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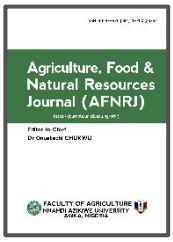

Original Article

Effects of dietry penta-herbal plant meal inclusion on performance and haematological indices of Noiler Hens

OPEN ACCESS

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ABSTRACT

This study examined the effects of a penta-herbal plant meal (P-HPM) mixture on the performance and haematological indices of Noiler hens. The P-HPM, comprising equal proportions of Moringa oleifera, Azadirachta indica, Vernonia amygdalina, Ocimum gratissimum, and Hibiscus sabdariffa, was incorporated into five experimental diets (T1–T5) containing 0%, 1.25%, 2.5%, 3.75%, and 5% P-HPM, respectively, with T1 serving as the control. Seventy-five 12-week-old Noiler hens were randomly allotted to the five dietary treatments, with fifteen birds per treatment and three replicates of five birds each in a completely randomized design. After 14 weeks of feeding, dietary P-HPM significantly ($P < 0.05$) affected several productive performance parameters, with hens fed the 2.5% P-HPM diet attaining first lay at 115.67 days (14.66 days earlier than the control) and recording the highest hen-day egg production (75%) and egg mass (3676.9 g). Haematological indices, including haemoglobin concentration (7.97–8.65 g/dL), packed cell volume (29.67–35.30%), red blood cell count (7.29–8.34 × 10⁶/mL), and white blood cell count (5.37–6.30 × 10⁶/mL), were not adversely affected by dietary P-HPM supplementation. P-HPM at 1.25–2.5% produced the most favourable laying performance, whereas higher inclusion levels were associated with reduced performance. Therefore, 1.25–2.5% P-HPM is recommended for noiler hens under the conditions of this study

KEYWORDS: *Laying birds; Medicinal plants; Phytogenic feed additive Poultry nutrition, Productive efficiency*

INTRODUCTION

Poultry production is an important component of the livestock industry and contributes substantially to food security, income generation and employment in many developing countries, including Nigeria (Erdaw & Beyene, 2022). Among the improved dual-purpose chicken breeds, Noiler hens have gained increasing acceptance because of their rapid growth, egg production potential and adaptability to tropical production conditions (Adetunji & Ola, 2020; Dogara *et al*., 2021). However, maintaining good health and productive performance remains important for sustainable Noiler production.

The increasing interest in natural feed additives has encouraged the use of medicinal plants as phytogenic supplements in poultry production. These plants contain diverse bioactive compounds, including flavonoids, phenolic compounds, alkaloids, saponins and tannins, which may support nutrient utilisation, antioxidant defense, immune function and overall physiological health of birds (Jamil *et al.*, 2022; Rehman *et al*., 2025; Lu *et al*., 2026). Consequently, the use of combinations of medicinal plants as functional feed additives has received attention because different plant materials may provide complementary biological activities.

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Moringa oleifera is widely recognized for its high protein content, balanced amino acid profile, vitamins, minerals and antioxidant compounds and has been reported to improve growth performance, immune response, digestive enzyme activity and antioxidant status in poultry (Mahfuz & Piao, 2019; Abubakar *et al.*, 2021; Mohai *et al.*, 2025). *Vernonia amygdalina* possesses antimicrobial, anti-inflammatory and antioxidant activities that promote bird health (Mandey *et al*., 2022; Kabir *et al.,* 2026). *Azadirachta indica* has antibacterial, antifungal, antiviral, antioxidant and immunomodulatory properties (Devi & Sharma, 2023; Mohanasundaram & Antoneyraj, 2025). Likewise, *Ocimum gratissimum* contains essential oils and flavonoids with antimicrobial properties (Edo *et al.,* 2023; Maphetu *et al.,* 2026), while *Hibiscus sabdariffa* is rich in anthocyanins and other phenolic compounds with antioxidant activity (Salem *et al.*, 2022). The five plants were combined based on the complementary nature of their bioactive constituents and biological activities. Combining different plant materials may provide a broader range of phytogenic effects and may result in complementary interactions among their bioactive compounds (Abdelli *et al.*, 2021; Abd El-Hack *et al.*, 2022).

Despite the documented benefits of these medicinal plants individually, information on their combined use as a penta-herbal plant meal (P-HPM) in Noiler hens remains limited, particularly regarding egg production performance and haematological indices. In addition, the appropriate dietary inclusion level and effects of prolonged supplementation of the combination have not been fully established. Based on the complementary biological activities of the constituent plants, it was hypothesised that dietary supplementation with P-HPM would improve egg production performance while maintaining normal haematological status in Noiler hens. Since haematological indices provide useful information on the physiological, nutritional and health status of birds (Asaniyan & Akinduro, 2020; Goodchild *et al*., 2022), this study evaluated the effects of dietary P-HPM supplementation on egg production performance and haematological indices of Noiler hens.

MATERIALS AND METHOD

Experimental Site

The experiment was conducted at the University of Ilorin Teaching and Research Farm, Ilorin, Kwara State, Nigeria, located at approximately 8°27′23.9″ N latitude and 4°39′42.9″ E longitude. The farm is situated within the southern Guinea savanna zone of Nigeria. Laboratory analyses were conducted at the Department of Animal Production Laboratory, University of Ilorin, Ilorin, Kwara State, Nigeria.

Preparation of Test Material

Young leaves of bitter leaf, neem, scent leaf and moringa leaves were harvested from a private garden and *Hibiscus sabdariffa* calyces were sourced from an open market. The leaves of each plant were collected during rainy season (May - June) and were confirmed and authenticated at the Herbarium of the Department of Plant Biology, University of Ilorin, Nigeria. The plant materials were washed and air-dried at room temperature under shade. The penta-herbal plant meal (P-HPM) was prepared by separately crushing the dried plant materials and combining the four-leaf materials and roselle calyces in equal proportions (1:1:1: 1:1). Equal proportions were used to ensure an equal contribution of each botanical to the composite formulation and to prevent any single plant material from dominating the mixture.

Experimental Birds and Management

Day-old Noiler chicks were purchased from Amo Farm Sieberer Hatchery Limited, Ibadan, Nigeria and reared under a uniform feeding programme until 12 weeks of age. The birds were fed commercial chick starter from 0 to 6 weeks and commercial grower mash from 7 to 12 weeks to meet their nutritional requirements during the early growth and rearing phases and to provide a uniform nutritional background before introduction of the experimental diets. At 12 weeks of age, 75 Noiler pullets, with an overall mean initial body weight of 1.62 kg/bird, were randomly selected from the base population and transferred from deep-litter housing to battery cages equipped with nipple drinkers and long trough feeders. Each cage compartment measured 47 cm × 39 cm × 42 cm (length × width × height), and three pullets were housed per compartment, providing approximately 611 cm² (0.061 m²) of floor space per bird**.** Water and the diets were given *ad libitum* throughout the experiment. Strict adherence to standard management procedures, including vaccination, clean water supply and cleanliness were observed. The experimental feeding period lasted 14 weeks, from 12 to 26 weeks of age, after which the experiment was terminated and blood samples were collected.

Experimental Design

The experiment was conducted using a completely randomized design (CRD) involving five dietary treatments, with 15 Noiler pullets per treatment and three replicates of five pullets each.

Experimental Diets

Commercial grower mash was fed to all treatment groups from 12 weeks of age until the flock attained 5% hen-day egg production. At this point, all treatment groups were simultaneously switched to commercial layer mash, while their respective P-HPM supplementation levels were maintained. The P-HPM was incorporated into the basal diets at 0, 1.25, 2.5, 3.75 and 5.0% for T1, T2, T3, T4 and T5 respectively as shown in Table 1.

Data Collection

Performance parameters evaluated during the experiment included feed intake, body weight gain, body weight at first egg, age at first egg, hen-day egg production, egg weight and egg mass. Feed intake was recorded daily for each replicate by

measuring the difference between feed offered and feed refused. Birds were weighed at the commencement of the experiment and subsequently at weekly intervals until the onset of lay to determine body weight gain and body weight at first egg. Thereafter, body weight measurements were discontinued to avoid unnecessary stress that could affect egg production. Egg production and egg weight were recorded daily from the onset of lay for each treatment until termination of the experiment at 26 weeks of age. The egg-recording period therefore varied among treatments according to their respective ages at first lay. The average egg weight for each replicate was determined using an electronic platform scale.

Table 1: Supplementation levels of P-HPM (%)

T1 (control)	Basal Diet without P-HPM
T2	98.75% basal diet + 1.25% P-HPM
T3	97.5% basal diet + 2.5% P-HPM
T4	96.25% basal diet + 3.75% P-HPM
T5	95.00 % basal diet + 5% P-HPM

Blood Sample Collection

At 26 weeks of age, following overnight feed withdrawal, blood samples were collected from three randomly selected birds per treatment (one bird per replicate) via the brachial (wing) vein. Approximately 2mL of blood was collected into EDTA tubes for haematological analysis. All samples were labelled, transported under chilled conditions and delivered to the laboratory within 2hrs of collection to preserve sample integrity and minimize haemolysis (Kelly & Alworth, 2013).

Haematological parameters determined included packed cell volume (PCV), haemoglobin concentration (Hb), red blood cell (RBC) count, white blood cell (WBC) count, platelet count, differential leukocyte count, mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH) and mean corpuscular haemoglobin concentration (MCHC). These parameters were determined using an automated haematology analyser (Sysmex K-1000).

Statistical Analysis

Data generated were subjected to one-way analysis of variance (ANOVA) using the Statistical Analysis System (SAS), Version 9.1 (SAS Institute Inc., Cary, NC, USA). The statistical model used was:

$$Yij = \mu + Ti + eij, \quad (1)$$

where Yij is the observed value of the dependent variable, μ is the overall mean, Ti is the effect of the ith dietary treatment, and eij is the random error. Where treatment effects were detected at $p < 0.05$, means were separated using Duncan's Multiple Range Test. Differences among treatment means were considered at $p < 0.05$.

RESULTS AND DISCUSSION

Performance Characteristics of Noiler Hens Fed P-HPM Supplemented Diets

The performance characteristics of Noiler hens fed P-HPM-supplemented diets are presented in Table 2. Dietary supplementation affected daily feed intake, age at first lay, hen-day egg production, average egg weight, total eggs laid and egg mass ($P < 0.05$), whereas body weight at 12 weeks and body weight at first egg were not affected ($P > 0.05$). Daily feed intake increased progressively from 123.49 g/bird/day in the control group to 135.00 g/bird/day in birds fed 5% P-HPM. Body weight at 12 weeks ranged from 1581.60 to 1643.80 g, while body weight at first egg ranged from 2115.33 to 2310.87 g, with comparable values across treatments. Age at first lay was lowest in birds fed 2.5% P-HPM (115.67 days), followed by those fed 1.25% P-HPM (124.00 days), while the control and 3.75% P-HPM groups recorded 130.33 days. Hen-day egg production was highest in birds fed 1.25% and 2.5% P-HPM (75%), compared with 63%, 50% and 42% in the control, 3.75% and 5% P-HPM groups, respectively. Similarly, total eggs laid and egg mass were highest at 1.25% and 2.5% P-HPM and declined at the higher inclusion levels. Average egg weight, however, increased progressively with P-HPM inclusion, from 47.16 g in the control group to 50.32 g at 5% P-HPM. Feed consumed per dozen eggs were lowest in birds fed 1.25% and 2.5% P-PLM, with statistically comparable values between the two treatments, but increased markedly at 3.75% and 5% P-HPM.

The results show a clear non-linear response to P-HPM supplementation. The improvement in age at first lay, hen-day egg production, total eggs laid an egg mass at 1.25–2.5% P-HPM was not maintained at higher inclusion levels. In contrast, average egg weight continued to increase with increasing P-HPM inclusion. This suggests that the response to P-HPM differed among the various components of laying performance. The absence of differences in body weight at 12 weeks and at first egg also indicates that the improved laying performance at the lower inclusion levels was not accompanied by differences in body weight.

The earlier onset of lay observed particularly at 2.5% P-HPM may reflect an effect of the bioactive constituents of the herbal mixture on reproductive development. Phytochemicals such as flavonoids, phytoestrogens and phytosterols have been associated with modulation of reproductive processes in poultry (Sarvestani *et al*., 2020; Lu *et al*., 2026). The improved laying performance observed at 1.25–2.5% P-HPM is also consistent with findings of Li *et al*., (2022), who reported improved productive performance with phytogenic feed supplementation and Shen *et al*., (2022), who reported favourable reproductive responses in laying hens supplemented with 2.5% Moringa oleifera leaf powder. Kargbo and Kanu (2017) similarly reported improved performance in pullets fed neem leaf meal.

Table 2: **Performance characteristics of Noiler hens fed P-HPM supplemented diets**

Performance parameters	Treatments						
	T1	T2	T3	T4	T5	SEM	P-value
DFI (g/b)	123.49^{e}	124.58^{d}	126.04^{c}	129.17^{b}	135.00^{a}	0.25	<0.0001
BWt@12wks (g)	1581.6	1643.8	1617	1630.87	1604.47	66.48	0.8098
BWt@FE (g)	2290.13	2210.40	2115.33	2310.87	2257.20	76.18	0.0654
Age@FL (days)	130.33^{a}	124.00^{b}	115.67^{c}	130.33^{a}	128.67^{ab}	2.91	0.0005
HDEP (%)	63^{b}	75^{a}	75^{a}	50^{c}	42^{c}	0.05	<0.0001
AEW (g)	47.16^{c}	48.59^{bc}	48.83^{ab}	49.78^{ab}	50.32^{a}	0.81	0.0064
TEL	44.00^{b}	52.67^{a}	52.67^{a}	34.67^{c}	29.33^{c}	3.62	<0.0001
FC/dozen E (g)	2360.7^{c}	1991.3^{c}	2022.7^{c}	3146.1^{b}	3915.6^{a}	287.84	<0.0001
Egg mass(g/hen/day)	29.64^{b}	36.56^{a}	36.77^{a}	24.65^{c}	21.10^{c}	273.57	<0.0001

Means on the same row with different superscripts are significantly (P<0.05) different; SEM = Standard Error of Means; T_1 = control diet, T2 = 1.25% P-HPMl; T_3= 2.5% P-PLMl; T_4 = 3.75% P-HPM;; T_5 = 5% P-HM; Wt@12wks(g)=weight at twelve weeks; BWt@FE(g)- Body Weight at first egg; Age@FL(days)= age at first lay; TFI/b/d(g=: Total feed intake per bird per day (g).; AEW(g)=Average Egg weight; HDEP(%)=Hen day Egg production; TEL= Total eggs laid per bird, FC/dozen E = Total feed consumed to produce dozen eggs; CF/dozen E (₦)= Cost of feed to produce dozen egg.

The progressive increase in feed intake with increasing P-HPM inclusion did not result in corresponding improvements in egg production at the higher inclusion levels. Although increased feed intake may be related to changes in dietary characteristics associated with plant materials (Jha & Mishra, 2021), the decline in laying performance at 3.75% and 5% P-HPM suggests that greater feed consumption did not translate into better productive output. Nutrient dilution at higher inclusion levels may have contributed to this response (Ogbuewu & Mbajiorgu, 2024). The higher amount of leaf material may also have increased dietary fibre and the concentration of phytochemicals and other anti-nutritional compounds, which could have affected nutrient utilization (Valenzuela-Grijalva *et al*., 2017; Martínez *et al*., 2025).

The increase in average egg weight with P-HPM inclusion agrees with the findings of Mosobalaje and Adedoyin (2021) and Onwumelu *et al*., (2023), who reported improvements in egg characteristics in hens receiving herbal leaf supplements. Despite the increase in egg weight at the higher inclusion levels, the accompanying decline in hen-day egg production and egg mass indicates that greater egg size did not compensate for the reduction in laying rate. The results indicate that the improvement in laying performance observed at 1.25–2.5% P-HPM was not maintained at the higher inclusion levels, despite the continued increase in feed intake.

Haematological Indices of Noiler Hens Fed P-HPM-Supplemented Diets

The haematological indices of Noiler hens fed diets supplemented with P-HPM are presented in Table 3. Dietary supplementation did not affect haemoglobin concentration, packed cell volume, red blood cell count, platelet count, mean corpuscular haemoglobin, mean corpuscular volume, mean corpuscular haemoglobin concentration, white blood cell count, lymphocytes, monocytes, neutrophils or eosinophils (P > 0.05). Haemoglobin concentration ranged from 7.97 to 8.91 g/dL, packed cell volume from 29.67 to 35.30%, and red blood cell count from 7.29 to 8.34 × 10^{6}/µL across the dietary treatments. Similarly, white blood cell count ranged from 5.37 to 6.30 × 10^{3}/µL, while the values of the differential leukocyte counts and erythrocytic indices remained comparable across treatments.

The absence of differences in haemoglobin concentration, packed cell volume and red blood cell count indicates that P-HPM supplementation did not adversely affect erythropoiesis or the oxygen-carrying capacity of the blood. Similarly, the comparable values of white blood cell count, lymphocytes, monocytes, neutrophils and eosinophils indicate that P-HPM supplementation did not alter the measured leukocyte parameters. The comparable values of mean corpuscular volume, mean corpuscular haemoglobin, mean corpuscular haemoglobin concentration and platelet count further suggest that P-HPM supplementation did not adversely affect the measured erythrocyte and platelet indices. The present findings are consistent with Akinola & Ovotu (2018), who reported no adverse effects of *Moringa oleifera* leaf meal supplementation on blood constituents of laying hens. Similarly, Chen *et al.,* (2020) and Onunkwo *et al.,* (2022) reported that dietary inclusion of herbal feed additives did not adversely affect the haematological profile of poultry. The comparable haematological responses across the P-HPM treatments in the present study therefore suggest that inclusion of the herbal mixture up to 5% did not adversely affect the measured haematological indices.

Table 3: **Effects of P-HPM leaf meal on haematology indices of Noiler hens**

Parameters	Treatments						
	T1	T2	T3	T4	T5	SEM	p-value
HGB (g/dL)	8.91	8.65	8.75	7.97	8.41	1.238	0.896
PCV (%)	32.17	31.30	35.30	29.67	30.33	4.251	0.546
RBC ($\times 10^6$/ µL)	7.72	8.05	8.34	7.29	7.91	0.782	0.574
Platelets ($\times 10^3$/µL)	6.75	6.88	6.75	6.80	6.74	0.351	0.999
MCH (pg)	11.42	10.78	10.63	10.98	10.63	1.409	0.952
MCV (fL)	41.37	38.96	42.93	40.76	38.30	4.813	0.769
MCHC (%)	27.64	25.60	24.82	26.87	27.77	2.246	0.455
WBC ($\times 10^3$/µL)	5.74	5.92	6.30	5.37	5.50	0.710	0.547
Lymphocytes (%)	49.28	47.79	45.48	48.91	47.46	3.123	0.618
Monocytes (%)	7.89	7.75	8.62	8.75	8.57	1.281	0.813
Neutrophils (%)	38.81	40.69	41.90	38.99	40.65	3.404	0.780
Eosinophils (%)	4.02	3.78	3.90	3.34	3.30	0.665	0.594

SEM = Standard error of the mean; T1 = Control diet; T2 = 1.25% P-HPM; T3 = 2.5% P-HPM; T4 = 3.75% P-HPM; T5 = 5.0% P-HPM; HGB = haemoglobin; PCV = packed cell volume; RBC = red blood cell count; WBC = white blood cell count; MCV = mean corpuscular volume; MCH = mean corpuscular haemoglobin; MCHC = mean corpuscular haemoglobin concentration

CONCLUSION AND RECOMMENDATIONS

Penta-herbal plat meal supplementation improved the laying performance of Noiler hens at 1.25% and 2.5% inclusion levels, as reflected in higher hen-day egg production, total eggs laid an egg mass. Feed consumption per dozen eggs were lowest at 1.25% and 2.5% P-HPM, with comparable values between the two inclusion levels. However, increasing P-HPM beyond 2.5% resulted in reduced laying performance and increased feed consumption per dozen eggs. Therefore, P-HPM inclusion levels of 1.25% and 2.5% appeared to provide the most favourable performance under the conditions of the present study. Based on the findings of this study, P-HPM supplementation at 1.25% inclusion level is recommended for Noiler hens under similar production conditions.

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Authors' Contributions

OIA conceptualized the study and designed the experiment. OA & LSO collected data, performed data analysis, and wrote the first draft of the manuscript. AOS performed literature searches and reviewed the first draft of the manuscript. All authors read and approved the final draft of the manuscript.

Ethical Statement

This study adhered to ethical research standards as approved (UERC Approval Number: UERC/ASN/2024/2793) by the Ethical Committee of the University of Ilorin, Nigeria, ensuring responsible data use, informed community participation, non-invasive environmental practices, transparency, and adherence to the animal handling protocols.

AI Declaration Statement

The authors declare that ChatGPT was used solely to improve the manuscript structure and language. All outputs were critically reviewed, verified, and approved by the authors, who accept full responsibility for the accuracy and integrity of the manuscript.

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