FUDMA JOURNAL OF ANIMAL PRODUCTION AND ENVIRONMENTAL SCIENCE

(*FUDMAJAPES*)

Volume 1 issue 1 2025

Effect of Mahogany (*Khaya senegalensis*) Leaf Extract on Growth Performance, Carcass Characteristics and Nutrient Digestibility of Broiler Chickens in Semi-Arid Zone of Nigeria

[1]Yaduma, M., [1]Kwari, I.D., [1]Duwa, H., [2]Balami, S.I. and [1]Kaanti, A.M.

[1]Department of Animal Science, University of Maiduguri, P.M.B. 1069, Maiduguri, Borno State.

[2]Department of Animal Science, Borno State University, P.M.B. 1122, Maiduguri, Borno State.

Corresponding author: Balami, S.I. Email: simonbalami92@gmail.com , Tel: 07037870423

Keywords:
Khaya senegalensis, Broiler Chickens, Performance, Nutrient Digestibility, Carcass

ABSTRACT

A study was conducted using two hundred (200) day old broiler chickens to investigate the effect of Mahogany (Khaya senegalensis) leaf extract on the growth performance, carcass characteristics and nutrient digestibility of broiler chickens in Semi-Arid zone of Nigeria. The broiler chicks of mixed sexes were randomly allotted into five treatment groups of 40 birds each in a completely randomized design (CRD). The treatments were as follows: T1 = 0.00mil/L, T2 = 25mil/L, T3 = 50mil/L, T4 = 75mil/L and T5 = 100mil/L of mahogany leaf extract administered via drinking water on daily basis. Each treatment was replicated four times with 10 chicks per replicate. The following data were collected and analyzed; feed intake, weight gain, feed conversion ratio and weight of cutoff parts. Faecal samples were for digestibility and nutrient digestibility coefficient was calculated. At the end of the experiment, results showed significant (P<0.05) effect of Khaya senegalensis leaf extract on final weight with T1 (0 ml/L) and T4 (75 ml/L) having higher (P<0.05) values (2108.51 g/b and 20.78.44 g/b respectively) while T3 (50 ml/L) had higher (P<0.05) total feed intake that the other treatments. T4 and T5 had similar (P>0.05) feed conversion ratio which was better that the other treatments. Higher (P<0.05) average live weight, slaughter weight and dressed weight were recorded for birds fed 0, 25, 50 and 100ml/L compared with the birds fed 75ml/L KS leaves. In conclusion, Mahogany (Khaya senegalensis) leaf extract could be added up to 75ml/L without adverse effect on productive performance of broiler chickens in semi-arid zone of Nigeria.

Citation: Yaduma, M., Kwari, I.D., Duwa, H., Balami, S.I., & Kaanti, A.M. (2025). Effect of Mahogany (*Khaya senegalensis*) Leaf Extract on Growth Performance, Carcass Characteristics and Nutrient Digestibility of Broiler Chickens in Semi-Arid Zone of Nigeria. FUDMA Journal of Animal Production & Environmental Science, 1(1), 133-144. https://doi.org/10.33003/japes.2025.v1i1.133-144

INTRODUCTION

One of Nigeria's fastest-growing industries, the poultry sector has undergone a radical transformation in recent decades, moving from an unscientific farming method to a commercial production system (Angelakis *et al.*, 2013). In addition to being a rich source of protein and having rapid returns on investment, broiler chicken farming provides a source of revenue (Kekocha, 1994). All things considered, the most common livestock operation is still the production of chicken. In the majority of nations, it is a key component of sociocultural and economic advancements as well as gains in food security (Alders, 2005, Dieye *et al.*, 2010). Nonetheless, there are a number of obstacles that the developing country feed industry must overcome. These obstacles include a high feed to gain ratio and rising feed costs due to the high cost of feed ingredients (Abbas, 2013). One way that these obstacles have been addressed is by using feed additives.

The utilization of various contemporary growth-promoting strategies and appropriate disease control methods has been the primary cause of the chicken industry's tremendous rise (Angelakis *et al.*, 2013). Global demand for affordable, high-quality feed is always growing, which highlights how important it is to produce broilers profitably by employing the right growth promoters to maximize nutrient uptake (Huyghebaert *et al.*, 2011).

Several livestock farmers have gone out of business due to the high cost of conventional feedstuff, which has decreased the amount of

animal protein produced overall and its availability for human dietary needs. According to reports, 60–80% of the total cost of raising livestock in developing countries alone is related to feed supplies (Igboeli, 2000; Esonu, 2006). As a result, chicken farmers are increasingly looking for unusual feed ingredients, such as leaf, bark, and seed meals of ethnomedical plants, that may be less costly (Okoli *et al.*, 2001). It has been established that different plant extracts are used in the production of broilers (Essien *et al*., 2007; Nworgu *et al.*, 2007; Galib & Noor, 2010). Since ancient times, phytobiotics have been used as food preservatives, health-promoting ingredients, and to give food flavor and scent. In order to maximize the production potential of poultry birds, where the usage of natural phytogenic medicines is currently gaining popularity as feed additives in poultry rations (Hashemi and Davoodi, 2010; Khan *et al*., 2012).

Animal performance can be improved by medicinal plants, which include the entire plant as well as its leaves, flowers, bark, and extracts. Tree species *Khaya senegalensis* (KS) is a member of the Meliaceae family. It has many medical uses, such as antibacterial and antimalarial properties. In addition, it is well known that KS stem bark has anti-sickling (Fall *et al.*, 1999), antifungal (Abdelgaleil *et al.*, 2004), anthelmintic (Ademola *et al.*, 2004; Ndjonka *et al.*, 2011), anti-cancer (Androulakis *et al.*, 2006; Zhang *et al.*, 2009), antimicrobial (Sule *et al.*, 2008), antihyperglycemic (Kolawole *et al.*, 2012), and antiprotozoal (Ibrahim *et al.*, 2013) qualities in addition to scavenging free radicals. Moreover, the stem bark of KS has been shown to have hepatotoxic (Abubakar *et al*., 2010; Kolawole *et al*., 2011) as well as hepatoprotective (Ali *et al*., 2011) effects on rats (Sule *et al*., 2008). According to Awohouedji *et al*. (2013), KS leaves have 11% crude protein, 43% neutral detergent fibers, and 17% ash on a dry matter basis. As predicted, a number of active substances, including terpenoids, flavonoids, alkaloids, glycosides, steroids, calicedrin, saponins, and tannins, have been extracted from the KS bark and leaves (Makut *et al*., 2008). The bark and leaves of KS have also been found to contain certain limonoids (Nakatani *et al*., 2002; Yuan *et al*., 2013). Despite KS's demonstrated medicinal efficacy, nothing is known about the effects of the plant's leaves. If growth performance of broiler chickens exposed to different leaf extracts are promoted and tracked, Nigeria's poultry industry will have improved beyond its current state. For consumers, the high price and usage of traditional commercial multivitamins to promote growth has already resulted in more negative effects than positive ones.

Feed additives are substances given to chicken diets to boost health, reduce morbidity, and promote productivity (FAC, 1998). Due to their abundance in the natural environment and lack of residual effects, plant-based feed additives, also known as phytogenics, have recently been marketed as growth-promoting feed additives for broiler chickens (Ndelekwute *et al.*, 2015). This is due to the fact that enterocytes in the colon absorb the active elements of phytogenic feed additives, which the body then rapidly metabolizes (Kohlert *et al.*, 2000). Therefore, the study's goal was to ascertain how Mahogany (*Khaya senegalensis*) leaf extract affected the broiler chickens' growth performance, carcass features, and nutritional digestibility.

METHODOLOGY

Experimental Site

The study was conducted at the Livestock Teaching and Research Farm of the Department of Animal Science, University of Maiduguri, Borno State. Maiduguri is located at the Northeastern corner of Nigeria and situated between Latitudes of 11°15’ and 12° North and Longitudes 31° 05’ and 14° East and at an average altitude of 345m above sea level (Raji *et al*., 2010). The area falls within the semi-arid zone of West Africa which is characterized by short rainy season (3 to 4 months per annum) and a long dry season (8 to 9 months) (Aliyu, 2012).

Sourcing and Preparation of *Khaya senegalensis* (KS) Leaf Extract and Dosage

Fresh Mahogany (KS) leaves were collected within Maiduguri and its environs, and washed with clean water to remove any dirt. The leaves were mashed with mortar and pestle. It was then packed into a container. 100g of the mash was weighed into a container and two litres of clean water was added to it. The

extract was filtered to avoid residue and allowed to stand for 24hrs under laboratory condition and 2litres of the solution was served to the animals in each of the treatment. The solution was administered to the birds at graded levels of 0.00 (T_1), 25 mill/L (T_2), 50 mill/L (T_3), 75 mill/L (T_4) and 100 mill/L (T_5) via drinking water on daily basis.

Experimental Birds and Management

A total of two hundred (200) day old Marshal strain broiler chickens from Zartech hatchery were used for the experiment. The broiler chicks of mixed sexes were randomly allotted into five treatment groups of 40 birds each in a completely randomized design (CRD). The treatments were as follows: T1 = 0.00 ml/litre, T2 = 25.00 ml/litre, T3 = 50.00 ml/litre, T4 = 75.00 ml/litre and T5 = 100.00 ml/litre of KS leave extract. Each treatment was replicated four times with 10 chicks per replicate placed in a deep-litter pen of fresh wood shavings measuring 1.50m x 1.50m. All the groups were served water and feed *ad-libitum* with a formulated diet as presented in Table 1.

Data Collection

Feed intake: a set quantity of feed was given each morning, and the amount that was left over was measured the following day. Feed intake was defined as the difference between the feed that was provided and the feed that was left over. The following formula was used to determine the average feed intake.

$$Feed\ Intake\ (FI) = Daily\ feed\ served - Daily\ feed\ left\ over$$

Gain in body weight: This was computed using the body weight information. By deducting the body weight from the current week, the body weight gain was calculated.

$$\text{Body weight gain (g)} = \text{Present week weight (g)} - \text{Previous week weight (g)}$$

Feed Conversion Ratio (FCR): The ratio of feed intake to body weight gain (g) was used to calculate the FCR.

$$FCR = \frac{Average\ Feed\ Intake\ (g)}{Average\ Body\ weight\ Gain\ (g)}$$

Apparent Nutrients Digestibility: The entire collection process was applied. Between 56 and 64 days of age, the chickens' digestibility was assessed. It was carried out in specifically made metabolism cages with feeding and drinking troughs that were automated and separate. From each treatment, three birds per replication were chosen at random and sent to metabolism cages so that the apparent digestibility of the nutrients could be obtained. After allowing the birds to acclimate for three days, after which each chicken was given 160 g of feed. The faecal droppings from each treatment were bulked and used for proximate analysis after their entire droppings were collected for four days and oven dried at 68 ^{O}C. In the Animal Science Laboratory, the approximate composition of the feed and droppings was examined. The following formula was used to calculate the apparent nutrients' digestibility.

$$Digestibility\ Coefficient\ (\%) = \frac{(Nutrient\ in\ Feed\ x\ FI) - (\%\ Nutrient\ in\ Faeces\ x\ FO)\ x\ 100}{\%\ Nutrient\ in\ Feed\ x\ FI}$$

Aduku and Olukosi, 1990)

Data Analysis: All data collected were subjected to analysis of variance (ANOVA) using Statistical Analytical System (SAS) version 9.1 (SAS, 2002). Duncan Multiple Range Test (DMRT) was used to separate treatment means where significant differences exist at 5% level of probability (0.05 level of significance) (Duncan, 1995).

Table 1: Ingredients Composition and Calculated Analysis of Broiler Starter and Finisher Diets (%)

Ingredients	Starter	Finisher
Maize	54.00	58.00
Groundnut cake	20.00	5.00
Soybean meal	10.00	20.00
Wheat offal	7.50	8.50
Fish meal	5.00	4.00
Bone ash	2.00	2.50
Limestone	0.50	0.50
Min-vit premix*	0.40	0.40
Methionine	0.30	0.30
Lysine	0.10	0.10
Salt	0.20	0.20
TOTAL	100.00	100.00
Calculated Analysis (%)		
Crude protein	22.46	20.19
Crude fibre	3.69	3.97
Ash	2.58	3.06
Ether extract	5.11	4.23
Nitrogen free extract	66.16	68.57
Calcium	1.00	1.10
Phosphorus	0.44	0.50
ME (Kcal/kg)	2839.58	2955.18

2.5kg composition of broiler starter premix supplying the following: VitaminA=12000mg,VitaminD_3=300000mg,VitaminE=30000mg,Vitamin$K_3$2000mg,VitaminB_1=2000mg,VitaminB_2=1,600 mg,Niacin=8,000mg,Pantothenic=2,000mg,VitaminB_6=600,VitaminB_{12}=4mg,Folicacid=200mg,BiotinH_2=300mg,Choline+ Chloride=7,0000mg,Cobalt=80mg,Copper=1,200mg,Iodine=400mg,Iron=8000mg,Manganese=1,6000mg,Selenium=80mg, Zinc=1,2000mg. Antioxidant=500m

*composition of broiler finisher premix supplying the following per kg of feed: VitaminA=3,400IU,VitaminD_3=600IU,VitaminE=4,000IU,Vitamin$K_3$600mg,VitaminB_1=640mg,VitaminB_2=1,600mg,Niaci n=8,000mg,Pantothenic=2,000mg,VitaminB_6=600,VitaminB_{12}=4mg,Folicacid=200mg,BiotinH_2=300mg,Choline+Chloride= 7,0000mg,Cobalt=80mg,Copper=1,200mg,Iodine=400mg,Iron=8000mg,Manganese=1,6000mg,Selenium=80mg,Zinc=1,200 0mg and Antioxidant=500m

RESULTS AND DISCUSSION

Growth performance of broiler chickens fed diets containing *Khaya senegalensis* leaf extract

The growth performance of broiler chickens fed diets containing *Khaya senegalensis* leaf extract is presented in Table 2. There was no significant (P>0.05) effect of *Khaya senegalensis* leaf extract on initial weight of the birds which ranged from 547.15 g/b for birds fed 100 ml/L of *Khaya senegalensis leaf* extract to 586.15 g/b for birds fed 0 ml/L of the extract. Significant (P<0.05) effect of *Khaya senegalensis* leaf extract was recorded for final live-weight, total feed intake, daily feed intake, total weight gain, daily weight gain, feed conversion ratio, total water intake and daily water intake. Significantly (P<0.05) higher final live-weight (2108.51 g/b), total weight gain (1522.36 g/b) and daily weight gain (43.50 g/b/d) were recorded for birds fed 0ml/L *Khaya senegalensis* leaf extract which were similar with the birds fed 75ml/L *Khaya senegalensis* leaf extract (2078.44 g/b, 1494.62 g/b and 42.70 g/b/d respectively). There were however lower (P<0.05) final live-weight (1983.37 g/b), total weight gain (1408.22 g/b) and daily weight gain (40.24 g/b/d) obtained for birds fed 25ml/L *Khaya senegalensis* leaf extract compared to 0ml/L but similar with birds fed 50ml/L (1996.42 g/b, 1437.44 g/b and 41.07 g/b/d respectively) and 100ml/L (1986.78 g/b, 1439.63 g/b and 41.13 g/b/d respectively) *Khaya senegalensis* leaf extract. Higher (P<0.05) total feed intake (5088.60 g/b) and daily feed intake (145.39 g/b/d) were recorded for birds fed 0ml/L compared to those fed 25ml, 75ml and 100ml/l. Birds fed 75ml/L had total and daily feed intakes (4678.10 g/b and 133.66 g/b/d

respectively) similar to those of birds fed 25ml/L (4607.20 g/b and 131.63 g/b/d respectively). There were however lower (P<0.05) total feed intake (4483.40 g/b) and daily feed intake (128.10 g/b/d) for the birds fed 100ml/L *Khaya senegalensis* leaf extract compared the other treatments except for birds fed 25ml/L *Khaya senegalensis* leaf extract.

Feed conversion ratio (3.12) was better (P<0.05) for birds fed 75ml/L and 100ml/L *Khaya senegalensis* leaf extract compared to birds fed 0ml/L (3.36), 25ml/L (3.28) and 50ml/L (3.48) *Khaya senegalensis* leaf extract. There was poor feed conversion ratio (3.48) obtained for the birds fed 50ml/L *Khaya senegalensis* leaf extract although similar with birds fed 0ml/L *Khaya senegalensis* leaf extract. Higher (P<0.05) total water intake (14005.00 ml/b) and daily water intake (400.14 ml/b/d) were recorded for birds fed 0ml/L *Khaya senegalensis* leaf extract which was similar with birds fed 75ml/L (13764.70 ml/b and 393.28 ml/b/d), followed by birds fed 50ml/L (13571.50 ml/b and 387.76 ml/b/d) *Khaya senegalensis* leaf extract which was also similar with birds fed 75ml/L. This was followed by birds fed 25ml/L (13333.90 ml/b and 380.97 ml/b/d) *Khaya senegalensis* leaves extract which was also similar with birds fed 50ml/L. There were lower total water intake (13221.40 ml/b) and daily feed intake (377.75 ml/b/d) recorded for birds fed 100ml/L *Khaya senegalensis* leaf extract although, there were also similar with birds fed 25ml/L.

The final body weight of birds fed 0ml/L *Khaya senegalensis* leaf extract was 1.43% higher than that of birds fed 75ml/L *Khaya senegalensis* leaf extract while birds fed 75ml/L *Khaya senegalensis* leaves extract had 4.57% higher weight than the birds fed 25ml/L *Khaya senegalensis* leaf extract which had the least final body weight. Total weight gain of birds fed 0ml/L *Khaya senegalensis* leaf extract was 1.82% higher than that of the birds fed 75ml/L *Khaya senegalensis* leaf extract which has 5.78% higher gain than the birds fed 25ml/L *Khaya senegalensis* leaf extract. Birds fed 75ml/L *Khaya senegalensis* leaf extract had better feed conversion ratio because they consumed the least feed with higher weight gain compared to the control. This implies that *Khaya senegalensis* leaf extract improved the utilization of feeds. In line with this study, feed efficiency was improved in Japanese quail fed neem supplemented ration (Mahmud *et al.*, 2015). The improvement of feed efficiency by the use of mahogany leave extract might be due to the content of polyphenolic compounds which might have increased the activity of digestive enzymes, decreased pathogenic microorganisms and inhibits toxins present in feed (Younan *et al*., 2019). The increased growth performance resulting from improved feed efficiency could be due to antimicrobial and anti-protozoal properties of *Khaya senegalensis* leaf extract, which helped to reduce the microbial load of birds (Wanker *et al*., 2009; Abdel-Wareth *et al*., 2014; Mukta, 2022). The significantly (P<0.05) higher final body weight, total weight gain and daily weight gain recorded for birds fed 0ml/L *Khaya senegalensis* leaf extract which was similar with that of birds fed 75ml/L *Khaya senegalensis* leaf extract might be attributed to the active substances present in the leaf that can improve digestion and metabolism and possess bacterial and immune-stimulant activities (Ghazalah and Ali, 2008). The lower (P<0.05) values obtained for final body weight, total weight gain and daily weight gain for birds fed 25ml/L *Khaya senegalensis* leaf extract which was at similar to those fed 50ml/L and 100ml/L *Khaya senegalensis* leaf extract, respectively were slightly higher than the values reported by Beg *et al*. (2018) who fed neem Leaf (*Azadirachta indica*) meal as an alternative to antibiotic in broiler ration. Also, the final body weight and average daily weight gain values recorded in this study were lower than the values reported by Mukta (2022) who fed mahogany and chalta leaves as supplements.

Table 2: Growth Performance of Broiler Chickens Fed Diets Containing *Khaya senegalensis* Leaf Extract

Parameters	*Khaya senegalensis* leaves extract (ml/L)					SEM
	T1 (0ml/L)	T2 (25ml/L)	T3 (50ml/L)	T4 (75ml/L)	T5 (100ml/L)	
Initial Weight (g/b)	586.15	575.15	558.98	583.83	547.15	20.70^{NS}
Final Weight (g/b)	2108.51^{a}	1983.37^{b}	1996.42^{b}	2078.44^{a}	1986.78^{b}	22.95*
Total Feed Intake (g/b)	5088.60^{a}	4607.20^{bc}	4959.00^{a}	4678.10^{b}	4483.40^{c}	67.33*
Daily Feed Intake (g/b/d)	145.39^{a}	131.63^{bc}	141.69^{a}	133.66^{b}	128.10^{c}	1.92*
Weight Gain (g/b)	1522.36^{a}	1408.22^{b}	1437.44^{b}	1494.62^{a}	1439.63^{b}	21.12*
Daily Weight Gain (g/b/d)	43.50^{a}	40.24^{b}	41.07^{b}	42.70^{a}	41.13^{b}	0.60*
Feed Conversion Ratio	3.36^{bc}	3.28^{b}	3.48^{c}	3.13^{a}	3.12^{a}	0.06*
Total Water Intake (ml/b)	14005.00^{a}	13333.90^{cd}	13571.50^{bc}	13764.70^{ab}	13221.40^{d}	156.02*
Daily Water Intake (ml/b/d)	400.14^{a}	380.97^{cd}	387.76^{bc}	393.28^{ab}	377.75^{d}	4.46*
Mortality (%)	0.50	0.50	2.00	0.00	0.00	

^{abcd}Means with different superscript within row differed significantly (P<0.05), NS = Non significant, SEM = Standard error of mean

Carcass characteristics of broiler chickens fed diets containing Khaya senegalensis leaf extract

The carcass characteristics of broiler chickens fed diets containing *Khaya senegalensis* leaf extract is shown in Table 3. There were significant (P<0.05) effects of *Khaya senegalensis* leaf extract on all carcass characteristics studied. Higher (P<0.05) average live weight, slaughter weight and dressed weight were recorded for birds fed 0, 25, 50 and 100ml/L *Khaya senegalensis* leaf extract compared with the birds fed 75ml/L *Khaya senegalensis* leaf which had the lowest values. Higher (P<0.05) carcass weight (1590.80 g/b) was recorded for birds fed 0ml/L *Khaya senegalensis* leaf extract and lower (P<0.05) carcass weights (1378.30 g/b) were obtained for birds fed 25, 50 and 100 ml/L *Khaya senegalensis* leaf extract. The lowest carcass weight was obtained in birds fed 75ml/L *Khaya senegalensis* leaf extract. Major cuts expressed as percentage of dressed weight revealed that higher (P<0.05) head (3.03%) was obtained for birds fed 25ml/L *Khaya senegalensis* leaf extract which was similar with that of birds fed 75ml/L (2.94%) *Khaya senegalensis* leaf extract, followed by that of birds fed 50ml/L (2.88%) *Khaya senegalensis* leaf extract which was also similar with that of birds fed 75ml/L *Khaya senegalensis* leaf extract. The lowest (P<0.05) head (2.67%) was recorded for birds fed 0ml/L *Khaya senegalensis* leaf extract but similar to the values for birds fed 100ml/L (2.70%) *Khaya senegalensis* leaf extract. Higher (P<0.05) shank were recorded for birds fed 25, 50 and 75ml/L *Khaya senegalensis* leaf extract and lower (P<0.05) shank were obtained for birds fed 0 and 100ml/L *Khaya senegalensis* leaf extract. Thigh (12.58%) was highest (P<0.05) for birds fed 100ml/L *Khaya senegalensis* leaf extract although similar with that of birds fed 50ml/L (12.47%) *Khaya senegalensis* leaf extract, followed by that of birds fed 25ml/L (12.18%) *Khaya senegalensis* leaf extract which was also similar with that of birds fed 50ml/L *Khaya senegalensis* leaf extract, and the lowest (P<0.05) thigh (11.69%) was recorded for birds fed 75ml/L *Khaya senegalensis* leaf extract but also similar with that of birds fed 0ml/L (12.03%) *Khaya senegalensis* leaf extract. Higher (P<0.05) wing (8.29%) was recorded for birds fed 25ml/L *Khaya senegalensis* leaf extract although similar with the birds fed 0ml/L (8.09%) and 50ml/L (8.14%) *Khaya senegalensis* leaf extract. This was followed by that of birds fed 75ml/L (7.99%) *Khaya senegalensis* leaf extract which also is similar with that of birds fed 0ml/L and 50ml/L *Khaya senegalensis* leaf extract. The lowest (P<0.05) wing (7.45%) was obtained for birds fed 100ml/L *Khaya senegalensis* leaf extract. Back (9.91%) was highest (P<0.05) for birds fed 100ml/L *Khaya senegalensis* leaf extract while lower (P<0.05) back (9.03%) were recorded for birds fed 0, 25, 50 and 75ml/L *Khaya senegalensis* leaf extract. Highest (P<0.05) neck (6.78%) was obtained for birds fed 25ml/L *Khaya senegalensis* leaf extract, followed by that of birds fed 50ml/L

(6.40%) *Khaya senegalensis* leaf extract although similar with that of birds fed 0ml/L (6.25%) *Khaya senegalensis* leaf extract and the lowest (P<0.05) neck were recorded for birds fed 75 and 100ml/L *Khaya senegalensis* leaf extract but similar with that of birds fed 0ml/L *Khaya senegalensis* leaf extract. Breast (23.90%) was highest (P<0.05) for birds fed 0 and 75ml/L *Khaya senegalensis* leaf extract, followed by that of birds fed 25ml/L (22.84%) *Khaya senegalensis* leaf extract, and the lowest (P<0.05) breast were recorded for birds fed 50 and 100ml/L *Khaya senegalensis* leaf extract. Highest (P<0.05) drumstick (10.82%) was obtained for birds fed 0ml/L *Khaya senegalensis* leaf extract although similar with that of birds fed 25ml/L (10.57%) and 50ml/L (10.64%) *Khaya senegalensis* leaf extract, while lowest (P<0.05) drumstick were recorded for birds fed 75 and 100ml/L *Khaya senegalensis* leaf extract which were however at par with that of birds fed 25 and 50ml/L *Khaya senegalensis* leaf extract. Chest (7.54%) was highest (P<0.05) for birds fed 100ml/L *Khaya senegalensis* leaf extract although similar with that of birds fed 0ml/L (7.14%) *Khaya senegalensis* leaf extract which is also at par with that of birds fed 50ml/L (6.84%) and 75ml/L (6.85%) *Khaya senegalensis* leaf extract. The lowest (P<0.05) chest (6.43%) was obtained for birds fed 25ml/L *Khaya senegalensis* leaf extract but also similar with that of birds fed 50ml/L and 75ml/L *Khaya senegalensis* leaf extract. The results of internal organs expressed as percentage of live weight revealed that highest (P<0.05) gizzard (2.62%) was recorded for birds fed 50ml/L *Khaya senegalensis* leaf extract which was at par with that of birds fed 0ml/L (2.56%) *Khaya senegalensis* leaf extract, followed by that of birds fed 25ml/L (2.48%) which was similar with that of birds fed 100ml/L (2.45%) and 0ml/L *Khaya senegalensis* leaf extract. The lowest (P<0.05) gizzard (2.40%) was obtained for birds fed 75ml/L *Khaya senegalensis* leaf extract which was also at par with that of birds fed 25ml/L and 100ml/L *Khaya senegalensis* leaf extract. Highest (P<0.05) liver (1.67%) was recorded for birds fed 100ml/L *Khaya senegalensis* leaf extract which was similar with that of birds fed 25ml/L (1.60%) *Khaya senegalensis* leaf extract, followed by that of birds fed 50 and 75ml/L *Khaya senegalensis* leaf extract which were also similar while the lowest (P<0.05) liver (1.45%) was obtained for birds fed 0ml/L *Khaya senegalensis* leaf extract. Heart (0.49%) was highest (P<0.05) for birds fed 25ml/L *Khaya senegalensis* leaf extract while lower (P<0.05) heart was recorded for birds fed 0, 50, 75 and 100ml/L *Khaya senegalensis* leaf extract. For crop, highest (P<0.05) value (0.53%) was recorded for birds fed 100ml/L *Khaya senegalensis* leaf extract but similar with that of birds fed 25ml/L (0.49%) and 50ml/L (0.49%) *Khaya senegalensis* leaf extract, followed by that of birds fed 75ml/L (0.46%) *Khaya senegalensis* leaf extract which is also similar with that of birds fed 25ml/L and 50ml/L *Khaya senegalensis* leaf extract. The lowest (P<0.05) crop (0.42%) was obtained for birds fed 0ml/L *Khaya senegalensis* leaf extract which was also at par with that of birds fed 75ml/L *Khaya senegalensis* leaf extract. Caecum were highest (P<0.05) for birds fed 75 and 100ml/L *Khaya senegalensis* leaf extract, followed by that of birds fed 0ml/L (0.71%) *Khaya senegalensis* leaf extract, while the lowest (P<0.05) caecum (0.57%) were recorded for birds fed 25 and 50ml/L *Khaya senegalensis* leaf extract. Highest (P<0.05) abdominal fat were obtained for birds fed 100ml/L *Khaya senegalensis* leaf extract which was similar with that of birds fed 0ml/L (2.13%) *Khaya senegalensis* leaves extract, followed by that of birds fed 25ml/L (1.96%), while the lowest (P<0.05) abdominal fat were recorded for birds fed 50 and 75ml/L *Khaya senegalensis* leaf extract. Intestinal length (217.00cm) was highest (P<0.05) for birds fed 0 and 100ml/L *Khaya senegalensis* leaf extract which were similar with that of birds fed 50ml/L (210.00%) and 75ml/L (213.75cm) *Khaya senegalensis* leaf extract. The lowest (P<0.05) intestinal length (204.25cm) was recorded for birds fed 25ml/L *Khaya senegalensis* leaf extract which was similar with that of birds fed 50ml/L and 75ml/L *Khaya senegalensis* leaf extract, respectively.

The dressing percentages and major cuts obtained in this study were higher than the values reported by Adamu (2024). The thigh weight reported is lower than the 18.87 – 21.28% reported by Oluyemi and Robert (2000). The breast weight obtained in this research were slightly lower (26.32 to 27.13%) to values reported by Onu *et al.* (2011).

Gizzard weights reported were lower than the values (3.77 - 4.37%) reported by Oladunjoye and Ojebiyi, (2010). The variations observed in this study for all carcass parameters might be attributed to strain of the birds and environmental condition in which the birds were raised.

Table 3: Carcass Characteristics of Broiler Chickens Fed Diets Containing *Khaya senegalensis* Leaf Extract

	Khaya senegalensis leaves extract (ml/L)					
Parameters	T1 (0)	T2 (25)	T3 (50)	T4 (75)	T5 (100)	SEM
Live weight (g/b)	2094.80^{a}	2061.30^{a}	2098.30^{a}	1919.50^{b}	2134.00^{a}	39.67*
Slaughter weight (g/b)	2036.30^{a}	2003.50^{a}	2039.80^{a}	1866.50^{b}	2073.00^{a}	39.79*
Carcass weight (g/b)	1590.80^{a}	1512.50^{b}	1513.30^{b}	1387.30^{c}	1519.50^{b}	33.14*
Dressed weight (g/b)	1976.00^{a}	1937.30^{a}	1961.80^{a}	1797.50^{b}	1993.80^{a}	38.50*
Dressing %	94.34^{a}	93.89^{b}	93.49^{c}	93.63^{bc}	93.43^{c}	0.14*
Major cuts (% dressed weight)						
Head	2.67^{c}	3.03^{a}	2.88^{b}	2.94^{ab}	2.70^{c}	0.06*
Shank	4.05^{b}	4.39^{a}	4.56^{a}	4.37^{a}	4.13^{b}	0.12*
Thigh	12.03^{cd}	12.18^{bc}	12.47^{ab}	11.69^{d}	12.58^{a}	0.19*
Wing	8.09^{ab}	8.29^{a}	8.14^{ab}	7.99^{b}	7.45^{c}	0.10*
Back	9.27^{b}	9.03^{b}	9.16^{b}	9.30^{b}	9.91^{a}	0.22*
Neck	6.25^{bc}	6.78^{a}	6.40^{b}	5.98^{c}	5.99^{c}	0.16*
Breast	23.90^{a}	22.84^{b}	21.74^{c}	23.62^{a}	21.39^{c}	0.31*
Drumstick	10.82^{a}	10.57^{ab}	10.64^{ab}	10.45^{b}	10.37^{b}	0.17*
Chest	7.14^{ab}	6.43^{c}	6.84^{bc}	6.85^{bc}	7.54^{a}	0.24*
Organs (% of live weight)						
Gizzard	2.56^{ab}	2.48^{bc}	2.62^{a}	2.40^{c}	2.45^{bc}	0.06*
Liver	1.45^{c}	1.60^{ab}	1.53^{b}	1.54^{b}	1.67^{a}	0.04*
Heart	0.43^{b}	0.49^{a}	0.45^{b}	0.43^{b}	0.44^{b}	0.01*
Crop	0.42^{c}	0.49^{ab}	0.49^{ab}	0.46^{bc}	0.53^{a}	0.03*
Caecum	0.71^{b}	0.57^{c}	0.59^{c}	0.80^{a}	0.79^{a}	0.02*
Abdominal fat	2.13^{ab}	1.96^{b}	1.42^{c}	1.45^{c}	2.22^{a}	0.11*
Intestinal length (cm)	214.50^{a}	204.25^{b}	210.00^{ab}	213.75^{ab}	217.00^{a}	4.79*

^{abcd}Means with different superscript within row differed significantly (P<0.05), SEM = Standard error of mean

Apparent Nutrient Digestibility by broiler chickens fed diets containing Khaya senegalensis leaf extract

The apparent nutrient digestibility of broiler chickens fed diets containing *Khaya senegalensis* leaf extract is presented in Table 4. There was significant (P<0.05) effect of *Khaya senegalensis* leaf extract on dry matter, crude protein, crude fibre, ether extract and nitrogen free extract digestibility coefficients. Higher (P<0.05) dry matter digestibility (77.36%) was recorded for birds fed 0ml/L *Khaya senegalensis* leaf extract, followed by that of birds fed 75ml/L (76.32%) *Khaya senegalensis* leaf extract; and then followed by birds fed 25ml/L *Khaya senegalensis* leaf extract which was similar with birds fed 50ml/L *Khaya senegalensis* leaf extract. The lowest (P<0.05) dry matter (69.88%) digestibility was obtained from birds fed 100ml/L *Khaya senegalensis* leaf extract. Crude protein, crude fibre and nitrogen free extract digestibilities (79.89, 72.99 and 75.26 %) were higher (P<0.05) for birds fed 0ml/L *Khaya senegalensis* leaf extract, followed by that of birds fed 75ml/L (78.35, 70.06 and 73.01 %) *Khaya senegalensis* leaf extract and then followed by that of birds on 25ml/L *Khaya senegalensis* leaf extract which were similar with that of birds fed 50ml/L *Khaya senegalensis* leaf extract. The lowest (P<0.05) crude protein, crude fibre and nitrogen free extract digestibilities (76.00, 66.51 and 60.32 %) were recorded in birds served 100ml/L *Khaya senegalensis* leaf extract. Higher (P<0.05) ether extract digestibility (80.04%) was recorded in birds fed 0ml/L *Khaya senegalensis* leaf extract, followed by birds fed 75ml/L *Khaya senegalensis* leaf extract, and then followed birds fed 25ml/L *Khaya*

senegalensis leaf extract. The lowest (P<0.05) ether extract (73.05%) digestibility was obtained in birds fed 100ml/L *Khaya senegalensis* leaf extract which was similar with birds fed 50ml/L (73.91%) *Khaya senegalensis* leaf extract.

Dry matter and crude protein digestibilities of birds fed 0ml/L *Khaya senegalensis* leaf extract were 1.38% and 1.93% higher than that of birds fed 75ml/L *Khaya senegalensis* leaf extract which however had 8.44% and 3.00% higher dry matter and crude protein digestibility than birds fed 100ml/L *Khaya senegalensis* leaf extract. Similarly, crude fibre and ether extract digestibilities of birds fed 0ml/L *Khaya senegalensis* leaf extract were 4.01% and 5.07% higher than that of birds fed 75ml/L *Khaya senegalensis* leaf extract which were 2.00% and 6.87% higher than that of birds served 100ml/L *Khaya senegalensis* leaf extract.

The nitrogen free extract digestibility of birds served 0ml/L *Khaya senegalensis* leaf extract was 2.99% higher than birds served 75ml/L *Khaya senegalensis* leaf extract which also had 17.38% higher nitrogen free extract digestibility than the birds fed 100ml/L *Khaya senegalensis* leaf extract. The nutrient digestibilities of the diets were good since the values of the digestibility coefficients were above 60%. The higher nutrient digestibilities obtained may be due to the presence of phytochemicals which have pharmacological effect on the digestive system of the birds by increasing the activity of digestive enzymes, decreased pathogenic microorganisms and inhibits toxins present in the feed (Obikaonu, 2012; Younan *et al*., 2019).

Table 4: Apparent Nutrient Digestibility by Broiler Chickens Fed Diet Containing *Khaya senegalensis* Leaf Extract

	Khaya senegalensis leaves extract (ml/L)					
Parameters (%)	T1 (0)	T2 (25)	T3 (50)	T4 (75)	T5 (100)	SEM
Dry matter	77.36^{a}	70.60^{c}	70.34^{cd}	76.32^{b}	69.88^{d}	0.26*
Crude protein	79.89^{a}	77.19^{c}	77.09^{c}	78.35^{b}	76.00^{d}	0.23*
Crude fibre	72.99^{a}	68.01^{c}	68.45^{c}	70.06^{b}	66.51^{d}	0.42*
Ether extract	80.04^{a}	76.96^{c}	73.91^{d}	78.44^{b}	73.05^{d}	0.47*
Nitrogen free extract	75.26^{a}	66.38^{c}	65.83^{c}	73.01^{b}	60.32^{d}	0.32*

^{abcd}Means with different superscript within row differ significantly (P<0.05), NS = Non significant, SEM = Standard error of mean

CONCLUSION AND RECOMMENDATION

The result of this study showed that birds fed 0 ml/L and 75 ml/L of *Khaya senegalensis* leaf extract had better performance in terms of final weight and feed conversion ratio. However, chickens fed 50 ml/L of *Khaya senegalensis* had higher feed Intake. *Khaya senegalensis* leaf extract can be administered to broiler chickens at 75 ml/L without having any adverse effect. Similar study can be conducted to investigate the effect of the extract administered through the feed.

REFERENCES

Abbas, T. E. (2013). The use of *Moringa oleifera* in poultry diets. *Turkish Journal of Veterinary and Animal Science*: 492-496.

Abdelgaleil, S. A., Iwagawa, T., Doe, M., & Nakatani, M. (2004). Antifungal limonoids from the fruits of *Khaya senegalensis*. *Fitoterapia*, 75:566-572.

Abdel-Wareth, A. A. A., Hammad, S., & Ahmed, H. (2014). Effects of *Khaya senegalensis* leaves on performance, carcass traits, hemtological and biochemical parameters in rabbits. *EXCLI Journal.* 13: 502–512.

Abubakar, A. L., Malik, O. O., Bashar, Y. A. & Muffau, M. (2010). Growth Performance of Broiler finishers fed Garlic (*Allium salivium*) supplemented diets. *Proceedings 35th Conference of Nigeria Society for Animal Production.* 14th-17th March; 372-374.

Adamu, B. I. (2024). Performance, carcass and meat quality characteristics of broiler chickens fed diets containing *Moringa oleifera* leaf powder as substitute for synthetic lysine. PhD Thesis, Department

of Animal Production, Federal University of Technology, Minna. Pp. 1 – 123.

Ademola, I. O., Fagbemi, B. O. & Idowu, S.O. (2004). Evaluation of the anthelmintic activity of *Khaya senegalensis* extract against gastrointestinal nematodes of sheep: *in vitro* and *in vivo* studies. *Veterinary Parasitology* 122:151-164.

Aduku, A. O. & Olukosi, J. O. (1990). *Rabbit Management in the Tropics*, Living Faith Books Publishers, Abuja, FCT, pp. 1- 42.

Alders, R. G. (2005). Improving rural livelihood through sustainable Newcastle Disease Control in village chickens: priorities for intervention. *The Proceedings of the Institutions for Tropical Veterinary Medicine 10th International Conference* on "Livestock, Community and Environment" 20-23rd August 2005, *Pp*. 199-205, Copenhagen, Denmark. 195.

Ali, S. A. M., Elbadwi, S. M. A., Idris, T. M. & Osman, K.M. (2011). Hepatoprotective activity of aqueous extract of *Khaya senegalensis* bark in rats. *Journal of Medical Plants Research*, 5: 5863-5866.

Aliyu, J. (2012). Productivity Assessment of Four Strains of Indigenous Chicken in a Semi-Arid Region of North-Eastern Nigeria. *Ph.D. Thesis*, Department of Animal Science, University of Maiduguri, Maiduguri, Nigeria.

Androulakis, X. M., Muga, S. J, Chen, F., Koita, Y., Toure, B., & Wargovich, M. J. (2006). Chemopreventive effects of *Khaya senegalensis* bark extract on human colorectal cancer. *Anticancer Research* 26:2397-2405.

Angelakis, E., Merhej, V., & Raoult, D. (2013). Related actions of probiotics and antibiotics on gut microbiota and weight modification. *The Lancet Infectious Diseases,* 13(10): 889-899.

Awohouedjia, D. Y. G., Babatoundec, S., Adounkpeb, J. G., Houinato, M. & Hounzangbe-Adote, S. (2013). Supplementing *Panicum maximum* with two medicinal forages in the diet of Djallonke sheep at the Benin national sheep center. *Journal of Animal Science,* 2:285-295.

Beg, M.A.H., Rubel, M.Z.U., Aftabuzzaman, M., Nahid, M.T.A. and Begum, M. (2018). Efficacy of neem leaf (*Azadirachta indica*) meal as an alternative to antibiotic in broiler ration. *Asian Journal of Research in Animal and Veterinary Sciences*, 2(4): 1-10. DOI: 10.9734/AJRAVS/2018/v2i430029

Dieye, P. N, Missohou, N. A., & Faye, A. (2010). L'aviculture familiale: Un levier pouraméliorer les revenus des éleveurspauvres au Sud du Sénégal. In: Faye B, Duteurtre, G., editors. L'élevage, richesse des pauvres. Paris: Editions Quae; Pp.191-201.

Duncan, D. B. (1955). New Multiple Range Tests. *Biometrics*, 11:1.

Esonu, B. O., Opara, M. N., Okoli, I. C., Obikaonu, H. O., Udedibie, C. & Iheshiulor, O. O. M. (2006). Physiological Response of Laying Birds to Neem (*Azadirachta indica*) Leaf Meal-Based Diets: Body Weight, Organ Characteristics and Haematology. *Online Journal of Health and Allied Sciences*, 2:4. www.ojhas.org/issue 18/2006-2-4.htm

Essien, J. P., Ebong, G. A., & Akpan, E. J. (2007). Antioxidant and Antitussive Properties of *Gongronemalatifolium*. *Journal of Appl. Science Environment Management* 11(4): 47-50.

FAC (1998). Feed Additive Compendium. Miler Publishing Company, USA, 56p.

Fall, A. B., Vanhaelen-Fastré, R., Vanhaelen, M., Lo, I., Toppet, M., & Ferster, A. (1999). In vitro antisickling activity of a rearranged limonoid isolated from *Khaya senegalensis*. *Planta Med,* 65:209-212.

Galib, A. M. A., & Noor, M.W. (2010). A comparative study on diet supplementation with a mixture of herbal plants and dandelion as a source of prebiotics on the performance of Broilers. *Pakistan Journal of Nutrition*, 9(1)

Ghazalah, A. A. & Ali, A.M. (2008) Rosemary leaves as a dietary supplement for growth in broiler chickens. *International Journal of Poultry Science*, 7(3):234-239.

Hashemi, S. R. & Davoodi, H. (2010). Phytogenics as New Class of Feed Additive in Poultry Industry. *Journal of Animal and Veterinary Advances.* 9: 2295–2304.

Huyghebaert, G., Ducatelle, R., & Immerseel, F. V. (2011). An update on alternatives to antimicrobial growth promoters for

broilers. *Veterinary Journal*, 187(2): 182 – 188.

Ibrahim, M. A., Musa, A. M., Aliyu, A. B., Mayaki, H. S., Gideon, A., & Islam, M. S. (2013). Phenolics-rich fraction of *Khaya senegalensis* stem bark: antitrypanosomal activity and amelioration of some parasite-induced pathological changes. *Pharmaceutical Biology*, 51:906-913.

Igboeli, G. (2000). Animal production and Agricultural in the new millennium. *Nigerian Society for Animal Production.* 26; 1- 3.

Kekocha, C. C. (1994). Poultry production handbook. London: Macmillan.

Khan, R. U., Naz, S., Nikousefat, Z., Tufarelli, V., Javdani, M., Qureshi, M. S. N. & Laudadio, V. (2012). Potential applications of ginger (*Zingiber officinale*) in poultry diets. *World's Poultry Science Journal*, 68(2): 245-252.

Kohlert, C., Van-Rensen, I., März, R., Schindler, G., Graefe, E. U., & Veit, M. (2000). Bioavailability and pharmacokinetics of natural volatile terpenes in animals and humans. *Planta Médica*. 66:495-505.

Kolawole, O. T., Kolawole, S. O., Ayankunle, A. A., & Olaniran, O. I. (2012). Anti-hyperglycemic effect of *Khaya senegalensis* stem bark aqueous extract in Wistar Rats. *European Journal of Medicinal Plants,* 2:66-73.

Kolawole, S. O., Kolawole, O. T., & Akanji, M. A. (2011). Effects of aqueous extract of *Khaya senegalensis* stem bark on biochemical and hematological parameters in rats. *Journal of Pharmaceutical Toxicology,* 6:602-7.

Mahmud, M., Peter, S., James, G., & Wosilat, A. (2015). Growth performance of growing quails (*Coturnix japonica*) fed graded levels of Neem. *International Journal of Applied Research*, 1: 4 – 7.

Makut, M. D., Gyar, S. D., Pennap, G. R. I., & Anthony, P. (2008). Phytochemical screening and antimicrobial activity of the ethanolic and methanolic extracts of the leaf and bark of *Khaya senegalensis*. *African Journal of Biotechnology*, 7: 1216-9.

Mukta, N. S. (2022). Evaluation of growth performance, carcass characteristics and serum biochemical parameters of broiler by supplementation of Mahogany and Chalta leaves. MSc. Animal Science, Department of Animal Science and Nutrition, Faculty of Veterinary Medicine. Chattogram Veterinary and Animal Sciences University Khulshi, Chattogram-4225, Bangladesh. Pp. 1-44.

Nakatani, M., Abdelgaleil, S. A., Kassem, S. M., Takezaki, K., Okamura, H., & Iwagawa T. (2002). Three new modified limonoids from *Khaya senegalensis*. *Journal of Natural Products,* 65:1219-1221.

Ndelekwute, E. K., Enyenihi, G. E., Assam, E. D., Ufot, U., & Out, O. (2015). Lime (*Citrusaurantifolia*) juice a natural source of organic acids can improve the growth of broiler chickens. Advances in Animal Biosciences, Science with Impact. *Proceedings of the British Society of Animal Science*, 14-15 April, 2015, Chester, U.K. 220p.

Ndjonka, D., Agyare, C., Lüersen, K., Djafsia, B., Achukwi, D., & Nukenine, E. N. (2011). In vitro activity of Cameroonian and Ghanaian medicinal plants on parasitic (*Onchocerca ochengi*) and free-living (*Caenorhabditis elegans*) nematodes. *Journal of Helminthology,* 2011; 85:304-12.

Nworgu, F. C., Ogungbenro, S. A., & Solesi, K. S. (2007). Performance and some blood chemistry indices of broiler chicken served fluted pumpkin (*Telefaria occidentalis*) leaves extract supplement. *American-Eurasian Journal of Agriculture & Environmental sciences*, 2(1):90-99.

Obikaonu, H. (2012). Evaluation of the nutritional value of Neem (*Azadirachta indica*) leaf meal on the performance of finisher broilers. 15: 1235–1239.

Okoli, I. C., Ebere, C. S., Emenalom, O. O., Uchegbu, M. C., & Esonu, B. O. (2001). Indigenous Livestock production paradigms revisited. III: An assessment of the proximate values of most preferred indigenous browses of South Eastern Nigeria. *Tropical Animal Production Investment*, 4:99-107.

Oladunjoye, I. O., & Ojebiyi,O. O. (2010). Performance characteristics of broiler chicken (*Gallus gallus*) fed rice (*Oryza*

sativa) bran with or without Roxazyme G2G. *International Journal of Animal and Veterinary Advances* 2:135-140.

Oluyemi, J.A. and Robert, F.A. (2000). Poultry production in warm wet climate Revised Edition. Macmillian press London.

Onu, P. N., Otuma, M. O., Odukwe, C. A., & Aniebo, A. O. (2011). Effects of Different levels of Bovine blood / rumen content mixture on productive performance, carcass characteristics and economics of production of finisher broilers. I*nternational Journal of food, Agriculture and Veterinary science* 1(1):10-16.

Raji, A.O., Igwebuike, J.U., & Kwari, I.D. (2010). Regression models for estimating breast, thigh and fat weight and yield of broilers from non-invasive body measurements. *Agriculture Biology Journal of North American,* 1(4): 15-22

Sule, M. S., Abdulraheem, R. B. & Aminu, B.M. (2008). Potency of aqueous stem bark extract of *Khaya senegalensis* against liver diseases in rats. *Bayero Journal of Pure and Applied Sciences,* 1:29-31.

SAS. (2002). Statistical Analysis System, Computer Software Version 9.1: Statistical SAS Institute Inc. Cary, Northern Carolina 27513, USA.

Wanker, A., Shirbhate, R. N., Bahiram, K. B., Dhenge, S. A., & Jasutkar, R. A. (2009). Effect of Neem (*Azadirachta indica*) leaf powder supplementation on growth in broilers. 2(10): 396–397.

Younan, G., Mohamed, M., & Morsy, W. (2019). Effect of dietary supplementation of olive leaf extract on productive performance, blood parameters and carcass traits of growing rabbits. *Egyptian Journal of Nutrition and Feeds*, 22:173–182.

Yuan, C. M., Zhang, Y., Tang, G. H., Di, Y. T., Cao, M. M., & Wang, X. Y. (2013). Khayseneganins A-H, limonoids from *Khaya senegalensis*. *Journal of Natural Products,* 76:327-33.

Zhang, H., Tan, J., Vanderveer, D., Wang, X., Wargovich, M. J., & Chen, F. (2009). Khayanolides from African mahogany *Khaya senegalensis* (Meliaceae): *A revision. Phytochemistry*, 70:294-9.