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Effect of Concentrate to Fresh *Gmelina arborea* Leaf Combinations on Haematological and Serum Biochemical Parameters of Rabbit Bucks

Terzungwe Ahemen[1*], Onyilokwu Pius[1] and Philip A. Addass[1]

[1]Department of Animal Breeding and Physiology, University of Agriculture, Makurdi, Nigeria.

Authors' contributions

This work was carried out in collaboration among the three authors. Author TA designed the work wrote the protocol and the first draft of the Manuscript. Author OP managed the literature searches and the analyses of the study. Author PAA performed the statistical analysis. All authors read and approved the final manuscript.

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ABSTRACT

This study aimed to investigate the effects of concentrate on fresh *Gmelina arborea* leaf (FGAL) combinations on haematological and serum biochemical parameters of rabbit bucks. Twenty four (24) rabbit bucks of mixed breeds (New Zealand white x Chinchilla) with the average live weight of 852 g, aged between 12 and 14 weeks were subjected to a feeding trial for 14 weeks. The rabbits were randomly allocated into four treatments (each treatment contained 6 rabbits): Treatment 1 (100% concentrate: 0% FGAL), Treatment 2 (75% concentrate: 25% FGAL), Treatment 3 (50% concentrate: 50% FGAL), Treatment 4 (25% concentrate: 75% FGAL). The results obtained in this study showed that packed cell volume (PCV), white blood cell (WBC), haemoglobin (Hb), mean corpuscular haemoglobin concentration (MCHC) and white blood cell differentials were not significantly affected by the dietary treatments. Red blood cell (RBC), mean corpuscular volume (MCV) and mean concentration haemoglobin (MCH) differed significantly ($P<0.05$) among treatments. Serum globulin, urea, creatinine and cholesterol were significantly ($P<0.05$) influenced

**Corresponding author: E-mail: drtahemen@gmail.com;*

by the dietary treatments, while total protein, albumin and glucose were not affected. The results revealed that fresh *Gmelina arborea* leaf in combination with concentrate had no adverse effects on haematological and serum biochemical parameters of rabbit bucks.

Keywords: Gmelina arborea leaf; concentrate; rabbit bucks; haematological; biochemical parameters.

1. INTRODUCTION

Low protein intake can lead to diseases like mental retardation and kwashiorkor. Nigerians are constantly faced with the problem of low animal protein intake which has an influence on the general well-being and health of the ever-increasing population [1]. According to FAO [2] livestock production is increasing at the rate below 5% while the human population is increasing at the rate above 10%. Nigeria as one of the developing nations with a high population is not an exception to this global phenomenon. In African countries, [3] estimated the average animal protein consumption in Nigeria to be 7.4 g per capita/day as compared to 38 g per capita/day of animal protein consumed in South Africa. Inadequate supply of proteins from such traditional livestock as cattle, goat, sheep, pig and poultry has led to a shift of emphasis towards enhanced Productivity of these animals. As a contingency plan, the search for the more economical source of animal proteins makes rabbit production attractive [4].

Rabbits have some attributes such as short generation interval, high fecundity, rapid growth rate, genetic diversity, ability to utilise forages, high-quality proteins, low-cost management requirements, and adaptation over a wide range of ecological environment which enhance its production [5]. Ojebiyi et al. [6] reported that the rabbit has peculiar digestive physiology which permits the use of forages and agro-industrial by-products, thus making it non-competitive species with a man for cereals and legume grains. These qualities of the species, besides more others, make rabbits breeding one of the solutions for protein deficiency countries [7,8].

In spite of these advantages over other livestock, feed cost and scarcity still limit profitable rabbit production in the country. Aduku [9] reported that the cost of feed accounts for about 80% of the total cost of production of farm animals. This is because unavailability of grains and the high cost of feed ingredients have made the price of animal feed to increase. This constitutes problems in the expansion of commercial rabbit production in Nigeria. The scarcity and high prices of feedstuffs have led animal nutritionists and researchers to look for an alternative, unconventional, and cheap sources of feeding materials [10,11].

Studies have shown that rabbits can thrive on some tropical forages supplemented with concentrates [12,13]. Such forages are cheap, abundant and available in many parts of Nigeria [14]. One of such forages is *Gmelina arborea*. *Gmelina arborea* is commonly found in many parts of Nigeria. It is under-utilised by man, which may help to reduce the cost of production and establish a sustainable livestock development in Nigeria, especially in areas with a prolonged dry season [5].

Gmelina arborea is a medium-sized tree up to 30-40 m tall; bole with average diameter 50cm but sometimes reaching 140 cm. The leaves contain nutrients that can support both ruminant and non-ruminant nutrition. Annongu and Folorunso recorded [15] that *Gmelina arborea* fruit meal when processed and at 30% dietary inclusion in pig's ration has no adverse effects on haematology and serum biochemical analysis of the animals.

Gmelina arborea leaf has not been exploited adequately as forage for rabbits. Unfortunately, there is inadequate information on the nutritional effects of *Gmelina arborea* leaf on blood chemistry. Opara et al. [16] stated that as the quest for unconventional and cheap sources of feedstuffs for livestock continues, it becomes imperative to always investigate the health and physiological implications of such materials on the animals. Therefore, this study was designed to investigate the effect of concentrate to fresh *Gmelina arborea* leaf (FGAL) combinations on haematology and serum biochemistry.

2. MATERIALS AND METHODS

2.1 Experimental Site

The experiment was carried out at the Rabbitry unit of Livestock Teaching and Research Farm, Federal University of Agriculture, Makurdi, Nigeria. Makurdi is located on latitude 7° 14

North and longitude 8° 21 East, which lies within the Southern Guinea Savannah region of Nigeria. The daily temperature ranges between 24 to 36°C, and high temperature is experienced between late February and April. Annual rainfall ranges from 508 to 1016 mm [17].

2.2 Source of *Gmelina arborea* Leaves

The fresh *Gmelina arborea* leaves were collected from Gmelina trees within Makurdi Local Government Area of Benue State. The leaves were identified and authenticated by Dr. Emmnuel E. Tembe of the Department of Forest Production, Federal University of Agriculture Makurdi. A voucher specimen (L-05) of the leaf is deposited in the Department for future reference. The fresh *Gmelina arborea* leaves were slightly chopped for easy handling and consumption by the rabbits. Fig. 1 presents *Gmelina arborea* Leaves.

2.3 Feed Ingredients

The Concentrate diet made up of maize, soybean meal, rice offal, bone meal, vitamin premix, salt and methionine. The ingredients and nutrients composition of the concentrate diet is shown in Table 1.

2.4 Experimental Diets

Four dietary treatments consisting of concentrate to fresh *Gmelina arborea* were weighed and fed to the rabbit bucks in the following ratios: T_1 (100: 00), T_2 (75: 25), T_3 (50: 50), T_4 (25: 75). That means:

Treatment 1 (T_1) – concentrate only at 100 g/rabbit/day (Control diet)

Treatment 2 (T_2) – concentrate at 75 g /rabbit /day +25 g of fresh *Gmelina arborea* leaf

Treatment 3 (T_3) – concentrate at 50 g /rabbit /day + 50 g of fresh *Gmelina arborea* leaf.

Treatment 4 (T_4) – concentrate at 25 g /rabbit /day + 75 g of fresh *Gmelina arborea* leaf.

Table 1. Ingredient composition of the concentrate diet

Ingredients	Percentages (%)
Maize	43.70
Soybean meal	29.30
Rice offal	23.00
Bone meal	3.00
Vitamin premix	0.50
Salt	0.30
Methionine	0.20
Total	100.00
Calculated nutrients composition	
Crude protein (%)	18.20
Crude fibre (%)	10.68
Ether extract (%)	4.85
Calcium (%)	1.19
Lysine (%)	0.94
Phosphorus (%)	0.55
Methionine (%)	0.48
Metabolizable energy (Kcal/kg)	2,512.21
Proximate nutrients composition	
Crude Protein (%)	20.03
Crude fibre (%)	10.73
Ether Extract (%)	4.23
Ash (%)	9.01
NFE (%)	56.00
Metabolizable energy (Kcal/kg)	3075.12

Fig. 1. *Gmelina arborea* leaves

2.5 Experimental Animals and Design

A total of 24 rabbit bucks of mixed breeds (New Zealand white x Chinchilla) with an average live weight of 852 g, aged 12 to 14 weeks were obtained from local farmers around Makurdi and Gboko area of Benue State. The rabbits were housed individually in hutches (wire mesh cages) measuring 60 cm x 50 cm and raised 60 cm above the ground level in an open-sided shade for proper ventilation. The hutches were cleaned and disinfected a few days before the arrival of the rabbits. A drinker and feeder were fitted in each hutch to curtail water and feed wastage. The rabbits were acclimatised for two weeks before the commencement of the experiment during which they were treated for both ecto and endo-parasites using ivermectin (0.2 mg /kg body weight).

2.6 Experimental Procedure

After a 2-week adjustment period, the 24 rabbit bucks were weighed and randomly assigned to 4 dietary treatments with the ratios of concentrate to fresh *Gmelina arborea* leaf combinations respectively. The feeds were weighed according to the ratios in grams (g) and administered to the animals daily after cleaning of the hutches, feeders and washing of drinkers. Water was supplied *ad-libitum*. Weight gain was determined on a weekly basis. At the end of 14^{th} week of the feeding trial, three rabbits from each treatment were randomly selected for determination of haematological and serum biochemical parameters.

2.7 Haematological Indices

Three (3) ml of blood samples were collected from the jugular vein into clean sterile laboratory sample bottles treated with anticoagulant-ethylene diamine tetra-acetic acid (EDTA) for haematological analysis. The parameters that were determined were: packed cell volume (PCV), haemoglobin (Hb), red blood cell (RBC), white blood cell (WBC), neutrophils, eosinophils, basophils, lymphocytes and monocytes. All haematological characteristics were determined by conventional laboratory methods [18].

2.8 Serum Biochemical Indices

During blood collection, a set of EDTA free blood sample bottles were used to collect 3 ml each of blood samples for biochemical study. The parameters determined were: total protein, globulin, albumin, urea, creatinine, glucose and cholesterol. These parameters were determined using standard methods as described by [19].

2.9 Statistical Analysis

Data collected were subjected to One Way Analysis of Variance (ANOVA) using Minitab Statistical Software [20]. Where significant differences occurred among treatment means, they were separated using Duncan's Multiple Range Test [21].

3. RESULTS AND DISCUSSION

Haematological indices of rabbit bucks fed concentrate to fresh *Gmelina arborea* leaf combinations are presented in Table 2. The results showed no significant effects among treatments on packed cell volume (PCV), white blood cells (WBC), haemoglobin (Hb) and mean corpuscular haemoglobin concentration (MCHC).

The values recorded for packed cell volume across treatment groups in this study were within the normal range of 25-45% reported by [22] for clinically healthy rabbits. This implies that the animals were healthy. Significant ($P<0.05$) decrease was observed for red blood cells (RBC) in treatment four as compared to treatment 3. This may be associated with inadequate feed intake. However, the RBC values obtained in this study were within the normal range of 3.7-7.5 x 10^6/ml and 4.0-8.0 x 10^6/ml as reported by [22] and [23]. Aletor [24] reported that blood variables are most consistently affected by dietary influence including RBC, PCV and plasma proteins. Bitto and Gemade [25] reported that an increase in RBC value is associated with high dietary protein, disease-free animals and function as an oxygen carrier. Jiwuba et al. [26] observed that *Gmelina arborea* could stimulate erythropoiesis and influence metabolism when weaner rabbits were fed varying levels of dried *Gmelina arborea* leaf meal. The increase in RBC level up to treatment 3 suggests that the dietary treatment is capable of increasing protein level in rabbit bucks. It could also mean that the dietary treatment may support erythropoiesis, the better oxygen carrying capacity and feed utilisation up to treatment 3. Similarities exist in haemoglobin (Hb) concentrations among the dietary treatments, agree with the report of Adeyemo et al. [27] who observed similarities in Hb concentrations when growing rabbit was fed concentrate to forage at different ratios.

Table 2. Haematological parameters of rabbit bucks fed concentrate to fresh *Gmelina arborea* leaf combinations

Parameters	T1	T2	T3	T4	P-values
Packed cell volume (%)	33.00±3.00	32.67±3.67	30.67±6.36	32.33±0.882	0.98
Red blood cell (x 10^{12} /L)	4.73±0.07^{ab}	4.83±0.23^{ab}	5.03±0.49^{a}	3.97±0.18^{b}	0.02
Haemoglobin (g/dl)	11.00±1.00	10.90±1.20	10.23±2.11	10.77±0.29	0.98
MCV (fl)	69.87±7.37^{ab}	67.20±4.10^{ab}	59.60±6.82^{b}	80.03±4.92^{a}	0.04
MCH (pg)	23.30±2.50^{ab}	22.43±1.33^{ab}	19.80±2.34^{b}	27.23±1.67^{a}	0.02
MCHC (g/dl)	33.37±0.03	33.17±0.33	33.37±0.07	33.30±0.06	0.83
White blood cell (x 10^{9}/L)	4.53±1.53	3.60±0.20	4.40±0.76	2.67±0.39	0.45
Differential White	blood Cell	count (%)			
Lymphocytes	60.00±3.00	61.33±1.67	56.00±1.73	62.67±3.28	0.34
Neutrophils	31.33±0.67	31.00±1.00	34.67±0.88	31.33±1.76	0.16
Eosinophils	3.33±0.33	3.00±1.00	3.33±0.67	2.33±1.20	0.83
Basophils	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00
Monocytes	4.67±2.67	4.00±2.00	4.33±1.20	3.67±1.20	0.98

$^{a, b,}$ = means with different superscripts are significantly different (P<0.05); ± Standard Error of Mean; Mean Corpuscular Volume; MCH = Mean Corpuscular Haemoglobin; MCHC = Mean Corpuscular Haemoglobin Concentration

T1= Diet containing 100 g concentrate
T2= Diet containing 75 g concentrate + 25 g fresh Gmelina arborea leaf
T3= Diet containing 50 g concentrate + 50 g fresh Gmelina arborea leaf

Differences were observed for mean corpuscular volume (MCV) and mean corpuscular haemoglobin (MCH), while mean corpuscular volume concentrations (MCHC) were similar among the treatments. Njidda et al. [28] revealed that MCV, MCH and MCHC are used in diagnosing anaemic conditions. However, MCHC has been reported to be the most accurate value that indicates anaemic condition [29]. Values obtained for MCV, MCH and MCHC, across treatment groups were within the normal range of 58 to 79.6; 19.2 to 29.5 and 31.1 to 37.0 respectively, as reported by Ahemen et al. [30]. Ahemen et al. [30] reported that when the red blood cell indices values fall within the normal range for rabbits, it implies that the diets did not have negative effects on red blood cell indices during the feeding trial, but when the values fall below the normal range, it is an indication of anaemia. The results, therefore, showed that the animals were not anaemic, and it also suggests that concentrate to FGAL combination may have no deleterious effect on haematological indices of the rabbit bucks.

The white blood cells (WBC) showed similar values across the treatments. Ahemen et al. [31] reported non-significant effect treatment on WBC when rabbits were fed water spinach (*Ipomoea aquatic*) leaf meal. It indicates that *G. arborea* leaf may enhance the immune system of rabbit bucks. The significant decrease observed in treatment 4 may be due to low feed intake. Leucocytes differentials of rabbit bucks fed concentrate to FGAL at different ratios also showed similarities between treatments in the absence of basophils. Opara et al. [16] reported significant (P<0.05) differences in neutrophils and lymphocytes in addition to the absence of basophils when aqueous extracts of *G. arborea* leaves was fed to rabbits. The result on leucocytes differential obtained in study agrees with that of [32] who reported similarities in all the leucocytes differentials on rabbits fed *Moringa oleifera* leaf meal. The presence of monocytes in the blood of rabbit bucks in this experiment contradicts the work of [22] who recorded the absence monocytes in rabbits fed pawpaw peal meal but agrees with the report of [33] who recorded monocytes when rabbits were fed cassava leaf meal. Studies have shown that blood is often considered as life in animals and it is an important index of physiological, pathological and nutritional status in the organism [34,35]. Therefore, the results obtained in this study on haematological parameters may suggest a normal physiology of the rabbit bucks fed FGAL in combination with concentrate. It could also mean an adequate immune system of the rabbit bucks.

The results obtained from the serum biochemical analysis of rabbit bucks fed concentrate to fresh *Gmelina arborea* leaf combinations are presented in Table 3.

Table 3. Serum biochemistry of rabbit bucks fed concentrate to fresh *Gmelina arborea* leaf combinations

Parameters	T1	T2	T3	T4	P-value
T. Proteins (g/dL)	4.37±00.3	4.63±0.27	4.30±0.10	4.30±0.00	0.36
Albumin (g/dL)	1.43±0.07	1.27±0.06	1.23±0.98	1.53±0.07	0.56
Globulins (g/dL)	2.93±0.03^{b}	3.37±0.23^{a}	3.07±0.07^{ab}	2.77±0.07^{b}	0.04
Urea (mg/dl)	41.87±5.47^{bc}	34.60±0.90^{c}	59.53±3.37^{a}	51.07±7.33^{ab}	0.03
Creatinine (mg/dl)	1.47±0.07^{a}	0.43±0.07^{b}	0.90±0.40^{ab}	0.50±0.10^{b}	0.03
Glucose (mg/dl)	49.37±0.17	49.00±0.90	46.53±4.63	43.03±0.87	0.29
Cholesterol (mg/dl)	118.10±7.40^{a}	98.73±3.93^{ab}	99.40±3.00^{ab}	93.20±3.00^{b}	0.03

$^{a, b, c}$ = means with different superscripts are significantly different (P<0.05); ± Standard Error of Mean
T1= Diet containing 100 concentrate,
T2= Diet containing 75 concentrate + 25 fresh Gmelina arborea leaf
T3= Diet containing 50 concentrate + 50 fresh Gmelina arborea leaf,
T4= Diet containing 25 concentrate + 75 fresh Gmelina arborea leaf

The results showed no significant difference in total proteins, albumin and glucose. Significant (P<0.05) effects were observed on globulins, urea, creatinine and cholesterol, on the serum biochemical parameters of the rabbit bucks. Serum biochemical analysis is carried out to determine the extent of heart attack, liver damage, kidney damage, evaluation of blood protein quality and amino acid requirements of vertebrates [36].

The similarities observed in this study on serum total proteins and albumin agrees with the report of [31] who also reported similarities for total proteins and albumin. Opara et al. [16] observed differences on total proteins when rabbits were fed aqueous extract of *G. arborea*. A significant increase was observed for globulins in treatments 2 and 3, with treatment 2 showing superiority to treatments 1 and 4. This result agrees with the finding of [16] who recorded differences in globulins. The values recorded in this study were below the range (3.90 to 4.28 g/dl) reported by Vantsawa and Daramola [32]. The results on total proteins and globulins also mean that the immune system of the rabbit bucks was not compromised since globulins and serum proteins are involved in the immune system [37].

The urea and creatinine levels obtained in this study were below the normal range of 81 to 250 mg/L and 1.4 to 16.6 mg/l reported by [22]. The lower the value of serum urea and creatinine for a particular test feedstuff, the better the protein quality contained in the test feedstuff [38,39]. Hawkey et al. [40] reported that an increase in blood urea is attributable to poor utilisation of feedstuff as a result of anti-nutritional factors in the test feedstuff. This is in line with the report of [41] that ability to digest feed, however, depends on the nutrient composition of the diet. Amata and Iwelu [42] revealed that Gmelina fruits possess oxalate, phytic acid, phenol, tannin, alkaloids and saponin as anti-nutritional factors. The authors further affirmed that high levels of phytates and oxalates have long been known to inhibit the absorption and utilisation of minerals by animals including man.

Glucose showed similar values among the dietary treatments. It was observed that as the percentage of FGAL increases, glucose level decreases across the groups. This may be attributed to the anti-diabetic property of *G. arborea* leaf [43]. Cholesterol was significantly depressed in treatments 4 as compared to the control. This is corroborated by the report of [26] who observed significant depression in cholesterol levels when weaner rabbits were fed varying levels of dried *Gmelina arborea* leaf meal. Though the values obtained for cholesterol in this study is above (11.58 to 46.47 mg/dl) that reported by Jiwuba et al. [26].

4. CONCLUSION

There were no marked variations in the haematological and biochemical indices during the period of study. Where significant differences existed no definite pattern was observed across the treatments and values obtained fall within the normal range for rabbits. This showed that fresh *Gmelina arborea* leaf in combination with concentrate could be fed to rabbit bucks without adverse effects on haematological and serum biochemical parameters.

ETHICAL APPROVAL

The study was carried out with permission from the Nigeria Institute of Animal Science Welfare

and ethics Committee (Act No.36 of 2007) in collaboration with The Department of Animal Breeding and Physiology, Federal University of Agriculture Makurdi, Nigeria.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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