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Comparative Study of Growth and Hematologic Characteristics in Dwarf Rabbit Doe (*Oryctolagus cuniculus*) Fed with Cowpea and Peanut Offal in the North Region of Cameroon

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Abstract

Background and purpose: Cowpea and peanut offal are massively produced in the North region of Cameroon and kept in the fields or sometimes burn after the harvest. They are rich in some interesting nutritive substances (proteins, cellulose, calcium, and phosphorous…) and can be used to boost the growth performances of herbivore animals in dry season or in the area characterized by a scarceness of fresh herbs. The present study was designed to compare the growth and hematologic characteristics in dwarf does (*Oryctolagus cuniculus*) fed with cowpea and peanut offal in the Bethleem Foundation farm in Mouda, North region of Cameroon.

Methods: Twenty (20) dwarf rabbits aged 8 to 12 weeks and weighing in average 852.5g ± 200g were randomly assigned to two groups corresponding to two treatments of 10 rabbits each. Both groups were comparable in terms of body weight. After 90 days of experimentation, the animals in each group were sacrificed to evaluate the development of digestion organs and hematological characteristic values.

Results: Food intake increased significantly (P<0.05) in rabbits fed cowpea offal (7718.30 ± 51.1g) compared peanut (7775.36 ± 32.95g). Cowpea offal increased non-significantly live body weight (1242.42 ± 90.07g) and gain weight (203.60 ± 35.75g) compared to peanut (1194.57 ± 58.27g and 174.22 ± 34.54 respectively for live body weight and weight gain). The feed conversion ratio was significantly lower in rabbits

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exposed to cowpea (20.28 ± 5.59) compared to peanut (36.41 ± 15.68). With the exception of carcass yield 2, which increased significantly ($p < 0.05$) in animals fed cowpea offal compared to those fed peanut hay, the values of digestion organs and hematological characteristics were comparable in animals fed both offal. With respect to peanut offal, the weights of the filled stomach, intestine, intestinal density and stomach content tended to increase in animals exposed to cowpea hay.

Conclusion: Cowpea offal induces the best growth performance and should be preferably used in the dry season to compensate for the lack of pasture.

Introduction

In the whole world, the consumption of animal proteins continues to increase due to the growth of the population and eating habits. In Africa, one-third of the population is undernourished, mainly in animal proteins [1]. In order to solve this problem, a special attention was focused on the animals such rabbits with high growth and reproductive performances [2]. According to Lebas [3]; Jentzer [4], a female rabbit gives birth to 51.8 offsprings per year in the suitable environment. The annual production of meat supplied by rabbits is 25 to 35 times its weight, which corresponds to 130 kg of carcass yield per year [5]. In 6 to 16 weeks old, rabbit meat protein content is 45% higher than in lambs. This high protein efficiency combined with excellent prolificity make rabbits the highest productivity per hectare among all meat produce [6]. In addition, rabbit has high nutritional and dietary qualities in meat. The protein proportion in rabbit meat is 21 vs. 18 and 19.5% respectively in beef and chicken [7]. The production of the rabbit is estimated at more than one million tonnes per year in the whole word. In Cameroon, rabbit meat production is 600 tonnes per year [8]. Despite the interest and importance of rabbit productions, breeders in arid areas face rising cost of production or poor performance in general and particularly in drying season due to the scarceness of fresh herbs.

Rabbits are herbivores that feed mainly on herbs and seeds that do not directly consume by human, unlike pigs and poultry that compete with humans on feed [9]. In the dry season, herbs are scare and the breeder complete rabbit diet with commercial ingredients. This situation increases the cost of production at the expense of profit. As a result, cowpea and peanut offal which is let in the fields or sometimes are burn after the harvests seem to be an obvious solution. They are rich in cellulose, protein, and digestible nitrogen materials [10]. Peanut offal has high content of crude protein (100-180 g/kg dry matter) and lower neutral detergent fiber (466 g/kg dry matter) [11]. It is also rich in Calcium (12 g/kg dry matter) and phosphorous (1.7 g/kg dry matter) [12]. In the other hand, the proportions of crude protein, organic matter and cellulose in cowpea offal are 13.6, 85.2 and 32% respectively [13]. Due to the chemical composition of these offal, they can be used in the arid area to reduce the cost of production and boost herbivore animal performances. This work highlights the effects of cowpea and peanut offal in animal production and more specifically the effect of both offals on growth characteristics; development of digestive organs and hematological parameters in dwarf does.

Materials and methods

Study area

The study was conducted from February to May 2019 in Mouda, a village in the Moutourwa district, Department of Mayo-kani and Region of Extreme North Cameroon. Mouda is located between the 10th degree Latitude Nord (10-21' 565''N) and the 14th degree Longitude East (14-13'915''E). It is 33 km from the city of Maroua and about 17 km from the city of Moutourwa.

Plant material

The plant material consisted of cowpea (*Vigna unguiculata*) and peanut (*Arachis hypogea*) offal, harvested in November 2018 at Moutourwa district and stored as ruminant food. The mortar and pestle allowed us to pound both offals to facilitate its ingestion by the animals (Figure 1 & 2).

Figure 1: Intact *V. unguiculata* offal **(a)** and Pounded **(b)**

Figure 2: Intact *A. hypogea* offal **(a)** and Pounded **(b)**

Animal material and experimental design

The experiment lasted 12 weeks and a total of 20 dwarf does of 2 to 3 months, weighing 800-900 g, reared at Farm of the Betheleem Foundation of Mouda, were used. The 20 rabbits were equally divided into two groups comparable in terms of their body weights. Animals of each group were individually maintained in cages of wire netting (42 cm long, 25.5 cm wide and 28 cm high) and in galvanized metal, forming a battery of cages. The animal weight was taken at the beginning and weekly to the end of the experiment for the determination of growth performances. The animals received feed and water ad libitum in adapted eater and an automatic drinker respectively.

Parameters measured

Food consumption

Food give to an animal was weighed and distributed daily. The refusals in each group were collected at the end of the day, weighed with an electronic scale of 500 g and 10-1 g precision and recorded from the first day to the last. Daily food consumption was calculated by the following formula.

$$FC\ (g) = \frac{(Amount\ of\ food\ distributed\ (g) - Refusals(g))}{\text{Expirience length (day)}}$$

Life body weight and body weight gain

The animals were weighed using an electronic scale of 7 kg and 10^{-1} precision, on the first day and every week thereafter. Body weight gain was obtained by the difference in life body weight of two consecutive weeks according to the procedures of McDonald *et al*. [14]

Feed conversion ratio

The weekly Feed conversion ratio was obtained by dividing the amount of food ingested during each week by the body weight gain in the same week.

Organs characteristics and hematological analysis

At the end of the experiment, animals of each group were slaughtered for organs characteristics assessment and blood samples were collected for hematological analysis.

The animals were slaughtered according to the following steps:

1- Animals were fasted for 24 hours;

2- They were weighted with the electronic scale of 7 kg and 10^{-1} precision, and slaughtered by decapitation as indicated by Jourdain [15];

3- The skin of the rabbit including the tail and complete entrails were carefully removed;

4- The head and limbs were cut off.

➢ The relative weight of each organ was calculated using the following formula:

Relative weight (%) = (Organ weight (g)/(Live weight (g)) X 100

➢ Carcass yields were calculated according to the following formula:

Carcass yield 1 (%) = (Weight of the carcass (g)/(Life body weight (g)) X 100

Carcass yield 2 (%) = (weight (g) of the carcass –Hear -Limbs-Heart- Liver -Pancreas)/(**Life body weight**

➢ **Bowel measurement**

The small intestine length was measured with the cut done from the start of the duodenal loop to the end of the ileum and hanging vertically alongside a measuring tape. The density of the intestine was calculated by dividing the intestine weight by its length [16].

➢ **Hematological parameters**

Blood collected during decapitation in the identified tubes with anticoagulant was used for blood count using a veterinary hematology automaton. The parameters studied included white blood cell, red blood cell, hemoglobin, haematocrit and platelets...

Statistical analysis

The statistical analysis of the data was performed using SPSS 20.0 software. Differences between groups were assessed using student t- test and a p value of less than 0.05 was considered as significant. The results obtained are expressed as mean ± standard deviation.

Results

Effects of offal type on growth characteristics in dwarf Rabbit Doe

Table 1 summarizes growth performance in dwarf rabbits doe fed on cowpea (*V. unguiculata*) and peanuts (*A. hypogea*) offal. As a result, food intake increased significantly ($p< 0.05$) in cowpea-fed rabbits in reference to that of peanut. The values of live body weight and body weight gain were comparable in animals fed with cowpea and peanuts offal. Although statistically comparable, the values of these growth characteristics have tended to increase in animals exposed to cowpea offal. The Food conversion ratio decreased significantly ($p< 0.05$) in rabbits fed cowpea offal compared to peanuts.

Variation in carcass yield and relative organ weights in dwarf Rabbit Doe depending on the type of offal

Table 2 shows the variation in carcass yield and relative organ weights in dwarf Rabbit Doe depending on the type of offal. It shows that, with the exception of carcass yield 2, which increased significantly ($p< 0.05$) in cowpea-fed animals, the values of the other parameters were comparable between animals fed with both offals. However, in the reference to the peanut offal-fed animals, the value of carcass yield 1 has tended to increase in rabbits exposed to cowpea offal. The reverse effect was recorded with the head, liver, pancreas and abdominal fat weights in the same group.

Effects of offal type on the development of digestive organs and stomach content in dwarf Rabbit Doe

The effects of offal type on the development of digestive organs and stomach content in dwarf Rabbit Doe are summarized in Table 3. As a result, the weights of the digestion organs under study and the content of the stomach in rabbits were not significantly ($P > 0.05$) affected by both types of offal. However, the weights of the intestine and filled stomach, the density of the intestine and the content of the stomach have tended to increase with cowpea offal. Conversely, the weight of the empty stomach and the length of the intestine decreased.

Hematological parameters in dwarf Rabbit Doe fed with cowpea and peanut offal

Leukocyte indexes

Table 4 summarizes the effects of the offal type on the Leukocyte indexes in dwarf Rabbit Doe. The results show that cowpea and peanut offal did not have a significant effect ($p> 0.05$) on the leukocyte indexes considered. Although statistically comparable, the values of white blood cells, lymphocytes, monocytes and granulocytes decreased in cowpea-fed animals compared to the values recorded in rabbits exposed to peanut.

Erythrocyte and Platelet Indexes in cowpea and peanut offal-fed dwarf Rabbit Doe

Table 5 highlights Erythrocyte and Platelet Indexes in cowpea and peanut offal-fed dwarf Rabbit Doe. It shows that the values of the Erythrocyte and platelet indexes studied were not significantly affected ($p> 0.05$) by offal whatever the type. However, the values of red blood cells, hemoglobin, Plateletcrit have tended to decrease in cowpea-fed animals with reference to peanut.

Table 1: Effects of offal type on growth characteristics in dwarf Rabbit Doe.

Growth characteristics	Types of offal		*P-value*
	V. unguiculata (n=10)	*A. hypogea* (n=10)	
Feed intake (g)	7718.30 ± 51.18[b]	7775.36 ± 32.95[a]	0.00
Life body weight (g)	1242.42 ± 90.07	1194.57 ± 58.27	0.26
body weight gain (g)	203.60 ± 35.75	174.22 ± 34.54	0.08
Food conversion ratio	20.28 ± 5.59[b]	36.41 ± 15.68[a]	0.01

[a, b] On the same line, means with the different letter were significantly different (p< 0.05). *n* =number of Rabbit Doe

Table 2: Variation in carcass yield and relative organ weights in dwarf Rabbit Doe depending on the type of offal.

Parameters (g /100 g bw)	Types of offal		*P-value*
	V. unguiculata (n=10)	*A. hypogea* (n=10)	
Carcass yield 1	51.79 ± 4.30	49.30 ± 2.53	0.20
Carcass yield 2	80.84 ± 5.00[a]	74.18 ± 3.85[b]	0.01
Head	10.09 ± 0.70	10.12 ± 0.26	0.93
Limbs	2.78 ± 0.34	2.59 ± 0.50	0.42
Kidneys	0.28 ± 0.08	0.22 ± 0.06	0.19
Heart	0.28 ± 0.08	0.22 ± 0.06	0.19
Liver	2.22 ± 0,23	2.23 ± 0.38	0.96
Pancreas	0.12 ± 0.05	0.13 ± 0.05	0.73
Skin + fur	7.13 ± 0.84	6.71 ± 0.88	0.38
Abdominal fat	0.20 ± 0.14	0.24 ± 0.11	0.61

[a, b] On the same line, means with the different letter were significantly different (p< 0.05). *n* =number of Rabbit Doe

Table 3: Effects of offal type on the development of digestive organs and stomach content in dwarf Rabbit Doe.

Parameters	Types of offal		*P-value*
	V. unguiculata (n=10)	*A. hypogea* (n=10)	
Filled stomach (g /100 g bw)	4.50 ± 1.38	4.10 ± 1.64	0.62
Empty stomach (g /100 g bw)	1.28 ± 0.22	1.37 ± 0.33	0.56
Weights of the intestine (g)	12.83 ± 3.90	12.25 ± 2.15	0.74
Length of the intestine (cm)	28.51 ± 2.78	29.49 ± 1.85	0.45
Density of the intestine (g/cm)	0.45 ± 0.13	0.41 ± 0.07	0.57
Contents of the stomach (g)	3.22 ± 1.27	2.73 ± 1.44	0.50

n =number of Rabbit Doe.

Table 4: Leukocyte indexes in dwarf Rabbit Doe fed with cowpea and peanut offal.

Leukocyte indexes (10^3 /µl)	Types of offal		P- value
	V. unguiculata (n=10)	*A. hypogea* (n=10)	
White blood cell	5.12 ± 2.63	7.82 ± 4.13	0.17
Lymphocyte	3.77 ± 1.67	5.84 ± 3.07	0.14
Monocyte	0.10 ± 0.07	0.25 ± 0.28	0.19
Granulocyte	1.23 ± 0.99	1.73 ± 0.90	0.34

n =number of Rabbit Doe.

Table 5: Erythrocyte and Platelet Indexes in cowpea and peanut offal-fed dwarf Rabbit Doe

Erythrocyte and Platelet Indexes	Types of offal		P-value
	V. unguiculata (n=10)	*A. hypogea* (n=10)	
Red blood cell (×10⁶ /µl)	4.47 ± 1.53	5.17 ± 0.78	0.30
Hemoglobin (g/dl)	10.82 ± 3.61	10.91 ± 1.03	0.95
Haematocrit (%)	33.85 ± 12.27	41.41 ± 5.23	0.16
Mean cell Volume (fl)	75.42 ± 5.94	80.57 ± 7.61	0.18
Mean cell hemoglobin (pg)	19.36 ± 2.03	21.44 ± 3.12	0.19
Mean cell hemoglobin concentration (g/dl)	25.55 ± 0.95	26.54 ± 2.58	0.39
Red blood cell distribution width (%)	18.32 ± 1.61	18.34 ± 0.62	0,98
Platelet count (10³ /µl)	177.78 ± 21.52	139.28 ± 69.46	0.65
Plateletcrit (%)	0.72 ± 0.88	0.60 ± 0.23	0.72
Mean platelet volume (fl)	4.62 ± 0.80	4.54 ± 0.76	0.84
Platelets distribution width (%)	26.35 ± 3.80	25.81 ± 3.21	0.77

n =number of Rabbit Doe.

Discussion

In the present study, food intake increased significantly (p<0.05) in cowpea offal-fed dwarf Rabbit Doe in reference to that of animals fed on peanut offal. This effect would result from certain constituents of cowpea offal that have increased their digestibility. According to Rivière [17], food ingestion is correlated to its availability, constituents and animal desire. Live body weight and body weight gain values have tended to increase in animals exposed to cowpea offal in reference to peanuts. This result would be justified by the high rate of crude protein in cowpea offal. River [18] reported raw protein levels of 10.7% and 14.0%, for peanut and cowpea offal respectively. According to Fanny [19], proteins are interesting elements for growth and development of animal cells. A food rich in proteins would increase the animal membrane thickness and subsequently increase animal weight. The food conversion ratio decreased significantly (p<0.05) in rabbits fed cowpea offal compared to peanuts. This effect would result from an increase in the body weight gain in the same group.

Carcass yields 1 and 2 increased in cowpea offal-fed animals compared to those fed on peanuts. The increase in carcass yield is a logical consequence of the increase in live body weight and body weight gain noted in cowpea offal-fed animals group. According to Ouhayoun [20], the rabbit's carcass yield is positively correlated with its live body weight.

The weights of filled stomach and stomach content increased non-significantly (p> 0.05) in cowpea offal-fed animals in reference to peanut. This effect would result from the high cellulose content of cowpea offal which is 34.8% versus 32.1% for peanuts [13]. A high cellulose intake would increase food transit time in the gastrointestinal tract.

The weights of the kidneys and livers were respectively used to verify the nephrotoxicity and hepathotoxicity. According to Rouas [21], kidneys and liver are key animal organs which eliminate various environmental toxins that continually attack and destroy animal cells. The liver has many metabolizing enzymes that allow the degradation and purification through the urinary tract the hydrophilic compounds and the biliary elimination of less water-soluble compounds. The kidney, due to the formation of urine, is the second key organ of the detoxification process. The kidneys have xenobiotic metabolism enzymes that contribute to the purification and detoxification of the body. The increase in the weight of these organs would testify to their great involvement in the elimination of undesirable substances to the body. In the present study, liver and kidney weights were comparable in cowpea and peanut offal-fed animals.

The weight and the density of the intestine are used as indicators of better digestion and absorption of nutrients in the animal gastrointestinal tract [22]. The increase in the values of these characteristics would positively correlate to the increase in the size of the villi in the lumen of the small intestine and therefore the absorption area of nutrients. The cowpea offal in the present investigation induced slightly increase in weight and density of the intestine. These results would justify a good absorption of cowpea offal nutrients.

Leukocyte indices (white blood cells, lymphocytes, monocytes, granulocytes) are the body's defense cells that attack foreign particles [23]. The proliferation of these blood cells would testify the microbial attack. In this study, the values of leukocyte indices were comparable in cowpea and peanut offal-fed animals. The values of the erythrocyte and platelet indices studied were not significantly affected (p<0.05) by the offal whatever the type. The variation in red blood cell count and hemoglobin rate is usually associated with endogenous and exogenous variation factors in which is classified food quality [24]. Red blood cells transport oxygen to body cells and deliver carbon dioxide to the lungs. They are also other additional functions including participation in control of systemic nitric oxide metabolism, redox regulation, blood rheology and viscosity (Kuhn *et al*. [25] while hemoglobin determines an animal's ability to withstand a certain level of respiratory stress [26]. These parameters can be used to determine the pathological condition of animals, while blood acts as a pathological reflector of animals exposed to toxins [27,28] and animals with normal values of blood composition show interesting performance [29].

Conclusion

At the end of this study on growth and hematologic characteristics in dwarf Rabbit Doe (*Oryctolagus cuniculus*) fed with cowpea and peanut offal in the North region of Cameroon. Cowpea offal induces an increase in growth characteristics (food intake, live body weight and weight gain) in rabbits in reference to peanuts. Carcass Yields 1 and 2 as well as density of the intestine increase in dwarf Rabbit Doe fed-cowpea offal compared to peanuts. Conversely, the weights of the detoxifying organs decrease. Based on these results, rabbit breeders can preferably use cowpea offal to boost the growth performances in dry season or in the area characterized by a scarceness of fresh herbs.

Ethical issue

Experimental protocol used in the present study was in accordance with recommendations of institutional guidelines for the care and use of laboratory animals. Rabbits were humanly handled in respect of the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments.

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