



Dietary Effect of Garlic, Synbiotic and Organic Acidifier on Growth and Reproductive Performance of Layer Chickens

By

Alausa, O. J.,^{1*} Adewole, F.A.,² Egbeyale, L.T.,² Jegede, A.V.,³ Okusanya, P.O.¹ & Akinlade, O. O.⁴

¹Department of Animal Health and Production Technology, The Federal Polytechnic Ilaro

²Department of Animal Production and Health, Federal University of Agriculture, Abeokuta

³Department of Animal Nutrition, Federal University of Agriculture, Abeokuta

⁴Department of Animal Production Technology, The Federal Polytechnic Ilaro



Abstract

The movement worldwide to abandon the use of antibiotics in poultry production has led to a search to find natural alternatives. The aim of the research was to investigate the impact of the dietary supplementation of a commercial pullet basal diet containing: garlic powder (0.3%), a commercial synbiotic (0.025%), an organic acidifier (0.1%), and a synthetic antibiotic (0.1%) on the growth and laying performance of commercial pullets. A population of 240 pullets (12 weeks old) was assigned to 5 dietary treatments in a fully randomized study (four replicates in each diet treatment). Measures of performance parameters were done in three stages, which are grower (12-16 weeks), early lay (18-30 weeks), and mid-lay (30-42 weeks). One-way ANOVA was used to analyse the data. The only stage in which feed intake was significantly ($p < 0.05$) influenced was in the grower stage where the synbiotic and organic acidifier groups went at high feed intake, whereas garlic supplementation did not affect body weight negatively. At early lay, the egg weight was the most in the garlic group and the weight of first-egg the most in synbiotic group. There was decreased feed intake with organic acidifier and antibiotic treatment as compared to control. The paper finds that garlic and synbiotics have the potential to promote the quality of eggs and their metabolic performance at critical transition phases, and a balanced basal diet is able to maintain performance in the longer term.

Keyword: Egg weight, feed intake, laying birds, nutrient efficiency

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1. Introduction

Poultry egg production plays an essential role in the global provision of protein, as eggs provide better and more affordable animal protein and essential nutrients that support human health (FAO, 2021). Production and integrity of egg production are dependent on a great deal of interdependence and include feed, disease management, breeding, and housing infrastructure (Afolabi et al., 2020). In this case, feeding remains the most manageable and economic solution toward improving product and sustainability of hens.

The traditional use of growth promoters in chicken feed in the form of antibiotic growth promoters (AGPs) has also improved the measures of growth and dietary effectiveness. Yet, their constant application has given rise to significant consumer and environmental concerns, including the development of drug-resistant strains of bacteria, accumulation of the remnants of medicines in the food, and environmental contamination (Oladokun et al., 2021). These issues have enhanced the search process of natural and viable dietary supplements that are capable of triggering growth,

enhancing welfare, and sustaining reproductive functioning devoid of the adverse effects associated with the use of antimicrobials.

Another possible alternative is phytochemicals or plant-based feed additives, which are herb-based active ingredients that supplement the livestock welfare and performance (Abd El-Ghany, 2024). One of them is the garlic (*Allium sativum*) that has been recognized as one of the strongest natural performance enhancers in the feeding of chickens. Garlic contains numerous sulfur-based compounds such as allicin, alliin, and diallyl disulfide which have an antibacterial, antioxidative, cholesterol-lowering, and immune-stimulating effect (Ahmed et al., 2022; Abd El-Ghany, 2024). These working components increase feed ratio and egg production through the improvement of nutrient uptake, maintenance of gut microorganisms, as well as triggering the production of digestive juices (Olatoye et al., 2023). In addition, the antibacterial and antioxidative properties of garlic help prevent pathogenic gut microorganisms and stimulate the beneficial ones such as *Lactobacillus* spp., which result in

*Corresponding Author: Alausa, O. J.



improved intestinal status, biological balance, and increased edible output in layers.

Synbiotics which combines probiotics with prebiotics have also been considered as viable alternatives to antibiotics due to their combined effect on gut health, immune response and overall performance. The probiotic component (e.g., *Lactobacillus*, *Bifidobacterium*, *Bacillus* spp.) provides the beneficial microorganisms to the digestive system, and the prebiotic component (such as inulin, fructo-oligosaccharides, or mannan oligosaccharides) is a certain source of food that enhances the proliferation and activity of these microorganisms (Markowiak and Ślizewska, 2018). This combination improves the balance of intestinal microbes, nutrient absorption and metabolic performance leading to better growth, health and reproductive performance in layers. Recent studies have shown that the inclusion of synbiotics enhances the feed efficiency, egg production, and egg quality and reduces the disease-causing bacteria such as *Escherichia coli* and *Clostridium perfringens* (Prentza et al., 2022; Gao et al., 2023; White et al., 2024). The improved gut environment increases nutrient digestion particularly proteins and fats that facilitates the growth of eggs and general performance in reproductive functions.

Also organic acids and organic acid salts are now easily used as feed supplements to improve output and intestinal health in chicken production. These acids such as formic, acetic, citric, lactic, fumaric, and propionic are known to have a germ-killing effect, the ability to lower the pH of the gut, and positive effects on nutrient uptake and gut morphology (Adil et al., 2023; Hameed et al., 2024). Organic acids enhance accessibility to and assimilation of nutrients, enhance the rate of feed consumption, and enhance the development of reproductive tissues and egg production (Akeem et al., 2021; Abd El-Hack et al., 2023). Furthermore, they improve the ovarian activity, follicle growth, and endocrine equilibrium, likely through the better use of nutrition and reduced oxidative stress in the reproductive system (Abd El-Hack et al., 2023).

In summary, garlic, synbiotics, and organic acids signify natural, versatile dietary supplements able to stimulating growth, preserving gut health, and supporting reproductive performance in laying hens. Their synergistic modes of action spanning from microbial control and oxidative protection to enhanced nutrient utilization establish them as feasible substitutes for antibiotic growth promoters in viable egg production.

Despite these positive benefits of using garlic, synbiotics, and organic acids as natural feed supplements, their effectiveness varies depending on such variables as concentration, source, method of application, ration development, and flock maturity. On this basis, this study aimed at examining the effectiveness of one of the synbiotics and organic acidifiers powder of garlic on growth and reproductive output of chickens.

2. Materials and Methods

2.1 Experimental procedure

Fresh garlic (*Allium sativum*) was sourced from open market in Abeokuta metropolis, Nigeria. Garlic cloves were minced and oven dried at 70°C until a constant weight and was then grounded into powder and included in the basal diet. Synbiotic powder, organic acidifier powder and antibiotics powder were bought from a reputable veterinary pharmacy. Garlic powder was mixed with the feed at 3g per kg feed. Synbiotic powder (*Innovad Lummance*), organic acid powder (*Formycine Gold Px*) and antibiotics powder (*Keproceryl*) were used according to the manufacturer's recommended doses.

2.2 Experimental birds and management

A sum of 240 twelve-week-old commercial pullets purchased from a reputable farm was used for the experiment. Following a two-week acclimatization period, they were randomly grouped to one of five treatments, each with four replicates of twelve birds.

2.3 Experimental layout

Five treatment groups were created by randomly assigning the birds. After that, each treatment group was split up into four replicates, each of which had twelve birds, for a total of 48 birds per treatment group. This study used a completely randomized design.

The following were the treatments:

Treatment 1: Control diet

Treatment 2: Control diet + Garlic powder (0.3%)

Treatment 3: Control diet + Synbiotic powder (0.025%)

Treatment 4: Control diet + Organic acidifier powder (0.1%)

Treatment 5: Control diet + Synthetic antibiotic (0.1%)

2.4 Data collected

2.4.1 Growth performance parameters

The data below were collected on growth performance parameters; feed intake, weight gain, and feed conversion ratio (FCR).

2.4.1.1 Daily feed intake (DFI)

This was calculated as = feed left over/ total number of days/ total feed given.

2.4.1.2 Daily weight gain

The weight of the birds was taken every week up to first lay. The weight gain was obtained by the difference between the initial weight of the birds and the final weight. The weight gain was calculated on a daily basis by division of weight gained by days.

2.4.1.3 Feed conversion ratio

This was established by computing birds food consumption and divide it by weight gain of the birds.

2.4.2 Parameters of egg production at laying point.

2.4.2.1 Age at first lay: the number of days from hatch to the day the first egg was laid.

2.4.2.2 Body weight of hen at first lay: this was determined to be the weight of the total live pullet divided by the number of the weight of the pullet in the group.

2.4.3 Egg production performance

At 2.00 p.m. every day, the eggs were picked by hand. The weight and the amount of the eggs laid were recorded each day. Electronic scale was used to determine the weight of the egg. New feeds (including treatments) were served on a daily basis. The intake of the feed was calculated weekly on the residues obtained and subtracted the feed fed. The percentage of egg production was estimated to be the hen-day egg production.

- i. **Henday egg production:** is determined by dividing the total daily of the number of eggs laid by the total number of live birds daily.
- ii. **Egg mass:** This is calculated by the multiplication of the average weight of an egg and the Henday factor.
- iii. **Feed/kg egg:** This is calculated by dividing the quantity of feed that has been fed on by the weight of the egg.

2.5 Statistical Analysis

Data generated were subjected to One-Way Analysis of Variance using Duncan multiple range test for mean separation.

3.0 Result and Discussion

Table 1 shows the influence of dietary addition of garlic, synbiotic, organic acidifier and synthetic antibiotics on the growth performance attributes of pullets. The findings indicated that feed intake was the only ingredient that was significantly ($p < 0.05$) affected. The final weight, initial weight and weight gain and FCR were not significantly ($p > 0.05$) affected. The dietary group which was fed on organic acidifier and synbiotics had a significantly ($p < 0.05$) higher feed intake in the dietary groups as compared to the on diet which was fed on garlic.

Table 1: Effect of diets containing garlic, synbiotic, organic acidifier and synthetic antibiotics on growth performance of pullets at 16 weeks of age

Parameter	Control	Garlic	Synbiotic	Organic acidifier	Synthetic antibiotic	SEM
Initial weight (g)	858.33	859.17	859.17	859.17	857.50	0.03
Final weight (g)	1440.00	1437.50	1429.17	1415.00	1425.00	0.08
Weight gain (g)	13.58	13.84	13.77	13.57	13.22	0.17
Feed intake (g)	123.81 ^{ab}	121.33 ^b	125.10 ^a	124.41 ^a	123.37 ^{ab}	0.46
Feed conversion ratio	8.97	8.85	9.24	9.44	9.15	0.12

^{a,b}: Means bearing with different superscripts in a row differ significantly ($P < 0.05$)
SEM = Standard Error of Mean.

The results presented in Table 2 shows the effect of dietary inclusion of Garlic, Synbiotic, Organic Acidifier and synthetic antibiotics on body weight gain, feed intake, FCR, hen-day egg production, egg weight and egg mass of laying hens at the early phase of laying (18 to 30 weeks of age). Hens on the control diet recorded significantly ($P < 0.05$) highest feed intake while those on organic acidifier and synthetic antibiotics had significantly ($P < 0.05$) lowest feed intake. The weight of first egg was significantly ($P < 0.05$) heaviest in synbiotic group while it was smallest in the synthetic antibiotic group. Hens on garlic also had the significantly ($P < 0.05$) heaviest egg weight among the diet groups, while organic acidifier had the smallest weight. However, the values recorded for garlic is statistically similar to that of the control, synbiotic and synthetic antibiotics. The FCR, Egg mass, Henday, Age at first lay and Weight of hen at first lay showed no significant differences ($P > 0.05$) among the treatments.

Table 2: Effect of diets containing garlic, synbiotic, organic acidifier and synthetic antibiotics on laying performance of egg-type chickens at early stage of laying (18-30weeks)

Parameters	Control	Garlic	Synbiotic	Organic Acidifier	Antibiotics	SEM
Age at 1 st lay (days)	146.25	151.75	147.50	147.75	146.50	0.95
Feed Intake (g)	99.08 ^a	98.24 ^{ab}	98.39 ^b	96.23 ^c	97.50 ^{bc}	0.28
Weight at 1 st lay (g)	1435.00	1437.50	1422.50	1420.00	1432.50	5.3
Weight of 1 st egg (g)	43.15 ^{ab}	43.05 ^{ab}	43.65 ^a	38.15 ^{ab}	37.63 ^b	0.94
Egg weight (g)	49.29 ^{ab}	50.46 ^a	49.57 ^b	47.11 ^b	48.80 ^{ab}	0.47
Hen/day (%)	67.47	66.32	65.06	67.60	64.93	0.64
Egg mass (g)	33.24	33.44	32.23	31.85	31.67	0.36
Feed/kg egg	2.99	2.94	3.06	3.03	3.09	0.03

Table 3 represents the outcomes of the dietary addition of Garlic, Synbiotic, Organic Acidifier and antibiotics on the

*Corresponding Author: Alausa, O. J.

body weight increase, feed consumption, FCR, hen-day egg production, egg weight and egg mass of laying hens at mid stages of laying period (30 to 42 weeks). No significance difference ($P < 0.05$) was found in all the parameters measured because none of the parameters was affected by the dietary treatments.

Table 3: Effect of diets containing garlic, synbiotic, organic acidifier and synthetic antibiotics on laying performance of egg-type chickens at mid stage of laying (30-42weeks)

Parameters	Control	Garlic	Synbiotic	Organic Acidifier	Antibiotics	SEM	P-value
Feed intake (g)	119.74	120.71	121.06	120.46	120.68	0.21	0.38
Egg weight (g)	54.66	54.80	54.08	52.36	53.32	0.42	0.33
Henday (%)	84.58	86.18	84.40	87.73	85.31	0.57	0.35
Egg mass (g)	46.21	47.22	45.64	45.93	45.46	0.33	0.52
Feed/kg egg	2.60	2.56	2.65	2.63	2.66	0.02	0.40

Discussion

The results indicate that the effectiveness of feed additives is relative, being very much dependent on the physiological phase of the bird, and there is a considerable implication on the poultry nutrition strategies. The major goal in the pullet stage is to reach even and desired body weight to produce optimal future lay. The findings show that the initial weights of the groups were almost the same ($P=0.99$) and the final weights, weight gain and Feed Conversion Ratio (FCR) showed no significant difference between the groups. This was shown to have an advantageous growth promotion effect of the additives as the synthetic antibiotic (Luckstadt et al., 2004; Adil et al., 2010). This implies that any healthy bird that is well managed requires this kind of additives everywhere and this is in line with the current world trend where in-feed antibiotic use is being reduced. The much higher consumption in the synbiotic and the organic acidifier test groups, which also carry the numerically most unfavorable FCRs (9.24 and 9.44, respectively), give reason to suspect a possible decline in dietary efficiency. The rises in feed consumption without a subsequent weight gain may be attributed to a microbial acclimatization period. Synbiotics (probiotics and prebiotics) have the potential to change the gut microbiome that may temporarily raise the energy requirement of the host to turnover microbials and then decrease the nutrient digestibility, as the novel microbial community settles down (Pourabedin and Zhao, 2015; Naseri et al., 2012; Houshmand

et al., 2012; Falaki et al., 2011). On the same note, organic acids may also modify gut flora, and thus could produce the same effect that is short-lived. Conversely, the group which had the lowest feed intake was that of the garlic group, which is congruent with the research that placed emphasis on biological active properties of organosulfur compounds in garlic. Such substances were found to balance intestinal microbiota, increase the secretion of digestive enzymes, and promote the absorption of nutrients (Qureshi et al., 2017). The fact that the garlic group had a statistically advantage in weight and reduced FCR on less nutritional feed results in better efficiency with nutrient use.

The lay is a time of extreme physiological and metabolic response, with energy and nutrient demands of the bird changing radically in favor of egg production. It is in this stressful transition that the particular advantages of the additives can be seen the most. There is a tremendous transition out of the growth stage. The highest feed intake is at the control group, whereas the lowest feed intake is at the organic acidifier and antibiotic groups. This is an indication that during periods of high demand, these additives have the potential to enhance the efficiency of the metabolism energy usage. Organic acids have the potential to complement the digestibility of minerals such as calcium (which is important to shell quality) and protein and thus hens may be able to fulfill their needs with reduced dietary intake (Abdel-Raheem and Abd-Allah, 2011; Adil et al., 2010; Cross et al. 2007).

The results of the assessment of the egg weight and Quality show the most encouraging advantage of garlic as natural additive since it gave the heaviest eggs an important economic characteristic. Probably, the mechanism is associated with the beneficial effect of garlic on lipid metabolism. Garlic allicin and other compounds have been depicted to activate the liver and enhance the production and transportation of the yolk lipids (lipoproteins), which increases the size of the yolk and, consequently, makes the egg heavier (Olukomaiya et al., 2020). The Synbiotic group gave birth to the highest first egg, which is a prime indicator of maturity of the reproductive tract. The finding that the first egg weight in the synbiotic was heavier indicates that the gut health and nutrient absorption was more effective because of the synbiotic, which might have increased the strength in developing the oviduct and ovarian follicle hierarchy (Mookiah et al., 2014).

The fact that there was no difference between the hen-day production and the egg mass shows that although additives played a part in determining the size of the eggs, it did not play a part in determining the rate of lay. This supports the idea that the basal diet was nutritionally complete to sustain the levels of production and the additives were of a qualitative but not quantitative value. The system of the hen has become mature and stable by mid-lay period. The most notable finding was none significant differences in all parameters measured in the treatment groups. This implied that when the birds evolved to meet the high requirements of lay and were in a physiological plateau, the benefit presented by the additives could no longer be observed. The hens of each group, including the control group, could produce at high and

comparable levels (e.g. Henday >84%). It implies that in the case of a resilient bird, in the open conditions, the long-term use of these particular additives may not be economically viable because their effects are most significant in pivotal transition periods (Soltan, 2008; Yesilbag & Colpan, 2006).

5.0 Conclusion and Recommendation

The experiment was able to show a stage dependent response to the dietary additives:

- Additives had no effect on growth, and only garlic and synbiotic had potential to enhance efficiency by increasing metabolic efficiency (reducing intake) and egg quality (increasing weight).
- The effect of the additives reduced indicating that there was no long term benefit over the control diet.

Further research should be carried out till latter phase of lay to fully check the effect of the test ingredients on layers.

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