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Effect of Lactic Acid Bacteria Probiotics on Growth Performance and Nutrient Digestibility of Ross 308 Broiler Chicks

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Abstract

The impact of lactic acid bacteria probiotics on growth performance and nutrient digestibility was appraised using two hundred (200) broiler chicks (Ross 308 Strain), in a broiler battery cage system at the Poultry Unit of Plateau the State College of Agriculture, Garkawa. Completely randomized design was used with five treatments replicated four times. Treatment1 contained LABPs minimum presence of 0.0 × 108 CFU, treatments2,3,4and5 contained LABPs minimum presence of: 7.2 × 108 CFU *L. Plantarum*, 4.2 × 107 CFU *Pediococcus pentosaceous* , 1.8 × 108 CFU *L. fermentum* and combination of *L. plantarum, Pediococcus pentosaceous* and *L. fermentum* for every ml. No significant (p>0.05) are changes were discovered on: initial body weight and survival percentage but significant (p<0.05) differences were notice on: final live weight, daily feed intake, weigh t of gain, feed conversion ratio, protein intake, protein efficiency ratio, energy intake, energy efficiency ratio and efficiency of performance index of broiler chicks fed lactic acid bacteria probiotics. Signification changes occurred in all nutrient of it digestibility parameters except ether. Therefore, the utilization of mixture of lactic acid bacteria such as the *L. plantarum* , *Pediococcus pentosaceous* and *L. fermentum* is hereby recommended for used, since reduction in feed of intake and fibre digestibility linked to ceacal fermentation of provides good substrates for fibre metabolisms which produced efficient feed conversion and better final live weight compared to the utilization of single lactic acid bacteria probiotic.

Keywords: Lactic acid bacteria; Digestibility; Broiler Chicks

Introduction

Description of problem

The amendment of the digestive system of broiler chicks in the early hour's stage of their gut development with useful microorganisms is aim at instigating the development of beneficial bacteria by altering gastrointestinal microbiome to reduce harmful microbes competent of inflicting infection. Increase in the activity and balance of intestinal microbes in addition to bacterial enzymes, which are observed to promote the digestion of protein, lipid, carbohydrates, as well as synthesis of vitamins thereby contributing to the nutrition of the birds and reduction on the cost of production and odour in poultry houses [1]. Timmerman reported slight increase by 1.84% in broiler productivity in daily weight gain, feed efficiency, and mortality in broiler chickens fed Multispecies Probiotic Species (MSPB) of human origin [2].

The previous studies of Sadi, Sri-Harimurti, Rahayu reported that useful microbes provides protective function for animals from harassment by means of harmful organisms intended for causing ailment in the process of competition for critical nutrients and receptors on host cells during the production of bacteriocins as well as other inhibitory substances, thus, make the gut surroundings not conducive for pathogens to take possession of the gastrointestinal tracts [3]. In a related study, Ari reported beneficial micro-organisms as crucial to gene activation in the development, function and colonization of harmful microbes in the gastrointestinal tract of chickens and certain bacteria in broiler chickens might be associated with growth performance [4]. Sri-Harimurti, Widodo reported appreciably (p<0.05) progress in cumulative feed consumption, body weight gain and feed conversion ratio broilers fed lactic acid bacteria probiotics and development in body weight, average weight gain and feed conversion ratio of bird complemented with 2.0/100 kg of Lactobacillus acidophilus [5,6]. At the end of 28 days, probiotic supplementations extensively upgraded the body weight, daily weight gain of broiler chicks as a result of better feed conversion [7]. Development in broiler performance are repeatedly connected by means of increased in nutrient digestibility and energy consumption [8] and probiotics enhance accessibility of energy levels by increasing carbohydrate digestibility through improving organic material digestibility, in addition to diminishing bacterial β -glucuronidase, β -glucosidase and urea enzymes performance[9,10]. It is also, well recognized that probiotics modify gastrointestinal pH and flora towards increasing action of intestinal enzymes along with digestibility of nutrients [11]. The study, for that reason, considers the usage of lactic acid organisms as feed additive w ith t he s ole intend o f promoting performance and nutrient digestibility.

Materials and Methods

Location of the study

The experiment was conducted within August to September, 2019 at the Poultry Unit of the Plateau State College of Agriculture, Garkawa. Garkawa town is located on latitude 80 58E and longitude 9045N, with an elevation of 240 m above sea level within the southern guinea savanna zone of Nigeria characterized by six months of rainy season (May to October) and six months of dry season (November to April), determined using Global Positioning System (GPS) [12].

Experimental diets preparation

Feed used for the experiment was formulated using least cost formulation software. Ingredients composition and calculated nutrients of the experimental diets are as presented in **Table 1** below. Lactic Acid Bacteria Probiotic (LABP) used as a diets of *isonitrogenous* (23% CP) and *isocaloric* (3005.48 kcal/kg) diets. Treatment 1 contained LABP minimum presence of 0.0 × 108 CFU, Treatment 2=7.2 × 108 CFU *L. plantarum*, Treatment 3=4.2 × 107 CFU *Pediococcus pentosaceous*, Treatment 4=1.8 × 108 CFU *L. fermentum* and Treatment 5=Combination of *L. plantarum, Pediococcus pentosaceous* and *L. fermentum* for every ml. Freeze dried LABPs were then re-constituted with 100 ml of normal saline and one (1) ml was given directly to the birds immediately on arrival at the farm via oral dosing and repeated at week two and three, respectively.

Ingredients	T1	T2	T3	T4	T5
Maize	41.26	41.26	41.26	41.26	41.26
GNC	32.38	32.38	32.38	32.38	32.38
SBM	5	5	5	5	5
Rice offal	7.7	7.7	7.7	7.7	7.7
Fish meal	3	3	3	3	3
Bone meal	2.2	2.2	2.2	2.2	2.2
Limestone	1	1	1	1	1
*Premix	0.25	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25	0.25
Meth	0.16	0.16	0.16	0.16	0.16
Salt	0.25	0.25	0.25	0.25	0.25
SCM (%)	5	5	5	5	5
Palm oil	1.55	1.55	1.55	1.55	1.55
Total	100	100	100	100	100
IMOs	0	L.p	P. p	L. f	Cocktail
Calculated analysis					
Price/kg	172.36	177.36	177.36	177.36	177.36
Price/ME	57.35	57.35	57.35	57.35	57.35
Price/CP	7.49	7.49	7.49	7.49	7.49
DM	86.88	86.88	86.88	86.88	86.88
ME Kcal/kg	3005.48	3005.48	3005.48	3005.48	3005.48
CP (%)	23	23	23	23	23
CF (%)	4.9	4.9	4.9	4.9	4.9
EE (%)	7.05	7.05	7.05	7.05	7.05
Lys (%)	1.09	1.09	1.09	1.09	1.09
Meth (%)	0.5	0.5	0.5	0.5	0.5
Meth +cyst (%)	0.81	0.81	0.81	0.81	0.81
Ca (%)	1.17	1.17	1.17	1.17	1.17
Available p (%)	0.71	0.71	0.71	0.71	0.71

Ground Nut Cake (GNC), Soya Bean Meal (SBM), Sugar Cane Molasses (SCM), Kilogram(Kg) , Metabolizable Energy (ME), Indigenous Microbial Organisms (IMO), Dry Matter (DM), Crude Protein (CP), Crude Fibre (CF), Ether Extract (EE), Lysine (lys), Methionine (meth), Calcium (Ca), Phosphorus (P) and Percentage (%), L.p=Lactobacillus Plantarum, P.p=Pediococcus pentasaceous L.f =L. fermentum, cock tail=L. plantarum, Pediococcus pentasaceous and L. fermentum

*Vitamin-Mineral premix (BIOMIX(R)) was supplier per kg diet; Vit. A 500I U; Vit. D3 888, IU; Vit. E12,000 mg; Vit. K315000 mg; Niacin 12000 mg; Pantothenic acid 2000 mg, Biotin 1000 mg; Vit b12 3000 mg; Folic acid 15000 mg; Choline chloride 6000 mg, Manganese 1000 mg; Vit. Iron 15000 mg; Zinc 800 mg; Copper 400 mg; Iodine 80 mg; Cobalt 400 mg; Selenium 8000 mg

Table 1: Ingredients and nutrient composition of broiler starts (0-4 weeks) diet (as fed basis).

Animal population, management and design

Two hundred (200) broiler chicks (Ross 308 Strain) of mixed sexes were obtained from a reputable farm and raised in broiler battery cage system. Warmth was supplemented for a period of three weeks using croford a locally fabricated charcoal heater. Feed and non-medicated water were then given ad libitum. Vaccination scheduled of National Veterinary Research Institute Vom was followed for Gunmboro and Newcastle disease, respectively. Two hundred (200) Ross 308 broiler chicks were divided into five groups of 40 chicks replicated four times with ten birds each in a completely randomized design.

Data collections for growth and nutrient digestibility

Feed intake and body weights of the chicks were assess weekly using a sensitive weighing scale at the end of the week while body weight gain per unit of feeds eaten was determined as final live weight minus initial weight. FCR of the birds were determined as total feed intake divided total body weight gain and protein efficiency ratio calculated as gain in body weight divided by protein intake of the diet. Where Protein Intake

(PI)=feed intake dry matter multiplied by crude protein in the diet. Performance index (100%) was calculated by the equation established by North (1981). Performance index=live body weight in Kg divided by FCR and multiplied by 100%. Energy Efficiency Ratio (EER) was determined as body weight gain divided by total energy intake multiplied by 100%. Where Energy Intake (EI)=feed intake dry matter multiplied by energy in the diet. Survival percentage was recorded as they occurred in the course of the experiment and convey as percentage. i.e. total number of dead birds divided by total number of birds alive multiplied by 100%.

At the end of week three remaining birds per replicates were used for apparent nutrients digestibility study. The birds in each cage were offered a quantity of feeds per day after which fecal samples were collected for 4 days, weighed, sun dried for 24 hours and re-weighed daily. Thereafter, the fecal samples were pooled, bulked, milled and thoroughly mixed to obtain homogenous mixture. Samples from each replicates were then taken and analysed for proximate nutrients composition as proposed by AOAC [13]. Apparent digestibility was determined using established formular of Mc Donald (1995) as nutrient consumed minus nutrient voided in feeds divided by nutrient consumed multiplied by100%. The ME kcal/kg of the diet and fecal samples were calculated using Pauzenga (1985) as: 37 × %CP+81.8 × %EE+35.5 × %NFE [14-16].

Statistical analysis

Data collected for each variable was analysed by one way ANOVA using SPSS 21.0 version (SPSS, 2010) and where significant mean differences were noticed, means were separated using the same package [17].

Results and Discussion

Table2 below present results of growth performance of broiler chicks fed Lactic Acid Bacteria (LABPs) as feed additive. No significant (p>0.05) differences were noted on: initial body weight and survival percentage, but considerable (p<0.05) disparity were noticed on: final live weight, daily feed intake, weight gain, feed conversion ratio, protein intake, protein efficiency ratio, energy intake, energy efficiency ratio and performance index of broiler chicks fed LABPs.

Significant (p<0.05) elevated final live weights were noticed in broiler chicks fed *L. Plantarum, Pediococcus pentosaceous* and *L. fermentum* lactic acids bacteria probiotic compared to those fed single strain of lactic acid bacteria probiotics. Broiler chicks fed Pediococus pentosceus had the lowest live weight among LABP's single strain based diets. This agrees with the study of (Sri-Harimurti) that reported increased in body weight and effective performance of chickens fed Lactobacillus culture [18]. But Ashayerizadeh reported no significant improvement in the performance of birds fed mixture of Lactobacillus culture [19].

Broiler chicks offered *Lactobacillus plantarum, Pediococcus pentosaceous* and *Lactobacillus fermentum* had the same pattern of significant (p<0.05) variations for daily feed and feed protein intake along with energy efficiency ratio which were similar to control treatment except protein intake. Significant reduction in daily feed and energy intake was prominent in chicks fed multiples lactic acid bacteria (T5). However, lower feed intake, protein intake and energy efficiency ratio in multiple strains of LABP's produced higher weight gain which could be due wider site for intestinal nutrient absorption that that led to improvement.

Higher protein and energy utilization was visible in chicks supplemented with multiple LABP which yielded higher performance index than single LABP. Broiler chicks fed *L. plantarum, Pediococcus pentosaceous* and *L. fermentum* had the best feed conversion and energy utilizations when compared to other dietary treatments. The proliferation of lactic acids bacteria like lactobacillus used in this study contributed immensely in producing others microbes that aid the breakdown of feed particles due to microbial-host interaction as reported by Ari and Forte, these microbial interaction improves nutrients utilization for the production of more body tissues as a results of enzymatic activities that might contributed to the production of amylase, protease and other intrinsic factors in the GIT that might increase surface area and promotes the absorption of nutrients that translated to higher body weight gain[4,7]. The production of polypeptide bacteriocin by LAB inhibited the growth harmful microbes. This corroborated with the outcomes of Hassan [20].

Parameter	Trt 1	Trt 2	Trt 3	Trt 4	Trt 5	SEM	P- value
IBW (g/b)	55	54.86	54.82	54.86	54.88	0.06	0.92 NS
FLW(g/d)	320.00	282.83^{b}	291.39^{b}	290.00^{b}	344.38^{a}	8.12	0.04*
AFI (g/d)	33.72^{a}	31.44^{a}	30.72^{ab}	30.95^{ab}	27.88^{b}	0.59	0.02*
CFI 0-4 week (g/b)	944.25^{a}	880.39^{a}	860.16^{ab}	866.60^{ab}	780.15^{b}	16.46	0.02*
AWG (g/d)	9.46^{ab}	8.14^{b}	8.45^{b}	8.40^{b}	10.34^{a}	0.29	0.04*
FCR	3.57^{b}	3.93^{b}	3.64^{b}	3.70^{b}	2.71^{a}	0.13	0.00*
PI (g/d)	7.73^{a}	6.99^{b}	6.98b	7.03b	6.33^{b}	0.13	0.01*
PER	1.22b	1.17b	1.22b	1.19b	1.63a	0.05	0.00*
EI (g/d/b)	104.11^{a}	97.07^{a}	94.84^{ab}	95.55^{ab}	86.01^{b}	1.82	0.02*
EER	0.09^{b}	0.08^{b}	0.09^{b}	0.09^{b}	0.12^{a}	0	0.00*
SP (%)	93.33	90.23	96.97	95.46	92.73	1.75	0.82NS
Perf. index	8.95^{b}	8.83^{b}	8.43^{b}	8.94^{b}	12.52^{a}	0.52	0.03*

*a, b=Means on the same row with different superscripts are significantly different (p< 0.05). Not Significant (NS) (p>0.05), Standard Error of Mean (SEM), Initial Body Weight (IBW), Average Feed Intake (AFI), Final Live Weight (FLW), Average Daily Weight Gain (ADWG), Feed Conversion Ratio (FCR), Protein Intake (PI), Protein Efficiency Ratio (PER), Energy Intake (EI), Energy

Table 2: Effect of lactic acid bacteria Probiotics on growth performance of broiler starter.

Presented in **Table 3** is comparative apparent nutrient digestibility of broiler chicks fed lactic acid bacteria probiotic. Addition of LABP's as feed additive had significant (p<0.05) effects on dry matter, crude protein, crude fibre, ash and nitrogen free extract and no significant difference for digestible ether extract and metabolizable energy. Comparative apparent nutrient digestibility dry matter, crude protein, crude fibre and ether extract contents vary from 84.47-88.66%, 75.93-81.98%, 31.52-61.32% and 93.20-94.70% and that of ash, nitrogen free extract and energy varies from 58.30-70.75%, 95.01-97.84% and 90.57-92.53%.

Feed Parameter	Trt 1	Trt 2	Trt 3	Trt 4	Trt 5	SEM	p.value
Dry matter (%)	88.66[a]	88.56[a]	85.49[ab]	87.15[ab]	84.22[b]	0.58	0.03*
Crude protein (%)	80.26[a]	81.98[a]	77.87[ab]	75.68[b]	79.22[ab]	0.74	0.04*
Crude fibre (%)	61.32[a]	54.75[a]	36.33[b]	56.09[a]	31.52[b]	3.45	0.00*
Ether extract (%)	93.92	94.07	94.14	94.7	93.2	0.27	0.54NS
Ash (%)	68.43[ab]	70.75[a]	60.58[bc]	65.93[abc]	57.95[c]	1.57	0.02*
NFE (%)	97.65[a]	97.08[a]	96.75[a]	97.84[a]	95.01[b]	0.3	0.00*
Metabolizable energy	92.53	92.51	91.22	91.399	0.57	0.33	0.23NS

*a, b, c, d= Means on the same row with different superscripts are significantly different (p<0.05). Not significant (NS) (p>0.05), Standard Error of Mean (SEM), Trt=Control, Trt2=Lactobacillus plantarum, Trt 3=Pediococcus pentasaceous, Trt 4=Lactobacillus fermentum, Trt 5=cock tail of L. Plantarum, Pediococcus pentasaceous and L. Fermentum, g/b/d=gram per bird per day, percentage (%), Nitrogen Free Extract (NFE).

Table 3: Effect of lactic acid bacteria probiotics on nutrient digestibility of broiler chicks.

Lactic acid bacteria probiotics utilization as feed additives in this study enhances dry matter content of broiler chicks fed control treatment and *Lactobillusplantarum* followed by treatment *Pediococcus pentosaceous,* and *L. fermentum*, while significant decreased was reported in birds fed mixtures of LAB as: *L. plantarum, Pediococcus pentosaceous* and *L. fermentum.* However, significant (P<0.05) increased in dry matter content reported in these treatments increases the feed intake of the birds and as significant decreased was observed in broiler chicks fed treatment 5 mixtures of *L. plantarum, Pediococcus pentosaceous* and *L. fermentum.*

Management of LABP's based diets significantly (p<0.05) increase protein digestibility in broiler chicks supplemented with *Lactobacillus plantarum* which was statistically similar to the control birds followed by *Pediococcus pentosaceous* and mixtures of *L. plantarum, Pediococcus pentosaceous* and *L. fermentum;* whereas *L. fermentum* (T4) had the least protein utilization.

Chicks fed dietary treatment the control, *Lactobacillus plantarum*, and *L. plantarum* had significant (p<0.05) higher crude fibre utilization due to none released of sufficient intestinal enzymes that could handle fibre digestion. This means that LABP's did not properly decompose feed organic matter consumed like cellulose and lignin. Broiler chicks fed *Pediococcus pentosaceous* and mixtures LABP (T5) significantly decreased fibre content of the diets. Decreased in fibre content in T5 might be connected to ceacal fermentation that produces lactic acids and hydrogen peroxide as end product [21]. Feeding broiler chicks with mixture of lactic acids microorganisms created more surface area for microbial survival, thereby promoting digestive development which aid in promoting digestibility of protein and fat. Insignificant (p>0.05) difference for ether extract across treatment groups could mean LABP's provides good substrates for fat metabolisms. Ash percentage ranged from 58.30-70.75%, thought, significant (p<0.05) higher ash percentage was noted in T2 followed by T1 and T4, while T5 had the least percentage ash digestibility.

Treatment 1,2,3,and 4 had significant (p<0.05) higher absorption of nitrogen free extract being major component of the feed with appetite stimulation but, some intrinsic properties of single indigenous microorganisms supplementation did not influence feed conversion ratio, protein efficiency ratio, energy efficiency ratio and performance index of the birds [22]. However, low nitrogen free extract digestibility in mixtures of *L. plantarum, Pediococcus pentosaceous* and *L. fermentum* yielded better feed conversion ratio which led to significant increase in performance index of broiler chicks fed. The energy utilization of broiler chicks was statistically similar regardless of treatment groups [23].

Conclusion

Poultry feeds as a potential route of entry for pathogens into meat was modified with a village of beneficial bacteria known as lactic acids probiotics to reduce pathogen load and to alter the digestive system for the digestion of nutrients. Broiler chicks fed T5 (*L. plantarum, Pediococcus pentosaceous* and *L. fermentum*) had the best feed conversion, protein and energy ratio utilizations which yield better body weight resulted to higher performance index. The abundance of lactic acids bacteria like lactobacillus used in this study contributed immensely to improvement in feed conversion ratio of T5 which led to higher body weight due to microbial-host associations. However, low crude fibre and nitrogen free extract digestibility in T5 yielded better feed conversion ratio which led to significant increase in performance index of broiler chicks fed combination of indigenous microbial organisms.

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Conflict of Interest

The authors declare that there has been no conflict of interests.

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