evaluation to ascertain villi morphometric. The morphometric indices that were evaluated include villi height, villi width, crypt depth, surface area, perimeter and the ratio of villi height to villi depth at the Histology Laboratory, Department of

Human Anatomy, Ahmadu Bello University, Zaria.

Statistical analysis

All data obtained from the experiment were statistically analysed using the General Linear Model Procedure of Statistical Analysis Systems software package while significant difference between treatments means were separated using Tukey's Procedure (SAS, 2002).

Results and discussion

Growth performance of broiler chicks fed diets containing *Ocimum gratissimum* and *Ocimum canum* leaves (0-4 weeks)

The growth performance of broiler chicks

fed diets containing *Ocimum gratissimum* and *Ocimum canum* leaves as phytobiotics is presented in Table 3. The result showed that there were significant differences in final weight, weight gain, feed intake, feed conversion ratio (FCR) and feed cost per kg gain. Final weight, weight gain and feed intake were higher ($p < 0.05$) for broiler chicks fed diets supplemented with oxytetracycline, *Ocimum gratissimum* at 800g/100kg diet and *Ocimum canum* at 400g and 800g respectively. FCR and feed cost per kg gain were better ($p < 0.05$) for birds fed diets containing oxytetracycline and the experimental materials. The findings of this study showed that inclusion of *Ocimum gratissimum* and *Ocimum canum* in the diets of broiler chickens have

positive effect in improving the growth and economic efficiency. In several studies, researchers have also stated that feed additives may stimulate early gut development and improve overall efficiency of the chicken gastro intestinal tract (Donoghue, 2003; Apajalahti *et al.*, 2004). The high performance of the broiler chicks fed diet containing AGP showed that antibiotics improve feed efficiency and growth rate. This could be attributed to its antimicrobial effect especially in handling the pathogenic strains of bacteria. In a similar study where the diets of broiler chickens were supplemented with chlortetracycline, oxytetracycline and penicillin, it was reported to improve growth rate (Anonymous, 2015).

Table 3: Performance of broiler chicks fed diets supplemented with *Ocimum gratissimum* and *Ocimum canum* (0-4weeks)

Parameters	Inclusion levels of experimental materials (g/100kg diet)						SEM
	0	<i>Ocimum gratissimum</i>		<i>Ocimum canum</i>		Oxytet	
		400	800	400	800		
Initial weight (g/b)	46.46	46.46	46.46	46.47	46.42	46.53	0.34
Final weight (g/b)	943.15 ^c	952.78 ^{bc}	1000.38 ^{ab}	1000.56 ^{ab}	1042.94 ^a	1030.98 ^{ab}	43.30
Weight gain (g/b)	896.69 ^b	906.32 ^b	953.91 ^{ab}	954.10 ^{ab}	996.52 ^a	984.45 ^a	43.21
Feed intake (g/b)	1497.63 ^a	1421.85 ^b	1501.41 ^a	1474.42 ^{ab}	1492.33 ^{ab}	1462.54 ^{ab}	38.64
FCR	1.68 ^b	1.57 ^a	1.58 ^a	1.54 ^a	1.50 ^a	1.50 ^a	0.05
Feed cost (</kg)	118.10	121.10	124.10	121.10	124.10	121.60	NA
FC/kg gain (</kg)	197.93 ^b	190.12 ^{ab}	195.40 ^b	187.18 ^a	185.91 ^a	182.04 ^a	6.11
Mortality (%)	2.98	2.98	2.98	1.49	0.00	1.49	1.66

^{abc}Means with the same superscripts along the rows are not significantly different ($p > 0.05$), SEM: standard error of means, NA: not analyzed, FCR: Feed conversion ratio, FC/kg gain: Feed cost/kg gain.

Growth performance of broiler chickens fed diets containing *Ocimum gratissimum* and *Ocimum canum* leaves (5-7 weeks)

The growth performance of broiler chickens fed diets containing *Ocimum gratissimum* and *Ocimum canum* leaves as phytobiotics is presented in Table 4. The result showed that there were significant differences ($p < 0.05$) in final weight, weight gain, feed intake, feed conversion ratio (FCR) and feed cost per kg gain. Final weight, weight gain and feed intake were higher ($p < 0.05$)

for broiler chickens fed diets supplemented with oxytetracycline, *Ocimum gratissimum* and *Ocimum canum* at 800g/100kg diets, respectively. FCR were better for broiler chickens fed diets containing *Ocimum canum* at 800g per 100kg diet (1.71) and AGP (1.77) while feed cost per kg gain were better ($p < 0.05$) for birds fed diets containing oxytetracycline and the experimental materials. The higher final weight and total weight gain observed for broiler chickens fed diets containing the

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experimental material and oxytetracycline could be as a result of exclusive elimination of harmful bacterial load in the gut of the birds leading to higher concentration of beneficial bacterial that helped in effective feed digestion and nutrient utilization. Phytogetic feed additives had been shown to have antimicrobial effect in the gut of livestock (Khan *et al.*, 2009; Pandey *et al.*, 2015). In another study by Weerasingha and Atapattu (2013), NGPs was reported to improve growth rate and efficiency of feed utilization. Feed intake was highest ($p < 0.05$) for birds fed diet containing 800g of *Ocimum gratissimum* (3011.70g/bird). The higher feed intake by birds on higher levels of *Ocimum gratissimum* could be as a result of the appetite stimulating effect of the essential oil of the material. The result of this study agrees with the findings of the

studies conducted by Grashorn (2010) and Pandey *et al.* (2015) that phytogetic feed additives stimulates higher feed intake in livestock. The findings of this study showed that inclusion of *Ocimum gratissimum* and *Ocimum canum* in the diets of broiler chickens exerts a positive effect in the growth performance of broiler chickens. The high performance of the broiler chickens fed diet containing AGP showed that antibiotics improve feed efficiency and growth rate. This could be attributed to its antimicrobial effect especially in increasing the population of beneficial strains of bacteria. In several studies, researchers have also stated that feed additives may stimulate early gut development and improve overall efficiency of the chicken gastro intestinal tract (Donoghue, 2003; Apajalahti *et al.*, 2004).

Table 4: Growth performance of broiler chickens fed diets supplemented with *Ocimum gratissimum* and *Ocimum canum* (5-7weeks)

Parameters	Inclusion levels of experimental materials (g/100kg diet)						SEM
	0	<i>Ocimum gratissimum</i>		<i>Ocimum canum</i>		Oxytet	
		400	800	400	800		
Initial weight (g/b)	1001.11	1001.36	1009.96	1015.91	1018.33	1016.19	10.32
Final weight (g/b)	2426.72 ^b	2478.03 ^b	2650.74 ^a	2513.88 ^b	2689.36 ^a	2645.54 ^a	65.68
Weight gain (g/b)	1425.61 ^c	1476.67 ^c	1640.78 ^a	1497.96 ^{bc}	1671.03 ^a	1629.35 ^{ab}	69.89
Feed intake (g/b)	2853.20 ^{ab}	2771.50 ^b	3011.70 ^a	2772.90 ^b	2865.20 ^{ab}	2877.70 ^{ab}	103.59
FCR	2.00 ^c	1.88 ^{bc}	1.85 ^b	1.85 ^b	1.71 ^a	1.77 ^{ab}	0.07
Feed cost (</kg)	105.10	108.10	111.10	108.30	111.30	109.10	NA
FC/kg gain (</kg)	210.51 ^b	203.14 ^{ab}	205.22 ^{ab}	200.56 ^{ab}	190.32 ^a	193.28 ^a	8.47
Mortality (%)	1.51 ^b	1.51 ^b	0.00 ^a	0.00 ^a	0.00 ^a	0.00 ^a	0.45

^{abc}Means with the same superscripts along the rows are not significantly different ($p > 0.05$), SEM: standard error of means, NA: not analyzed, FCR: Feed conversion ratio, FC/kg gain: Feed cost/kg gain.

Effect of Ocimum gratissimum and Ocimum canum inclusion in broiler chickens diets on intestinal microbial content

Table 5 shows the microbial count in the gut of broiler chickens fed diets containing *Ocimum gratissimum* and *Ocimum canum*. The population of *Bacillus* and *Lactobacillus* spp. were increased by the

inclusion of *Ocimum gratissimum* and *Ocimum canum* in the diets of broiler chickens. *Bacillus* spp. are one of the beneficial harmless microbes in the microbiota. Essential oil of oregano oil could improve the intestinal ecosystem of animals via promoting the growth of beneficial bacteria species and suppressing the growth of potential pathogenic bacterial

species (Lin et al., 2011). *Lactobacillus spp.* are commensal bacteria that have long been known for their ability to activate the intestinal immune system and increase resistance to disease. These bacteria have been reported to produce a wide variety of short chain fatty acids which are bacteriostatic for a subset of bacteria spp. Many essential oils stimulate growth of beneficial microbes and limit number of pathogenic bacteria in poultry (Wenk, 2000, Lan et al., 2003). The result showed that addition of *Ocimum gratissimum* and *Ocimum canum* reduced the concentration

of *Escherichia coli*, *Clostridium spp.*, *Salmonella spp.*, *Enterobacteriaceae* and *Pseudomonas spp.* in broiler chickens than the control. Some studies have revealed that Essential oils such as oregano and garlic oil inhibit microorganisms like *E. coli* and other Enterobacterial counts, *Clostridium* count, *Staphylococcus aureus*, *Salmonella typhimurium* and *Listeria monocytogenes* (Aligiannis et al., 2001; Friedman et al., 2002; Kirkpinar et al., 2011). In another study, levels of pathogenic bacteria and by implication incidence of digestive diseases were reduced by an essential oil, CRINA® Poultry Plus (DSM, 2013).

Table 5: Intestinal bacteria count of broiler chickens fed diet containing *Ocimum gratissimum* and *Ocimum canum*

Bacteria (×10 ³ CFU/g)	Inclusion levels of experimental materials (g/100kg diet)						SEM
	0	<i>Ocimum gratissimum</i>		<i>Ocimum canum</i>		Oxytet	
		400	800	400	800		
<i>Bacilli spp.</i>	4.17 ^c	5.53 ^{ab}	6.10 ^a	4.90 ^b	6.10 ^a	4.80 ^{bc}	0.33
<i>Lactobacilli spp.</i>	13.80 ^b	16.20 ^a	16.30 ^a	16.23 ^a	15.57 ^a	16.03 ^a	0.76
<i>Clostridium spp.</i>	1.27 ^c	0.97 ^{bc}	0.90 ^{abc}	0.47 ^{ab}	0.23 ^a	0.77 ^{ab}	0.37
<i>Salmonella spp.</i>	0.03 ^b	0.00 ^a	0.00 ^a	0.00 ^a	0.00 ^a	0.00 ^a	0.01
<i>Escherichia coli</i>	0.40 ^b	0.03 ^b	0.00 ^a	0.00 ^a	0.00 ^a	0.03 ^b	0.15
<i>Pseudomonas spp.</i>	0.13 ^b	0.07 ^a	0.00 ^a	0.03 ^a	0.00 ^a	0.07 ^a	0.06
<i>Enterobacteriaceae</i>	3.03 ^b	2.13 ^{ab}	1.55 ^a	2.20 ^{ab}	1.87 ^{ab}	1.83 ^a	0.60

^{abc}Means with the same superscripts along the rows are not significantly different (p>0.05), SEM: standard error of means, Oxytet-Oxytetracycline

Villi morphometric of broiler chickens fed diets containing *Ocimum gratissimum* and *Ocimum canum*

Table 6 showed the results of the effect of *Ocimum gratissimum* and *Ocimum canum* villi morphometry of cross section of the ileum. Significant (p<0.05) differences were observed in all parameters measured. Villi area was higher (p<0.05) for birds fed dietary supplement of 400g of *Ocimum gratissimum*, 400g and 800g of *Ocimum canum* and AGP (Oxyteracycline) than the control. Villi perimeter, height, width, crypt depth and villi height/crypt depth ratio were higher (p<0.05) for birds fed diets

containing 800g of *Ocimum canum* and AGP (Oxyteracycline) than the control. The morphology of intestinal villi and crypts has been associated with intestinal function and growth in chickens. Higher intestinal villi are associated with increased absorptive surface area of the intestine and thus, an increased absorptive capacity with resultant higher body weight gain (Kanduri et al., 2013). A lower villus/crypt ratio has been associated with the presence of toxins, poor nutrient absorption and increased secretion in the gastrointestinal tract, diarrhoea, reduced disease resistance and lower overall performance. A large crypt

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indicates a fast tissue turnover and a high demand for new tissue (Xu *et al.*, 2003). The result obtained in this work showed that the gut morphology may be responsible for the higher growth performance and better nutrient utilization of the broiler chickens fed dietary supplements of *Ocimum gratissimum* and *Ocimum canum*. Beneficial bacteria such as *Bacillus Subtilis*

aid in maintaining optimum villi height and crypt depth supporting the gut's ability to absorb nutrients for animal maintenance and growth (Awad *et al.*, 2009; Lee *et al.*, 2010). Presence of longer villi has been reported to increase crypt depth of the mucosa of the small intestine resulting in better feed conversion (Sherief *et al.*, 2011).

Table 6: Villi morphometric of broiler chickens fed diet containing *Ocimum gratissimum* and *Ocimum canum*

Parameters	Inclusion levels of experimental materials (g/100kg diet)						SEM
	<i>Ocimum gratissimum</i>			<i>Ocimum canum</i>		Oxytet	
	0	400	800	400	800		
Area (μm) ²	12,768 ^c	17,139 ^{ab}	14,306 ^{bc}	18,785 ^a	17,446 ^{ab}	17,878 ^{ab}	2,023
Perimeter (μm)	667.35 ^b	792.81 ^a	633.83 ^b	819.88 ^a	777.38 ^a	688.58 ^b	63.75
Villi height (μm)	295.64 ^{bc}	356.06 ^{ab}	266.09 ^c	365.00 ^a	360.99 ^a	298.69 ^{bc}	30.95
Villi Width (μm)	81.75 ^{bc}	91.71 ^{ab}	98.46 ^a	98.28 ^a	105.82 ^a	75.73 ^c	7.29
Crypt depth (μm)	93.00 ^c	99.70 ^{bc}	116.88 ^a	101.38 ^{bc}	109.19 ^{ab}	117.27 ^a	7.63
V.H/C.D	3.27 ^a	3.69 ^a	2.25 ^b	3.53 ^a	3.45 ^a	2.63 ^b	0.30

^{abc}Means with the same superscripts along the rows are not significantly different ($p > 0.05$), SEM: standard error of means, Oxytet-Oxytetracycline, V: Villi, C: Crypt, V.H/C.D: Villi Height/Crypt Depth

Conclusions

From the findings of this study, addition of *Ocimum gratissimum* and *Ocimum canum* in broiler chickens diets significantly improved growth performance at the starter and finisher phases. Intestinal microbiota and gut morphometric were significantly improved by addition of *Ocimum gratissimum* and *Ocimum canum* in broiler chickens diet. Farmers and feed millers can use *Ocimum gratissimum* and *Ocimum canum* at 800g/100kg diets as an alternative to synthetic antibiotic growth promoters for improved performance.

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