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Effect of different levels of fluted pumpkin leaf (*Telfairia occidentalis*) in grower rabbit diets: Assessing growth parameters, haematological profiles, and serological responses

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Abstract

The effect of fluted pumpkin leaf (FPL) on the growth performance, haematology, and serology of growing rabbits were examined. Seventy-five weaned rabbits of Dutch breed, with a mean weight of 513 g, and different sexes were allotted into 5 treatments with 3 replicates and each replicate housing five weaned rabbits. The five treatment diets were formulated to contain FPL at inclusion levels of 0 % (control), 30 %, 50 %, 70 % and 100 % in a completely randomized design. The animals were fed twice daily and given water to drink *ad libitum* for the fifty-six days (Jan to Mar, 2023) of the feeding trial. The proximate analysis showed that FPL was rich in protein and minerals but low in fibre, hence a good protein and mineral supplement for weaned rabbits in the tropics. The final weight, weight gain, weight gain per day, average weight gain, and feed conversion ratio differed significantly ($P < 0.05$) amongst the rabbits fed the experimental diets. The blood parameters examined included packed cell volume (PCV), red blood cell (RBC), white blood cell (WBC), mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH), and mean corpuscular haemoglobin count (MCHC), which differed significantly in comparison ($P < 0.05$). The serum, total protein, albumin, and globulin analysed did not show any significant difference among the treatment. The inclusion of 50 % FPL could be efficiently utilised and tolerated by growing rabbits without adversely affecting growth performance and blood profile.

Keywords: blood parameters, Dutch breed, proximate analysis, serum, weaned rabbits

1 Introduction

In most developing countries, population growth and increasing economic activity are making it more and more difficult for the livestock industry to meet the urgent demand for animal protein (Olalekan *et al.*, 2019; Haque *et al.*, 2020). This shortage of animal protein is associated with increased production cost and scarcity of essential ingredients. These factors account for around 75-85 % of current production costs in intensive monogastric livestock production in Africa (Fasuyi & Nonyerem, 2007). This situation, especially in developing African nations (including Nigeria), has necessitated the investigation of several novel plant protein and energy sources (Ekokotu *et al.*, 2018; Anzani *et al.*, 2020; Irabor *et al.*, 2021a; Irabor *et al.*, 2022a; Irabor *et al.*, 2022b) that could serve as an initiative for sustainable development and food security. The intensive use of livestock with short generational intervals could be one of the answers to the current animal protein availability in developing nations (Ahaotu *et al.*, 2017). In Nigeria, the lack of animal protein could be compensated by pseudo-ruminants such as rabbits (Yahaya *et al.*, 2023). Rabbits (*Oryctolagus cuniculus*) are monogastric herbivores with post–gastric digestion that can effectively utilise fibrous fodder, such as grasses and legumes (Henchion *et al.*, 2017). Amata & Okorodudu (2016) penned that the rabbit appears to be the most sustain-

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able means of producing high-quality animal protein for the expanding populations of lesser-developed countries. Siddiqui *et al.* (2023) noted the tremendous potentials and favourable traits of rabbits which include a rapid growth rate, fast gestation, great prolificacy, comparatively inexpensive production costs, and good nutritional quality of rabbit meat with minimal levels of fat, salt, and cholesterol. Importantly, rabbit meat is of superior quality to most other meats, being very low in fat/cholesterol contents (59 mg per 100 g of muscle) and relatively low in energy (789 kJ per 100 g meat) as compared to other animal protein sources (Elazab *et al.*, 2022). However, a major issue affecting rabbit production (cuniculture) is the lack of knowledge about feed supplements with high nutritional and health benefits that also increase the weight gain of rabbits at a reasonable cost (Siddiqui *et al.*, 2023).

Numerous researchers have explored the inclusion of non-conventional feed (vegetables) in the feeding regime of rabbits such as sweet potato leaf (*Ipomoea batatas*), moringa leaf (*Moringa oleifera*), fluted pumpkin leaf (*Telfairia occidentalis*) and neem leaf (*Azadirachta indica*) (Nuhu, 2010; Abonyi *et al.*, 2012; Alikwe *et al.*, 2014; Unigwe *et al.*, 2016). Many of these plants that grow in Nigeria and other tropical and subtropical regions, especially the leaves, have found general acceptance and are used scientifically to improve the performance and health of livestock. Plants such as *Telfairia occidentalis* contain nutrients and phytochemicals that can be used as dietary supplements to increase weight gain, feed intake, disease resistance, and feed utilisation, as well as provide healing and preventive effects when consumed by livestock.

In recent times, numerous researchers have used the leaves of moringa (*Moringa oleifera*), Sweet potato (*Ipomoea batatas*), duckweed (*Lemna minor*), pawpaw seed, Maize cob, *Tridax procumbens*, groundnut shell and fluted pumpkin (*Telfairia occidentalis*), as feed supplements, laying emphasis on the nutritional and health relevance of these leaves to the growth and gut performance of the animals (Obeagu *et al.*, 2014; Irabor *et al.*, 2016; Unigwe *et al.*, 2016; Cohen-Zinder *et al.*, 2017; Ekokotu *et al.*, 2018; Obongekpe, 2020; Irabor *et al.*, 2021b; Irabor *et al.*, 2022b; Irabor *et al.*,2022c; Irabor *et al.*,2022d; Ekelemu *et al.*, 2023; Irabor *et al.*, 2023; Sanubi *et al.*, 2023). The leaves *Moringa oleifera* can play an important role in dairy cattle nutrition and health since these are rich in antioxidant, antimicrobial and anti-inflammatory properties (Cohen-Zinder *et al.*, 2017; Obongekpe, 2020). Obeagu *et al.* (2014) posited that fluted pumpkin can act as an important source of protein, oil, fat, minerals, and vitamins. The tropical rainforests of West Africa are home to fluted pumpkin, with south eastern Nigeria having the highest diversity (Oladele *et al.*, 2021). This makes fluted pumpkin simply affordable, easily available, and sustainable resource (Nnamani, 2015).

The physiology, haematology, and serology of farm animals are affected by several variables, the most important of which is nutrition (Ajao *et al.*, 2013). According to Alagbe (2017), haematological factors, such as erythrocytes, leukocytes, mean corpuscular haemoglobin concentration, are helpful in assessing feed toxicity, particularly when it comes to feed components that have an impact on farm animals' blood and health. Considering its low cost, availability and nutritional composition, fluted pumpkin leaf could be an interesting dietary supplement for rabbits. Therefore, this research was conducted to evaluate the growth performance, haematology, and serum biochemistry of grower rabbits offered different levels of fluted pumpkin leaf (FPL).

2 Materials and methods

2.1 Study site

The research was conducted at Dennis Osadebay University, Anwai, Asaba Teaching and Research Farm (Latitude 6°14' N and Longitude 6°49' E). Asaba is marked with moderate rainfall and soil fertility, which brings it within the rainforest zone. The rainy season is between April and October, with a mean annual rainfall of 1500 mm. The dissemination is bimodal, with peaks in July and September and low precipitation in August. The mean annual temperature is 23.8 °C. The area has a mean relative humidity of 77.2 % (Asaba Meteorological Office). The investigation was conducted over the course of eight weeks (9^{th} January to 5^{th} March, 2023).

2.2 Experimental animals and management

Seventy-five grower rabbits (Dutch breed) aged four weeks old, procured from a reputable farm in Delta state, were used for the experiment. Before beginning the trial, the specimens were given two weeks to acclimate to the environment. During this period, they were fed guinea grass (*Panicum maximum*), coat button (*Tridax procumbens*), and pellet concentrate feed. They were also given medications (prophylactics) periodically to prevent illness during the experimental period. The rabbits were kept in well-ventilated individual hutches and provided feed twice daily with fresh, clean water *ad libitum*. The difference between the quantity served and the leftovers was calculated as daily feed intake. Body weight was measured on a weekly basis using a weighing balance (Camry 20 kg spring dial mechanical weighing scale) to ascertain the weight gained. Other routine management practices which included washing the drinkers and feeders daily, and sweeping and cleaning the hutches, were duly observed.

2.3 Experimental diet and design

After the acclimation period, the seventy-five rabbits were assigned to five dietary treatment groups (FPL0, FPL30, FPL50, FPL70 and FPL100), fifteen rabbits per treatment in a completely randomized design (CRD). Each rabbit was a replicate. The five dietary treatments were as follows:

FPL0: 100 g of concentrate feed per rabbit and day;
FPL30: 70 g of concentrate feed + 30 g of FPL per rabbit and day;
FPL50: 50 g of concentrate feed + 50 g of FPL per rabbit and day;
FPL70: 30 g of concentrate feed + 70 g of FPL per rabbit and day;
FPL100: 100 g of FPL per rabbit and day.

The fresh leaf of *T. occidentalis* was harvested from the teaching and research farm and fed fresh to the rabbits. The concentrate feed (VITAL Grower's mash, table 1) was procured from a reputable animal feed store in Asaba, Delta state. The proximate compositions (crude protein, crude fibre, moisture, ash, and ether extract) of the experimental forage and the concentrate feed (vital grower feed) were determined by the methods of AOAC (1990) (see table 2).

Table 1: *Ingredient composition of the concentrate feed (vital grower feed).*

Ingredient	*share (%)*
Maize	42.00
Corn bran	10.00
Wheat offal	17.00
PKC	20.00
GNC	4.50
SYBM	2.00
Oyster shell	1.00
Bone meal	3.00
Salt	0.25
Premix	0.25
Total	100.0

source: Vital Feed Grower Mash (25 kg); PKC, palm kernel cake; GNC, ground nut cake; SYBM, soybean meal.

2.4 Growth trial

In the mornings, the experimental diets were fed in different feeding troughs to assess their feed consumption. At the start of the experiment, all animals were weighed before being assigned to one of the three replicates for each treatment. During the experimental period, the animals were weighed weekly. Parameters determined included initial and final weight gain, average body weight gain, daily feed intake, average feed intake, feed conversion ratio, and feed efficiency.

2.5 Blood collection and parameters

Haematology parameters were determined by appropriate haematological procedures as described by Adewale *et al.*, 2021. Blood sampling was carried out in the eighth week of the experiment. Three rabbits were randomly selected from each treatment. Blood was collected from each rabbit via the ear vein using sterile needles and syringes and placed in sterilised bottles containing ethylenediaminetetra acetic acid (EDTA). The erythrocyte counts, total leukocyte counts, haemoglobin (Hb) concentration, and packed cell volume (PCV) parameters were determined using the method described by Jimoh *et al.*, 2020. Blood constants mean corpuscular volumes (MCV), mean corpuscular haemoglobin (MCH) and mean corpuscular haemoglobin concentration (MCHC) were determined using the following:

$$\text{Mean corpuscular volume (MCV \%)} = \frac{PCV}{RBC} \times 10$$

$$\text{Mean corpuscular haemoglobin (MCH \%)} = \frac{Hb}{RBC} \times 10$$

The serological parameters considered total protein ($g\,dl^{-1}$), urea ($mg\,dl^{-1}$), albumin ($g\,dl^{-1}$), and globulin ($g\,dl^{-1}$).

2.6 Statistical analysis

The data were calculated using one-way analysis of variance (ANOVA), and the differences between the means were separated using Duncan's multiple range test (SPSS, 2021).

3 Results

The constituent composition of the experimental diets can be seen in Table 1 and 2. From Table 3, the growth performance and feed intake of rabbits fed varied inclusion levels of FPL and concentrate can be observed. The report on performance showed an increase in the growth of rabbits fed with the different experimental diets. However, experimental animals which received FPL50 recorded the best results in average weight gain. This result was closely followed by FPL30, FPL0, FPL70 and lastly, FPL100. The haematological responses of the rabbits are displayed in Table 4. It can be seen from Table 4 that the packed cell volume (PCV),

Table 2: *Proximate composition of* Telfairia occidentalis *and concentrate feed (vital grower feed).*

Parameters	T. occidentalis *(%)*	*Concentrate (%)*
Dry matter	87.7	97.4
Ash	7.0	8.3
Crude protein	14.0	16.9
Crude fibre	8.7	8.3
Ether extract	10.8	3.6
Nitrogen free extracts	46.3	57.8

haemoglobin (Hb), red blood cell (RBC), white blood cell (WBC), mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH) and mean corpuscular haemoglobin concentration (MCHC) differed significantly as inclusion level of the test ingredient increased across diet. However, the neutrophils, lymphocyte, monocyte, eosinophils and basophils levels did not show any significant difference.

Table 5 shows the serological response of the rabbits to the feeding regimen. In this study, no significant changes in serum biochemical parameters were observed, indicating that neither dietary treatment had a negative effect on the serum biochemistry of the rabbits.

4 Discussion

4.1 Growth performance of rabbits fed fluted pumpkin leaf

The growth performance of the rabbits receiving FPL together with concentrates showed the nutritional and health relevance role fluted pumpkin can play in grower rabbits. This response to the feeding schedule is consistent with Taiwo *et al.* (2005) and Adeyemo *et al.* (2014) who found that rabbits can be fed forage in combination with concentrates to achieve optimal growth performance. Amata & Okorodudu (2016) asserted that considering the feed conversion ratio improves the understanding of growth performance. The feed conversion ratio shows how much weight the animals have gained for each gram of feed consumed. FPL50 had the optimal weight gain and feed conversion ratio, which may have been attributed to the increased nutrients resulting from the combination of both diets fed to the animals under this treatment. The results indicated that the treatment with a combination of concentrate and the test ingredient at 50 % inclusion level each recorded the best feed conversion ratio, which is in agreement with Mmereole *et al.* (2011), who stated that rabbits could obtain the best feed conversion ratio and weight gain on diets with forage as additive or partial replacement due to their ability to ferment forage and extract the nutrients from it. This result is similar to Ikyume (2019), who ascribed that compounded concentrate alone does not give optimum performance. However, this observation could result from the bulkiness of the diet, the breed of rabbits used, type of concentrate used, state of concentrate used and the environmental conditions. The results from FPL50 in this study are in close conformity with the findings reported by Adeyemo *et al.* (2013) that for optimal performance of rabbits, 50 % of concentrate and 50 % forage should be fed as this percentage gave the highest average weight gain. This is also in line with the opinion of Nworgu *et al.* (2007), who reported that forage could account for up to 50 % of the rabbit diet, as differences in the growth rate were observed in rabbits fed a mixture of concentrates and forages compared to those fed concentrates or forages alone.

Lowest average daily feed intake was recorded in FPL100 as compared to the highest found for the FPL50 treatment. This could be attributed to the increased palatability and digestibility of the mixed diet which is in agreement with Atchade *et al.* (2019), who reported an increase in feed intake per day observed in rabbits fed with a concentrate / forage mixture, as compared to rabbits fed only concentrate. Ironkwe & Ukanwoko (2016) also confirm that daily feed intake tends to increase when the proportion of forage increases. Szendrő *et al.* (2015) suggested that rearing rabbits on forages and a concentrate as an energy supplement is more suitable in underdeveloped countries where commercial feeds are either unavailable or prohibitively expensive. The results of this study conforms with Nuamah *et al.* (2019), who concluded that raising rabbits entirely on forages and concentrate at any inclusion level will yield optimum output.

4.2 Haematological and serological analysis of rabbits fed fluted pumpkin leaf

Haematological parameters can be used to detect feed toxicity, especially when the feed ingredient affects blood formation (Adedokun & Ayandiran 2022; Sanubi *et al.*, 2023). Blood parameters variables are most consistently affected by dietary influence including RBC, PCV, and plasma proteins, (El-Ratel, 2023). The PCV value of rabbits fed FPL ranged from 26.40 – 31.50 % (Table 5), which was lower than found by Ayo-Ajasa *et al.*, (2020) whose results ranged from 39.00 to 48.33 %, but higher than the values of 13.50 to 22.60 % found by Ubua *et al.* (2019); both studies used neem leaves (*Azadirachta indica*) at varying inclusion levels.

The haemoglobin values found in this study were relatively similar and ranged between 9.38 and 11.52 g dl^{-1}, falling within the ranges of 9.11 – 13.39 g dl^{-1} and 9.21 – 14.70 g dl^{-1} as reported for healthy rabbits by Adewale *et*

Table 3: *Performance of grower rabbits fed graded levels of* Telfairia occidentalis *and concentrate feed (n=15 per treatment).*

Parameter	*FPL0*	*FPL30*	*FPL50*	*FPL70*	*FPL100*	*SEM*
Initial weight (g)	520.0	509.0	512.0	522.0	510.0	2.88
Final weight (g)	1232.5^b	1245.5^b	1261.0^a	1124.0^c	1036.8^d	10.32
Weight gain (g)	712.5^b	736.5^a	749.0^a	602.0^c	526.8^c	3.72
Weight gain/day (g)	12.7^b	13.2^a	13.4^a	10.8^c	9.4^d	0.06
Total feed intake/rabbit/56 days (g)	2273.3^b	2246.7^b	2171.1^a	2137.8^c	2113.0^d	0.18
Feed conversion ratio (g)	3.2^b	3.1^b	2.9^c	3.6^a	4.0^a	0.03

FPL0: 100 g of concentrate feed per rabbit and day; FPL30: 70 g of concentrate feed + 30 g of FPL per rabbit and day; FPL50: 50 g of concentrate feed + 50 g of FPL per rabbit and day; FPL70: 30 g of concentrate feed + 70 g of FPL per rabbit and day; FPL100: 100 g of FPL per rabbit and day

Table 4: *Haematology of grower rabbits fed graded levels of* Telfairia occidentalis *and concentrate feed (n=3 per treatment).*

Parameter	*FPL0*	*FPL30*	*FPL50*	*FPL70*	*FPL100*	*SEM*
PCV (%)	26.4^c	28.5^b	30.6^a	29.3^b	31.5^a	0.26
Hb ($g\,dl^{-1}$)	9.4^c	9.8^b	10.9^a	9.8^b	11.5^a	0.07
RBC ($\times 10^{12}\,L^{-1}$)	5.3^a	4.9^b	5.2^a	4.9^b	5.6^a	0.04
WBC ($\times 10^{12}\,L^{-1}$)	7.4^b	8.8^a	8.5^a	7.6^b	8.0^a	0.09
Neutrophils (%)	51.4	51.5	51.5	50.5	50.5	0.11
Lymphocyte (%)	44.3	43.7	44.3	45.0	44.5	0.11
Monocyte (%)	2.1	1.8	2.0	2.3	2.0	0.03
Eosinophils (%)	2.1	2.0	2.0	1.5	2.8	0.04
Basophils (%)	0.03	0.00	0.00	0.20	0.00	0.00
MCV (fl)	91.0^d	110.7^a	109.9^b	110.6^a	99.6^c	1.60
MCH ($pg\,cell^{-1}$)	31.6^d	38.0^a	37.8^a	36.9^b	35.8^c	0.49
MCHC (%)	35.6^b	33.3^c	35.7^b	33.5^c	37.9^a	0.09

For FPL0 - FPL100: see table 3. ^{abcd}: Means with different superscripts in the same row differ significantly ($p < 0.05$). RBC: red blood cell; MCV: mean corpuscular volume; MCH: mean corpuscular haemoglobin; WBC: white blood cell; PCV: Packed cell volume; MCHC: mean corpuscular haemoglobin concentration; Hb: haemoglobin.

al. (2021) and Omokore & Alagbe (2019), respectively. This result suggests an efficient distribution of oxygen within the system of the rabbit. The major functions of haemoglobin are to transport oxygen tissues for oxidation of ingested food, to release energy for other body functions and also transport carbon dioxide out of the body (Adewale *et al*., 2021). The RBC level ranged between ($4.86 – 5.61 \times 10^{12}$ L^{-1}) which fell within the recommended values of ($4.0 – 8.6 \times 10^{12}$ L^{-1}) for normal rabbits (Adewale *et al*. 2021). This implies that the utilisation of the FPL up to 100 % does not have any deleterious effect on the erythropoietic tissues of rabbits and is also an indication that the experimental rabbits had the ability to transport a higher number of oxygen in their system which enhanced their health status. In white blood cells (WBC), results from the study shows that animals fed FPL was significantly ($p < 0.05$) higher in the FPL70 group but still within the range of ($3.0 – 12.0 \times 10^3$ dl^{-1}) (Omokore & Alagbe 2019). WBC functions to fight infections, defend any foreign body against invasion and produce antibodies in immune response, this result indicated

Table 5: *Serology of grower rabbits fed graded levels of* Telfairia occidentalis *and concentrate feed (n=3 per treatment).*

Parameter	*FPL0*	*FPL30*	*FPL50*	*FPL70*	*FPL100*	*SEM*
Total protein ($g\,dl^{-1}$)	6.5	6.8	6.6	6.7	6.6	0.02
Albumin ($g\,dl^{-1}$)	3.9	3.9	3.9	3.9	3.9	0.00
Globulin ($g\,dl^{-1}$)	2.6	2.9	2.7	2.8	2.7	0.00

For FPL0 - FPL100: see table 3.

that the specimens were healthy because the decline in the WBC level was below the normal range is an indication of infection of allergic conditions, and certain parasitism while elevated values of WBC indicate the existence of a recent infection, usually bacteria (Jiwuba *et al.*, 2016).

The productive performance characteristics of the rabbits fed a combination of the concentrate and fluted pumpkin both at 50 % (FPL50) had the best values for final weight, weight gaine and feed conversion ratio compared to other treatments. Also, the same FPL50 was found to be more palatable to the rabbits considering the values recorded for average feed intake. It is therefore concluded that Telfairia occidentalis can be used effectively to improve weight gain as well as a viable nutritional supplement in the diet of grower rabbits.

A carcass evaluation should be conducted to determine if the test ingredient affected the carcass quality. It is also suggested that animals should be tested and treated of any infection during the acclimatization (adaption and conditioning) period before trials of this nature. More so, grower rabbits can be reared to maturity in 10 (ten) weeks using locally available fodders such as FPL which will in turn reduce the use of concentrate and cut down production cost.

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Conflict of interest

The authors declare that they have no conflict of interest.

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