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Laying performance and egg quality characteristics of pullets fed diets supplemented with two selected Commercial feed additives

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Abstract

The unethical use of antibiotics as growth promoters in poultry and its attendant health implications necessitated the search for bio-friendly alternatives. Two commonly used feed additives in place of antibiotics in the Ikorodu area of Lagos state are 4-Bac Extra® (probiotic) and Salmonil® organic acid). A study was conducted to evaluate the laying performance and egg characteristics of laying birds fed diets supplemented with 4-Bac Extra® and Salmonil®, respectively. Fifty-four 50- week old laying hens were randomly assigned to three treatment diets with three replicates of six birds each, in a completely randomized design. A basal diet-BD (T1) was formulated devoid of probiotics or organic acid, while T2 and T3 was constituted having BD with Salmonil® and 4-Bac Extra®, respectively at their recommended dosage. The laying birds were fed the respective diets for 12 weeks. Data were collected on feed intake, hen-day production, egg length, egg width, egg weight, shell weight, shell thickness, egg surface area, egg shape index, yolk height, yolk diameter, albumen height, albumen diameter, yolk weight, albumen weight, yolk ratio, yolk index and yolk colour. Birds fed 4-Bac Extra® diet were significantly (p<0.05) better than others in hen-day (55.43%), egg weight (70.81g) and albumen weight (44.37g), respectively. All other parameters measured were not significantly (p>0.05) influenced by the inclusion of probiotics or organic acid. Birds fed Salmonil® were not significantly (p>0.05) better than those fed the control diet, in all the parameters. It is recommended that 4-Bac Extra® could be used by poultry farmers in the locality.

Keywords: Egg quality, performance, pullet, feed additives, poultry farmers.

Performances de ponte et caractéristiques de la qualité des œufs de poulettes nourries avec des régimes complétés par deux additifs alimentaires commerciaux sélectionnés

Résumé

L'utilisation contraire à l'éthique d'antibiotiques comme stimulateurs de croissance chez la volaille et ses implications sur la santé ont nécessité la recherche d'alternatives bio-respectueuses. Deux additifs alimentaires couramment utilisés à la place des antibiotiques dans la région d'Ikorodu, dans l'État de Lagos, sont le 4-Bac Extra® (probiotique) et l'acide *organique Salmonil®). Une étude a été menée pour évaluer les performances de ponte et les caractéristiques des œufs de poules pondeuses nourries avec des régimes complétés respectivement par 4-Bac Extra® et Salmonil®. Cinquante-quatre poules pondeuses âgées de 50 semaines ont été assignées au hasard à trois régimes de traitement avec trois répétitions de six oiseaux chacune, dans un plan complètement randomisé. Un régime de base-BD (T1) a été formulé sans probiotiques ni acide organique, tandis que T2 et T3 ont été constitués avec du BD avec Salmonil® et 4-Bac Extra®, respectivement à leur dose recommandée. Les poules pondeuses ont été nourries avec les régimes respectifs pendant 12 semaines. Des données ont été recueillies sur la consommation alimentaire, la production quotidienne de poule, la longueur de l'œuf, la largeur de l'œuf, le poids de l'œuf, le poids de la coquille, l'épaisseur de la coquille, la surface de l'œuf, l'indice de forme de l'œuf, la hauteur du jaune, le diamètre du jaune, la hauteur de l'albumen, le diamètre de l'albumen, le poids du jaune, poids de l'albumen, rapport du jaune, indice du jaune et couleur du jaune. Les oiseaux nourris avec le régime 4-Bac Extra® étaient significativement meilleurs (p < 0,05) que les autres en termes de jours de poule (55,43 %), de poids d'œuf (70,81 g) et de poids d'albumine (44,37 g), respectivement. Tous les autres paramètres mesurés n'étaient pas influencés de manière significative (p>0,05) par l'inclusion de probiotiques ou d'acide organique. Les oiseaux nourris au Salmonil® n'étaient pas significativement meilleurs (p>0,05) que ceux nourris avec le régime témoin, dans tous les paramètres. Il est recommandé que 4-Bac Extra® puisse être utilisé par les éleveurs de volailles de la localité.*

Mots-clés : Qualité des œufs, performance, poulette, additifs alimentaires, aviculteurs.

Introduction

Commercial poultry production ranks among the highest source of animal protein in Nigeria. Its increment has been faster than any other food producing animal industry (Babazadeh *et al.,* 2011). In order to meet up with the expected results in terms of productivity, poultry farmers have been reported to use antibiotics to boost productivity and laying performance, increase feed efficiency and prevent intestinal infections (Agyare *et al.*, 2018). This practice gave rise to the challenges of antibiotic-resistant bacteria and drug residues in meat and eggs which has resulted in usage restrictions, by many countries, on the administration of antibiotics in livestock production. The United States Department of Agriculture (USDA, 2015) and the European Union (WAP, 2022) have completely banned the use of antibiotics in livestock production. Similarly, National Agency for Food and Drug Administration Control (NAFDAC) outlawed the use of antibiotics in animal feeds in Nigeria since 2018. To ameliorate the negative resultant effects of antibiotics usage, different compounds have been studied as natural and safe alternatives to antibiotics. These include probiotics, prebiotics, organic acids, phytogenic feed additives among others. Probiotics are viable microorganisms (bacteria or yeasts) that exhibit a beneficial effect on the health of the host when they are ingested (Rajesh *et al.*, 2020). Probiotics have been reported to improve feed conversion for the target species, reduce morbidity or mortality, and benefit the consumer through improved product quality (Sjofjan *et al.*, 2021*).* The supplementation of probiotics in diet of laying hens may play an important role in altering the lipid metabolism of chickens. Many investigators have pointed out that probiotics could reduce the cholesterol content of egg yolk (Li *et al.,* 2006; Mikulski *et al.,* 2012) and serum (Sjofjan *et al.*, 2021).

One of the commonly available brands of probiotics in the locality is *4-Bac Extra®* ® -

containing *Lactobacillus acidophilus and other strains. Salmonil®* is a brand of organic acid stabilizer which contains organic acids and oxine copper. These two products are the most commonly used by poultry farmers in the locality and thus adopted for the study.

This study was therefore designed to investigate the effect of the use of *4-Bac Extra®* (probiotic) *and Salmonil®* (organic acid) on the performance and egg qualities of laying birds so as to establish their suitability as alternative growth promoter. The objectives were therefore, to determine the laying performance of birds fed *4-Bac Extra® and Salmonil®* -supplemented diets, the egg's internal quality characteristics and evaluate the effects of *4-Bac Extra® and Salmonil®* on external egg qualities of the laying birds.

Materials and Methods

Experimental procedure

The study was conducted at the Poultry Unit, Department of Animal Production, Lagos State University of Science and Technology, Ikorodu, Lagos State, Nigeria. Fifty-four laying hens 50-week old were purchased from a reputable farm around lkorodu environment. The **probiotic** used, *4-Bac Extra®* - contain mostly *Lactobacillus acidophilus and Salmonil®* which contains organic acids and oxine copper. They were obtained from a licensed feed additive seller. The feed ingredients were purchased at a reliable feed mill in Ikorodu, Lagos State. Prior to the arrival of the birds, the cages were thoroughly cleaned and disinfected. Each bird was thereafter weighed and transferred to the individual cages. The birds were acclimatized for two weeks for stability before the commencement of the study. Feed and water were provided *ad libitum* and all necessary routine management were strictly adhered to throughout the period of 10 weeks of the study.

A basal diet (BD) was formulated (Table 1). The inclusion of 4-Bac Extra® - and Salmonil® as additives constituted the respective experimental treatments as follows:

Treatment 1: Control (no probiotic, no organic acid)

Treatment 2: BD + *Salmonil®* (organic acid at 3kg/ton)

Treatment 3: BD + 4 Bac Extra (probiotic at 1kg/ton).

The rate of inclusion of the probiotic and organic acids were according to the manufacturers' instructions.

The experiment was a completely randomized design (CRD) with three treatments replicated thrice. Each replicate contained six (6) birds.

Table 1: Composition of the experimental diet

Ingredients	**(%)**
Maize	44.00
Groundnut cake	10.00
Wheat offal	25.00
Soya bean meal	06.00
Fishmeal	02.00
Limestone	07.00
Bonemeal	05.00
Methionine	0.30
Lysine	0.20
Layers' premix*	0.25
Table salt	0.25
Total	**100.00**

*Premix to provide the following per Kg of diet Calcium 27.3 %, Crude fibre 0.02 % ,Vitamin A (E672) 4000000 IU, Vitamin D3 (E671) 1000000 IU. Vitamin E (all-rac-α-tocopheryl acetate) (3a700) 6000 IU. Vitamin B1 (thiamine mononitrate) 600 mg. Vitamin B2 (riboflavin) 1600 mg. Vitamin B6 (pyridoxine hydrochloride) (3a831) 1200 mg. Vitamin B12 (cyanocobalamin) 6000 µg. Vitamin K3 (menadione nicotinamide bisulfite) 800 mg. Pantothenic acid (calcium-D-pantothenate) (3a841) 3200 mg. Niacinamide (3a314) 8000 mg. Biotin (3a316) 40000 mg. Folic acid (3a316) 200 µg. Choline chloride (3a890) 80000 mg. Iron (E1; as ferrous carbonate) 16000 mg. Iodine (E2; as calcium iodate anhydrous) 600 mg. Copper (E4; as cupric sulphate pentahydrate) 4000 mg. Manganese (E5; as manganous oxide) 32000 mg. Zinc (E6; as zinc oxide) 20000 mg. Selenium (E8; as sodium selenite) 60 mg.

Data were collected on feed intake, hen day, external egg quality parameters (egg width, egg length, egg weight, shell weight, shell thickness, egg surface area, and egg shape index), internal egg quality parameters (yolk height, albumen height, yolk diameter, albumen diameter, yolk weight, albumen weight, yolk color, yolk index, yolk ratio, haugh unit) on a weekly basis.

Data collected were calculated as stated below:

Feed intake= Total feed supply - Total leftover

$$\text{Hen day production} = \frac{\text{Number of eggs laid} \times 100}{\text{Number of birds}}$$

The external egg parameters were determined as follows:

Egg length and egg width were measured with digital Vernier caliper. Egg weight and shell weight were measured using sensitive digital scale. Egg shell thickness was measured at the large end, the equator and the small end by using a micrometer caliper

$$\text{Egg Shape Index} = \frac{\text{Egg width} \times 100}{\text{Egg length}}$$

$$\text{Egg surface area} = (3.155 - 0.0136l + 0.0115w) \times l \times w$$

l = egg length,

w = egg width

The Internal egg parameters were determined as follows;
Yolk height and albumen height were measured with digital micrometer. Yolk diameter and albumen diameter were measured with digital Vernier caliper
Yolk weight and albumen weight were measured with sensitive digital scale.

Yolk colour was determined with Roche Colour fan

$$\text{Yolk Index} = \frac{\text{Yolk height}}{\text{Yolk diameter}} \times 100$$

$$\text{Yolk ratio} = \frac{\text{Yolk weight}}{\text{Egg weight}} \times 100$$

$$\text{Haugh Unit (HU)} = 100 \times \log (h - 1.7w^{0.37} + 7.6)$$

h = height of the albumen (mm),
w = weight of egg (g)

Egg mass was calculated by multiplying percentage hen-day egg production by the average egg weight in grammes.

Feed conversion ratio was expressed as grams of feed consumed per gramme of egg mass

All data were subjected to Analysis of Variance (ANOVA). Significant differences were separated using the Duncan Multiple Range Test. All statistical analyses were done using the Assistat 7.7 beta software.

Results and Discussion

Table 2: Proximate composition of the experimental diets

Variables	(%)
Dry matter	93.04
Crude protein	18.87
Crude fibre	10.52
Ether extract	2.41
Ash	8.61
Nitrogen Free Extract	52.63
Metabolizable energy	2443.98kcal/kg

Table 3: Laying and productive performance of birds fed *4-Bac Extra® and Salmonil®*-supplemented diets

PARAMETERS	CONTROL	*SALMONIL®*	4-BAC	SEM
Initial body weight (g)	1989.00	2026.00	1932.00	0.02
Final body weight (g)	2006.00	2026.00	2077.00	0.02
Body weight gain (%)	0.85	0.00	7.51	
Egg weight (g)	66.15^{b}	68.53^{ab}	70.81^{a}	1.34
Dry matter intake, g/day	110.93	112.17	110.61	0.13
Egg mass (g)	34.33	35.09	39.25	0.15
Hen day production	51.90^{b}	51.20^{b}	55.43^{a}	1.30
FCR	3.23^{b}	3.20^{b}	2.82^{a}	0.04

^{a,b} - different superscripts within a row indicate statistically significant differences at $P < 0.05$; SEM - standard error of mean; mm – millimeter, g – gramme.

Table 4: Mean External Egg quality characteristics of laying birds fed *4-Bac Extra*® and *Salmonil*® -supplemented diets

PARAMETERS	CONTROL	*SALMONIL*®	4-BAC	SEM
Egg width (mm)	44.28	44.57	44.80	0.15
Egg length (mm)	61.19	61.31	62.67	0.34
Egg weight (mm)	66.15^{b}	68.53^{ab}	70.81^{a}	1.34
Shell weight (mm)	0.52	0.54	0.53	0.05
Shell thickness (mm)	7.93	8.73	8.18	0.23
Egg surface area (cm^2)	331.81	332.05	332.58	0.22
Egg shape index (%)	72.83	72.92	71.67	0.40

^{a,b} - different superscripts within a row indicate statistically significant differences at $P < 0.05$; SEM - standard error of mean; mm – millimeter, g – gramme, cm – centimeter.

Table 5: Mean Internal Egg quality characteristics of laying birds fed *4-Bac Extra*® and *Salmonil*® -supplemented diets

PARAMETERS	CONTROL	*SALMONIL*®	4-BAC	SEM
Yolk height (mm)	17.27	17.02	17.53	0.09
Albumen height (mm)	6.10	5.59	5.84	0.09
Yolk diameter (mm)	40.39	41.18	41.33	0.29
Albumen diameter (mm)	130.59	130.58	130.95	0.12
Yolk weight (g)	17.17	18.13	18.53	0.40
Albumen weight (g)	39.63^{b}	41.40^{ab}	44.37^{a}	1.38
Yolk colour	4.37	4.23	4.27	0.04
Yolk index	1.69	1.67	1.67	0.06
Yolk ratio (%)	25.98	26.54	26.29	0.16
Haugh Unit	65.34	66.55	66.76	0.44

^{a,b} - different superscripts within a row indicate statistically significant differences at $P < 0.05$; SEM - standard error of mean; mm – millimeter, g – gramme.

Laying and productive performance

Table 3 shows the laying and productive performance of birds fed *4-Bac Extra® and Salmonil®* -supplemented diets. The laying birds had similar (P<0.05) initial weights. However, the percent weight increment was noticeable in birds supplemented with *4-Bac Extra® probiotics (7.51%) which indicated growth improvement for them.* Statistical analysis showed that hen-day production differed significantly (P<0.05) across all treatments. The mean value recorded for birds on the *4-Bac Extra*® diet (55.4%) was significantly higher than their counterparts on the *Salmonil*® diet (51.2%) and the Control diet (51.9%). Similarly, the FCR was best (2.82) in birds fed *4-Bac Extra*® supplemented diets. This result agreed with the findings of Haruna *et al.* (2019) who fed commercial multi-strain probiotics to 40-week old layers and recorded statistically significant differences in egg production compared with the control. *4-Bac Extra*® also contains multi-strain bacteria which positively affected the gut health-leading to better feed utilization and laying performance. However, significant differences (P<0.05) were not recorded between the eggs of *Salmonil*® supplemented birds and the control. The results were similar to those reported by Lalev *et al.* (2011) and who recorded non-significant increases in the rate of lay of layers fed diets supplemented with probiotics.

Egg External quality characteristics

The **external quality characteristics of** eggs laid by chickens in the study is contained in Table 4. It revealed that eggs of birds fed *4-Bac Extra*® diet (70.81g) weighed significantly (P<0.05) more than those fed the control diet (66.15g) which recorded the least. However, there were no significant differences (P>0.05) between the control birds and those fed *Salmonil*® supplemented diet. This indicated that inclusion of *4-Bac Extra*® probiotics improved egg weight while *Salmonil*® made no difference. This result conformed with the findings of Mohan *et al.* (1995) who reported that probiotics inclusion in the diet of laying birds did not influence the egg weight significantly (P>0.05). For the egg width, egg length and egg surface area, birds fed *4-Bac Extra*® diet recorded higher numerical values than others but the difference were not significant (P>0.05). The shell thickness of eggs of *Salmonil*® - supplemented birds (8.73mm) were higher but not significantly (P>0.05) better than others. Birds fed *4-Bac Extra® and Salmonil*® -supplemented diets had better shell weights (8.18g and 8.37g) than those fed the Control diet (7.93g). However, there were no significant differences (P>0.05) between treatment means. The finding is in agreement with Mohan *et al.* (1995) who reported that probiotics inclusion did not influence egg shell weight significantly (P>0.05) but at variance with Sjofjan *et al.* (2021) who reported improvement in egg shell quality.

Similarly, e**gg shape index of layers fed** *Salmonil*® diet had the highest mean value (72.92g) closely followed by their counterparts on the control diet (72.82g). The least value (71.67g) was recorded for birds on the *4-Bac Extra*® diet. This results were higher than values reported by Aro *et al.* (2009). They also reported that the quality of an egg produced is reflected by the egg shape index. Statistical analysis revealed that there were no significant differences (P>0.05) between the treatment means.

Egg Internal quality characteristics

Table 5 shows the **eggs' internal quality characteristics of birds in the study.** Birds fed *4-Bac Extra*® supplemented diet recorded the highest mean **yolk height** (17.53mm) followed by those fed the control diet (17.27mm). The least value (17.02mm) was by birds fed *Salmonil*® supplemented diet. Statistical analysis revealed that there was no significant difference (P>0.05) between the treatment means. This observation is at variance with the findings of Garba *et al.* (2010) who reported significantly higher values in laying birds. The albumen height revealed that birds on the control diet had the highest mean value (6.10mm) when compared with their counterparts with the mean values of 5.59mm (*Salmonil*®) and 5.84mm (*4-Bac Extra*®) respectively. The Yolk diameter, albumen diameter and yolk weight were respectively, similar (P>0.05) among the treatment groups. The albumen weight of eggs from *4-Bac Extra*® supplemented layers (44.37g) was significantly (P<0.05) higher than the Control (39.63g) but similar (P>0.05) to those of *Salmonil*® diet (41.40). It followed the trend in egg weight which has high correlation with albumin weight. The remaining indices; yolk colour, yolk index and yolk ratio were respectively similar (P>0.05). Mahdavi *et al*., (2005), and Mohebbifar *et al.* (2013) found no considerable effects from inclusion of probiotic in the layers' diet. Probiotics used in this study did not improve yolk coloration of egg.

The Haugh Unit which summarises the egg quality (Table 5) revealed that birds on the *4-Bac Extra*® supplemented diet had the highest mean value (66.76) closely followed by their counterpart on the *Salmonil*® supplemented diet (66.55). The least value (65.34) was recorded for birds fed the control diets. Mahdavi *et al*. (2005) reported that using different levels of probiotics has no significant effect on Shell thickness, Haugh Unit and Shell hardness whereas Sjofjan *et al.* (2021) observed significant impact of probiotics inclusion.

Conclusion and Recommendations

It could be concluded that the inclusion of *4-Bac Extra®* probiotics in the diet improved the added weight of the experimental birds at the end of the study. Inclusion of *4-Bac Extra®* probiotics improved hen-day and egg weight of layers in the study. Other internal and external egg quality parameters were not significantly affected by the inclusion of *4-Bac Extra®* probiotics or *Salmonil®* (organic acid). It is therefore recommended that farmers could supplement their layers' feed with *4-Bac Extra®* probiotics for improved productivity and economic gains.

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