Growth Performance and Haematological Characteristics of Growing Rabbits Fed Concentrates and Forage

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Abstract— *This study evaluated the haematology and growth performance of growing rabbits fed concentrate diet and forage (Panicum maximum and Gynura aurantiaca). Twenty-four (24) growing rabbits at eight weeks (8) of age comprising of both sexes were randomly assigned to four (4) treatment groups of six (6) animals each and three (3) replicates per treatment with two (2) rabbits per replicate. The rabbits were balanced on initial weight basis. The treatment groups include T1, T2, T3 and T4. T1 (control) had 100 concentrate diet, T2 had 50%:50% of concentrate and Panicum maximum, T3 had 50%:50% of concentrate and Gynura aurantiaca and T4 had 50%:25%:25% of concentrate+Panicum maximum+Gynura aurantiaca respectively. The study was arranged in a Completely Randomized Design (CRD) format. The experiment lasted for eight (8) weeks. Pack cell Volume (PCV), Haemoglobin (Hb), Red Blood Cell (RBC), White Blood Cell (WBC), Neutrophil (N), Plateletes (PLT), Lymphocytes (L), Eosinophil (E) and Monocyte values ranged from 29.50 – 42.47%, 9.85 – 14.20%, 4.5 – 6.30%, 5.00 – 8.75%, 23.50 – 41.50%%, 206.00 – 268.50%, 49.00 – 68.52%, 2.50 – 4.00% and 4.00 – 7.50% respectively. Final weight, Weight gain, feed intake and FCR ranged from 1316 - 2108.33, 483.33 – 1008.33, 2554.63 – 3148.50 and 30.19 – 64.13 respectively. Panicum maximum and Gynura aurantiaca inclusion at different levels had a significant (P≥0.05) effect on haematological characteristics and growth performance of growing rabbits. Forages could be fed at 50%:50 %ratio of concentrate and forage in the diets of growing rabbits. Forages and concentrates is recommended at 50%:50% ratio is the diets of growing rabbits.*

Keywords— Rabbits, Gynura aurantiaca, Panicum maximum, Performance and Haematology.

I. INTRODUCTION

Food security is a widely debated development issue and yet remains a global challenge, as food insecurity becomes acute especially among vulnerable groups (marginal population, dependent population and victims of conflict) of the world (1; 2). Nigeria like many other developing countries of the world has a protein deficiency gap, especially that of quality animal protein (3). (4), also stated that reduction in the availability of animal protein due to poverty, overall economic slump, and low production of indigenous breeds of animals are some of the reasons for this insufficient intake of animal proteins. This low protein intake has remained a major nutritional problem, especially for the low income and non- wage earners (5). Proteins are among the most important nutrients in human diets, and an adequate protein supply is a prerequisite for normal growth and development of all organs in the body (6).

Inadequate supply of protein from the traditional livestock- cattle, sheep goat and chickens has led to the intensification of efforts to improve on productivity of these animals and to maximize food production and meet protein requirements in Nigeria, viable options need to be explored and evaluated (6). Studies show that the most viable option to bridge the protein malnutrition between the resource-poor world people and the resource-rich citizens is the utilization of short gestation unconventional livestock, especially monogastric animals (Rabbits and Pigs), of which rabbit is the most favoured (7). Hence, rabbits have been thought of as being suitable in this regard.

The preference of rabbit to other animals could be allied to intrinsic qualities of the animal which include: short gestation period, ease of management and, its highly prolific ability. Its practice of caecotrophy enhances its performance, relatively low

cost of production compared to other monogastric animals, high rate of reproduction, early maturity, small body size, rapid growth rate comparable to that of broiler chicken (8; 9), high genetic selection potential, efficient feed and land space utilization. Other qualities include ability to thrive on green forage, food wastes and agricultural by-products, potential income generation and limited competition with humans for similar food (9).

Rabbit meat has high nutritional value with high protein (56%), low fat (9%), low in cholesterol, sodium and calories (8%) and contain 28% phosphorus, 13% iron, 16% zinc, 14% riboflavin, 6% thiamine, 35% B12 and 48% niacin – making it ideal meat for hypertensive patients. Also, rabbitry requires comparatively low level of capital set – up, requiring little space and it is well-adapted to domestic rearing (7). Rabbits are maintained primarily on forages or concentrates alone, optimal productivity cannot be achieved (10).

Some of the conventional forages used for feeding rabbits include *Panicum maximum, Pureraria phaseloides, Centrosema pubescens, Mucuna cochinchinensis* and *Sida acuta* (11). Increased feed and nutrient levels have been advocated for breeding rabbits as a means of increasing litter size, adequate pregnancy maintenance and milk production by the does (12). However, the farmers are generally confronted with problems of high cost of concentrates, relatively smaller weight gain during the dry season, non-readily available market when the farmers are ready to sell their stock and inadequate knowledge and information about the advantages of eating rabbit meat (9). But to enhance rabbit production and productivity requires that resources are efficiently used with attention paid on profit maximization at minimum cost (13) and profit efficiency will lead to greater benefits to livestock producers in the country (14), (15) and (16) reported that *Panicum maximum* has dry matter (DM) content of 68.43-77.64 , CP ranged of 13.78, crude fibre 18.50 , NFE of 41.10 , ether extract of 6.00 and ash content of 19.80. Also works of (17) reported that the nutritive composition of *Gynura aurantiaca* contains 2.1 % crude protein, 0.6% crude fat, 1.4% ash, and 4.8% carbohydrate. They also buttressed that *Gynura aurantiaca* has an average nutrient concentration (in g/100 g of DM) of 2.08 for potassium (K), 0.31 for phosphorus (P), 0.61 for magnesium (Mg) and 6.59 for manganese (Mn). This suggests that *Panicum maximum* and *Gynura aurantiaca* could be harnessed efficiently in ruminant feeding.

II. MATERIALS AND METHODS

2.1 Location/Duration

The experiment was conducted at the Rabbitry unit, University of Port Harcourt Research and Demonstration Farm, Choba, Rivers state, Nigeria. The farm is 2 km to the University of Port Harcourt, Choba, Rivers State with annual temperature of 28°C. The experiment was conducted for a period of eight (8) weeks.

2.2 Experimental Animal and Design

Twenty-four (24) rabbits at eight (8) weeks of age comprising of both sexes with average weight of 435-438g were obtained from the rabbitry unit of Ignatius Ajuru University of Education Research and Teaching Farm, Rivers State, Nigeria.

The rabbits were randomly allotted to four treatments in a completely randomized design (CRD) with six (6) rabbits per treatment and two (2) rabbits per replicate. The rabbits were distributed randomly into four dietary treatment groups (T1, T2, T3, and T4).

The treatment diets were formulated as follows;

T1 : 100% concentrate (Control)

T2 : 50% concentrate + 50% *panicum maximum* (C+G)

T3 : 50% concentrate + 50% purple velvet (C+L)

T4 : 50% concentrate + 25% *panicum maximum* + 25% purple velvet (C+G+L).

2.3 Source of Experimental Feed Ingredient

The concentrate ingredients were obtained from Modern Agro Enterprise Port Harcourt, Rivers state while the *Panicum maximum* and *Gynura aurantiaca* were obtained from Aluu community. Thus, the forages were sundried for 2-3 days, ground, and incorporated with the concentrate before being fed to the rabbits.

TABLE 1
CALCULATED INGREDIENT OF CONCENTRATE FEED

Ingredients	T1
PKC	5.00
Maize	45.00
Maize offal	7.00
Wheat bran	4.50
Soya bean meal	16.00
Groundnut cake	11.00
Fish	4.75
Bone meal	3.00
Salt	0.25
Methionine	0.50
Lysine	0.50
Vitamin/ mineral premix	2.50
Total	100

TABLE 2
PROXIMATE COMPOSITION OF EXPERIMENTAL DIET

Feed ingredients (%)	T1
Dry matter	85.60
Crude protein	15.34
Crude fat	9.93
Ash	4.43
Crude fibre	15.27
Nitrogen free extract	41.55

TABLE 3
PROXIMATE COMPOSITION OF *PANICUM MAXIMUM*

Nutrient	Composition (%)
Dry matter	94.64
Crude protein	5.69
Crude fat	9.5
Ash	6.06
Ash	6.6
Crude Fibre	19.2
Nitrogen free extract	**53.62**

TABLE 4
PROXIMATE COMPOSITION OF *GYNURA AURANTIACA*

Nutrient	Composition (%)
Dry matter	97.95
Crude protein	5.69
Crude fat	3.40
Ash	5.80
Ash	5.80
Crude Fibre	57.01
Nitrogen free extract	**26.05**

2.4 Experimental Housing and Management

Panicum maximum and *Gynura aurantiaca* were fed to the rabbits after one week from arrival. The rabbits were allowed to acclimatize to the new environment for a period of seven days, after which, live weight differences between treatment groups were obtained. During the experiment, routine management was followed, and sanitary conditions were adequately maintained. Throughout the experiment, all treatment groups were given unlimited access to food and water (*ad libitum*). The rabbit was raised in hutches of 50cm by 35cm by 40cm dimensions. Intensive practice was adopted for this treatment.

2.5 Data Collection and Analysis

2.5.1 Weight Gain

The initial body weight of the rabbits were measured on arrival. The animals were weighed on weekly basis to determine weekly weight gain. At the end of the experiment, the rabbits were weighed and final weight was measured by subtracting the initial weight from the final weight. Body weight changes were determined by difference. An automatic weighing scale was used in determining the weight changes of rabbits.

Weight gain = final weight – initial weight

2.5.2 Feed Intake

The rabbits received weighed portions of feed daily between 7:00 and 8:00 in the morning, with the amount of feed being adjusted weekly to account for changes in weight. Water was given to the rabbits without restriction. Every day, leftover feed were collected and weighed on a scale. By deducting the leftover feed from the initial feed given, the daily feed intake was calculated.

Feed intake = Initial feed given —Leftover feed

2.5.3 Feed Conversion Ratio (FCR)

Feed conversion ratio represents the proportion of food that is converted into meat. It is calculated as feed intake divided by weight gain per rabbit throughout the study period.

$$\text{Feed conversion ratio} = \frac{\text{feed intake}}{\text{weight gain}}$$

2.5.4 Mortality

Mortality rate was evaluated by recording the number of deaths that occurred among the rabbits during the experimental period and it was expressed as percentage of the rabbit stock.

2.5.5 Haematological Parameters

At the end of the experiment, set of blood samples were collected from three rabbits per treatment using 3ml disposable syringe and was transferred into EDTA (Ethylene diameter tetra-acetic acid) bottles for haematological analysis such as; Packed Cell Volume (PCV), Haemoglobin (HB), Red Blood Cell (RBC), White Blood Cell (WBC), Platelets, Eosinophils, Neutrophils, Monocytes, Lymphocytes, Mean Corpuscular Volume (MCV) And Mean Hemoglobin Concentration (MHC) and Mean Corpuscular Hemoglobin Concentration (MCHC) (18).

Packed cell volume (PCV) was determined with Wintrobe's microhaematocrit method while Red blood cell (RBC) and White blood cell (WBC) was determined with improved Neubauer haemocytometer. The haemoglobin concentration (Hb) was determined using cyano-methaemoglobin method. The erythrocytic indices, mean cell volume (MCV), mean cell haemoglobin (MCH), and mean cell haemoglobin concentration (MCHC) was computed as described by (19).

2.6 Statistical Analysis

All data obtained were subjected to the Analysis of Variance (ANOVA). Significant treatments means were separated using Least Significance Difference (LSD) using the Statistical Package for Social Sciences (SPSS) software. Results were presents in tables.

2.6.1 Statistical model

The Statistical Model is stated as;

$$Yij = U + Ti + Eij$$

Where; Yij = Single Observation

U = Population mean

Ti = Effect where i^{th} treatment where i = 1, 2…4

Eij = Random error.

III. RESULTS

3.1 Effect of *Panicum maximum* and *Gynura aurantiaca* on Growth Parameters of Rabbit

Table 4.0 shows the effect of *panicum maximum* and *gynura aurantiaca* on growth parameters of rabbit. Initial weight, final weight, weight gain, feed intake and Feed conversion Ratio (FCR) showed significant difference ($P \leq 0.05$) within all treatment groups. In final weight, T4 was significantly ($P \leq 0.05$) different from T1, T2 and T3. T4 (2108.33) had the highest value, followed by T3 (1483.33) and T1 (1341.66) with T2 (1316.67) being the least value. Feed intake showed significant difference ($P \leq 0.05$). T4 (3148.50) had the highest value, followed by T2 (2820.00) then T3 (2583.00) and T1 (2554.63) having the least value although T2, T3 and T4 showed no significant ($P \geq 0.05$) difference, there was slight increase in their numerical values. The Feed Conversion Ratio (FCR) value was highest in T4 (64.13), followed by T2 (50.196) then T1 (37.14) and T3 (30.19) having the least value. T1 and T3 were not significantly ($P \geq 0.05$) different.

TABLE 5
GROWTH PARAMETERS OF RABBITS FED PANICUM MAXIMUM AND *GYNURA AURANTIACA*

Parameters	T_1	T_2	T_3	T_4
Initial weight (g)	750.00±232.14	833.33±232.14	833.33±232.14	1100.00±232.14
Final weight (g)	1341.66 ± 169.0^{b}	1316.67 ± 169.04^{b}	1483.33 ± 169.04^{b}	2108.33 ± 169.04^{a}
weight gain (g)	591.66 ± 286.04^{b}	483.33 ± 286.04^{c}	650.00 ± 286.04^{ab}	1008.33 ± 286.04^{a}
Feed intake (g)	2554.63 ± 189.5^{b}	2820.00 ± 189.53^{ab}	2583.00 ± 189.53^{b}	3148.50 ± 189.53^{a}
Feed conversion ratio (g)	37.14 ± 26.10^{c}	50.19 ± 26.10^{b}	30.19 ± 26.10^{c}	64.13 ± 26.10^{a}

[ab] Means within a row with different superscripts differ significantly at (P<0.05)

3.2 Effect of panicum maximum and *gynura aurantiaca* on Haematological Values of Growing Rabbits

Table 5 shows the effect of concentrate and forage on haematological parameters of rabbits. The result revealed that Pack Cell Volume, Haemoglobin, Red Blood Cell, White Blood Cell, Neutrophil, Platelet, Lymphocyte and Monocytes was significantly affected ($P \leq 0.05$) along different treatment groups.

1. **Pack cell volume:** Treatment 3 (42.47) had the highest response ($P \leq 0.05$) on PVC values while treatment 2 (29.50) had the lowest response ($P \leq 0.05$) on PVC values, however treatments 1 (37.50) and treatment 4 (35.50) showed no significant difference in their values.
2. **Haemoglobin:** The result on HB values showed that treatment 3 (14.20) and treatment 1 (12.50) was significantly ($P \leq 0.05$) higher than treatment 4 (10.20) and treatment 2 (9.85). Treatment 3 (14.20) showed the highest value and treatment

2 (9.85) with the least value. The treatment effect also showed that treatment 4 (10.20) and treatment 2 (9.85) had no significant difference between their values.

3. **Red blood cell:** Treatment 3 (6.30) had the highest response ($P \leq 0.05$) on RBC values while treatment 2 (4.55), and 4 (4.5) respectively had the least value with no significant difference. Treatment 1 was the second highest with (5.65).
4. **White blood cell:** The result showed that treatment 4 (8.75) had the highest response ($P \leq 0.05$) of WBC and treatment 3 (5.00) had the least response. Treatment 2 (6.95) showed the second highest value and treatment 1 (6.65) showed the third highest value, however the two treatments (2 and 1) respectively showed no significance difference in their WBC values.
5. **Neutrophils:** The result on neutrophils showed that treatment 3 (23.50) had the least response, when compared to other treated groups.
6. **Platelets:** Platelet values in treatment 2 (268.50) showed a higher value than treatment 4 (262.50) but however showed no significant difference between its values. Treatment 1 (206.50) and 3 (206.00) showed a significant reduction in platelets values than treatment 2 (268.50) and 4 (262.50).
7. **Lymphocytes:** The treatment effect on lymphocyte values showed that treatment 3 (68.50) had the highest significant response ($P \leq 0.05$) while treatment 2 (49.00) showed the least response ($P \leq 0.05$) on lymphocyte values. Treatment 1, 2 and 4 also showed a significant reduction in their lymphocyte values with no significant difference between their values.
8. **Eosinophil:** Eosinophil value showed no significant ($P \geq 0.05$) influence amongst the groups but treatment 2 (3.00) and 3 (3.00) had the same numerical values of eosinophil and all the treatment showed a slight increase in numerical values.
9. **Monocyte:** The results showed that treatment 1 (7.50) had the highest significant response ($P \leq 0.05$) while treatment 4 had the least significant response ($P \leq 0.05$) on monocyte values.

IV. DISCUSSIONS

4.1 Growth Performance

The highest values of weight gain among rabbits in T3 could mean that an equal mixture of concentrate and purple velvet plant gave better weight gain than concentrate mixed with *panicum maximum* (T2). This result is in agreement with the report of (20) which said that highest weight gain was recorded in rabbits on treatment 3 (50C: 50F) concentrate and forage ratio. The superior value of T2 could be attributed to the high palatability of *panicum maximum* diet compared to purple velvet diet. The low value of feed intake in T1 can also be attributed to the absence of forage in the diet. The highest feed intake value of T4 could be attributed to an equal combination of the two test plants along with concentrate. Thus, the best Feed Conversion Ratio (FCR) in T3 (30.19), could be attributed to the absence of forage in the diet. T4 (64.13) had the highest value and this can be attributed to higher percentage of forage (mixture of *Panicum maximum* and purple velvet) and poor nutrient retention by the animals in T4. This was in tandem with those reported by (20) who recorded similar result on feed conversion ratio of rabbits fed concentrate and forage. It also affirms that the mixture of treated diet could help in efficient conversion of the available nutrients into usable parts leading to the better performance in the study.

4.2 Haematological Parameters

The effect of feeding concentrates diet and forage (*panicum maximum* and *gynura aurantiaca*) to growing rabbits on haematological values – Pack Cell Volume (PCV), Haemoglobin (Hb), Red Blood Cell (RBC), White blood Cell (WBC), Neutrophil (N), Platelets (P), Lymphocyte (L) and Monocyte (M) showed significant difference, except for Eosinophil (E) which did not show any significant difference. These results are in agreement with (21) who reported that there was significant difference in the haematological parameters of rabbits fed with graded levels of wild sunflower forage. This positive response proves that the test plants affect the haematological parameters of rabbits at various inclusion level. According to (22), the changes in haematological values are often used to determine various status of the animal's body and also determine the stress due to environmental, nutritional and pathological factors.

The PCV value of T2 (29.50), indicates possible anaemia, this is in agreement with (23) who reported that PCV less than 30% indicates anaemia, especially if the RBC and haemoglobin levels are low as well and this was evident in the result in **Table 6**. According to (24) increased PCV shows better transportation of nutrients, therefore feeding T3 diet would yield higher primary and secondary polycythemia than T2, T1 and T4 diet.

The significant increase in the value of RBC in T3 can be attributed to the high value of PCV in the same treatment. High RBC could be a result of increasing freedom from disease, this was reported by (25). (26) also suggested that increase in RBC, counts as an indication of reduced damage to erythrocytes.

The higher values obtained for Haemoglobin concentration (Hb) in T3 (14.20), and T1 (12.50) compared to T4 (10.20) and T2 (9.85), which fell within the normal range (10 - 15) for rabbits as reported by (27), could be due to increased biosynthesis of haem in bone marrow (28). The same goes for the similarity in PCV values of T3 (42.47) and T1 (37.50), since haemoglobin has direct relationship with PCV.

The values of WBC also fell within the normal range of 4.5 – 11 (27), with T4 (8.75) being the highest, followed by T2 (6.95), T1 (6. 65) and T3 (5.00), being the least. Although T2 and T1 are not significantly different. The values of WBC compared favourably in the groups with very slight increase in numerical value. The significant effect of the treatments on WBC could mean that the test plants had stimulatory effect on the defense and immune system of the body (29)

Lymphocytes (L), Neutrophil (N), Eosinophil (E) and Monocyte (M) values fell within the normal range reported by (30). Eosinophils forms part of the granulocytes that make up leucocytes in animals. There was no significant difference in the eosinophil value and no observed abnormal linear decrease with equals levels of concentrate and the forages. This reflects the possible absence of toxin/ poison since there is nothing to promote inflammatory defense reaction from test plants. This corresponds with (31) who reported that the major function of eosinophil is detoxification.

V. CONCLUSION AND RECOMMENDATION

5.1 Conclusion

From this study it was observed that for optimum performance of rabbit, they should be fed mixture of concentrate and Forage. Also, Inclusion of forage in the diet of rabbit is also needed to enhance feed intake. Furthermore, the combination of the test plants with concentrate seemed to yield adequate results in the haematological values of rabbits, therefore this combination can be utilized in rabbit production.

5.2 Recommendation

For optimum performance of rabbit, they should be fed 50% of concentrate and 50% of forage because this percentage gave highest average weight gain**.** From the result of the study, it may be adequate to combine more than one forage in rabbit diet.

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