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Research Article

Response of Broiler Chickens to Diets Containing Graded Levels of Cultured Indigenous Microorganisms

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Abstract

Antibiotic growth promoters have been banned as livestock feed additives in several countries due to growing human health concerns. Sequel to the aforementioned challenge, Animal Scientists have been researching incessantly to find alternatives which poses no danger to human health. A 49-day feeding trial was conducted to assess the growth performance, carcass characteristics, organ weights, and economics of production of broiler chickens fed diets containing varying levels of indigenous microorganisms (IMOs). A total of two hundred (200) unsexed day-old Ross broiler chicks were randomly assigned to diets containing 0 g/kg, 0.8 g/kg, 1.6 g/kg. 2.4 g/kg and 3.2 g/kg of IMOs, respectively. Each of the five dietary treatments had four replicates of ten birds each, in a completely randomized design (CRD). The results of the study revealed that, growth performance parameters such as final body weight, total body weight gain and daily weight gain were significantly influenced ($P < 0.05$) by the inclusion of IMOs. The experimental birds fed diets containing 2.4 g/kg of IMOs had higher final body weight (2006.67g), total weight gain (1964.16g), and daily weight gain (40.09 g) while the treatments containing 1.6 g/kg of IMOs had the least final weight (1690 g), total weight gain (1646.23 g) and daily weight gain (33.59 g). Other growth parameters such as daily feed intake and feed conversion ratio (FCR) were not significantly influenced ($P > 0.05$) by the inclusion of IMOs. The carcass cuts and organ weights were not influenced significantly ($P > 0.05$) by the inclusion of IMOs. The results of the economics of production revealed that, the birds offered diets containing 2.4 g/kg IMOs generated higher revenue and profit than other treatments. It is therefore, concluded that, 2.4 g/kg of indigenous microorganisms (IMOs) can be incorporated into the diet of broiler chickens for improved weight gain, revenue and profit.

Keywords: Broiler Chickens; Growth Performance; Carcass Characteristics; Organ Weight; Economics; Indigenous Microorganisms

Introduction

There has been an unprecedented increase in the global human population in the past two decades. According to [1], world population has increased from 6 985 603 105 in 2010 to 8 118 835 999 in 2024. The increase in the population has resulted to an increased demand for food [2]. The poultry subsector of the livestock sector has a potential role in providing food and livelihood securities for the teeming population. According to [3], broiler chicken farming is by far the largest terrestrial animal production industry in the world, with about 70 billion broiler chickens slaughtered on yearly basis.

Feed additives are used in broiler production to improve the efficiency of feed conversion as well as health. Antibiotics have long been used as first choice feed additives ([4-6]). However, in recent past, there are proven evidences that some industrialized countries

have imposed ban on the use of certain antibiotics as growth promoters in a bid to prevent the spread of antibiotic resistance in the human population [7]. There is no doubt that phytogenic and other feed additives such as probiotics have been gaining acceptance as growth promoters [8]. According to [9], probiotics are a solution and substitute for antibiotic growth promoters in broiler chicken production. They are gut friendly organisms that depopulate harmful organisms thereby enhancing the wellness of the animal and optimal performance. According to [10], the purpose of giving probiotics is to increase endurance, digestibility of feed, and good microbial growth.

Indigenous Microorganisms (IMOs) are naturally occurring microorganisms and can be trapped in our environment. They improve the intestinal health of farm animals by encouraging the development of a positive microbiota [11], preventing intestinal colonization of enteric pathogen [12], reduced faecal noxious gas emission, generation of antimicrobial compounds, antibiotic resistance patterns, improved digestion and antibody-mediated immune response [13], and demonstrable efficacy and safety [14].

Thus, the use of indigenous microorganisms (IMOs) as probiotic feed additives in broiler chicken diets will substitute antibiotic growth promoters which have been banned due to human health challenges, improve animal performance and produce quality and safe animal protein for human consumption. This study, therefore, investigated the response of broiler chickens to diets containing graded levels of cultured indigenous microorganisms.

Materials and Methods

Experimental site

This research was conducted at the Poultry Pen, Livestock Teaching and Research Farm, Joseph Sarwuan Tarka University, Makurdi. Makurdi town, the headquarters of Benue State, is located at latitude 7° 43' and longitude 80^0 3' E [15]. The Benue floodplain is between 0 m and 100m above sea level. The area is warm, characteristic of a tropical climate, with a minimum temperature of 24.20 + 1.40°C and a maximum temperature of 36.33 + 3.70°C [16]. From February through April, temperatures may reach 35°C to 40°C in Makurdi town. Rainfall is between 508 and 1016mm, and the relative humidity is between 39.50 + 2.20 and 64. 00 ± 4.8% and a mean wind speed of 2.47 knots/second northeast [16].

Preparation of indigenous microorganisms (IMOs)

Rice grains were parboiled in a tower trim aluminum pot for ten minutes. The parboiled rice was transferred to earthen pot. The earthen pot was covered with clean piece of cloths to prevent insects and rodent attacks. The pot was placed into the ground about 5cm deep under a shade for 7 days to prevent the impact of solar radiation and rainfall. After the 7th day, the pot was removed from the soil. The alcoholic smell of the rice indicated the presence of IMOs. The IMOs were mixed with molasses in the ratio of 1:1 w/w. The mixing of the IMOs with molasses triggered the proliferation of lactobacillus species because they are sugar-loving microbes. The mixture of IMOs and molasses was transferred to a clean white container, covered and placed in a cool environment away from sunlight for 7 days and ready for use.

Preparation of experimental diets

Five iso-nitrogenous and iso-caloric diets were compounded and designated as T1, T2, T3, T4 and T5. Indigenous microorganisms were included in the diets at 0.8g/kg, 1.6g/kg, 2.4g/kg and 3.2g/kg for T1, T2, T3, T4 and T5 respectively, as shown in table 1 and 2.

Experimental birds and management

Two hundred (200) unsexed day-old Ross broiler chicks were obtained from Agrited Farm, Ibadan, South-Western Nigeria. Before the arrival of the chicks, the experimental pen and all the equipment were thoroughly sanitized and disinfected. Upon the arrival of the experimental chicks, the initial weight of all the chicks were taken using a sensitive scale. Thereafter, the birds were allotted to five dietary treatments with four replicates of ten birds each, in a completely randomized design (CRD). The chicks were brooded for a period of four weeks. The environmental conditions were kept optimal: the ambient temperature within the chicks' brooding pen was set at 37^0C at day old, and thereafter adjusted according to chicks' reactions to heat source; the relative humidity was 55% while light was supplied for 22 hours on daily basis throughout the breeding period. The brooding of the chicks and data collection went on concurrently. Routine medications and vaccinations were carried out to ensure the proper health of the birds. The birds were all vaccinated against Newcastle disease with the use of the lasota vaccine in normal saline water intra-ocularly at day one, then against infectious bursal disease (gumboro) with

Experimental diets					
Ingredients (%)	**T1(0g/kg)**	**T2(0.8g/kg)**	**T3(1.6g/kg)**	**T4(2.4g/kg)**	**T5(3.2g/kg)**
Maize	34.65	34.65	34.65	34.65	34.65
FFSB	51.30	51.30	51.30	51.30	51.30
Maize offal	10.00	10.00	10.00	10.00	10.00
Bone ash	3.00	3.00	3.00	3.00	3.00
Salt	0.30	0.30	0.30	0.30	0.30
Lysine	0.25	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25	0.25
VMP	0.25	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00	100.00
Calculated nutrients					
Crude protein (%)	23.00	23.00	23.00	23.00	23.00
Crude fibre (%)	4.79	4.79	4.79	4.79	4.79
ME(Kcal/kg)	2932.00	2932.00	2932.00	2932.00	2932.00

Table 1: Ingredient composition of diets for starter broiler chicks.

0g/kg, 0.8g/kg, 1.6g/kg. 2.4g/kg and 3.2g/kg represents the levels of inclusion of Indigenous microorganisms in the diets; FFSB= Full fat soyabean, VMP= Vitamin-mineral premix; ME = metabolizable energy.

Experimental diets					
Ingredients (%)	**T1(0g/kg)**	**T2(0.8g/kg)**	**T3(1.6g/kg)**	**T4(2.4g/kg)**	**T5(3.2g/kg)**
Maize	42.70	42.70	42.70	42.70	42.70
FFSB	40.75	40.75	40.75	40.75	40.75
Maize offal	12.00	12.00	12.00	12.00	12.00
Bone ash	3.50	3.50	3.50	3.50	3.50
Salt	0.30	0.30	0.30	0.30	0.30
Lysine	0.25	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25	0.25
VMP	0.25	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00	100.00
Calculated nutrients					
Crude protein (%)	20.00	20.00	20.00	20.00	20.00
Crude fibre (%)	4.79	4.79	4.79	4.79	4.79
ME(Kcal/kg)	2908.00	2908.00	2908.00	2908.00	2908.00

Table 2: Ingredient composition of diets for finisher broiler chickens.

0g/kg, 0.8g/kg, 1.6g/kg. 2.4g/kg and 3.2g/kg represents the levels of inclusion of Indigenous microorganisms in the diets; FFSB = Full fat soyabean, VMP = Vitamin-mineral premix; ME = metabolizable energy.

the use of the gumboro vaccine, which was administered orally in drinking water at day 14, and finally lasota was administered orally through drinking water at day 21. The birds were raised in a deep litter half-walled house, with its upper half covered with wire mesh. Feed and water were served *ad libitum* throughout the experimental period, which lasted for 49 days.

Data collection

Growth performance

The following performance parameters were measured.

Weight gain

The initial weight of the chicks was taken at the commencement of the feeding trial using a sensitive weighing scale. The daily weight gain was determined by dividing the total weight gain against the number of days that the feeding trial lasted (56 days).

The weekly weight gain was measured as the difference between the weight of the current week and previous week, while the final weight gain obtained by subtracting the final weight from the initial weight of birds.

Feed intake

Feed intakes were determined by recording the weights (g) of feeds offered and feeds left over, and calculating the difference between weight (g) of feed served and weight of feed left over. The daily feed intake was determined by dividing the total feed intake against the number of days that the feeding trial lasted (49 days).

Feed conversion ratio

The feed conversion ratio (FCR) was calculated by dividing the total feed intake by the total weight gain of the birds.

Carcass yield

Prior to the termination of the feeding trial, five birds per treatment, one from each replicate, with similar weight to the replicate's average weight were fasted of feed for 18 hours. Thereafter, the animals were bled and the carcass evaluated as described by [17]. Carcass was separated into cuts namely breast, thigh, drumstick, wing, and back; and offals, namely shank, head. and fats, and internal organs, including the heart, liver, spleen, gall, pancreas, gizzard, proventriculus, lungs and kidney. The gastro-intestinal tract (GIT) morphometry components; small intestine, large intestine, and caeca, were also examined. All parts were weighed using a sensitive digital scale.

Economics of production

The cost of each ingredient including services such as processing and transportation as well as the cost of culturing microorganisms were added together to arrive at a realistic cost of feed. The formula for each diet was used to determine the cost per kg of the feeds by multiplying the unit cost of each ingredient by its proportion in the diet to determine its cost contribution to the diet.

The sum of the cost contributions from all the ingredients in the diet gave the unit cost (₦) Kg^{-1} of the diet. The cost of feed consumed per bird during the experimental period was obtained by multiplying the total feed consumed in kg per bird by the cost per kg of the diet. The total cost of production was obtained by the summing up the cost of a day-old chick, the cost of feed consumed per bird, and other costs incurred per bird such as house maintenance, feeders, drinkers, medications, and litter materials. The cost of reusable items was measured using straight line depreciation according to their lifespan, as recorded at the Livestock Teaching and Research Farm, Joseph Sarwuan Tarka University, Makurdi. The cost per kg of diet multiplied by the feed conversion ratio gave the feed cost per kg weight gain. Revenue per bird referred to the value (₦) per kg of live weight. Gross margin (profit) was obtained by subtracting the total cost of production from revenue.

Statistical analysis

All data collected (except economic data) during the experiment were subjected to One-way analysis of variance (ANOVA) using SPSS as a statistical software. Where there was significant difference in the treatment means, Duncan Multiple Range Test was employed in the separation of the means.

Results and Discussion

Table 3 shows the results of the effects of including varying levels of IMOs on growth performance of broiler chickens. There was significant difference ($P < 0.05$) on the final weights of birds fed diets containing varying levels of IMOs. Even though there was no specific pattern of variation in the weight of the birds, the experimental birds fed diets containing 2.4 g/kg IMOs had higher final body weight (2006.67g), while birds fed diets containing 1.6 g/kg IMOs had the least weight (1690 g). There was significant difference ($P < 0.05$) on both the total and daily weight gain of birds. The

total weight gain in the study ranged from 1646.23 g to 1946.66 g. The highest total weight (1946.66g) was recorded in birds fed diets containing 2.4 g/kg of IMOs while the least (1646.23 g) was obtained from birds fed diets containing 1.6 g/kg of IMOs. The same pattern of variation was observed on daily weight gain parameter. The daily feed intake and the feed conversion ratio (FCR) were not significantly influenced (P > 0.05) by the inclusion of the IMOs in the diets of broiler chickens.

The result of the growth performance in this study is supported by the findings of [18], where they attributed growth promoting effect in birds to the administration of multi-species probiotic product (comprising *Lactobacillus reuteri, Enterococcus faecium, Bifidobacterium animalis, Pediococcus acidilactici, Lactobacillus salivarius*) in feed and water. The improved weight gain in this study can be attributed to the multiple beneficial activities of indigenous microorganisms. According to [19], who investigated the effect of beneficial microorganisms on growth performance, mortality and intestinal microflora in broilers, attributed improved weight gain to a collective effect of probiotic action including feed intake, nutrient digestibility, maintenance of beneficial gut microflora and increased digestive enzyme activity.

	Experimental diets						
Parameter	**T1(0g/kg)**	**T2(0.8g/kg)**	**T3(1.6g/kg)**	**T4(2.4g/kg)**	**T5(3.2g/kg)**	**SEM**	**P-value**
IW	47.60	47.71	43.77	42.01	49.10	10.90	0.24
FW	1763.33^{bc}	1800^{bc}	1690.00^{c}	2006.67^{a}	1951.00^{ab}	38.51	0.02
TWG	1715.73^{bc}	172.29^{bc}	1646.23^{c}	1964.66^{a}	1901.90^{ab}	37.41	0.03
DFI	81.15	88.76	82.43	96.44	92.32	2.21	0.12
DWG	35.01^{bc}	35.76^{bc}	33.59^{c}	40.09^{a}	38.81^{ab}	38.42	0.01
FCR	2.31	2.48	2.45	2.40	2.31	2.99	0.76

Table 3: Growth performance of broiler chickens fed diets containing varying levels of IMOs.

^{abc} means with different superscript on the same row are significantly different (P < 0.05); SEM = standard error of mean; IW = initial weight; FW = final weight; DWG = average daily weight gain; TFI = total feed intake; DFI = average daily feed intake; FCR = feed conversion ratio' IMOs = indigenous microorganisms.

Table 4 and 5 shows the result of carcass characteristics and organ weights of broiler chickens fed diets containing varying levels of IMOs. There was no significant difference (P > 0.05) on all the carcass cuts and internal organs under consideration. This is an indication that, the inclusion of the IMOs in the diets of broiler chickens had no adverse effects on carcass traits and gastrointestinal morphometry. This result stood parallel with the findings of [20], who reported significant (p < 0.05) differences among the treatments with respect to certain internal and external organs such as liver and heart weights as well as shank and thigh lengths, when broilers were fed diets containing varying levels of probiotics (*Saccharomyces cerevisae*). This variation may be precipitated by the type and number of probiotics used in the study. Despite the fact that there was no significant difference (P > 0.05) on the carcass cuts, the values fall within the range reported [21,22] as excellent carcass characteristics of broiler birds fed *Saccharomyces cerevisiae*. The absence of adverse effects on internal organs of birds fed diets containing IMOs is an indication that the GIT of the birds was healthy and that, the birds were not implicated of hepatomegaly and myocardial hypertrophy.

Table 6 shows the economics of production of broiler chickens fed diets containing graded levels of indigenous microorganisms. The cost per kg diet ranged from ₦ 372.60 to 372.88. The treatment with no IMOs had the least cost (₦ 372.60) per kg diet, while the highest (₦ 372.98) was the treatment with 3.2 g/kg of IMOs. There were little variations in the cost per kg diet across the treatment groups, and thus a pattern of variation established: as the level of IMOs was increased in the diet, the cost per kg diet slightly increased. The cost per kg weight gain in the study ranged from ₦ 637.62 to 700.66. The treatment with 2.4 g/kg IMOs had the least cost (₦637.62) per kg weight gain while the treatment with 0.8 g/kg IMOs had the highest cost (₦ 700.66) per kg weight gain. The total cost of production was highest (₦ 1677.95) in the treatment with 2.4 g/kg IMOs while the least (₦1409.66) was recorded in the treatment that contains no IMOs. The revenue generated from the sales of birds showed that birds fed diets containing 2.4 g/kg IMOs showed superior revenue (₦4500) while the least revenue (₦ 3802.50) was recorded in birds fed diets containing 1.6 g/kg IMOs. The experimental birds fed diet containing 2.4 g/kg IMOs showed

Experimental diets							
Parameter (g)	**T1(0g/kg)**	**T2(0.8g/kg)**	**T3(1.6g/kg)**	**T4(2.4g/kg)**	**T5(3.2g/kg)**	**SEM**	**P-value**
Liveweight	1976.33	2019.67	2056.00	1928.50	2184.00	38.00	0.73
Dressed wt	1446.00	1467.67	1503.00	1370.33	1386.07	32.86	0.75
Dressing %	73.20	72.52	73.13	70.99	68.91	0.66	0.18
Breast	29.63	28.83	32.08	30.68	30.41	0.71	0.73
Thigh	15.49	15.34	14.09	14.88	14.92	0.30	0.68
Drumstick	17.84	15.19	16.24	15.02	15.34	0.53	0.46
Back	14.23	14.86	13.88	14.71	15.01	0.25	0.42
Wings	11.68	12.20	11.86	11.95	11.93	0.13	0.81
Neck	8.99	9.52	8.60	9.05	9.36	0.16	0.47
Head	3.03	3.08	3.14	3.13	3.34	0.90	0.90
Shanks	6.43	6.54	6.89	6.36	6.57	0.26	0.98

Table 4: Carcass characteristics of broiler chickens fed diets containing varying levels of IMOs.

SEM = standard error of mean; P = level of probability; % = percent; wt = weight.

Experimental diets							
Parameter (g)	**T1(0g/k)**	**T2(0.8g/kg)**	**T3(1.6g/kg)**	**T4(2.4g/kg)**	**T5(3.2g/kg)**	**SEM**	**P-value**
Empty gizzard	2.08	2.06	1.81	1.85	1.92	0.51	0.53
Proventriculus	0.48	0.55	0.53	0.54	0.62	0.02	0.34
Heart	0.53	0.55	0.59	0.51	0.60	0.03	0.83
Liver	1.64	1.78	1.64	1.77	2.12	0.63	0.07
Lungs	0.49	0.56	0.54	0.60	0.73	0.03	0.19
Spleen	0.11	0.15	0.08	0.10	0.14	0.02	0.87
Kidney	0.62	0.74	0.62	0.65	0.66	0.63	0.75
Abdominal fat	0.98	1.32	0.68	0.86	1.19	0.10	0.29
Empty crop	0.33	0.29	0.34	0.33	0.30	0.02	0.95
Pancreas	0.23	0.25	0.26	0.33	0.30	0.24	0.21
Empty intestine	2.88	3.24	3.10	3.74	3.60	0.13	0.20
Oesophagus	0.20	0.13	0.18	0.14	0.21	0.02	0.21
Small intestine	2.44	2.69	2.47	3.14	3.00	0.12	0.27
Large intestine	0.26	0.24	0.26	0.25	0.85	0.11	0.31
Caeca	0.38	0.33	0.37	0.36	0.31	0.01	0.26

Table 5: Organ weights of broiler chickens fed diets containing varying levels of IMOs.

SEM = standard error of mean, P = level of probability.

Experimental diets					
Parameter (₦)	**T1(0g/kg)**	**T2(0.8g/kg)**	**T3(1.6g/kg)**	**T4(2.4g/kg)**	**T5(3.2g/kg)**
Cost/kg diet	372.60	372.69	372.79	372.88	372.98
Cost/kg weight gain	659.50	700.66	671.02	637.62	660.17
TCP	1409.66	1540.45	1429.03	1677.95	1603.80
Revenue	3960.00	4050.00	3802.50	4500.00	4387.50
Profit	2550.34	2113.14	2373.47	2822.05	2783.70

Table 6: Economics of production of broiler chickens fed diets containing varying levels of IMOs.

0 g/kg, 0.8 g/k, 1.6 g/k, 2.4 g/kg and 3.2 g/kg represent the levels of inclusion of IMOs; TCP = total cost of production.

superior profitability (₦ 2822.05), while the least profitability (₦ 2113.14) was recorded in birds fed diet containing 0.8 g/kg IMOs.

The high revenue and profit recorded in this study when IMOs were included up to 2.40 g/kg of the diet indicates that, the birds acquired more weight resulting to higher sales. The findings of this study corroborate [23], who established that, the use of different concentrations of probiotics in the diets of broiler chickens improved both economic and productive efficiencies.

Conclusion

Sequel to the findings of this study, it is concluded that 2.4 g.kg indigenous microorganisms (IMOs) can be incorporated into the diet of broiler chickens for improved weight gain**,** revenue and profit.

Acknowledgement

Not applicable.

Conflict of Interest

The authors declare that they have no conflict of interest.

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