Acacia auriculiformis leaves' powder as an alternative for antibiotics uses in broilers organic farming

Tagouèlbè Tiho [1,*], Gningnini Alain Koné [1], Nahoulé Silué [2], Moya Josephine Djako [1] and Georges Djaah [1]

[1] *Graduate School of Agriculture, National Polytechnic Institute Felix Houphouet-Boigny (INP-HB), Yamoussoukro, Cote d'Ivoire (Ivory Coast).*
[2] *Agropastoral Management Institute (IGA), Péléforo Gon Coulibaly University (UPGC), Korhogo, Côte d'Ivoire (Ivory Coast).*

World Journal of Advanced Research and Reviews, 2024, 21(01), 2675–2685

Publication history: Received on 20 December 2023; revised on 27 January 2024; accepted on 29 January 2024

Article DOI: https://doi.org/10.30574/wjarr.2024.21.1.0357

Abstract

The experiment tested Acacia auriculiformis leaves' powder actions on broilers' growing performance and their blood plasma lipid profile. So, an experiment with 150-day-old broiler chicks was set. At the end of week 3, all the broilers were weighed, and 10 homogenous groups of 12 chicks each were constituted, within whose 5 groups per gender. Also, Acacia auriculiformis (Aa) leaves were collected, dried during 2 weeks in laboratory rooms, and were powdered with a blender. Then, in addition to a control diet, 4 diets were made by incorporating 0.75%, 1.5%, 2.25% and 3%Aa leaves' powder. So, the diets were 0%Aa, 0.75%Aa, 1.5%Aa, 2.25%Aa, and 3%Aa, respectively. Randomly, each broilers' group was fed on a diet for 7 weeks and the birds were weekly weighed. At the end of week 10, 3 broilers of similar weights were slaughtered per group. Their blood was collected in 2 types of tubes, for blood cells count, and blood plasma lipid analysis. As a result, white blood cell (WBC) counts were 22.80, 21.52, 20.28 and 18.11*103/µL, with diets 0%Aa, 2.25%Aa, 1.5%Aa, and 3%Aa, respectively. Thus, this WBC count decrease confers an antibiotic action to Aa leaves powder. Following, HDL cholesterol content increased from 31.62 for diet 0%Aa to 37.80 mg/dL for diet 1.5%Aa (+6.18 mg/dL, $p<0.001$). Simultaneously, with 1.5%Aa, triglyceride content was the smallest for 21.03 mg/dL ($p<0.001$), and protein content was the highest for 4.01 g/dL. In conclusion, at 1.5% in the diet, Acacia auriculiformis leaves' powder may be very beneficial to broilers' organic rearing.

Keywords: *Acacia auriculiformis*; Antibiotic; Broiler; Organic farming; White Blood Cell Count.

1. Introduction

Generally, in west African countries like Burkina Faso, Cote d'Ivoire, Mali and Senegal, cooking requires a long time on fire. When the family can afford gathering some meat, mainly, it is cooked in a soupe. Thereafter, this sauce is usually poured on the meal, or people immerse the meal bole in the sauce. So, during the long boiling period, the bush meat or local hard chicken meat become tender. In fact, the local birds are reared over 6 months before weighing 1 kg. Nowadays, due to population growth, nearby relatively big cities such as Bobo-Dioulasso in Burkina Faso, Abidjan in Cote d'Ivoire, Bamako in Mali and Dakar in Senegal, broilers' farmers adopted the fast-growing selected broilers' strains. Although the hot and humid atmosphere, with good professional rearing methods, these birds weigh around 1.2 kg at 35 days of age.

These broilers' soft meat is found in restaurants for those who are eating out, far away from home because of job obligations. But this soft meat is not adequate for home cooking habits, because it just disintegrates in the soupe during cooking, and the meat is not as sweet as the local chicken meat. Because West African family ties are very strong, usually people eat together at home as a family for night meals and during weekends. Thus, an important market is lost for fast growing broilers' strains, while people are eating together as a family. Therefore, in the aim to produce heavy weight

* Corresponding author: Tagouèlbè Tiho, E-mail: tihotag@gmail.com

carcass with fast growing broilers, having some relative hard, and succulent meat compared to the local chickens, more and more chickens' farmers are rearing the broilers from 70 to 90 days. Unfortunately, broilers are subjected to many diseases or infections such as colibacillosis caused by *Escherichia coli*, Marek due to Marek's disease virus, coccidiosis caused by *Eimeria* sp, a protozoan parasite, *avian influenza* due to *Avian influenza* virus, virulent Newcastle caused by *Avian paramyxovirus*, *Salmonellosis* caused by *Salmonella bacteria*, and Mycoplasma due to *Mycoplasma pneumoniae* …

The longer the chickens last in breeding, the more veterinary products are needed to fight against diseases. Moreover, in humid and hot tropical conditions, pathogens grow rapidly. Generally, poultry farmers use large spectra antibiotics to control Eimeria spp. [1-2]. So, to reduce intestine internal parasites bad effect on broilers' growth, because of some bacteria resistance to familiar antibiotics [2-3], more and more medicinal plants are used [4-5]. Elsewhere, mixing Artemisia afra leaves in poultry feed decreased oocyst count [5]. Moreover, adding black cumin seeds in broiler chicks' diets decreased coliform and Escherichia coli populations [4]. These medicinal plants used in poultry farming have high polyphenols content, and good antioxidant activity [6]. In addition to the well-known medicinal plants, a screening of Acacia auriculiformis (Aa) bark showed the presence of carbohydrates, anthraquinone glycosides, saponins, phenols, tannins, flavonoids, steroids and terpenoids [7]. Recently, many studies revealed that Acacia auriculiformis' parts such as leaves, barks and roots are good sources of phytochemicals [8-10]. In fact, the plant is widely used in traditional medicine against many illnesses [10]. Considering the rich phytochemical composition of Aa tree' parts, the work hypothesis was that ''Acacia auriculiformis dried leaves powder could be a good growth and health promotor for broilers''. The subsequent objectives were to assess the broilers' growth performance, blood cells count, and blood plasma lipides profile, after 70 days rearing period, alongside different Aa leaves' powder incorporation rates. The introduction should be typed in Cambria with font size 10. Author can select Normal style setting from Styles of this template. The simplest way is to replace (copy-paste) the content with your own material. In this section highlight the importance of topic, making general statements about the topic and presenting an overview on current research on the subject. Your introduction should clearly identify the subject area of interest.

2. Material and methods

2.1. Acacia auriculiformis dried leaves' powder

Acacia auriculiformis leaves were collected and dried in the laboratory room for 14 days. During drying, the leaves were turned over every 2 days to avoid rotting. Then, they were crushed using a blender (Solstar blender, BL 1545-GSLB SS, Singapore). Under these conditions, the leaves retained their green colour without significant degradation. After grinding, the powders were kept in well dried and closed bottles.

2.2. Experiment groups

A total of 150-day-old Cobb-500 broiler chicks were used. The chicks were housed at the graduate school of agriculture experimental station, at the National Polytechnic Institute Felix Houphouët Boigny (INP-HB) in Yamoussoukro, Côte d'Ivoire (Ivory Coast) [11]. Before broiler chicks' arrival, the rearing area has been cleaned and disinfected, and the floor was covered with wood chips. At night, the chick rearing area of 20 m^2 (5m x 4m) was electrically heated with 4 light bulbs of 100 watts each. For that issue, the lamps were suspended at 50 cm from the ground. In these conditions, the starter period lasted 21 days, including 7 heating days. On day 21, based on their head size and body faithers growth, the chicks were sexed and weighed. Based on the mean μ (Eq 1), chicks outside the confidence interval (α=0.5; Eq. 2, Eq. 3, Eq. 4) were discarded. Then, the selected broilers were randomly divided into 10 groups of 12 chicks each. Thereafter, the experiment lasted 7 additional weeks. So, in total, the experiment lasted 10 weeks. The females and males were reared separately. So, there were 5 groups in each category.

$$\mu = \frac{1}{n} * \sum_1^n x_i \qquad (1)$$

$$\mu-\sigma \leq \mu \leq \mu+\sigma \qquad (2)$$

It was the interval for the selected broilers for the experiment.

$$V_x = \frac{1}{n} * \sum_{i=1}^n (x_i - \mu)^2 \qquad (3)$$

$$\sigma = \sqrt{V_x} \qquad (4)$$

Where μ is the least square mean, σ is the standard error, and Vx is the variance.

2.3. Broilers rearing

Based on Aa leaves' powder incorporation rates, 5 diets were made during the growing and finishing period (Table 1). Because the diets contained 0%, 0.75%, 1.5%, 2.25% and 3% Acacia auriculiformis dried leaves powder, they were named 0%*Aa*, 0.75%*Aa*, 1.5%*Aa*, 2.25%*Aa* and 3%*Aa*, respectively. For each 12 chickens' group, the rearing area was 4 m^2 (2 mx2 m). So, the density was 3 chickens per square meter. During this growing-finishing period, the chickens were raised on woods, 50 cm above the ground. In fact, this system constitutes good sanitary prophylaxis, like a slated system. Indeed, the chickens cannot rummage in the litter and peck the fallen feedstuff. This reduces the ingestions of parasite oocysts. Additionally, the chickens were rationed. In practice, they were fed once a day at 12 O'clock, and each bird received 120 g per day from day 30 to day 70. Weekly, the chickens were weighed. The experiment took place in the rainy season, from August to October 2022, the rearing house ambient temperature varied between 22°C and 29°C, and the humidity fluctuated between 61 and 84%.

2.4. Blood cells count

On day 71, 8 AM, the broilers were weighed in each diet group (0%*Aa*, 0.75%*Aa*, 1.5%*Aa*, 2.25%*Aa*, 3%*Aa*). Just after, the group mean was computed (ξ). Following, the gap between each chicken weight and the group mean was computed (Eq. 5). Thereafter, 3 birds showing the smallest absolute interval gap were selected for blood collection. So, 15 (5 diets *3 birds) hens and 15 roosters were selected.

$$I = |x_i - \xi| \qquad (5)$$

Where ξ is the broilers' weights average in a diet group, and I is the absolute interval between each individual weight (x_i) and the group average weight (ξ).

Table 1 Experimental diets

Ingredients	**Weeks 1-3 (Starter diet)**	**Week-4 to week-10 (grower and finisher diets)**				
		0%*Aa*	0.75%*Aa*	1.5%*Aa*	2.25%*Aa*	3%*Aa*
Yellow corn	50	37	37	37	37	37
Yellow corn bran	0	12.50	11.75	11.00	10.25	9.50
Fish meal (62%CP)	20.00	20.00	20.00	20.00	20.00	20.00
Soya meal (42%CP)	20.00	18.00	18.00	18.00	18.00	18.00
Wheat bran	-	4.00	4.00	4.00	4.00	4.00
Premix, broilers' grower	-	6.00	6.00	6.00	6.00	6.00
Premix, broilers' starter	4.00	-	-	-	-	-
Eggshell powder		2.50	2.50	2.50	2.50	2.50
Acacias auriculiformis (*Aa*)	-	-	0.75	1.50	2.25	3.00
Cotton seed meal	6.00	-	-	-	-	-
Total	100	100	100	100	100	100
Analyses						
Dried matter (%)	90.67	91.93	91.50	91.28	92.81	90.65
Ash (%DM)	11.37	8.67	11.38	11.98	8.52	9.14
Fat (%DM)	4.50	4.00	4.20	4.30	4.35	4.40
Crude protein (%DM)	20.08	19.96	19.90	19.95	19.90	19.92
Total carbohydrate (%DM)	64.05	67.37	64.52	63.77	67.23	66.54
M. E. (kcal/kg)	3,153.2	3,227	3,140.5	3,123.3	3,249.8	3,229.8

Tot_Carb (Total carbohydrate) =100% - (CP% +Fat% +Ash%)[11], M. E: Metabolizable energy, M. E (kcal/kg (DM)): [3.87×CP%+ 8.37×CF% +4.12×Tot_Carb (%)] ×10 [11]

The animals were slaughtered. Simultaneously, for blood cells count objective, some blood samples were collected into tubes containing ethylene diamine tetra-acetic acid (EDTA) as anticoagulant [11]. Thereafter, these tubes were manually shaken to avoid the clots formation. Then, the blood cells count was performed with a SYSMEX KX 21N haematology robot (Zhejiang Xinke Medical Technology Co., Ltd, Zhejiang city, China). The haematological parameters such as haemoglobin (HGB), packed cell volume (PCV), red blood cells (RBC), mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH), mean corpuscular haemoglobin concentration (MCHC), white blood cells (WBC), platelet (PLT), lymphocytes, monocytes, granulocytes percentage, respectively LYM%, MON% and GRAN% were analysed.

2.2.1. Blood plasma lipids' profile

From 12 O'clock to 8 AM the next day, the duration is about 20 hours from the last meal to the slaughters [12]. Some blood was also collected in dry tubes, containing clots activation agent (Factor XII, Hagemann Factor), kept at room temperature for 20 min for precipitation [12]. Then, it was centrifuged during 1 min, and the plasma was collected and stored in a refrigerator at 4°C. As soon as possible, the different cholesterols' contents were assessed. Total cholesterol was assessed with Cromatest, (working solution Ref: 1118055, Lot 16704; and the standard Ref: 1918006, Montgat, Barcelona, Spain) (Tot. C, Eq. 6). Similarly, the high-density lipoprotein cholesterol (DHL. C) was analysed (HDL. C, Eq. 7). Cromatest working solution (Ref: 1133050), and standard (Ref 1933006, Montgat, Barcelona, Spain) were used. On the same way, triglycerides contents (working solution Ref: 1155050 Lot 16382; standard Ref: 1955006, Eq. 8) and total protein (Tot. prot) contents (working solution Ref: 1153050 Lot 16167; standard Ref: 1953006, Eq. 9) in the plasma were analysed. The absorbances readings were performed by using a UV-visible spectrophotometer, Shimadzu UV-1601 PC, Kyoto, Japan.

$$Tot.C(mg/dL) = \frac{Sample_{absorbance}}{Stsndard_{absorbance}} * 200; \text{ readings at 500 nm;} \quad (6)$$

$$HDL.C(mg/dL) = \frac{Sample_{absorbance}}{Stsndard_{absorbance}} * 50; \text{ readings at 550 nm;} \quad (7)$$

$$Triglycerides\ (mg/dL) = \frac{Sample_{absorbance}}{Stsndard_{absorbance}} * 20; \text{ readings at 500 nm;} \quad (8)$$

$$Tot.prot\ (g/dL) = \frac{Sample_{absorbance}}{Stsndard_{absorbance}} * 7; \text{ readings at 550 nm;} \quad (9)$$

Where 200, 50, 20 and 7 were the standards concentration.

2.4.2. Statistical analysis

During the tests, the results were generated by using three samples for each examination. Thereafter, for the statistical analysis tests, the results were tested with an Analysis of Variance (ANOVA), using XLSTAT 2014. The least-squares means were separated according to Newman-Keuls (SNK) multiple range tests in 95% (α = 5%) confidence interval.

3. Result and Discussion

These results cover broilers' growth performance, their blood cells count, and their blood plasma profile.

3.1. Broilers' growth

The broilers' growth was assessed by looking at the interaction between the factors such as the age expressed by week, the gender (male or female), and the diet (Table 2). From week-3 to week-10, the weights least square means from a week to another were different (Table 2.α). For example, from week-8 to week-10, the roosters' weight means were 1,984.31±18.07 g; 2,246±18.07 g, and 2,481.69±18.07 g, respectively for week-8, week-9, and week-10 ($p<0.0001$). At that time, the hens mean weights were 1,984.36±18.07 g; 2,227.87±18.07 g, and 2,454.60, respectively for week-8, week-9, and week-10 ($p<0.0001$). But, within a week, roosters and hens' weights were similar. As an illustration, in week 8, the weights 1,984.31±18.07 g for roosters, and 1,984.36±18.07 g for hens were similar ($p=0.998$). Again, on week 9, 18.13 g gap between the two means was not significant ($p=0.479$). Similarly, on week 10, the difference between the means, 27.09 g, among roosters and hens, was not important ($p=0.29$).

These increasing mean weights from week to week was reported by Tiho et al. [11]. Looking carefully at the leaves' powder incorporation percentages impact on broilers' weights, it appears that, an increasing incorporation rate led to decreasing weights (Table 2.ω). For instance, within week-10, when the leaves' powder incorporation rate was 0%, 0.75%, 1.5%, 2.25% and 3%, the weights were 2,506.88; 2,481.56; 2,472.19; 2,465.94; and 2,414.17 g, respectively.

Increasing the mash proportion surely lead to a decreasing overall weight [11]. For example, when Simol et al. [13] incorporated some mulberry leaf powder at 0%, 20%, 30%, 40%, and 50%, the final live weights were 2047.17, 1991.67, 1994.25, 1758.58 and 1265.67 g, respectively. Remarkably, they reported that at finisher stage, the feed intake decreased, and were 95.70, 95.35, 94.41, 84.45, and 75.14 g, respectively at 0%, 20%, 30%, 40%, and 50% substitution rates. Similarly, Alwaleed et al. [6] incorporated some *Moringa oleifera* leaves' meals at 0%, 1%, 3%, 5% and 7% in broilers' feeds. Broilers' final weights were 2295, 2344, 2564, 2266, and 2197 g, respectively, at 6 weeks of age. So, the weights had a maximum at 3% incorporation rate with 2564 g and decreased at 5% and 7% [6] Herein, though the weights were similar within week 10, from 0%*Aa* to 3%*Aa*, the gap between 2,506.88 and 2,414.17 g was 92.71 g and represented 3.70% weight loss. Also, fixing an incorporation rate within a week, the roosters tend to grow faster than the hens.

Table 2 Broilers' weights according to the age (week), diets and gender

α. Interaction between age (week) and gender, effect on the weights		**ω. Interaction between week and diets, effect on the weights**		**φ. Interaction between weeks, gender, and diets, effect on the weights**	
weeks* gender	weight (g)	weeks*diets	weight (g)	weeks*gender*diets	weight (g)
w-10*M	2,481.69±18.07^{a}	w-10*0%*Aa*	2,506.88±28.58^{a}	w-10*M*0%*Aa*	2,515.63±40.42^{a}
w-10*F	2,454.60±18.19^{a}	w-10*0.75%*Aa*	2,481.56±28.58^{a}	w-10*F*0%*Aa*	2,498.13±40.42^{a}
w-9*M	2,246.00±18.07^{b}	w-10*1.5%*Aa*	2,472.19±28.58^{a}	w-10*M*1.5%*Aa*	2,496.88±40.42^{a}
w-9*F	2,227.87±18.19^{b}	w-10*2.25%*Aa*	2,465.94±28.58^{a}	w-10*M*2.25%*Aa*	2,491.56±40.42^{a}
w-8*F	1,984.36±18.07^{c}	w-10*3%*Aa*	2,414.17±29.05^{a}	w-10*F*0.75%*Aa*	2,483.75±40.42^{a}
w-8*M	1,984.31±18.07^{c}	w-9*0%*Aa*	2,276.56±28.58^{b}	w-10*M*0.75%*Aa*	2,479.37±40.42^{a}
w-7*F	1,748.35±18.07^{d}	w-9*0.75%*Aa*	2,255.63±28.58^{b}	w-10*F*1.5%*Aa*	2,447.50±40.42^{a}
w-7*M	1,747.28±18.07^{d}	w-9*1.5%*Aa*	2,230.94±28.58^{b}	w-10*F*2.25%*Aa*	2,440.31±40.42^{a}
w-6*M	1,472.00±18.07^{e}	w-9*2.25%*Aa*	2,225.30±29.05^{b}	w-10*M*3%*Aa*	2,425.00±4.42^{ab}
w-6*F	1,469.40±18.07^{e}	w-9*3%*Aa*	2,196.25±28.58^{b}	w-10*F*3%*Aa*	2,403.33±41.74^{b}
w-5*F	1,171.32±18.07^{f}	w-8*0%*Aa*	2,034.63±28.58^{c}	w-9*F*0%*Aa*	2,288.44±40.42^{bc}
w-5*M	1,162.24±18.07^{f}	w-8*0.75%*Aa*	1,997.63±28.58^{c}	w-9*M*0.75%*Aa*	2,276.88±40.42^{bc}
w-4*M	866.24±18.07^{g}	w-8*2.25%*Aa*	1,972.06±28.58^{c}	w-9*M*0%*Aa*	2,264.69±40.42^{bc}
w-4*F	852.42±18.07^{g}	w-8*1.5%*Aa*	1,964.38±28.58^{c}	w-9*M*1.5%*Aa*	2,248.13±40.42^{bc}
w-3*M	553.38±18.07^{h}	w-8*3%*Aa*	1,953.00±28.58^{c}	w-9*F*0.75%*Aa*	2,234.38±40.42^{c}
w-3*F	518.67±18.07^{h}	w-7*0%*Aa*	1,787.06±28.58^{d}	w-9*M*2.25%*Aa*	2,230.94±40.42^{c}
		w-7*0.75%*Aa*	1,753.90±28.58^{d}	w-9*F*2.25%*Aa*	2,219.67±41.74^{c}
		w-7*2.25%*Aa*	1,742.59±28.58^{d}	w-9*F*1.5%*Aa*	2,213.75±40.42^{c}
		w-7*1.5%*Aa*	1,739.00±28.58^{d}	w-9*M*3%*Aa*	2,209.38±40.42^{c}
		w-7*3%*Aa*	1,716.53±28.58^{d}	w-9*F*3%*Aa*	2,183.13±40.42^{c}

F: Female; M: male; W-3 to W-10: Week-3 to Week-10; Diets (0%*Aa*, 0.75%*Aa*, 1.5%*Aa*, 0.75%*Aa*, 1.5%*Aa*, 2.25%*Aa*, 3%*Aa*); $^{a, b, c, d, e, f, g, h}$ Means within a column, with different superscript significantly differ, by Newman-Keuls (SNK) multiple ranges test at 95% interval of confidence.

As an example, on week 10, at 1.5%*Aa*, the roosters weighed 2,496.88 g, while the hens weighed 2,447.50 g. Thus, the gap was 49.38 g, which was 2% weight loss. Similarly, at 2.25%*Aa*, the roosters remained heavier than the hens for 51.25 g. This fast-growing tendence is known as a sexual dimorphism in favour of roosters than hens [11]. Also, on week

9, at 0.75%*Aa*, the roosters weighed 2,276.88 g, whereas the hens weighed 2,234.38 g. Already, Tiho et al. [11] and Nowaczewski and Kontecka [14] reported that the roosters tend to grow faster than the hens, in the same environment.

When all the factors were combined, week*gender*diet (Table 2.φ), the elementary remarks were confirmed. For example, on week-10, the control diet without any leaves' powder took the lead. Notably, the roosters weighed 2,515.63 g and the hens followed with 2,498.13 g, thus a loss of 17.5 g. Surprisingly, during the week-10, the males fed on 1.5%*Aa* (0.75%*Aa**2) performed better than those fed on 0.75%*Aa*, and the results were 2,496.88 g and 2,479.37g, respectively. Though *Aa* mash percentage was double, the broilers' growing performance was improved by 17.51 g. This tendency was reported by Mashayekhi et al. [15], while they used *Eucalyptus* leaves' powder. Not only the broilers fed on the diets containing *Eucalyptus* leaves' powder performed the same as those fed on the diet containing the antibiotic, but also the diet containing 0.5% of the leaves' powder performed better compared to 0.25% diet [15]. So, the feed conversion ratios were 1.76 with the control diet, 1.65 for the diet containing an antibiotic, 1.73 with the diet containing 0.25% *Eucalyptus* leaves' powder, and 1.69 with the diet containing 0.5% *Eucalyptus* leaves' powder [15]. It could be concluded that, incorporating 1.5%*Aa* in the diet allowed a better expression of the broilers' physiology for their growth. Anyhow, with 1.5%*Aa*, within any week, the roosters were always heavier than the hens. However, 0.75%, 2.25%, and 3%*Aa* leaves' powder incorporation rates didn't meet the best physiological expression for broilers' growth. Similar observations were announced by Ampode and Asimpen [16] when they used *Azadirachta indica* leaves' powder in broilers' diets. The leaves powders' incorporation rates, 0%, 2%, 4%, and 6% led to 567.93 g, 531.93 g, 753.80 g, and 531.67 g, respectively, for the weight gain [16]. The derived feed conversion ratios were 2.86, 2.64, 1.90, and 2.67, in the same above order for the diets. Thus, they concluded that, 4% was the best *Azadirachta indica* leaves' powder incorporation rate in broilers' diets [16]. Because each tree has its own phytochemicals' contents in leaves, so the recommended leaves' powders incorporation percentages in broilers' diets differ.

3.1. Blood cells count

The white blood cells (WBC, 10^3/µL, Table 3) are important, because they are part of the immune system [17]. The WBC defend the body against infections and disease. Already, Nowaczewski and Kontecka [14], Grau et al. [18], and Wiyabot [19] concluded that broilers' blood cells count depends on the gender. Comparing WBC counts, and looking at the gender, hens have produced more WBC than the roosters (Table 3. π). Globally, with 25.30*10^3/µL for the hens, they had more WBC than the roosters whose WBC were 17.63*10^3/µL. This difference represented 30.32% of WBCs reduction from hens to roosters ($p<0.0001$). This tendency was reported by Nowaczewski and Kontecka [14], when they slaughtered their broilers at 44 days of age, because they reported 34.90*10^3/µL for hens, while the roosters had 32.60*10^3/µL, so 6.6% reduction. Herein results showed that F*0%*Aa* delivered 28.32*10^3/µL WBCs, while M*0%*Aa* had 17.27*10^3/µL. This difference was 11.05*10^3/µL decrease, equivalent to 39.02% loss ($p=0.000$). In more details Wiyabot [19] found that blood cells count depends on both gender and age. When broilers were less than 3 months of age, the roosters had more WBCs than the hens, respectively for 35.69*10^3/µL, and 33.930*10^3/µL [19]. But, between 3 and 6 months of age, the hens had more WBCs than the roosters for 45.31*10^3/µL, and 43.85*10^3/µL, respectively. Herein results were obtained when broilers were 70 days-old, and they corroborated Wiyabot [19] observations.

When the observations were focused on the effect of diets on WBCs counts, the outputs revealed that diets 0.75%*Aa*, 0%*Aa*, and 2.25%*Aa* broilers' blood had 24.62*10^3/µL, 22.80*10^3/µL and 21.52*10^3/µL, respectively. Moreover, these results were not different ($0.093\leq p\leq 0.209$). Thus, in this first group, WBC average content was 22.98*10^3/µL. In contrast, these diets' group got a different effect on WBC count than that of diet 3%*Aa*. For instance, from diet 0.75%*Aa* to diet 3%*Aa* (4 folds 0.75%*Aa*), WBC content dropped from 24.62*10^3/µL to 18.11*10^3/µL, so a decrease of 6.51*10^3/µL, equivalent to 26.44% loss ($p=0.001$). Besides, the interaction between the gender and the diets (gender*diets) gave a comprehensive understanding. Within the females' groups, diets 0%*Aa*, 0.75%*Aa*, and 2.25%*Aa* counted 28.32*10^3, 27.86*10^3 and 26.02*10^3 WBC per µL, respectively. Like the overall diets effect, with the interactions, the 3 diets constituted a similar group, with an overall 26.79±1.28*10^3/µL mean. The diet 2.25%*Aa* was a linking bridge between the first and the second group among the hens. Namely, diets 2.25%*Aa*, 1.5%*Aa*, and 3%*Aa* delivered 26.02, 22.19, and 22.10*10^3/µL, respectively. Moreover, these means were similar, leading an average of 23.44*10^3/µL for this second group ($0.067\leq p\leq 0.966$). Here again, within the females, from F*0.75%*Aa* to F*3%*Aa*, the WBCs contents dropped from 27.86*10^3/µL to 22.10*10^3/µL, and it was a loss of 5.76*10^3/µL, equivalent to 20.67% ($p=0.040$). Mainly, an increase of *Aa* incorporation rate in the diets led to a decrease in WBC contents. In males' group, the reactions were different from the females' one. In fact, diets 0.75%*Aa* and 1.5%*Aa* WBC counts were 21.37*10^3/µL and 18.37*10^3/µL, respectively. Remarkably, they were higher than that of the control diet (0%*Aa*) mean, which was 17.27*10^3/µL. In contrast, diets 2.25%*Aa* and 3%*Aa*, whose WBC contents were 17.01*10^3/µL, and 14.12*10^3/µL, respectively, less than the control (0%*Aa*). So, *Acacia auriculiformis* leaves powder impact on white blood cells depended on the incorporation percentages. Of course, 0.75%*Aa* to 1.5%*Aa* interval was advantageous while 2.25%*Aa* to 3%*Aa* interval had adverse effect on WBCs counts.

Though interactions M*1.5%*Aa,* and M*3%*Aa* WBC contents were similar, for 18.37*10^3/µL, and 14.12*10^3/µL, respectively (p=0.174). In fact, this 4.25*10^3/µL gap was a loss of 23.14%. Within the males, from M*0.75%*Aa* (21.37*10^3/µL), to M*3%*Aa* (14.12*10^3/µL), the 7.25*10^3/µL gap, was significant (p=0.012). Indeed, Mafouo et al. [14] found that, when an antibiotic was added to broilers' diets, WBC count decreases. For example, when they made a control diet and added 1g of doxycicline per kg of feed in another diet, WBC count decreased from 9.29 to 6.5*10^3/µL, respectively. This 2.79*10^3/µL gap represented 30.03% decrease. Again, even with human race, Tantiyavarong et al. [20] found that, under antibiotic administration, WBC counts decreased. Particularly, in human case, they concluded that there were 3 possible responses, whose were the early response, delayed response, and failure response. Fortunately, the early response covered more than 70% [20]. Anyhow, the WBC count decreased after antibiotic administration to patients [20]. In poultry farming, though some bacteria resistances to antibiotic are observed, globally, antibiotics are very important in poultry rearing [1].

Table 3 Blood cells' count following the gender, the diets, and the interaction gender*diets, at day 71**.**

WBC (10^3/µL)		**LYM (10^3/µL)**		**RBC (10^6/µL)**		**MCV (fL)**	
Gender		Gender		Gender		Gender	
F	25.30±0.63[a]	F	24.62±0.57[a]	F	2.48±0.05[a]	M	125.22±0.84
M	17.63±0.63[b]	M	17.25±0.57[b]	M	2.32±0.05[b]	F	123.59±0.84
p value	*<0.0001*		*<0.0001*		*0.049*		*0.183*
µ±σ							*124.40±0.84*
Diets		Diets		Diets		Diets	
0.75%*Aa*	24.62±0.99[a]	0.75%*Aa*	24.15±0.91[a]	0%*Aa*	2.44±0.08	1.5%*Aa*	126.05±1.32
0%*Aa*	22.80±0.99[ab]	0%*Aa*	22.35±0.91[ab]	2.25%*Aa*	2.40±0.08	0%*Aa*	125.03±1.32
2.25%*Aa*	21.52±0.99[abc]	2.25%*Aa*	21.14±0.91[ab]	0.75%*Aa*	2.40±0.08	3%*Aa*	123.80±1.32
1.5%Aa	20.28±0.99[bc]	1.5%*Aa*	19.21±0.91[bc]	1.5%*Aa*	2.39±0.08	0.75%*Aa*	123.73±1.32
3%*Aa*	18.11±0.99[c]	3%*Aa*	17.85±0.91[c]	3%*Aa*	2.38±0.08	2.25%*Aa*	123.40±1.32
p value					*0.745≤p≤0.996*		*0.292≤p≤1*
µ±σ					*2.40±0.08*		*124.40±1.32*
Gender*diets		Gender*diets		Gender*diets		Gender*diets	
F*0%*Aa*	28.32±1.40[a]	F*0%*Aa*	27.70±1.28[a]	F*0%*Aa*	2.64±0.12	M*0%*Aa*	128.43±1.87
F*0.75%*Aa*	27.86±1.40[a]	F*0.75%*Aa*	27.19±1.28[a]	F*2.25%*Aa*	2.49±0.12	M*1.5%*Aa*	126.60±1.87
F*2.25%*Aa*	26.02±1.40[ab]	F*2.25%*Aa*	25.47±1.28[ab]	F*1.5%*Aa*	2.46±0.12	F*1.5%*Aa*	125.50±1.87
F*1.5%*Aa*	22.19±1.40[bc]	F*3%*Aa*	21.76±1.28[bc]	F*0.75%*Aa*	2.42±0.12	M*0.75%*Aa*	124.00±1.87
F*3%*Aa*	22.10±1.40[bc]	M*0.75%*Aa*	21.11±1.28[bc]	F*3%*Aa*	2.38±0.12	F*3%*Aa*	123.80±1.87
M*0.75%*Aa*	21.37±1.40[bc]	F*1.5%*Aa*	21.00±1.28[bc]	M*0.75%*Aa*	2.37±0.12	M*3%*Aa*	123.80±1.87
M*1.5%*Aa*	18.37±1.40[cd]	M*1.5%*Aa*	17.42±1.28[cd]	M*3%*Aa*	2.37±0.12	F*2.25%*Aa*	123.53±1.87
M*0%*Aa*	17.27±1.40[cd]	M*0%*Aa*	17.00±1.28[cd]	M*1.5%*Aa*	2.32±0.12	F*0.75%*Aa*	123.47±1.87
M*2.25%*Aa*	17.01±1.40[cd]	M*2.25%*Aa*	16.80±1.28[cd]	M*2.25%*Aa*	2.31±0.12	M*2.25%*Aa*	123.27±1.87
M*3%*Aa*	14.12±1.40[d]	M*3%*Aa*	13.94±1.28[d]	M*0%*Aa*	2.25±0.12	F*0%*Aa*	121.63±1.87
p value					*0.392≤p≤1*		*0.292≤p≤1*
µ±σ					*2.40±0.12*		*124.40±1.87*

[a, b, c, d] Means within the same column and in the same category (gender, diets, Gender*Diet) carrying different superscripts are significantly different at 95% interval of confidence, by Newman-Keuls (SNK) multiple ranges test, µ±σ: Least square mean ± standard error, or p-value when there was a significative difference. WBC (*10^3/µL): White blood cells, LYM (*10^3/µL): lymphocytes, RBC (*10^6/µL): Red blood cells, MCV (fL): Mean corpuscular volume.

So, compared to the control diet (0%*Aa*), observing WBC count decrease after adding *A. auriculiformis* leaves' powder, these results may indicate that *Acacia auriculiformis* leaves' meal has an antibiotic function. Like *Eucalyptus* leaves powder [15], and *Azadirachta indica* leaves powder [16] use as poultry feed additives, the farming atmosphere conditions are important. In all cases, an optimum incorporation percentage is researched. Looking at the red blood cells (RBC*10^3/µL, Table 3), their major role is oxygen (O_2) transportation from the lungs to the cells deeply inside the body [21]. Also, the collect carbonic dioxide (CO_2) from de cells to the lungs [22]. In this experiment, apart from gender, diets, and the interaction (gender*diet) had no impact on red blood cell count. Like WBC count, RBC count depends on the broilers' gender. Wiyabot [19] observed that, between 3 and 6 months of age, broilers' RBCs counts were 3.29*10^6/µL for the females and 3.13*10^6/µL (-4.86%) for the males. Also, at 44 days old, Nowaczewski and Kontecka [14] counted 2.53*10^6/µL RBC in hens' blood and 2.48*10^6/µL (-1.97%) in roosters' blood. In this experiment, the hens had 2.48*10^6/µL RBC, while the roosters had 2.32*10^6/µL (-6.45%). Mainly, *Aa* leaves powder incorporation in the diets did not influence the red blood cells counts. So, the RBC count mean was 2.40*10^6/µL. Equally important, MCV values did not show any difference between the gender, the diets, and the interaction between gender and diets. So, the general mean of MCV was 124 fL. These findings were like those announced by Grau et al. [18], and Wiyabot [19].

3.2. Blood plasma lipid profile

In a coagulation process, the blood cells such as red blood cells, platelets, and white blood cells are draped in the coagulum. Moreover, the plasma is obtained after the centrifugation of the clotted blood. Finally, the plasma contains antibodies, proteins, cholesterols, and triglycerides. On table 4, total cholesterol (Table 4.γ) and triglycerides (Table 4.λ) were gender dependant, while HDL cholesterol (Table 4.χ) and Protein (Table 3. π) were not. Looking at total cholesterol contents, the males' plasma had 184.19 mg/dL while the females' one had 178.08 mg/dL. Moreover, this 6.11 mg/dL gap was important (p=0.021). These total cholesterol contents were closed to 105.26 mg/dL, and 106.7 mg/dL announced by Wiyabot [19]. In contrary, Wiyabot [19] did not observe any gender linkage, because the means were similar, when the broilers age was between 3 and 6 months. Also, Gakuya et al. [22] concluded that, total cholesterol content may vary alongside the gender. In fact, when they put 0%, 7.5%, 15% and 30% of *Moringa oleifera* leaves powder in broilers' feeds, the total cholesterol contents were 2.90-2.64, 2.86-2.60, 3.56-3.0 and 2.83-2.74 mg/dL, respectively, for males-females [22]. Again, according to Gakuya et al. [22], these total cholesterol contents were not different (p=0.12).

When it came to diets' effects on total cholesterol contents (Table 4.γ), only 2 classes were observed. In fact, diets 22.5%*Aa*, 0%*Aa*, 1.5%*Aa*, and 0.75%*Aa* constituted one group. So, this first group total cholesterol content mean was 184.21±2.90 mg/dL. The plasma from broilers of diet 3%*Aa* had the smallest total cholesterol contents, for 168.84±2.88 mg/dL, and this reduction of 15.37 mg/dL was 8.34% decline, (0.0001≤p≤0.003). Like these results, sometimes woody plants leaves' powders have significant effects on broilers blood plasma total cholesterol contents. As an illustration, Tokofai et al. [23] put 0%, 1%, 2, and 3% of *Vernonia amygdalina* leaf meal and obtained 139.3, 118.7, 108.2, and 107.3 mg/dL of total cholesterol contents (p=0.000). So, from the control up to 3% incorporation percentage of *Vernonia amygdalina* leaf powder, total cholesterol continued to decline [23].

Withing HDL-cholesterol contents (Table 4.χ), putting them together, the mean of females and males HDL-cholesterol content was 31.14±0.74 mg/dL (p=0.083). So, this result showed that the HDL-cholesterol content may not vary with the gender. This output followed Tiho et al. [11] and Wiyabot [19] conclusions. Though some numerical differences may be observed, but the overall HDL cholesterol contents between roosters and hens didn't show important difference. In contrast, the diets' effect was tremendous. Significantly, plasma from broilers of diet 1.5%*Aa* contained 37.80±1.16 mg/dL HDL cholesterol, and this result was higher than any other (0.000≤p≤0.001). Following, bloods' plasma from broilers of diets 0%*Aa*, 2.25%*Aa*, and 0.75%*Aa* had 31.62±1.16, 29.75±1.16 and 29.13±1.16 mg/dL, respectively (0.258≤p≤0.705). Finally, blood plasma from diet 3%*Aa* had 27.40±1.16 mg/dL HDL cholesterol content. Thus, *Acacia auriculiformis* leaves' powder incorporation percentages had an important effect on HDL cholesterol contents. Notably, diet 1.5%*Aa* effects on females and males' blood plasmas were important. To clarify, the plasma from broilers of 1.5%*Aa**F and 1.5%*Aa**M diets had 38.4 and 37.55±1.64 mg/dL of HDL cholesterol contents, respectively (p=0.833).

Elsewhere, from a control and introducing 7.5%, 15%, and 30% of *Moringa oleifera* leaves' powder in broilers' diets, Gakuya et al. [22] observed some variations in blood plasma HDL cholesterol contents. Firstly, at 0% (control), 7.5% and 15% incorporation percentages, HDL cholesterol contents were 1.67, 1.87, and 2.11 mg/dL [22]. Secondly, at 30% incorporation rate, HDL cholesterol dropped at 1.71 mg/dL. So, it may be concluded that, incorporating some trees leave powders in broilers' diets may lead to different physiological reactions in animals' bodies, following the incorporation percentages.

Table 4 Gender, diets, and gender*diets impact on blood plasma total cholesterol (mg/dL), HDL cholesterol (mg/dL), triglycerides (mg/dL), and protein (g/dL),

γ. Total cholesterol (mg/dL)		**χ. HDL cholesterol (mg/dL)**		**λ. Triglycerides (mg/dL)**		**π. Protein (g/dL)**	
Gender							
M	184.19±1.84[a]	M	32.05±0.74	M	32.13±0.91[a]	M	3.85±0.06
F	178.08±1.82[b]	F	30.23±0.74	F	28.92±1.05[b]	F	3.83±0.06
p value	*0.021*		*0.083*		*0.024*		*0.872*
μ±σ			*31.14±0.74*				*3.84±0.06*
Diets							
2.25%*Aa*	188.67±2.88[a]	1.5%*Aa*	37.80±1.16[a]	0.75%*Aa*	35.64±1.41[a]	1.5%*Aa*	4.01±0.10[a]
0%*Aa*	183.78±2.88[a]	0%*Aa*	31.62±1.16[b]	0%*Aa*	35.13±1.46[a]	3%*Aa*	3.89±0.10[ab]
1.5%*Aa*	182.65±2.88[a]	2.25%*Aa*	29.75±1.16[bc]	3%*Aa*	33.32±1.50[a]	0.75%*Aa*	3.89±0.10[ab]
0.75%*Aa*	181.74±2.97[a]	0.75%*Aa*	29.13±1.16[bc]	2.25%*Aa*	27.51±1.57[b]	0%*Aa*	3.79±0.10[ab]
3%*Aa*	168.84±2.88[b]	3%*Aa*	27.40±1.16[c]	1.5%*Aa*	21.0±1.78[c]	2.25%*Aa*	3.62±0.10[b]
Gender*diets							
0.75%*Aa**M	197.08±4.32[a]	1.5%*Aa**F	38.04±1.64[a]	3%*Aa**F	46.04±2.05[a]	1.5%*Aa**M	4.14±0.14[a]
2.25%*Aa**F	194.69±4.07[a]	1.5%*Aa**M	37.55±1.64[a]	0.75%*Aa**M	43.24±1.94[a]	3%*Aa**F	4.11±0.14[a]
1.5%*Aa**M	184.50±4.07[ab]	3%*Aa**M	35.91±1.64[ab]	0%*Aa**F	35.89±2.20[b]	0.75%*Aa**F	3.90±0.14[ab]
0%*Aa**M	184.31±4.07[ab]	0%*Aa**F	33.78±1.64[abc]	0%*Aa**M	34.36±1.94[bc]	1.5%*Aa**F	3.88±0.14[ab]
0%*Aa**F	183.25±4.07[ab]	2.25%*Aa**F	32.90±1.64[abcd]	1.5%*Aa**M	33.88±2.05[bc]	0.75%*Aa**M	3.87±0.14[ab]
2.25%*Aa**M	182.66±4.07[ab]	0.75%*Aa**M	30.73±1.64[bcd]	2.25%*Aa**M	28.59±2.05[bcd]	0%*Aa**F	3.80±0.14[ab]
1.5%*Aa**F	180.81±4.07[ab]	0%*Aa**M	29.47±1.64[bcd]	0.75%*Aa**F	28.04±2.05[bcd]	0%*Aa**M	3.77±0.14[ab]
3%*Aa**M	172.41±4.07[bc]	0.75%*Aa**F	27.52±1.64[cd]	2.25%*Aa**F	26.44±2.37[cd]	2.25%*Aa**M	3.77±0.14[ab]
0.75%*Aa**F	166.41±4.07[c]	2.25%*Aa**M	26.60±1.64[d]	3%*Aa**M	20.59±2.20[d]	3%*Aa**M	3.68±0.14[ab]
3%*Aa**F	165.27±4.07[c]	3%*Aa**F	18.90±1.64[e]	1.5%*Aa**F	8.19±2.90[e]	2.25%*Aa**F	3.46±0.14[b]

μ±σ: least square mean ± standard error; [a, b, c, d, e] Means within a column, with different superscript significantly differ, by Newman-Keuls (SNK) multiple ranges test at 95% interval of confidence.

Also, with *Vernonia amygdalina* leaf meal, Tokofai et al. [23] observed that at 1%, 2% and 3% incorporation percentages, HDL cholesterol contents increased importantly. For example, with the control broilers' blood plasma had 36.4 mg/dL HDL cholesterol contents. Thereafter, the animals had 74.1, 75.1, and 75.2 mg/dL HDL cholesterol contents at 1%, 2%, and 3% respectively [23]. So, *Vernonia amygdalina* leaf meal greatly improved the broilers' health. Depending on a tree, the optimum incorporation rate is specific. Nonetheless, by incorporating *Moringa oleifera* leaves' powder in broilers' feeds, Gakuya et al. [22] didn't observe a significative difference following the gender. Meanwhile, compared to the control, the HDL cholesterol contents have been increased in the diets with *Moringa oleifera* leaves' powder [22]. With *Acacia auriculiformis*, from 0.75%*Aa* to 3%*Aa* interval, 1.5%*Aa* incorporation rate allowed the best immune system response from the broilers by allowing the highest HDL cholesterol content for 37.80±1.16 mg/dL, and the smallest triglyceride content for 21.0±1.78 mg/dL. Referring to triglyceride contents, Friedewald et al. [12] showed that high triglyceride concentrations may not be so good for human health. In fact, after computing data on 232 men and 216 women, they concluded that low density lipoprotein (LDL cholesterol, LDL_{Chol}) can be greatly evaluated with equation 10. Singularly, when triglyceride concentration is divided by 5, the result refers to the very low-density lipoprotein (VLDL cholesterol, $VLDL_{Chol}$, Eq. 11). Because of this linear relationship between triglycerides and very low-density lipoproteins, an attention should be paid to the diet effect on blood plasma triglyceride contents.

$$LDL_{Chol}(mg/100\,mL) = Total_{Chol} - HDL_{chol} - \frac{Triglyceride\_concenration\ (mg/100\,mL)}{5} \quad (10)$$

$$VLDL_{Chol}(mg/100\,mL) = \frac{Triglyceride_{concenration}(mg/100mL)}{5} \quad (11)$$

Like total cholesterol contents, triglyceride contents differ with the gender. For instance, the males and females expressed 32.13 and 28.92 mg/dL, respectively. Furthermore, this difference of 3.21 mg/dL of triglyceride content represented 9.99% diminution, and it was important (p=0.024). Under *Acacia auriculiformis* leaves' powders effect, the blood serums from the males had more triglycerides contents than the females' ones. In contrary, triglycerides contents were not different according to the gender, when Gakuya et al. [22] put *Moringa oleifera* leaves' meal in broilers feeds.

Specifically, on the diets' effects on triglycerides contents, 1.5%*Aa* diet had the smallest average. With 21.03 mg/dL of triglyceride content, compared to the control (35.64 mg/dL), there was 14.09 mg/dL decrease, so a reduction of 40.12% (p<0.0001). Sometime, in hot and humid atmosphere conditions such as Nairobi in Kenya Gakuya et al. [22] observed that *Moringa oleifera* leaves' meal incorporation percentage had an important effect on triglyceride content. Beginning with 1.34 mg/dL with the control, triglyceride content dropped at 0.93 at 7.5%, 0.94 at 15% and 0.95 at 30%. But, under cool atmosphere conditions such as Egypt, increasing *Moringa oleifera* leaves powder in broilers' feeds led to an increase in triglyceride contents [6]. So, at 0%, 1%, 3%, 5% and 7%, the derived triglycerides contents were 85.67, 102.7, 110.3, 131.3, and 126 mg/dL [6]. Blood plasma proteins are important because they are part of the antibodies, whose are produced in response to a specific antigen [21]. Free from gender justification, blood plasma protein was greatly influenced by the diet (Table 4.π). Compared to diet 0%*Aa* result, though the difference was not significant, diet 1.5%*Aa* boosted the immune system from 3.79 g/dL to 4.01 g/dL, +5.8% (p=0.377). Likewise, Tokofai et al. [23] concluded that *Vernonia amygdalina* leaves' powder improved broilers' blood plasma protein content. From 38.6 g/L with the control, adding 1%, 2% and 3% of the leaves' powder increased the protein contents to 40.8, 45.6, and 41.9 g/L, respectively [23].

4. Conclusion

Increasingly, the broilers from organic farms, that use less and less synthetic antibiotics, are very popular on the market. These broilers are certainly housed in breeding buildings, but they also have access to natural rangelands. Thus, chickens consume termites, locusts, worms, and grasses. Unfortunately, they become seriously infected with roundworm larvae. In these conditions, *Acacia auriculiformis* leaves' powder which exhibits important antibiotic action could be very useful to organic poultry farming. African small holders in poultry farming should grow *Acacia auriculiformis* trees around the farm. By applying a good drying method, and good administration could reduce the production cost by avoiding synthesis antibiotic uses. In fact, between the incorporation percentages, from 0.75% to 3%, the best was 1.5%. Because *Acacia auriculiformis* trees are evergreen, a sanitary prophylactic action based on its leaves could be very helpful in hot and humid atmosphere conditions in West Africa.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

References

[1] Elhassan MMO, Khaier MAM, Elamin EA. The Efficacy of Salinomycin against experimentally infected broiler chickens with field isolates of Eimeria tenella in Khartoum state, Sudan, Animal and Veterinary Sciences. 2020, 8 (4), 71-75, doi: 10.11648/j.avs.20200804.11.

[2] Badr JM, El-Saidy FR, Abdelfattah AA. Emergence of multi-drug resistant Pseudomonas aeruginosa in broiler chicks, International Journal of Microbiology and Biotechnology. 2020, 5(2), 41-47, doi: 10.11648/j.ijmb.20200502.11.

[3] Sacko B, Sidibe S, Kouyate M, Traore O, Sow I, Coulibaly K, Babana AH. Prevalence of Salmonella spp isolated from poultry products (Carcasses and Eggs) from markets and slaughterhouses of Bamako, American Journal of Biomedical and Life Sciences. 2019, 7 (6), 179-183, doi: 10.11648/j.ajbls.20190706.19.

[4] Khalaji S, Zaghari M, Hatami KH, Hedari-Dastjerdi S, Lotfi L, Nazarian H. Black cumin seeds, Artemisia leaves (Artemisia sieberi), and Camellia L. plant extract as phytogenic products in broiler diets and their effects on performance, blood constituents, immunity, and caecal microbial population, Poultry Science. 2011, 90, 2500-2510, doi: 10.3382/ps.2011-01393.

[5] Jamil M, Aleem MT, Shaukat A, Khan A, Mohsin M, Ur-Rehman T, Abbas RZ, Saleemi MK, Khatoon A, Babar W, Yan R, Li K. Medicinal plants as an alternative to control poultry parasitic diseases, Life. 2022, 12, 449. https://doi.org/10.3390/life12030449

[6] Alwaleed S, Mickdam E, Ibrahim A, Sayed A. The effect of dried Moringa oleifera leaves on growth performance, carcass characteristics and blood parameters of broiler chicken, SVU-International Journal of Veterinary Sciences. 2020, 3 (1): 87-99.

[7] Sharma N, Singh S, Singh SK. Pharmacognostical standardization and preliminary phytochemical investigations on Acacia auriculiformis A. Cunn. Ex. Benth stem bark, Journal of Medicinal Plants Studies. 2017, 5 (1), 398-402.

[8] Saha B, Saha SK. Phytochemical Analysis of Acacia auriculiformis Pericarp through Liquid Chromatography-Electrospray Ionization-Mass Spectrometry, Indian Journal of Pharmaceutical Science. 2022, 84 (3), 660-668, DOI: 10.36468/pharmaceutical-sciences.961.

[9] Prayogo YH, Syafii W, Sari RK, Batubara I, Danu. Pharmacological activity and phytochemical profile of Acacia heartwood extracts, Sciencia Pharmaceutica. 2021, 89, 37. https://doi.org/ 10.3390/scipharm89030037

[10] Rangra NK, Samanta S, Pradhan KK.. A comprehensive review on phytopharmacological investigations of Acacia auriculiformis A. Cunn. ex Benth., Asian Pacific Journal of Tropical Biomedicine. 2019, 9(1), 1-11, DOI: 10.4103/2221-1691.250263.

[11] Tiho T, Koné GA, N'gatta ZR, Kouadio KB. Borassus aethiopum mature fruits' dried pulp effect on Cobb 500 broilers growth performance and their blood plasma cholesterol contents, International Journal of Poultry Science. 2022, 21, 65-72, DOI: 10.3923/ijps.2022.65.72.

[12] Friedewald WT, Levy RI, Fredrickson DS. Estimation of the concentration of low-density lipoprotein cholesterol in plasma, without use of the preparative ultracentrifuge, Clinical Chemistry. 1972, 18 (6), 499-502.

[13] Simol CF, Tuen AA, Khan HHA, Chubo JK, King PJH, Ong KH. Performance of chicken broilers fed with diets substituted with mulberry leaf powder, African Journal of Biotechnology. 2012, 11 (94), 16106-16111, DOI: 10.5897/AJB12.1622.

[14] Nowaczewski S, Kontecka H. Haematological indices, size of erythrocytes and haemoglobin saturation in broiler chickens kept in commercial conditions, Animal Science Papers and Reports. 2012, 30 (2), 181-190.

[15] Mashayekhi H, Mazhari M, Esmaeilipour *O. Eucalyptus* leaves powder, antibiotic and probiotic addition to broiler diets: effect on growth performance, immune response, blood components and carcass traits, Animal. 2018, 12 (10), 2049-2055 doi: 10.1017/S1751731117003731.

[16] Ampode KMB, Asimpen SM. Neem (*Azadirachta indica*) leaf powder as phytogenic feed additives improves the production performance, and immune organ indices of broiler chickens, Journal of Animal Health and Production. 2021, 9 (4), 362-370, http://dx.doi.org/10.17582/journal.jahp/2021/9.4.362.370

[17] Mafouo SV, Kana JR, Nguepi NK. Blood and gut micriobiota profiles of broiler chickens fed on diet supplemented with graded levels of Neem (Azadirachta indica) Oil, Animal and Veterinary Sciences. 2019, 7 (3), 78-82, doi: 10.11648/j.avs.20190703.12.

[18] Grau M, Cremer J M, Schmeichel S, Kunkel M, Bloch W. Comparisons of blood parameters, red blood cell deformability and circulating nitric oxide between males and females considering hormonal contraception: A longitudinal gender study, Frontiers in Physiology. 2018, 9 (1835), https://doi.org/10.3389/fphys.2018.01835

[19] Wiyabot T. Complete blood count and blood chemistry of Samae Dam chickens (Gallus Gallus) in small-holder farmers, Thailand, OnLine Journal of Biological Sciences. 2022, 22 (2), 223-229, DOI: 10.3844/ojbsci.2022.223.229.

[20] Tantiyavarong P, Traitanon O, Chuengsaman P, Patumanond J, Tasanarong A. Dialysate white blood cell change after initial antibiotic treatment represented the patterns of response in peritoneal dialysis-related peritonitis, International Journal of Nephrology. 2016, Article 6217135, 8 pages http://dx.doi.org/10.1155/2016/6217135

[21] Glenn A, Armstrong CE. Physiology of red and white blood cells, Anaesthesia and intensive care medicine. 2019, 20 (3), 170-174, DOI: S1472029919300013.

[22] Gakuya DW, Mbugua PN, Kavoi B, Kiama SG. Effect of supplementation of Moringa oleifera leaf meal in broiler chicken feed, International Journal of Poultry Science. 2014, 13 (4): 208-213.

[23] Tokofai MB, Idoh K, Oke EO, Agbonon A. Growth performance, haematological and biochemical parameters in broilers fed diets with varying levels of Vernonia amygdalina leaf meal, European Poultry Science. 2020, 84. 2020, DOI: 10.1399/eps.2020.321