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# Impact of *Cordyline fruiticosa* leaf meal supplemented diet on growth performance, egg production, egg quality and some heamatological indices of laying hen

**Alagbe Olujimi John**

## ABSTRACT

A total 500 – 35 weeks Lohmann brown hens randomly distributed into five treatments with five replicates (20 hens per replicate). Hens in treatment 1 (control group) was fed basal diet only and the other experimental groups were fed the same diet with the addition of *Cordyline fruiticosa* meal at 10 grams, 20 grams, 30 grams and 40 grams respectively in treatment 2, 3, 4 and 5. Hens fed *Cordyline fruiticosa* meal had higher body weight compared to the control in this order treatment 5 (T5) (1270.0 grams), 4 (1263.0 grams), 3 (1233.6 grams), 2 (1230.0 grams) and 1 (983.1 grams) ($P<0.05$) respectively. Average daily feed intake, feed conversion and mortality rate were influenced by the treatment ($P<0.05$). Hen day egg production and hen house egg production were higher in T5 (72.98%, 65.90%), T4 (72.72%, 69.85%), T3 (72.88%, 69.83%), intermediate in T2 (60.09%, 51.00%) and lower in T1 (51.19%, 41.85%). Egg shell strength, egg shell thickness, egg weight, albumen weight, yolk weight, yolk index and haugh unit were significantly ($P<0.05$) different among the treatment. Pack cell volume, haemoglobin, red blood cell, white blood cell, heterophil and lymphocyte count were influenced by the treatment. However, values fall within the established range for healthy laying hen. It was concluded that *Cordyline fruiticosa* meal can be fed to laying hens up to 40 grams'/kg diet without having any negative effect on the performance and health status.

**Keywords:** Antibiotics, *Cordyline fruiticosa* meal, laying hens, phytochemicals, food safety.

## 1. INTRODUCTION

Globally, antimicrobial resistance is a serious threat to human being and animals due to the misuse of antibiotics in animal feed (Singh et al., 2022; Daniel, 2020). This prompted the European Union and other countries in 2009 to place a ban on the use of antibiotic growth promoters to promote food safety and livestock sustainability (Agubosi et al., 2022a). According to the World Health Organization in 2015, about 600 million people worldwide become ill after consuming contaminated food out of which 420,000 people die including 125,000 children under the age of five. The use of herbs and their extracts have been considered as one of the potential alternative to antibiotics in animal production due to their non-toxic effect, no drug residue and withdrawal period. One of the useful underexplored medicinal plant is *Cordyline fruiticosa* which is widely distributed in Australia, Europe, America and Asia including India (Annisa et al., 2012; Dahlia et al., 2013).

The plant belongs to the family Asparagaceae which consists of over 480 species and it is evergreen, perennial monocotyledonous shrub having diverse leaf colours with tuber-like rhizomes (Fuedjaou et al., 2016; Hossain and Nagooru, 2011). Investigation on the phytochemical components in *Cordyline fruiticosa* leaves suggests that they are valuable source of different classes of biological active compounds such as phenols, alkaloids, flavonoids, saponins, terpenoids and tannins at various concentrations with numerous pharmacological properties (antimicrobial, antifungal, antiviral, antioxidant, hepato-protective, immunostimulatory, anti-inflammatory amongst others) (Fouedjou et al., 2014; Ding et al., 2019). In folk medication, the infusion of *Cordyline fruiticosa* leaf were used in the treatment of pyrexia, arthritis, tooth ache, gastrointestinal disease, skin infections, cough, bronchitis, tooth decay, malaria, stomach cramps and dysentery (Hemaiswarya et al., 2009; Elfita et al., 2019).

They have also achieved the potential to inhibit the activities of *Escherichia coli*, *Steptoccocus spp*, *Styphylococcus spp*, *Micrococcus spp*, *Bacillus spp* and *Salmonella spp* capable of altering the intestinal flora of birds (Cox and Wright, 2013; Cox et al., 2000). Previous studies have revealed that the utilization of plant extracts in the diet of birds are capable of promoting the growth of birds Wen et al., (2019), promoting the secretion of endogenous enzymes (pepsin, trypsin, amylase) and reducing the transit time of digesta An et al., (2018), promoting the proliferation of beneficial bacteria in the gut Ahmed et al., (2015), stimulating the immune system of birds thereby reducing mortality, improving palatability and modulating the fatty acid in the meat of animals (Hashemipour et al., 2013).

However, most outcome of these research have not been consistent due to variations in the age of plant used, dose or concentration administered, processing or extraction technique adopted, geographical location amongst others. There is also a dearth of information on the dietary supplementation of *Cordyline fruiticosa* leaf meal in laying hens. Evaluating its effects on hens will help to establish a tolerable level, promote food safety and livestock sustainability. The essence of this research was to determine the impact of *Cordyline fruiticosa* leaf meal on the growth performance, egg production and quality as well as some haematological indices of laying hens.

## 2. MATERIALS AND METHODS

**Experimental site and ethical approval**

The research was conducted at Sumitra Institute's poultry unit situated between 23o 13' N and 72o 41' E. Study was done in accordance with the guidelines and requirements of procedures that had been authorized by ethics council of the Institute (BN/006C/2020).

**Collection and processing of *Cordyline fruiticosa* leaf meal**

Fresh and matured leaves of *Cordyline fruiticosa* were harvested from the biological garden of Sumitra Institute, Gujarat in the month of January to March, 2021. Harvested leaves were sent to the department of taxonomy for proper identification and authentication where a voucher number AG/09D/2004 was assigned to it. Leaves were air-dried under a roof for 12 days until a constant weight was achieved, and then ground with an electronic blender and stored in a labeled zip lock nylon bags and transferred to Sumitra research laboratory for further examination.

**Animal care and experimental design**

500 – 35 weeks Lohmann brown birds with an initial weight of 1717 grams were purchased from a reputable hatchery in Gujarat and transferred to the Poultry section of Sumitra Institute, India and randomly distributed into five treatments with five replicates (20 hens per replicate). Birds were raised in a specially constructed galvanized battery cage with automated nipple drinkers and feeders in a

semi sided pen and equipped with fluorescent lamp in order to provide light for a 16-hour period per day and to increase feed intake/ laying. Before the beginning of the experiment, cages were properly disinfected with Morigad at the rate of 2 ml to 10 liters of water.

Birds in treatment 1 was fed regular diet (layers mash) while those in treatment 2, 3, 4 and 5 was fed regular diet supplemented with *Cordyline fruiticosa* leaf meal at 10 g, 20 g, 30 g and 40 grams per kilogram diet respectively. The feed used in this trial was consistent with the recommendation by Nutritional Research Council in 1994 as shown in (Table 1). Hens had free access to water and feed was provided twice a day (6:00 and 14:00). They were cared for according following commercial management techniques and the whole experiment lasted for 90 days adopting a completely randomized design.

**Parameters measured**

***Growth performance***

Feed consumed was estimated as the difference between the feed offered and the left over (remnants)

Average daily feed intake = Total feed intake divided by the number of experimental period

Average daily weight gain = Total weight gain divided by the number of experimental period

Feed conversion ratio = Average daily feed intake divided by the average daily weight gain

***Egg production estimation***

Eggs were collected three times a day from each replicate at 0800, 1200 and 1600 hours. The sum of the three collections along with the number of birds alive on each day was recorded and computed at the end of the period. Hen-day egg production (HDP) and hen housed egg production (HHP) was calculated using the formula below:

% HDP = total number of eggs produced/total number of hens present on that day multiplied by 100

% HHP = total number of eggs produced/number of hens originally housed multiplied by 100

***Egg quality analysis***

At the end of the experiment, egg analyzer TM (Model GT08-12A, China) was used to examine the egg shell strength, egg shell thickness, yolk weight, yolk length and yolk colour from twenty eggs randomly selected from each replicate. Egg weight was carried out with using Smeg digital stainless scale. Orka's digital haugh tester (Model TD-0029F, China) was used to measure the height of albumen while haugh unit was estimated manually using the formula below:

Haugh unit = $100 \times \log (H - 1.7 \times W0.37 + 7.6)$

Where H: height of albumen (mm); W: egg weight (g)

***Phytochemical evaluation of Cordyline fruiticosa leaf meal***

The laboratory procedures recently published by (Alagbe, 2024) were used for the determination of total phenols, tannins, alkaloids, saponins, flavonoids and steroids. Plant were examined at different optical density for quantification using a gas chromatography-mass spectrometry at 460 nm, 506 nm, 350 nm, 610 nm, 602 nm and 410 nm respectively. GC/MS Tripod (Model 81W-009C, China) was used and maintained to an inlet temperature of 406°C, scan rate of 12,000 amu/seconds, mass range (2.00 – 1,500 amu), filament emission current (400 μA) and pressure range of 120 psi to obtain an accurate result.

**Proximate evaluation of experimental diet**

Near infra-red kit (Model: TNOP NIRSTM, Netherlands) was used to analyze experimental diet. 300 grams of sample was placed in a collection tray after putting on the start button and kit was operated according to the manufacturer's recommendation. Result was obtained within 60 seconds and printed out from the visual display unit. To ensure precision in results, optical band, data resolution and wavelength was maintained at 9.00 nm, 0.6 nm and 2600 nm respectively.

***Blood analysis***

At the end of the trial, 2 mL of blood samples was collected from the wing vein of ten randomly selected birds per treatment into a labeled sample bottle with anticoagulant (ethylene diamine tetra acetic acid) and placed in an ice pack before it was sent immediately to Sumitra research laboratory, Gujarat for further evaluation. Parameters examined includes, pack cell volume, red blood cell,

haemoglobin, white blood cell, heterophils and lymphocytes. Samples were analyzed using DXH 560 AL haeamtology analyzer (Model HA/003C, China) and maintained at an ambient temperature of 18 – 32°C and humidity of 80 % to ensure accuracy in result.

***Data analysis***

Data obtained (growth performance, egg production egg quality and heamatological parameters) were analyzed using the general linear model procedures of Statistical Analysis Systems software (SAS) with the model containing treatments. Differences between treatment means were separated using Tukey's test (SAS, 2011). Significant differences were declared at P<0.05.

**Table 1** Gross composition of standard diet expressed in dry matter basis

| Feed ingredient used | Amount used expressed in kg |
|---|---|
| Corn | 50.00 |
| Wheat offal | 10.00 |
| Soya bean meal | 30.00 |
| Bone meal | 3.00 |
| Limestone | 6.00 |
| Lysine | 0.20 |
| Methionine | 0.25 |
| *Mineral /Vitamin Premix | 0.25 |
| Salt | 0.30 |
| Total | 100.00 |
| Analyzed values | - |
| Crude protein (%) | 17.85 |
| Crude fibre (%) | 6.33 |
| Ether extract (%) | 4.06 |
| Ash (%) | 8.77 |
| Metabolizable energy expressed in kcal/kg | 2708.4 |

2.5 kilogram of layer premix contained to 1 ton of feed is made up of: Thiamine, 3000 mg, riboflavin, 6000 mg, pyridoxine, 3500 mg, cyanocobalamin, 1000 mg, niacin, 25,000 mg, Panthotenic acid, 12,000 mg, folate, 500 mg, biotin, 1000 mg, Retinyl acetate, 10,000 iu., cholecalciferol, 2,000,000 iu., tocopherol, 20,000 iu., ascorbic acid, 52,000 mg, manganese, 8200 mg, iron, 6,200 mg, zinc, 300 mg, copper, 200 mg, cobalt, 150 mg, iodine, 200 mg, selenium, 100 mg, choline chloride, 50,000 mg.

**Experimental outcome**

Phyto-constituent's analysis of *Cordyline fruiticosa* leaf meal (Figure 1) showed that flavonoid had the highest concentration of 1007.5 mg/g followed by phenol (672.81 mg/g), terpenoid (560.2 mg/g), tannin (402.7 mg/g), alkaloid (201.5 mg/g), saponin (102.9 mg/g) and steroid (35.10 mg/g) respectively. As revealed in Table 2, growth performance of laying hens fed diet supplemented with *Cordyline fruiticosa* leaf meal. Average daily weight gain of hens fed *Cordyline fruiticosa* leaf meal at 10 kg (treatment 2), 20g *Cordyline fruiticosa* leaf meal/kg diet (treatment 3), 30 g/kg (treatment 4) were similar (P>0.05) to those fed 40 g/kg in treatment 5 but significantly higher (P<0.05) than those in the control in treatment 1 (no *Cordyline fruiticosa* leaf meal). Average daily feed intake among all the treatments were influenced (P<0.05) by the supplementation of *Cordyline fruiticosa* leaf meal in the diet of hens. The only mortality was recorded among birds in treatment 1 with 1.22 % (P<0.05).

Average weight gain, average daily weight gain, total feed intake and average daily feed intake values fell between 983.1 – 1270.0 grams, 10.92 – 14.11 grams, 10912 – 11209 grams and 121.4 – 124.5 grams correspondingly. Egg production of hens supplemented with *Cordyline fruiticosa* leaf meal presented in Table 3 revealed that hen day egg production and hen house egg production followed similar trend. Values obtained were higher in hens fed treatment 3 (20 g/kg), treatment 4 (30 g/kg) and treatment 4 (40 g/kg), intermediate in

treatment 2 (10 g/kg) and lower in birds fed control diet (treatment 1) (P<0.05). The reported values also took the form of 51.19 to 72.98 percent and 41.85 to 65.90 percent respectively. As presented in Table 4, egg quality parameters of hens fed diet supplemented with *Cordyline fruiticosa* leaf meal. Egg shell strength, thickness, egg shell, egg weight, albumen height, albumen weight, yolk weight, yolk colour, yolk height and haugh unit values show similarities in their trend.

Hens fed diet supplemented with *Cordyline fruiticosa* leaf meal at 20 g/kg (treatment 3), 30 g/kg (treatment 4) were similar to those fed treatment 5 (40 g/kg). The obtained values fell between 3.08 – 4.79 kg/cm2, 0.22 – 0.45 mm, 7.11 – 9.61 percent, 47.42 – 53.85 grams, 4.77 – 8.01 mm, 21.06 – 28.14 grams, 16.38 – 22.18 grams, 6.41 – 11.09, 39.80 – 43.75 mm, 40.10 – 45.92 mm and 71.35 – 87.60 respectively. As reported in Table 5, haematological parameters of hens fed diet supplemented with *Cordyline fruiticosa* leaf meal. Red blood cell count [2.07 to 2.96 (×1012/L)], haemoglobin concentration (8.04 to 11.83 g/dL), pack cell volume (28.06 to 32.10 percent), white blood cell count [12.18 to 16.14 (×109/L)], heterophils (28.03 to 36.03 percent) and lymphocytes (59.40 to 73.33 percent) correspondingly.

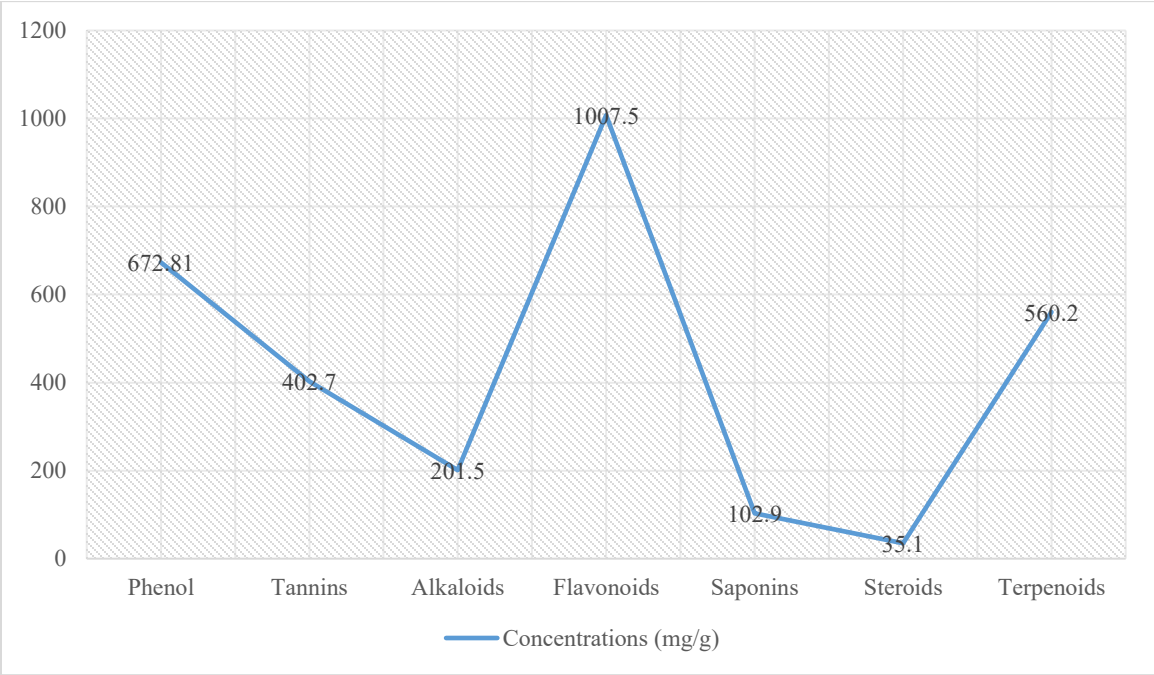


**Figure 1** Composition of phyto-constituents in *Cordyline fruiticosa* leaf meal

**Table 2** Growth performance of laying hens fed diet supplemented with *Cordyline fruiticosa* leaf meal

| Indices | Treatment 1 | Treatment 2 | Treatment 3 | Treatment 4 | Treatment 5 | *P-value* |
|---|---|---|---|---|---|---|
| Average initial body weight | 1717 ± 0.01 | 1717±0.01 | 1717±0.01 | 1717±0.01 | 1717±0.01 | 0.003 |
| Average final body weight | 2700.0b±2.01 | 2943.0a±2.04 | 2950.0a±1.88 | 2980.0a±1.82 | 2987.0a±1.02 | 0.506 |
| Average weight gain | 983.1b±0.03 | 1230.0a±0.05 | 1233.6a±0.03 | 1263.0a±0.03 | 1270.0a±0.04 | 0.112 |
| Average daily weight gain | 10.92b±0.08 | 13.58a±0.07 | 13.70a±0.09 | 14.00a±0.06 | 14.11a±0.08 | 0.174 |
| Total feed intake | 10912b±7.19 | 11203a±9.67 | 11205a±8.02 | 11208a±5.92 | 11209a±6.00 | 0.161 |
| Average daily feed intake | 121.4b±3.08 | 124.4a ±3.19 | 124.5a ±3.21 | 124.5a ±2.60 | 124.5a±3.72 | 0.284 |
| Feed conversion ratio | 2.41a±0.74 | 2.03b±0.52 | 2.03b±0.40 | 2.02b±0.55 | 2.02b±0.61 | 0.117 |
| Mortality (%) | 1.22±0.09a | - | - | - | - | 0.0001 |

Means on the same row having different superscripts are significantly different (P < 0.05); T1; treatment 1 (control): Basal diet without *Cordyline fruiticosa* leaf meal; T2: Basal diet with 10 g *Cordyline fruiticosa* leaf meal/kg diet; T3: Basal diet with 20 g *Cordyline fruiticosa* leaf meal/kg diet; T4: Basal diet with 30 g *Cordyline fruiticosa* leaf meal/kg diet; T5: Basal diet with 40 g *Cordyline fruiticosa* leaf meal/kg diet

**Table 3** Egg production of hens fed diet supplemented with *Cordyline fruiticosa* leaf meal

| Indices | Treatment 1 | Treatment 2 | Treatment 3 | Treatment 4 | Treatment 5 | *P value* |
|---|---|---|---|---|---|---|
| Hen day egg production | 51.19c ± 10.4 | 60.09b ± 8.77 | 72.88a± 9.48 | 72.72a ± 11.3 | 72.98a ± 10.9 | 0.021 |
| Hen housed egg production | 41.85c ± 7.08 | 51.00b ± 9.83 | 69.83a± 9.00 | 69.85a ± 8.82 | 65.90a ± 9.10 | 0.042 |

Means on the same row having different superscripts are significantly different (P < 0.05); T1; treatment 1 (control): Basal diet without *Cordyline fruiticosa* leaf meal; T2: Basal diet with 10 g *Cordyline fruiticosa* leaf meal/kg diet; T3: Basal diet with 20 g *Cordyline fruiticosa* leaf meal/kg diet; T4: Basal diet with 30 g *Cordyline fruiticosa* leaf meal/kg diet; T5: Basal diet with 40 g *Cordyline fruiticosa* leaf meal/kg diet

**Table 4** Egg quality parameters of hens fed diet supplemented with *Cordyline fruiticosa* leaf meal

| Indices | Treatment 1 | Treatment 2 | Treatment 3 | Treatment 4 | Treatment 5 | *P value* |
|---|---|---|---|---|---|---|
| Egg shell strength (kg/cm2) | 3.08b ± 0.04 | 3.51b ± 0.02 | 4.50a ± 0.03 | 4.78a ± 0.05 | 4.79a ± 0.04 | 0.112 |
| Egg shell thickness (mm) | 0.22b± 0.01 | 0.29b ± 0.00 | 0.41a ± 0.02 | 0.43a ± 0.01 | 0.45a ± 0.01 | 0.153 |
| Egg shell (%) | 7.11b ± 0.03 | 7.31b ± 0.03 | 9.45a ± 0.03 | 9.50a ± 0.03 | 9.61a± 0.03 | 0.168 |
| Egg weight (g) | 47.42b ± 5.60 | 49.60b ± 4.41 | 53.00a ± 3.82 | 53.09a ± 4.03 | 53.85a ± 4.00 | 0.421 |
| Albumen height (mm) | 4.77b ± 0.18 | 5.00b ± 0.22 | 7.77a ± 0.32 | 7.90a ± 0.45 | 8.01a ± 0.28 | 0.172 |
| Albumen weight (g) | 21.06b ± 0.10 | 21.33b ± 0.05 | 27.91a ± 0.08 | 28.06a ± 0.06 | 28.14a ± 0.06 | 0.160 |
| Yolk weight (g) | 16.38b ± 1.12 | 17.10b ± 1.10 | 22.10a ± 1.49 | 22.15a ± 1.03 | 22.18a ± 1.00 | 0.988 |
| Yolk colour | 6.41b ± 0.02 | 10.90b ± 0.01 | 10.98a ± 0.03 | 11.05a ± 0.02 | 11.09a ± 0.01 | 0.291 |
| Yolk length (mm) | 39.80b ± 5.31 | 40.20b ± 5.40 | 43.32a ± 5.81 | 43.40a ± 5.05 | 43.75a ± 5.69 | 0.166 |
| Yolk height (mm) | 40.10b ± 3.48 | 40.67b ± 3.50 | 45.80a ± 2.61 | 45.88a ± 3.00 | 45.92a± 2.84 | 0.128 |
| Yolk index (%) | 0.25b±0.06 | 0.40a±0.02 | 0.42a±0.22 | 0.44a±0.36 | 0.45a±0.50 | 0.0001 |
| Haugh unit | 71.35b ± 4.16 | 71.33b ± 4.03 | 87.10a ± 4.00 | 87.15a ± 3.91 | 87.60a ± 3.88 | 0.122 |

Means on the same row having different superscripts are significantly different (P < 0.05); T1; treatment 1 (control): Basal diet without *Cordyline fruiticosa* leaf meal; T2: Basal diet with 10 g *Cordyline fruiticosa* leaf meal/kg diet; T3: Basal diet with 20 g *Cordyline fruiticosa* leaf meal/kg diet; T4: Basal diet with 30 g *Cordyline fruiticosa* leaf meal/kg diet; T5: Basal diet with 40 g *Cordyline fruiticosa* leaf meal/kg diet

**Table 5** Haematological parameters of hens fed diet supplemented with *Cordyline fruiticosa* leaf meal

| Indices | Treatment 1 | Treatment 2 | Treatment 3 | Treatment 4 | Treatment 5 | Ref. values | *P value* |
|---|---|---|---|---|---|---|---|
| Red blood cell (×1012/L) | 2.07b ± 0.01 | 2.14b ± 0.00 | 2.88a ± 0.01 | 2.90a ± 0.00 | 2.96a ± 0.01 | 2.00 – 4.00 | 0.021 |
| Haemoglobin (g/dL) | 8.04c ± 0.03 | 9.03b ± 0.02 | 11.40a ± 0.01 | 11.80a ± 0.00 | 11.83a ± 0.02 | 6.50 -15.00 | 0.005 |
| Pack cell volume (%) | 28.06b ± 3.95 | 29.14b ± 4.12 | 31.92a ± 5.00 | 32.06a ± 4.14 | 32.10a ± 5.03 | 26.0 – 36.0 | 0.110 |
| White blood cell (×109/L) | 12.18b ± 2.11 | 15.32a ± 1.96 | 15.77a ± 2.04 | 16.03a ± 2.00 | 16.14a ± 1.84 | 9.0 – 21.00 | 0.017 |
| Heterophils (%) | 28.03c ± 4.00 | 30.18b ± 3.91 | 35.84a ± 2.91 | 36.00a ± 3.03 | 36.03a ± 3.69 | 18.0 – 40.0 | 0.402 |
| Lymphocytes (%) | 59.40c ± 12.5 | 66.87b ± 10.8 | 71.44a ± 11.5 | 72.86a ± 12.7 | 73.33a ± 12.0 | 40.0 – 87.0 | 0.071 |

Means on the same row having different superscripts are significantly different (P < 0.05); T1; treatment 1 (control): Basal diet without *Cordyline fruiticosa* leaf meal; T2: Basal diet with 10 g *Cordyline fruiticosa* leaf meal/kg diet; T3: Basal diet with 20 g *Cordyline fruiticosa* leaf meal/kg diet; T4: Basal diet with 30 g *Cordyline fruiticosa* leaf meal/kg diet; T5: Basal diet with 40 g *Cordyline fruiticosa* leaf meal/kg diet

## 3. DISCUSSIONS

Phyto-constituent profile of *Cordyline fruiticosa* leaf meal showed that it contains numerous compounds with pharmacological properties (Musa et al., 2020; Adewale et al., 2021). Phenols functions as local intestinal antioxidants which can reduce cellular oxidative damage in birds (Ojediran et al., 2024a). Many phyto-constituents have antimicrobial activities for instance, tannins, flavonoids, terpenoids and alkaloids develop their actions against pathogenic bacteria's by interacting with their cell membrane thus causing a conformational change in their membrane structure leading to the leakage ions (Alagbe et al., 2022a). Reports by Manu, (2022) have shown that saponins have the capability to improve the permeability of the gut walls of animals leading to improved absorption of minerals and nutrients in the body. Flavonoids and tannins have also been suggested to lower gut inflammation, modulate cytokine production from macrophages and support the development of acquired immunity (Alagbe, 2024).

Alkaloids and steroids possess hepato-protective, analgesic and antimalarial properties (Singh et al., 2022). Results on phenol (672.81 mg/g) and flavonoid (1007.5 mg/g) concentrations obtained in this study were higher than values reported by (Elfita et al., 2021). However, result conforms with the report of (Shihabudeen et al., 2010). The discrepancies in their outcome could be attributed to processing or extraction method adopted, specie as well as geographical location (Alagbe et al., 2020a; Alagbe et al., 2020b; Alagbe et al., 2020c; Shittu et al., 2021; Shittu and Alagbe, 2020). Outcome on growth performance showed that dietary supplementation of *Cordyline fruiticosa* leaf meal at 10 g/kg diet (treatment 2), 20 g *Cordyline fruiticosa* leaf meal/kg diet (treatment 3), 30 g/kg (treatment 4) and 40 g/kg (treatment 5) resulted in a significant increase in average final body weight of hens compared to the control (treatment 1). This suggests that *Cordyline fruiticosa* leaf meal has the potential to enhance the growth of birds, in particular the feed conversion ratio.

The synergy of phyto-constituents in *Cordyline fruiticosa* leaf meal in the diet can increase the activities of endogenous enzymes and influence uptake and transepithelial transport thus improving nutrient digestion and absorption in the body of birds. Findings of the present study (1717.0 – 2987.0 grams) were similar to those of Cabuk et al., (2006), who revealed that final body weight of hen fed diet supplemented with herbal essential oil was between 1888 – 2000 g. It also confirms the earlier reports of Botsoglou et al., (2005) who recorded an average final weight of 1833 – 2300 grams when laying hens were fed diet supplemented with rosemary, oregano, saffron and $\alpha$-tocopheryl acetate. Similarly, there was an arousal in the appetite of birds fed *Cordyline fruiticosa* leaf meal compared to the control treatment which suggests that it contains a pleasant aroma and triggers the increased secretions of enzymes which optimizes digestion and degradation of metabolic products as well as the absorption and metabolic conversion of supplied feed nutrients (Alagbe et al., 2022b; Adewale et al., 2021).

Results obtained is in consonance with the reports of Olgun and Yildiz, (2014) when laying hens were fed diet supplemented with essential oils mixture. Similar observation was made by Akbarian et al., (2011) who supplemented laying hen's diet with ginger root extract. No mortality recorded among birds fed *Cordyline fruiticosa* leaf meal which suggests that it contains some vital bioactive compounds with therapeutic properties such as antibacterial, antioxidant, anti-inflammatory, immune-stimulatory, antimicrobial amongst others which also resulted in a significant improvement in their feed conversion ratio (Singh et al., 2022). The outcome of this result confirms the earlier reports of Bozkurt et al., (2014) who examined the effect of herbs and essential oil on the performance of hens. Dietary supplementation of *Cordyline fruiticosa* leaf meal also resulted in a significant increase in hen day egg production and hen housed egg production. This confirms that it has the ability to efficiency of feed conversion ratio which translates in more egg production.

According to Nuraini et al., (2017), feed conversion of birds can be used as an index to ascertain the extent of egg production, birds with low values makes more efficient use of feed to produce eggs. The current study was in line with the reports of Sosin-Bzducha and Krawczyk, (2012), Merina et al., (2018), Muhammad et al., (2021) who reported similar results on response to various levels of plant extracts in diets in laying chickens. In contrast, Santoso and Fenita, (2016) noted non-significant results on hen day production and hen housed production of laying hen fed Sauropus androgynus leaf extract at 45 g/kg diet. Egg shell strength, egg shell thickness, egg weight, egg shell, albumen height, albumen weight, yolk weight, yolk colour, yolk height, yolk length and haugh unit were positively influenced as the level of *Cordyline fruiticosa* leaf meal increased in the diet of laying hens.

The result indicates that *Cordyline fruiticosa* leaf meal could contain some essential minerals such as calcium, phosphorus, potassium, magnesium and manganese which could ensure good egg shell quality, as well as xanthophylls which may influence the yolk colour of eggs (Ebenebe et al., 2013; Durmus et al., 2004). According to Alagbe, (2024), Ojediran et al., (2024b), most medicinal plants possess both nutritional and pharmacological properties. Odunsi, (2003), Oluyemi and Roberts, (2000), reported that a yolk index

in hens between 0.30 - 0.55 % is an indication of the good internal quality of egg especially from birds fed leaf meal-based diets. Nobakht and Moghaddam, (2012) also noted a positive correlation between Haugh unit, yolk and albumen. Therefore, an increase in egg weight translates to an increase in albumen and yolk weight. This might explain the increase in albumen weight in groups fed diets supplemented with *Cordyline fruiticosa* leaf meal relative to the control in treatment 1.

Results obtained in this current study is in agreement with the findings of Abdel-Wareth et al., (2013) when thyme and oregano were supplemented in the diet of laying hens. Haematological indices are tools used to ascertain the health status of an animal as well as their nutritional status (Ma et al., 2005). Pack cell volume value obtained in this study were within the normal range (26.0 – 36.0 %) cited by (Abdulkarimi et al., 2011; Agubosi et al., 2022b). Pack cell volume is used to diagnose polycythemia, anaemia, dehydration and other health conditions in animals (Daniel et al., 2023; Muritala et al., 2022). Red blood cell and haemoglobin values were within the normal values [(2.00− 4.00 (×1012/L)] and (6.50 – 15.0 g/dL) reported by (Sayiedpiran et al., 2011; Özek et al., 2011). Red blood cell carries oxygen and deliver them to the different body tissues from the lungs to the heart and other parts of the body (Alagbe, 2023a; Alagbe, 2023b).

Low red blood cell and haemoglobin count may indicate bone marrow damage, haemorrhagic infections, metabolic disorders, chronic inflammation and vitamin 12 deficiency (Musa et al., 2020). Red blood cell, haemoglobin and pack cell volume values were higher among birds fed 20 g *Cordyline fruiticosa* leaf meal per kg diet in treatment 3, 30 g *Cordyline fruiticosa* leaf meal/kg diet (treatment 4) and 40 g *Cordyline fruiticosa* leaf meal per kg diet (treatment 5) relative to other treatments. However, values were within the established range reported in Kahn, (2010), this result suggests that the laying hens were healthy. White blood cell values are responsible for fighting infections via the production of antibodies (Antruejo et al., 2011). White blood cell, heterophils and lymphocyte values recorded in this experiment were within the normal range [(9.00 – 21.00 (×109/L)]; 18.00 – 40.0 % and 40.0 – 87.00 respectively reported by (Sayiedpiran et al., 2011; Najafi and Torki, 2010).

White blood cell count in laying hens fed treatment 2, treatment 3 were similar ($P>0.05$) to those in treatment 4 and treatment 5 but significantly higher ($P<0.05$) than those in treatment 1. Conversely, heterophil and lymphocyte count follow similar pattern as values were higher in birds fed treatment 3, treatment 4 and treatment 5, intermediate in treatment 2 and lower in treatment 1 ($P<0.05$). Low white blood count suggests deficiencies in minerals and vitamins, bacteria or viral infections, liver disease and enlarged spleen (Agubosi et al., 2022c). Lymphocytes are immune cells capable of defending the body against pathogens and infections.

## 4. CONCLUSION

In conclusion, dietary supplementation of *Cordyline fruiticosa* leaf meal is therefore regarded as an option not only to improve growth performance, egg quality and blood parameters but to alleviate the risk of antimicrobial resistance in both birds and human being. *Cordyline fruiticosa* leaf meal can be supplemented up to 40 g/kg diet without causing any deleterious effect on the health status of laying hens.

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**Author contribution**

PhD Alagbe Olujimi John designed the experiment, data collection, statistical analysis and writing of the manuscript.

**Ethical approval**

In this article, the animal ethical guidelines and requirements of procedures that had been authorized by ethics council of the Department of Animal Nutrition and Biochemistry, Sumitra Research Institute (BN/006C/2020), Gujarat, India; the authors observed the impact of *Cordyline fruiticosa* leaf meal supplemented diet on growth performance, egg production, egg quality and some heamatological indices of laying hen. The Animal ethical guidelines are followed in the study for species observation, identification & experimentation. Also, the ethical guidelines for plants & plant materials are followed in the study.

**Informed consent:** Not applicable.

**Conflicts of interests**

The authors declare that there are no conflicts of interests.

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**Data and materials availability**

All data associated with this study are present in the paper.

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