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THE GROWTH PERFORMANCE AND CARCASS CHARACTERISTICS OF BROILER GUINEA FOWLS (*Numida meleagris*) FED ON DIETS CONTAINING RE3™ PROBIOTICS

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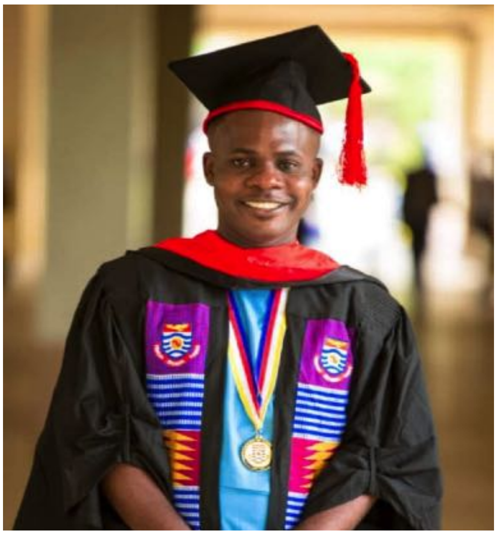

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ABSTRACT

The increasing abuse of antibiotics in production of food animals has led to development of resistant strains of bacteria (and other microbiota) which are responsible for several infectious diseases in animals and in humans. This study was conducted to investigate the effects of RE3^{TM}, a third-generation probiotic used in place of a conventional antibiotics (to minimise incidence of antimicrobial resistance in livestock and human consumers), on growth performance and some carcass characteristics of guinea fowls. One hundred and twenty guinea fowl keets of mixed sexes with an average weight of 28.3±0.364g were used for the study conducted in a Completely Randomised Design. There were 4 treatments in which RE3^{TM} was incorporated at; 0.0ml/kg feed (Diet 1; Control), 1.0ml/kg feed (Diet 2) ,1.5ml/kg feed (Diet 3) and 2.0ml/kg feed (Diet 4); each treatment had 30 birds. The feeding trial covered the entire meat production phase (starter, grower and finisher) which lasted for 84 days. Feed and water were given *ad libitum.* At maturity (12 weeks old), a total of thirty-six (36) birds (9 from each treatment, comprising 5 males and 4 females across the treatments) were selected, weighed and slaughtered. Carcass and viscera weights were taken, carcasses were then sectioned into primal cuts after 24-hour chilling at 4°C. Breast muscles from sampled carcasses were grilled for sensory evaluation by a trained panel, whilst the thigh muscles were subjected to proximate analyses. Data obtained were analysed for statistical significance using the one-way Analysis of Variance (ANOVA) Test, of the GenStat Statistical Package (Discovery Edition, VSN, 2012). Results obtained showed higher ($p < 0.05$) growth rates and lower feed conversion ratio for birds on the diets with 1.0 ml of RE3^{TM} per Kg feed. The carcass and body parts characteristics assessed however, showed no significant differences ($p > 0.05$), except for the thighs which were heavier ($p < 0.05$) in birds on the RE3^{TM} supplemented diets, compared with those on the control diets. The use of RE3™ probiotics, up to 2.0ml/kg feed for guinea fowls, had no adverse effects on the growth of the birds, but it reduced the cost of providing medication for the birds. Fat content in the meat reduced, as inclusions of RE3^{TM} increased in the diets. It is recommended that relevant Government authorities and other stakeholders should aid in promoting the use of probiotics, instead of antibiotics in livestock production to minimise possible antibiotic residue in meat.

Key words: Antibiotics, Guinea Fowls, RE3^{TM} Probiotic, growth performance, carcass characteristics

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INTRODUCTION

The meat and eggs of poultry provide an acceptable form of animal protein for consumers worldwide, due to their quality protein and high levels of unsaturated fatty acids [1]. However, increased livestock susceptibility to diseases emanating from stress-induced factors like intensive system of housing, have resulted in increased use of antimicrobial growth promoters (antibiotics) in livestock production. This is mainly to enhance gut health and control sub-clinical microbial challenges in farm animals and humans who consume farm animal products [2]. The continuous use of antibiotics, however, has been reported to result in the development of resistant strains of microorganisms [3]. Several countries, including the United Kingdom, the United States of America, Denmark and Sweden, have consequently banned the use of antibiotics as growth promoters, and enacted strict legislation on their use in animal production [4]. In 2006, the European Union (EU) also banned in-feed antibiotics for animal production in all its member countries [5].

Scientists have intensified research into products that can effectively replace in-feed antibiotics for growth and health promotion in animals, without adverse effects on health of livestock and human consumers. Direct-fed microbials (DFMs) or probiotics, have been suggested as alternative viable microorganisms which improve the growth and health of farm animals [6]. Probiotics are live microorganisms which are non-pathogenic and non-toxic, and when administered via the digestive route, improves the health of the host animal [7]. These have been proven by several research works as possible alternative to growth promoting antibiotics in animal feed [8, 9]. It has been reported that chicks dosed with *Lactobacillus* strains had lower numbers of coliforms in cecal macerates than in birds without it [10]. Other studies reported that addition of *Lactobacillus* products at 75 mg/kg feed significantly decreased coliform counts in the ceca and small intestine of turkeys [11].

In Ghana, guinea fowls perform various functions such as provision of income and dietary protein, particularly in the northern regions [12]. The meat and eggs are delicacies, particularly to people from the southern zone. Guinea fowl meat is also a good source of high-quality protein because it contains higher levels of unsaturated fatty acids, compared with beef, chevon and mutton [12]. Rearing of guinea fowls, if given the necessary boost, can serve as an income-generating activity for most rural folks, especially women in Northern Ghana [13].

Unlike chicken, little work has been done on the use of probiotics in guinea fowl production, despite its importance to the poultry industry in Ghana. Most research in poultry has generally focused on chicken, with findings extrapolated to the guinea fowl. There is, consequently a dearth of information on most aspects of the physiology of Guinea fowl in Ghana, including the possible influence of the use of probiotics in its production. This study therefore sought to ascertain the growth performance and some carcass characteristics of Guinea fowls (*Numida meleagris*) fed on diets containing differing levels of RE3^{TM} (a probiotic commonly available on the Ghanaian market), in place of conventional antibiotics to minimise incidence of antimicrobial resistance in livestock and human consumers. Studies on the beneficial impact on poultry performance have indicated that probiotic supplementation can have positive effects on livestock [14, 15]. According to Lutful and Kabir [16], liveweight of experimental chicken fed diets with RE3™ were higher than birds which were vaccinated but reared without RE3™.

MATERIALS AND METHODS

Experimental Site

This study was conducted at the Experimental and Meat Processing Units of the Department of Animal Science, University of Cape Coast, Ghana. The location lies in the Coastal Savanna belt, characterised by hot and humid conditions in most times of the year. The annual mean temperatures range from 24.0˚C in the cool periods of the year, to 34.5˚C in the hottest periods of the year, with an annual rainfall of 1500 mm and a relative humidity of 65-80%. The location lies on latitude 05˚ 05`N and longitude 1˚15`W.

Sources of RE3™ and Feed Ingredients Used

The Direct-Fed Microbial (DFM) used was RE3™ (the most commonly available on the Ghanaian market), a health and performance-boosting probiotic which contains Lactobacilli (1×10^{8} cfu/g), *Bacillus* species (1×10^{12} cfu/g) and Saccharomyces cerevisiae (yeast, 1×10^{5} cfu/g). This is a multi-strain type with microbial populations that improve the gut health of livestock for optimum performance [17]. The DFM was obtained from the Basic Environmental Systems and Technology Inc. (BEST), Canada, through its local agent in Ghana. The other ingredients such as whole-grain white maize, wheat bran, fish meal, soya bean meal, oyster shell grit and vitamin premix were purchased from accredited feed suppliers in the open market.

Experimental Design

A total of 120-day old guinea keets imported from the Netherlands were brooded for 4 weeks and randomly allotted to four (4) dietary treatments of 30 birds each, with an average weight of 28.3±0.364 g at the beginning of the experiment. The keets were housed in deep litter pens, in a Completely Randomised Design (CRD) since experimental conditions were similar for birds in all the treatments. The inclusion levels of RE3™ probiotic in the diets were 0.0ml/kg feed (Diet 1; control), 1.0ml/kg feed (Diet 2; as recommended in previous work involving chicken [18]), 1.5ml/kg feed (Diet 3; as recommended by manufacturers) and 2.0ml/kg feed as higher inclusion level to test the effects of higher doses on performance of the Guinea fowls (Diet 4). The inclusion rates of the RE3™ probiotic were maintained throughout the experimental period.

Growth Performance of Guinea Fowls on Experimental Diets

Feed Intake

Feed intake per day was estimated as the difference between feed offered and spilt/leftover feed after 24 hours of feeding. In doing this, feed offered was weighed out into troughs in the morning, and leftover/spilt feed weighed the following morning before the new feed was offered. The feeding trial was continued till the birds attained average market weight of 1.5 kg, in 12 weeks.

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Live Weight Gain
The guinea fowls were tagged, and were weighed individually on weekly basis, using an electronic scale (Sartorius, CP 245S, Madrid, Spain). Weight gain was calculated as the difference between the previous weight and the new weight recorded after a week.

Feed Conversion Ratio (FCR)
The Feed Conversion Ratio (FCR) of birds on the experimental diets were calculated as the ratio of feed taken to weight gained over the same period.

Proximate Composition of the Experimental Feed
Samples of the experimental feed were analysed in the Nutrition Laboratory of the School of Agriculture, University of Cape Coast for the proximate composition. The crude fat, crude protein and moisture contents of the products were determined according to the methods of the AOAC [19]. Metabolisable energy contents of the diets were calculated using the formula proposed by NRC [20].

Slaughtering and Dressing of Birds
At the end of the feeding trial, 9 guinea fowls were selected randomly from each treatment, weighed with an electronic scale (Sartorius, CP 245S, Madrid, Spain) after 12-hour feed withdrawal. The jugular veins were severed with a sharp knife and were allowed to bleed for about 60 seconds, after which they were scalded in warm water (80˚C) for about 60 seconds. The feathers were then plucked manually, after which the head and shanks were removed. The carcasses were eviscerated by making incisions around the vent to remove the viscera. The viscera were separated into the various components, and each was weighed. The carcasses were then washed, and warm carcass weights taken. The warm carcasses were then chilled at about 4^0C for 24 hours, and the chilled carcass weights were taken. Primal cuts were obtained from each of the carcasses, and each was weighed.

Sensory Evaluation of Meat
The breast muscles of birds from each of the treatments were used for sensory evaluation to assess the effects of RE3^{TM} supplementation on some meat quality parameters. The frozen breast muscles were thawed in a refrigerator at about 4˚C for 24hrs, after which they were grilled to a core temperature of about 70˚C in an electric oven (Cuisina EF70SS, Canterbury, UK), and then sliced into sizes of about 20 g and individually wrapped in aluminium foil. A panel of 12 students, aged between 18 and 30 years, were selected randomly and screened for taste acuity, after which they were trained according to the British Standard Institution [21] guidelines for evaluating food products. Each panellist was served with wrapped samples of meat from the 4 treatments. Water and slices of bread were provided as neutralisers in between tasting of products. Questionnaires were issued to each panellist to indicate their reaction to the products coded with random three-digit numbers. A seven-point category scale adopted from Teye *et al*. [22], with few modifications, was used to score the following characteristics of the products:

Colour: Extremely dark (1), Very dark (2), Dark (3), Intermediate (4), Pale (5), Very pale (6), Extremely pale (7).

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Aroma: Extremely weak (1), Very weak (2), Weak (3), Intermediate (4), Strong (5), Very strong (6), Extremely Strong (7).

Tenderness: Extremely tough (1), Very tough (2), Tough (3), Intermediate (4), Tender (5) Very tender (6), extremely tender (7).

Juiciness: Extremely dry (1), Very dry (2), Dry (3), Intermediate (4), Juicy (5), Very juicy (6)

Acceptability: Dislike very much (1), Dislike (2), Neither like nor dislike (3), Like (4) Like very much (5).

Statistical Analyses

Data obtained from the studies were analysed using the one-way ANOVA Test of the Genstat statistical package [23]. Where differences were observed, the means were separated using Tukey's Test at 5% ($p<0.05$) level of significance.

RESULTS AND DISCUSSION

From Table 1, the final body weight of birds on the highest inclusions (2.0ml/kg) of RE3^{TM} diets was higher ($p < 0.05$) than those on the other diets. This observation may be due to the action of the probiotic, which is reported to improve growth rates and efficiency of feed utilisation [24], as a result of factors such as the provision of a near pathogen-free gut environment which ensures reduction in the level of toxins produced in the gut [6, 25]. Addition of beneficial bacteria to animal feed have enzymatic effects on the breakdown of complex Non-Starch Polysaccharides (NSP) which would have otherwise been voided from the gut of the guinea fowls when suitable enzymes for digestion are not available [24]. Furthermore, the growth-promoting effects of probiotics can be attributed to the synthesis of organic acids and vitamins which are useful in the growth and health of farm animals [25]. Other reports indicate that addition of probiotics to the diet of birds increased their growth, compared to those fed on diets without probiotics [26, 27, 28].

The feed intake and feed conversion ratio of birds on the 1.0ml/kg RE3^{TM} probiotic were significantly lower than those on the other treatments. This might imply that the RE3^{TM} inclusion in that diet might be inadequate for normal performance of the birds. Other authors reported reduced feed intake in studies with low inclusions of RE3^{TM} in diets of chicken [28, 29].

It has been reported by Santoso *et al.* [18] that probiotics improve feed conversion ratio through several mechanisms, including alteration in intestinal flora, enhancement in growth of non-pathogenic, facultative, anaerobic and gram-positive bacteria forming lactic acid and hydrogen peroxide, suppression of growth of intestinal pathogens, and enhancement of digestion and utilisation of nutrients, confirming findings from NRC [16].

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The cost of rearing guinea fowls without probiotics was higher, amounting to USD $4.37 or 25.48 Ghana Cedis (GH₵) than those reared with RE3^{TM} probiotics (USD $3.70 or GH₵ 21.58). The final body weight of birds on the RE3^{TM} supplemented diets were higher ($p < 0.05$) than birds on the control diet (Table 2). The higher production cost observed in birds on the control diet may be due to the high cost of medication for such birds, compared to those on the RE3^{TM} probiotic diets [30]. These results agree with findings from Mandal *et al.* [29], which reported lower production cost of GH₵ 2.67 per broiler chicken on diets containing DFM as compared to the control diet of GH₵ 2.84. Other reports by Martins *et al.* [31] and Koop-Hoolihan [32] indicate that RE3^{TM} probiotic is a viable, affordable and efficient means of reducing the cost of producing chicken, as it can be used to replace antibiotics and coccidiostats in poultry production; and this probably was a major cause of the reduced cost of producing birds using RE3^{TM} probiotics.

The gross revenue generated per bird was relatively higher for guinea fowls raised on RE3^{TM} probiotic diets (T2; GH₵ 10.97, T3; GH₵ 10.74 and T4; GH₵ 12.45) compared with those on diets without RE3^{TM} probiotic (T1; GH₵ 7.25). The difference in cost of production was mainly due to lower costs of medication for birds on the diets with RE3^{TM} probiotics, unlike those on the control diets which were vaccinated.

The dressing percentage of the birds were not influenced ($p > 0.05$) by the use of RE3^{TM} in the diets (Table 3). There were no differences ($p > 0.05$) in the internal organ weights of birds in all treatments. According to previous studies, disease occurrence in livestock is evident in variations in colour, texture, size and weight of internal organs [33]. This finding is an indication that RE3^{TM} probiotic supplementation for Guinea fowls had no adverse effects on the health of the birds, similar to the findings of Edens [30].

The primal cuts from the carcasses did not differ ($p > 0.05$) in weight. The weights of the thigh and drumstick were however higher ($p < 0.05$) in birds fed diets with RE3^{TM} supplemented diets compared with those on the control diets. The possible mechanism through which the probiotic achieved this improvement are ascribed to its ability to enhance synthesis and bioavailability of nutrients, accompanied by its positive effects on intestinal activity and increased digestive enzymes [34], thereby promoting growth [35].

Meat from birds on diets with 2.0ml RE3^{TM} probiotics per kg feed had the least fat content, whereas those on the control diets had the highest fat content (Table 4). Generally, fat content decreased as the level of RE3^{TM} increased in the diet. This observation may be ascribed to the presence of probiotic microorganisms which are capable of hydrolysing bile salts or decrease the activity of acetyl-CoA carboxylase, the rate-limiting enzyme in fatty acid synthesis, thus, reducing the absorption and deposition of fat in the body of the birds [36]. Earlier studies also reported greater tendency of a higher ratio of unsaturated fatty acids in pectoral and thigh meat of broilers fed with probiotics–supplemented diets [37].

The sensory parameters of the meat were not significantly different across treatments, indicating that acceptability of meat by consumers may not vary when RE3^{TM} probiotics is used in Guinea fowl production (Table 5).

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CONCLUSION

The use of RE3™ probiotics, up to 2.0ml/kg in rations for guinea fowls, had no adverse effects on growth parameters of the birds. The fat content in the meat of birds fed diets with RE3™ were lower than those on the control diets. The cost of production reduced, as the use of probiotics reduced requirements for medication. Furthermore, the use of RE3™ probiotics had no adverse effects on the carcass and primal parts of the Guinea fowls, as well as internal organ weights.

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Table 1: Growth Performance of Guinea Fowls fed diets with RE3^{TM} (1- 12 weeks old)

	RE3^{TM} inclusions in the diets					
Parameter	0.0ml/kg	1.0ml/kg	1.5ml/kg	2.0ml/kg	SED	Sig.
Initial weight (g/bird)	27.97	28.25	28.61	28.23	0.26	NS
Final weight (g/bird)	1893.90^{b}	1887.61^{b}	1908.68^{b}	2015.17^{a}	31.82	*
Total weight gained (g/bird)	1865.93^{b}	1859.35^{b}	1880.08^{b}	1986.94^{a}	31.82	*
Growth rate(g/day/bird)	22.21^{b}	22.14^{b}	22.38^{b}	23.65^{a}	0.38	*
Total feed consumed(g/bird)	7390.08^{a}	7123.52^{b}	7421.49^{a}	7447.01^{a}	76.80	*
Daily feed intake(g/day)	87.98^{a}	84.80^{b}	88.35^{a}	88.65^{a}	0.09	*
FCR/bird	8.80^{a}	8.48^{b}	8.84^{a}	8.87^{a}	0.09	*

Means in the same row with similar superscripts are not significantly different. NS=Not significantly different (P>0.05); *= Significantly different (P<0.05); FCR= feed conversion ratio; SED= Standard error of Difference; Sig. = significance

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Table 2: Cost-Benefit Assessment of using RE3™ in place of conventional antibiotics in Guinea Fowl production (from 1-12 weeks old)

	RE3™ inclusions in the diet			
Parameter (GH₵)	0.0ml/kg	1.0ml/kg	1.5ml/kg	2.0ml/kg
(i) Cost of keet/bird	8.50	8.50	8.50	8.50
(ii) Costs at Starter Phase*	4.01	1.87	2.00	2.08
(iii) Costs at Grower Phase*	6.92	5.11	5.53	5.76
(iv) Costs at Finisher Phase*	6.05	6.10	6.13	6.04
(v) Total Cost ∑ (i, ii, iii, & iv)	25.48	21.58	22.16	22.38
(vi) Sale Price Per Kg bird	17.50	17.50	17.50	17.50
(vii) Weight Gained 0-12 Weeks	1.87	1.86	1.88	1.99
(viii) Total Income Per Bird (vi × vii)	32.73	32.55	32.90	34.83
(ix) Revenue generated (viii-v)	7.25	10.97	10.74	12.45

*Costs = Cost of feed and medication only; US$ 1 = GH₵ 5.83

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Table 3: Carcass Characteristics, Organ Weights and Primal Cuts of the meat of Guinea Fowls fed diets with RE3™

Parameter	RE3™ inclusions in the diet 0.0ml/kg	1.0ml/kg	1.5ml/kg	2.0ml/kg	SED	Sig.
Carcass Characteristics						
Live weight prior to slaughter (g)	1953	2028	1734	2002	107.56	NS
Bled weight (g)	1889	1961	1670	1932	105.98	NS
Warm carcass weight (g)	1508	1530	1319	1539	90.64	NS
Dressing percentage (%)	77.17	75.43	76.05	76.88	1.00	NS
Chilled carcass weight (g)	1473	1518	1299	1521	82.97	NS
Weight of Internal Organs						
Heart (% of carcass weight)	0.46	0.48	0.51	0.52	0.03	NS
Liver (% of carcass weight)	2.30	2.33	1.41	1.84	0.37	NS
Gizzard (% of carcass weight)	2.18	2.23	2.54	2.22	0.14	NS
Filled intestine (% of carcass weight)	4.31	4.15	3.45	3.71	0.28	NS
Primal Cuts						
Thighs (% of carcass weight)	20.79^{b}	31.66^{a}	35.30^{a}	31.45^{a}	2.50	*
Drumsticks (% of carcass weight)	9.05^{b}	9.60^{ab}	11.55^{a}	10.38^{ab}	0.76	*
Wings (% of carcass weight)	10.38	9.62	11.12	9.73	1.75	NS
Back (% of carcass weight)	6.23	4.61	6.20	5.71	0.86	NS
Breast (% of carcass weight)	23.79	25.33	25.55	24.59	2.40	NS
Neck (% of carcass weight)	5.42	5.33	6.88	6.79	0.66	NS

Means in the same row with similar superscripts are not significantly different. NS=Not significantly different ($p > 0.05$); *= Significantly different ($p < 0.05$); SED= Standard Error of Difference; Sig. = significance

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Table 4: Proximate Composition of the Meat of Guinea fowls fed diets with RE3^{TM}

	RE3^{TM} inclusions in the diet					
Parameter (%)	0.0ml/kg	1.0ml/kg	1.5ml/kg	2.0ml/kg	SED	Sig.
Moisture	65.74^{b}	66.84^{bc}	68.06^{c}	63.48^{a}	0.70	*
Crude Protein	31.00^{b}	25.13^{c}	36.25^{a}	36.35^{a}	0.59	*
Ether extract (fat)	25.95^{a}	21.01^{b}	16.09^{c}	15.54^{c}	0.59	*

Means in the same row with similar superscripts are not significantly different; * = significantly different ($p < 0.05$); SED= Standard error of Difference; Sig.= Significance

Table 5: Sensory Characteristics of the meat of Guinea fowls fed diets with RE3^{TM}

	Level of RE3^{TM} inclusion in the diet					
Parameter	0.0ml/kg	1.0ml/kg	1.5ml/kg	2.0ml/kg	SED	Sig.
Colour	5.00	5.06	4.67	5.17	0.32	NS
Aroma	4.56	4.39	5.00	4.72	0.38	NS
Juiciness	4.28	4.94	4.78	4.83	0.33	NS
Tenderness	4.22	5.00	5.06	4.83	0.37	NS
Acceptability	3.83	4.00	4.11	4.17	0.29	NS

Means in the same row with similar superscripts are not significantly different. NS=Not significantly different ($p > 0.05$); *= Significantly different ($p < 0.05$); SED= Standard error of Difference; Sig. = significance

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