Growth Parameters, Protein Digestibility And Health Status Of Rabbit *Oryctolagus Cuniculus* Fed With Palatable Leafy Vegetables

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Abstract

This study focused on using vegetable leaves for rabbit feeding. Rabbit fed with leaves of *Abelmoschus esculentus, Corchorus olitorius, Ipomea batatas, Vigna unguiculata, Solanum melongena* showed positive growth and high feed intake, while rabbits fed with leaves of *Amaranthus hybridus, Hibiscus sabdariffa, Manihot esculenta, Celosia argentea, Myrianthus arboreus, Basella alba, Talinum triangulare, Colocasia esculenta* showed low feed intake and weight loss. The digestibility of treatments supplemented with concentrate was better than that of the diet without fodder. Feed intake (157.62 g / day) and average weight (2081.87g) of rabbits fed with leaves of *Ipomea batatas*, were the highest while average daily gain (24.38 - 27.29 g/day) remained similar. The feed conversion ratio of the control treatment (3.51) was better than those obtained for treatments supplemented with concentrate (5.31 - 5.71). Urea and creatinine values were similar in all groups. Blood glucose (0.94 ± 0.04 g/L) and total protein (68.40 ± 0.14 g/L) of rabbit fed with leaves of *Solanum melongena* were the highest. Total cholesterol of rabbit fed with leaves of *Ipomea batatas* and control diet were the highest. The blood triglycerides of rabbit fed with control diet was the highest and differed to other treatments ($p < 0.05$).

Keywords: Leafy vegetables, growth, health, rabbit

Introduction

Food security is a top priority worldwide and mainly in developing countries. The nutritional needs are provided by the agricultural, fisheries and pastoral activity. The total requirements of meat and offal in Côte d'Ivoire are 152 462 tons carcass equivalent (TEC) in 2011 (Coulibaly, 2013) to an average production of about 92 679 TEC. The deficit is filled by imports. The production of small ruminants (sheep and goats) is about 15 524 TEC for a consumption of 20 491 TEC in 2011 (Coulibaly, 2013). It is very important to reduce these importations. One of the solutions to address this problem would be the farming of animals as rabbits. Indeed rabbits are very prolific animals with a gestation period of 30 ± 2 days and reach maturity in a short time (Adejimi *et al*., 2007). Rabbits are also considered effective for the meat production and they can use up to 30% against 10% crude fiber in most poultry species (Egbo *et al*.; 2001). Compared to meat from other species, rabbit meat is protein, vitamins and minerals rich. It contains little fat and high proportion of essential poly unsaturated fatty acids such as linoleic and linolenic acids (Aduku and Olukosi, 1990). Despite the nutritional benefits offered by rabbit meat and easy climate adaptation of species, rabbit breeding is less developed in Cote d'Ivoire.

One reason for this fact is the high cost of feed which is a factor affecting animal production in most African countries. Feed stuffs represent more than 60% of the total cost of rabbit production. The use of available and cheap ingredients to feed rabbit is therefore highly recommended. The emphasis was on the use of vegetable leaves in animal feeding as a valuable way to reduce the cost of animal feed (Bairagi *et al*., 2004; Adewolu, 2008) and on the other hand, to improve growth performance of rabbits. In Côte d'Ivoire, traditional leafy vegetables as *Amaranthus hybridus, Hibiscus sabdariffa, Vigna unguiculata, Abelmoschus esculentus, Manihot esculenta, Ipomoea batatas, Celosia argentea, Myrianthus arboreus, Basella alba, Talinum triangulare, Colocasia esculenta, Solanum melongena, Corchorus olitorius* have a short generation interval of about four months, and can therefore be cultivated twice a year; which guarantee their availability throughout the year (Kouamé, 2000). In addition they have good nutritive characteristics (Zoro *et al*., 2013; Acho *et al*., 2014; Oulaï *et al*., 2014).

The leaves of these plants have been used in the tropics as a cheap protein sources in animal feeds (Ekenyem and Madubuike, 2006). For instance, reports from several authors (Zoro *et al*., 2013; Acho *et al*., 2014; Oulaï *et al*., 2014) indicated that the leaves of these plants had high protein content (26 to 35%) and good mineral contents.

Despite the nutritive value of these leaves, it has been reported that they contain some anti-nutritive components (Zoro *et al*., 2013; Acho *et al*., 2014; Oulaï *et al*., 2014). Using concentrates alone for raising rabbits would

not be cost effective and leafy vegetables may not have a good balance of nutrients that can support their optimal performance. So, the objective of this study was to evaluate the palatability of the selected leaves and their effects on growth performance, protein digestibility and health of rabbits.

Materials and methods

Experimental layout

The study has been conducted in a traditional rabbit farm in Bingerville municipality (Côte d'Ivoire). The study area is located between 5° 21'708 "North latitude and 3° 54'639" West longitude.

The animal (550 ±34g) were cross bred New Zealand × California rabbits (Martignon *et al*., 2010), which weaned at 35 days of age and were housed individually in cage in wire-netting (70 × 40 × 50 cm) raised from 80 cm to ground. The cages were arranged in stripes and under the shade of large trees (natural ventilation and daylight). The average temperature recorded during the experimental period was 29±2°C. Water was provided *ad libitum.*

Experimental diets

The leaves of traditional leafy vegetables (*Amaranthus hybridus, Hibiscus sabdariffa, Vigna unguiculata, Abelmoschus esculentus, Manihot esculenta, Ipomoea batatas, Celosia argentea, Myrianthus arboreus, Basella alba, Talinum triangulare, Colocasia esculenta, Solanum melongena, Corchorus olitorius*) were used. These leaves were purchased daily at 7 a.m on markets of Abidjan district. Leafy vegetables were sorted and disinfected before distribution to animals. They were immersed in each 10 L of water containing 2 mL of sodium hypochlorite (bleach) Super clean® concentrated at 12° for a few minutes to be disinfected. Then they were allowed to drain at room temperature (Kimsé *et al*., 2013). A commercial pelleted from the society Ivograin® usually used to feed rabbits served as control diet (Table 1).

Screening test

The screening test of 10 days (Adehan *et al*.; 1994) was conducted to test the level of palatability of young rabbits fed with thirteen leafy vegetables. Each leafy vegetable has been distributed to five rabbits housed individually. The animals were acclimated to the experimental conditions and diets for seven (7) days (Pérez *et al*., 1995). They were fed *ad libitum* daily with different diets. During this period, the animals received prophylactic treatment with antibiotics. Thus, Coccilium forte® (Amprolium hydrochloride 20% and 0.2% vitamin K3) was used in the drinking water to prevent coccidiosis at a dose of 1g/L of water for three days (Kpodékon *et*

al., 2009). Each rabbit received 300 g of leaves once daily at 9 am (Kriaas *et al.*, 2001). A batch of rabbits was fed a diet composed solely of commercial feed pelleted (control food). After acclimatization period, the rabbits were fed to satiation with different diets twice daily (9 am and 17 pm) until the age of 42 days. Every morning, left over were removed and weighed to determine the amount of ingested leafy vegetables.

Substitution test

The most palatable leafy vegetables obtained in the screening test were used for substitution test (Table 1). Each diet was composed of 50% pelleted diet (80 g) (control diet) and 50% of each tested leafy vegetables (400g) (Kriaas *et al*.; 2001). The rabbits were fed to satiation with different diets twice daily (9 am and 17 pm) until the age of 98 days in random order (de Blas and Wiseman, 2010). Each diet has been distributed to five rabbits housed individually. Water was provided *ad libitum* and renewed each morning.

Six treatment groups were used in this experiment:

-A: mixture of *Solanum melongena* with 50 % pelleted diet;

-B: mixture of 50% *Abelmoschus esculentus* with 50 % pelleted diet;

-C: mixture of 50% *Vigna unguiculata* with 50 % pelleted diet;

-D: mixture of 50% *Corchorus olitorius* with 50 % pelleted diet;

-E: mixture of 50% *Ipomoea batatas* with 50 % pelleted diet;

-F: 100 % pelleted diet (control diet).

Table 1: Proximal composition of leafy vegetables and control diet

Parameters	A	B	C	D	E	F
DM(%)	26.73	23.38	24.23	26.09	24.21	79.85
CP(% MS)	14.04	12.31	17.20	16.84	15.32	14.75
EE(% MS)	5.29	4.82	5.00	4.64	5.46	3.70
CF(% MS)	13.41	14.29	15.46	12.62	17.35	12.56
Ash (% MS)	11.40	9.18	9.38	9.56	11.22	9.6

A= Solanum *melongena*; B= *Abelmoschus esculentus*; C= *Vigna unguiculata*; D= *Corchorus olitorius*; E= *Ipomoea batatas*; F= Control diet.

DM: Dry Matter; CP: Crude protein; EE: Ether extract; CF: Crude fiber

Source: Zoro *et al.*, (2013); Acho *et al.*, (2014); Oulaï *et al.*, (2014) for leafy vegetables. Kimsé *et al.*, (2013) for control diet.

Measurement of growth performances

The feed intake was assessed daily by determining the difference between the amount of food distributed and the left over with an electronic precision balance 1/100. Every week, each rabbit was weighted. These different weights were used to determine the average daily weight gain (ADG) and feed conversion ratio (FCR).

Measurement of digestibility of dry matter and protein

The hard faeces from each cage were collected every morning before food distribution from 56th to 60th day of age (Perez *et al*., 1995). Faeces were weighed and stored in plastic bags labeled at -20°C for laboratory analyzes. For digestibility test, all of the excreta of each batch was first defrosted and dried in an oven for 24 h at 80°C. Half of each batch of faeces parboiled (80°C) was dried for 24 h at 103°C to determine the dry matter (Perez *et al*., 1995). The determination of the dry matter was based on the principle of the AOAC (1990) method. The total protein determination was carried out on the first half of faeces that has been stoved at 80°C (Perez *et al*., 1995).

Sampling and analysis of blood parameters

At 88th day of age, blood samples were withdrawn from three (3) rabbits per batch randomly selected for analysis. Two samples of three (3) mL of blood from each rabbit fasted 10 hours were taken in sterile flasks (4 mL Vacutainer tubes; BD-Plymouth®) early morning (6:00), from the central artery of the ear with a sterile disposable syringe of 5 mL (Coulibaly *et al.*; 2007).

Blood samples for hematological analysis were collected in flasks containing ethylene diamine tetraacetic acid (EDTA) and were delivered to the laboratory within 2 h of collection and promptly assayed. Hematological analysis was based on MINDRAY® BC-3200 technology (Poljičak-Milas *et al.*, 2009).

The samples for biochemical analysis were centrifuged (500 rpm, 3 mm) and separated also within 2 h of collection. The resulting blood serum was stored at 4°C until assayed. Biochemical parameters determination used a spectrophotometer (BIOLYZER® 100) at a wavelength of 500 nm.

Biochemical analysis

Proximate composition of diets were determined as followed: dry matter after drying at 105°C for 24 h, fat by petroleum ether extraction (Soxtherm, Gerhardt, Germany), protein content (N × 6.25) by the Kjeldahl method after acid digestion, ash by combustion at 550°C in a muffle furnace to a constant weight and crude fiber by acid/alkali digestion (AOAC, 1990).

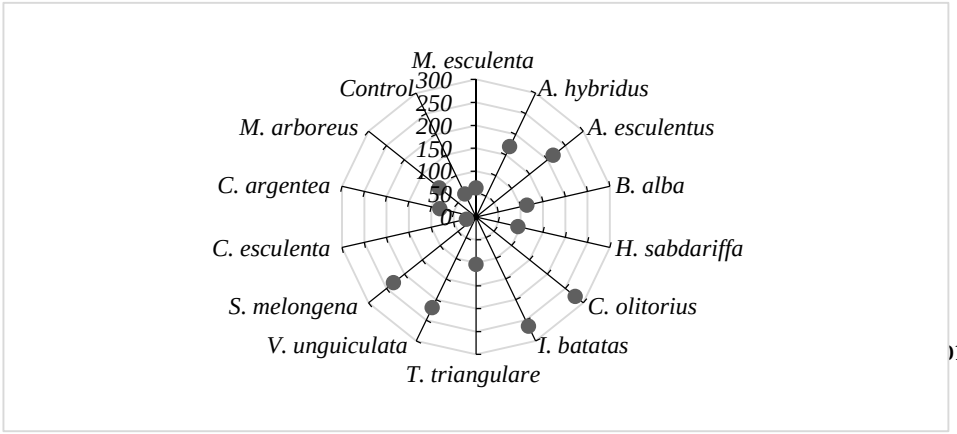
Statistical analysis

Data were subjected to analysis of variance (ANOVA) using SPSS17 software. Treatment means were compared by one-way analysis of variance followed by Duncan's test (0.05) (Duncan, 1955).

Results

Screening test

The rabbits fed with leaves of *Abelmoschus esculentus, Corchorus olitorius, Ipomea batatas, Vigna unguiculata* and *Solanum melongena* and those fed with concentrate showed positive growth and higher feed intake (216.16 g / d ± 43.50; 277.59 g / d ± 58.66; 364.80 g / d ± 39.85; 219.85 g / d ± 85.17; 229.70 g / d ± 38.75 respectively) (Figure 1). While rabbits fed with other leaves presented low feed intake and weight loss (Figure 2).



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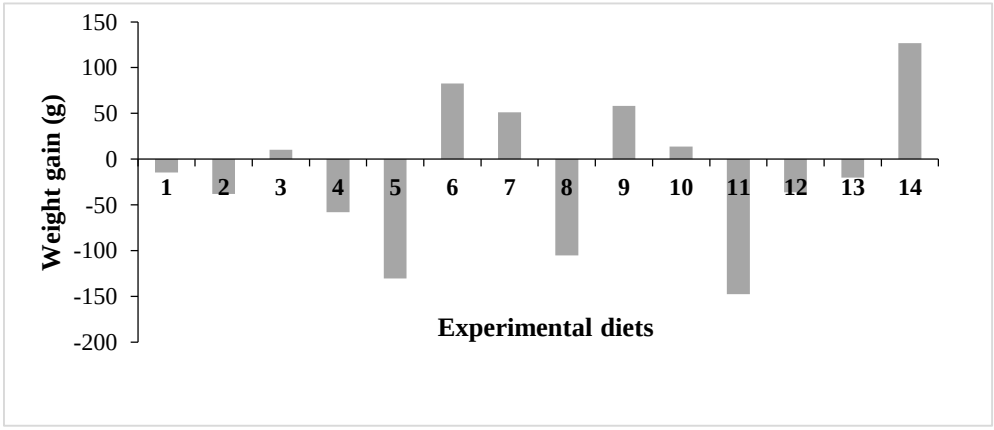

1= *Manihot esculenta*, 2= *Amaranthus hybridus*, 3= *Abelmoschus esculentus*, 4= *Basella alba*
5= *Hibiscus sabdariffa*, 6= *Corchorus olitorius*, 7= *Ipomea batatas*, 8= *Talinum triangulare*
9= *Vigna unguiculata*, 10= *Solanum melongena*, 11= *Colocasia esculenta*, 12= *Celosia argentea*
13= *Myrianthus arboreus*, 14=Control

Figure 2: Change in weight variations of older rabbits 35 days fed with 13 leafy vegetables for 10 days

Substitution test

After 56 days of breeding, changes in average weights of young rabbits per batch presented two stages of growth. Phase I (42-70 days of age)

indicated a period of strong growth and Phase II began with a lightweight top 70 to 98 days of age corresponding to the period of slow growth (Figure 3).

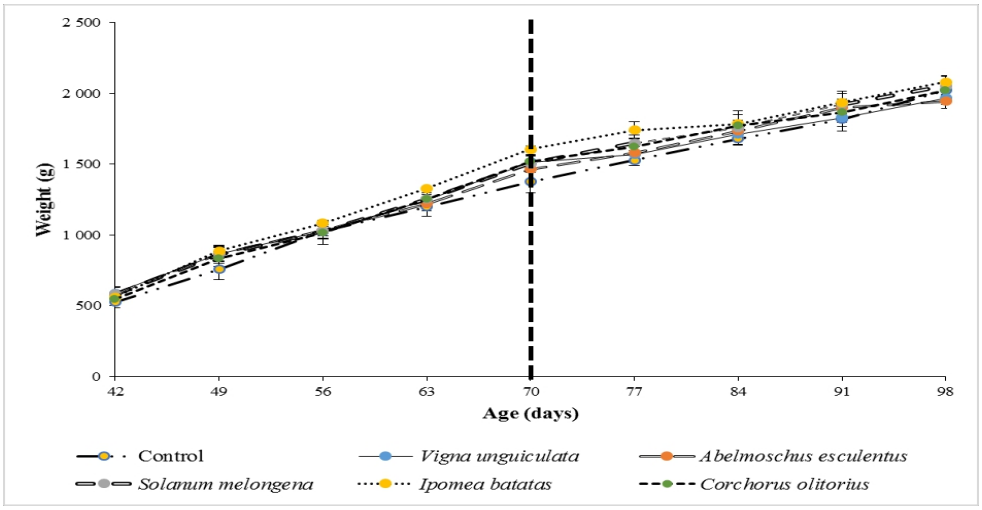

Figure 3: Evolution of body weights of rabbits aged 35 days fed with six diets for 56 days rearing

Daily weight gain ranged from 30.25 to 36.53 g/day and didn't differ ($p>0.05$) (Table 2). Daily feed intake (123.82-133.63 g/day) and feed conversion ratio (3-4.46) remained similar between different rabbit batches fed with a combination of leaves and pelleted diet ($p > 0.05$) but higher than those of batch fed with control diet 70 days (Table 2). During the same period, the rabbit fed with 50 % *Ipomea batatas* leaves added 50% control diet presented highest growth (1606.51 ± 23.99 g g) but did not differ from that obtained in the batches fed with the diets contained 50% *Vigna unguiculata* leaves and 50% leaves *Corchorus olitorius*. Lowest growth (1376.85 ±77.82 g) was recorded with the control diet (Table 2). However, during period from 70 to 98 days, the daily weight gain (16.23-24.32 g/day) decreased contrary to daily feed intake (104.64-177.81 g/day) and feed conversion ratio (4-8) that increased and differed between treatments ($p > 0.05$).

Table 2: Growth performance of rabbits

Parameters	*A	*B	*C	*D	*E	**F
Initial weight (g)	571.50 ± 52.14^{a}	572.78 ± 48.93^{a}	569.86 ± 39.74^{a}	545.61 ± 61.86^{a}	560.74 ± 22.35^{a}	536.02 ± 12.03^{a}
			Final weight (g)			
70 day of age	1504.79 ±61.78^{b}	1465.39 ± 8.84^{ab}	1513.67 ± 43.67^{bc}	1520.89 ± 43.94^{bc}	1606.51 ± 23.99^{c}	1376.85 ±77.82^{a}
98 day of age	2053.92	1944.22 ±	1968.17 ±	2024.15 ±	2081.87 ±	2022.14 ±

	±75.08^{bc}	51.08^{a}	46.14^{ab}	38.35^{abc}	36.57^{c}	60.55^{abc}
Daily weight gain (g/day)						
35 – 70 day of age	32.97 ± 6.74^{a}	30.68 ±7.91^{a}	32.53 ± 8.73^{a}	33.48 ± 6.06^{a}	36.53 ± 8.23^{a}	30.25 ± 3.92^{a}
70 – 98 day of age	19.61 ± 3.41^{ab}	17.10 ± 7.79^{ab}	16.23 ± 5.79^{a}	17.97 ± 4.66^{ab}	20.15 ± 1.22^{ab}	24.32 ± 3.48^{b}
35 – 98 day of age	26.29 ± 8.69^{a}	23.89 ± 10.27^{a}	24.38 ± 11.09^{a}	25.73 ± 9.68^{a}	28.34 ± 10.31^{a}	27.29 ± 4.67^{a}
Daily feed intake (g/day)						
35 – 70 day of age	123.82 ±18.314^{b}	124.24 ± 21.85^{b}	133.63 ±13.69^{b}	135.23 ± 13.52^{b}	139.43 ±20.35^{b}	90.60 ± 20.44^{a}
70 – 98 day of age	146.13 ± 5.178^{b}	148.67 ± 3.30^{b}	144.26 ± 7.90^{b}	152.64 ± 4.68^{b}	175.81 ± 7.17^{c}	104.64 ± 5,89^{a}
35 – 98 day of age	134.98 ± 17.25^{b}	136.46 ± 19.49^{b}	138.95 ±11.81^{b}	143.93 ± 13.20^{c}	157.62 ±24.04^{c}	97.62 ± 15.82^{a}
FCR						
35 – 70 day of age	3.96 ± 0.61^{a}	4.41 ± 0.72^{a}	4.46 ± 0.84^{a}	4.19 ± 0.69^{a}	4.07 ± 0.63^{a}	3.00 ± 0.48^{a}
70 – 98 day of age	7.45 ± 0.33^{b}	8.69 ± 0.45^{b}	8.89 ± 0.67^{b}	8.49 ± 0.94^{b}	8.73 ± 0.19^{b}	4.30 ± 0.76^{a}
35 – 98 day of age	5.13 ± 0.42^{b}	5.71 ± 0.57^{b}	5.70 ± 0.77^{b}	5.59 ± 0.86^{ab}	5.67 ± 0.32^{b}	3.51 ± 0.64^{a}

Values are means ± SD (n = 5). Means in the same row having different superscripts are significantly different (P < 0.05). (*): Each 50% leafy vegetables were associated to 50% control diet. (**): 100% control diet. FCR : Feed conversion ratio.

Dry matter and protein digestibility

Dry matter and protein digestibility ranged from 65.49 to 87.86 % and 89.73 to 94.82 % respectively (Table 3). The dry matter digestibility of rabbits fed with diets test added with leaves was higher than those obtained in rabbits fed with the control diet. Protein digestibility of rabbits fed with different diets tests did not differ statistically ($p > 0.05$) (Table 3).

Health status

Health status for each batch of rabbits was evaluated (Table 4). Symptoms observed were mainly bloating and diarrhoea. The rabbits fed with the control had been swollen (4 in all) while the other groups indicated one bloating per batch except the rabbits belonged to *Vigna unguiculata* group. One death by treatment was recorded in batches of rabbit fed with *Abelmoschus esculentus*, *Vigna unguiculata*, *Ipomea batatas* leaves however the dead rabbits had the diarrhoea except the rabbit group for *Vigna unguiculata* leaves.

Blood parameters

Blood parameters are presented in table 5. Urea content (0.21 - 0.27 g/L) and creatinine content (8.25 to 9.50 g/L) did not differ between treatments ($p > 0.05$). Blood glucose and total protein content of rabbit fed with *Solanum melongena* leaves were the highest and the lowest content was observed with rabbits fed with control diet and *Ipomea batatas* leaves, respectively. Total cholesterol content of blood rabbit fed with *Ipomea batatas* leaves and control diet were higher than those of other batches ($p > 0.05$).

Table 3 : Dry matter and protein digestibility in rabbit

Parameters	Diets					
	*A	*B	*C	*D	*E	**F
DMD (%)	84.51 ± 5.18^{b}	87.71 ± 4.57^{b}	83.76 ± 3.93^{b}	83.35 ± 4.35^{b}	87.86 ± 5.17^{b}	65.49 ± 6.37^{a}
PD (%)	94.82 ± 1.49^{a}	93.01 ± 7.05^{a}	91.92 ± 3.83^{a}	94.33 ± 1.94^{a}	96.22 ± 1.81^{a}	86.73 ± 12.81^{a}

Values are means ± SD (n = 5). Means in the same row having different superscripts are significantly different ($P < 0.05$). DMD : Dry matter digestibility, PD : Protein digestibility, (∗): Each 50% leafy vegetables were associated to 50% control diet, (∗∗): 100% control diet

Table 4: Health status of rabbits fed diets with different diets

Parameters	*A	*B	*C	*D	*E	**F
Bloating	1	1***		1	1***	4
Dead		1	1		1	

(∗): Each 50% leafy vegetables were associated to 50% control diet. (∗∗): 100% control diet. (***) : diarrhoea

Table 5: Blood parameters of rabbit groups fed leafy vegetables for 56 days

Diets	Blood parameters				
	Urea (g/L)	Glucose (g/L)	Creatinine (mg/L)	Total protein (g/L)	Total cholesterol (g/L)
∗*Solanum melongena*	0.27 ± 0.03^{a}	0.94 ± 0.04^{b}	9.50 ± 0.42^{a}	68.40 ± 0.14^{c}	0.31 ± 0.02^{a}
∗*Abelmoschus esculentus*	0.21 ± 0.01^{a}	0.82 ± 007^{ab}	9.05 ± 0.78^{a}	63.10 ± 1.27^{ab}	0.33 ± 0.05^{a}
∗*Ipomea batatas*	0.20 ± 0.05^{a}	0.86 ± 0.04^{ab}	8.67 ± 0.98^{a}	60.85 ± 1.77^{a}	0.46 ± 0.05^{b}
∗*Corchorus olitorius*	0.22 ± 0.07^{a}	0.81 ± 0.03^{ab}	8.25 ± 1.20^{a}	63.50 ± 1.13^{ab}	0.28 ± 0.05^{a}
∗*Vigna unguiculata*	0.24 ± 0.03^{a}	0.87 ± 0.04^{ab}	8.65 ± 0.35^{a}	66.65 ± 1.06^{c}	0.35 ± 0.01^{a}
∗∗Control	0.21 ± 0.04^{a}	0.77 ± 0.09^{a}	8.65 ± 0.64^{a}	63.80 ± 0.57^{b}	0.43 ± 0.01^{b}

Values are means ± SD (n = 5). Means in the same row having different superscripts are significantly different (P < 0.05), while values in the same row with same superscript are not significantly different (P > 0.05).

(∗): Each 50% leafy vegetables were associated to 50% control diet

(∗∗): 100% control diet

ND : No detected

HDL High Density Lipoprotein

LDL: Low Density Lipoprotein

Discussion

The present study was carried out to assess the effects of leafy vegetables feeding on the palatability, growth, digestibility of protein and health of rabbit *Orytolagus cuniculus*. The high feed intake recorded for the leaves of species *Abelmoschus esculentus*, *Corchorus olitorius*, *Ipomea batatas*, *Vigna unguiculata* and *Solanum melongena* showed that the rabbits appreciated these leaves. This high palatability had a positive effect on the rabbit growth. But this growth was significantly lower than rabbits fed only with the control diet. Indeed leafy vegetables are less nutritive than control granules to allow optimum growth. The reasons for these differences in palatability of rabbits fed with different forages are unknown, and could not be explained through this study. This because palatability is a complex phenomenon determined by dietary type and environmental variables (Marten, 1978; Molyneux and Ralph, 1992). It could be argued to aversion, the decrease in preference for food just eaten as a result of sensory input (taste, odor, texture, i.e. food's flavour) and post-ingestive effects unique to each food (Provenza, 1995) but not necessary to novel foods and macronutrient contents of their basal diet as suggested by some authors (Cheeke, 1986; Osakwe and Ekwe, 2007). Indeed, *Manihot esculenta* leaves contained 21% crude protein (CP) and *Abelmoschus esculentus* leaves (9.19% CP) had been refused and accepted respectively by the rabbit in this study.

The leafy vegetables *Abelmoschus esculentus*, *Corchorus olitorius*, *Ipomea batatas*, *Vigna unguiculata* and *Solanum melongena*, more palatable were then selected for the growth test.

The growth performances indicated a growth phase from 42 to 70 days of age where the growth increased quickly and another from 70 to 98 days of age corresponding to lowest growth. In fact, after weaning, rabbits continued their growth and their food requirements increased in quantity and quality. The food should cover the nutritional needs of the animals and allow them to externalize their growth potential (Kadi, 2012). Thus, the ingestion of rabbit increases correlatively to its live weight and reached a plateau between 4 and 5 months of age (Gidenne and Lebas, 2005). The growth increased in the first period resulted high amount of food consumed to cover

needs. The growth performances were improved and reached the high value at 70 days of age (de Blas and Wiseman, 2010). Similarity of diets composition explained similar growth performances.

Overall after 28 days of rearing, the final weight and daily weight gain of rabbits fed with combination of pelleted and leafy vegetables were highly compared to growth rabbits fed only with pelleted diet. The results obtained in this study corroborate with the findings of Ojewola *et al.* (1999) and Adeyemo *et al*. (2014) that rabbit perform better when fed mixture of forage and concentrate. Growing rabbits on concentrate recorded the lowest final weight and this could be attributed to concentrate feeding only without inclusion of forage in their diet. Also this is in accordance with the work of Adeyemo *et al*. (2013, 2014), who reported lower live weight in rabbit fed concentrate alone without supplementation with forage. The freshness of the leaves could also increase the appetite of young rabbits. The weights (1504,79 - 1606,51g) recorded to 70 days of age in the rabbits fed with *Solanum melongena, Ipomea batatas, Vigna unguiculata, Corchorus olitorius* leaves supplemented to pelleted, would be an opportunity for market through weight of 1.5 kg for rabbits (California, New Zealand) aged 70 days. This finding was better than those reported by Adeyemo *et al*. (2014) who showed that the substitution of 50% pellet with forage (*Tridax procumbens*) allowed to rabbits to gain 1.4 kg at 70 days of age. However, Kriaas *et al*. (2001) showed that the substitution of 50% pellet with green barley allowed rabbits to have of 1.7 kg at 70 days of age. Similarly, Adeyemo *et al*. (2013) studied the effect of concentrate to forage ratio on performance of rabbits, observed that for optimum performance of rabbits, 50% concentrate and 50% forage should be given to rabbits for optimum performance. Also Kimsé *et al*. (2014) reported that tropical forages such as *Centrosoma pubescens, Albizia lebbeck* and *Andropogon gayanus* in addition to industrial pellet diet, favored weight in rabbits closed to 1.7 kg at 70 days of age. This difference could be attributed to the high protein and crude fiber content of composition diet used by these authors.

The average feed conversion ratio FCR (3.51) calculated over the entire period of the diet test was significantly different from other indices for other diets that varied between 5.13 and 5.71 and this probably because of its energy level higher and better balanced as reported by Hedhly *et al*. (2010). The highest feed intake and feed conversion ratio (FCR) obtained in rabbits fed with combination, are in agreement with the reports of Abonyi *et al*. (2014).

The daily feed intake and daily weight gain obtained, whatever the regime, tend to decrease after the 10th week of age after the end of the optimal growing period. Our results corroborate those of Hedhly *et al*. (2010) and de Blas and Wiseman (2010).

The digestibility coefficients of dry matter and protein in combination diets recorded in this study were better than values reported by Adegobla and Okonkwo (2002). This high digestibility favored by the fiber of leaves which facilitated intestinal transit and increased the time of feed retention. Therefore, the rabbits fed with combination consumed probably more feed to satisfy their energy needs.

The rabbit health status was significantly affected by the diets in this study. This finding is reported by Kimsé *et al*. (2014). The digestive dysfunction leading to disorders whose main symptom is diarrhoea leading to morbidity and mortality in the growing rabbit as reported Berchiche *et al*. (1998); Lounaouci (2001), Kimsé *et al*. (2014). Almost all rabbits fed with pelleted diets were bloated while this symptom was observed in a rabbit fed with other diets. The morbidity and mortality of rabbits could be linked to change foods and the low crude fiber in this study.

Blood traits studied were all in accordance to Van Praag (2004). The values of the blood chemistry parameters were influenced by food except for urea and creatinine. These results were different to findings of Garba and Mohamed (2015) and, Njidda and Isidahomen (2010) who fed rabbits with other foods. The mean values obtained did not follow any specific trend across the treatments as reported Garba and Mohamed (2015) who fed rabbits with different inclusion level of yam peels in diet.

The recorded variations in total protein stemmed from the different rate of protein metabolism and utilization by the rabbits. The values obtained were in line with earlier observation for healthy rabbits (Makinde, 2016; Saleh *et al*., 2014). Rabbits fed with *Solanum melangena* and *Vigna unguiculata* had higher serum total protein value (68.40 g/L and 66.65g/L). This indicated that the diet was relatively of good quality and that rabbits fed with these diets were more efficient in protein metabolism and utilization. Rabbits fed with other diets showed similar values. This revealed that the rate of protein metabolism and utilization were similar.

The identical creatinine values indicated normal muscle metabolism as reported Onifade and Tewe (1993). The results also suggested that there was no wasting or catabolism of muscle tissues as reported by Njidda and Isidahomen (2010), and those animals were not surviving at the expense of body reserve. This was a good indication that dietary protein was well utilized by rabbits.

There were no significant differences ($P>0.05$) among treatments for urea. This is in agreement with the findings of Makinde (2016) who fed rabbits with concentrate diet supplemented with white lead tree (*Leucaena leucocephala*) or Siratro (*Macroptilium atropurpureum*) leaves. The urea values in this study indicated the good liver health. Then morbidity and

mortality recorded may be not associated with severe liver disease or protein malnutrition.

Glucose and cholesterol levels were within the normal range. Therefore, possibilities of anorexia, diabetes, liver dysfunction and mal-absorption of fat, which are the symptoms of abnormal glucose and cholesterol levels in the blood (Bush, 1991) are ruled out.

Conclusion

The integration of greenery in rabbit feed led to satisfactory growth and did not cause adverse effects on animal's health. Growth and health of rabbits subjected to this combination was better than those recorded with rabbits fed only with the concentrate. This combination also allowed for market sizes of rabbits at 70 days of age. The serum biochemistry of the experimental rabbits indicates that the experimental feed were nutritionally adequate for the experimental rabbit. These results have shown the potential usefulness of leafy vegetables as a complement in rabbits' feed. However, it would be interesting to determine the nutritive quality of rabbits obtained.

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