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Research Article

Effect of Moringa Oleifera Leaves and/or Stylosanthes Guianensis as a Protein Source on Post-Weaning Growth and Carcass in Guinea Pigs (Cavia Porcellus)

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Abstract

In order to contribute to the improvement of guinea pig feeding, a study was carried out between November 2020 and January 2021 at the T3F Batseng'la Poultry Farm (FERAVI T3F) and the Animal Production and Nutrition Research Unit of the Faculty of Agronomy and Agricultural Sciences (FASA) of the University of Dschang. It aimed to evaluate the effect of Moringa oleifera leaves and/or Stylosanthes guianensis as a protein supplement on post-weaning growth and carcasses of guinea pigs (Cavia porcellus). After weaning, 77 guinea pigs (36 females and 41 males) aged 3 weeks, all from a breeding experiment, were used. They were sexed, identified (with the number of the loop worn to their ear) and placed in fattening compartments at a rate of 19 ± 1 animals per treatment, corresponding to the group of their mothers respectively for the RMS0, RM30, RS30 and RMS15 rations (RMS0: control, RM30: 30% Moringa oleifera leaves, RS30: 30% Stylosanthes guianensis and RMS15: 15% Moringa oleifera leaves +15% Stylosanthes guianensis). The rations were allocated to their batches and each animal received 50 g of feed each day between 6 and 8 a.m. weighing of feed served and refusals determined feed intake. Weight growth was followed by weighing the pups from the start of the trial and then once a week until week 16. The weights recorded made it possible to evaluate the post-weaning weight evolution from the 3rd to the 16th week as well as the corresponding total gains (TG) and the corresponding average daily gains (ADG). The results show that: feed consumption was comparable between sex and between rations. The RMS15 ration showed better weight gains (TG and ADG) (359g, 334.67g, 346.84g and 3.95g, 3.68g, 3.81g) in males, females and regardless of sex respectively. Diets supplemented with forage legumes performed better than the control ration but remained comparable; a and the RMS15 ration containing 15% Moringa oleifera leaves +15% Stylosanthes guianensis would be most suitable for better growth in guinea pigs. Diets containing legumes resulted in the highest carcass weights, carcass yields, liver and cecum weights. Given the cost of production, the legumes in this study can be used as protein sources of choice for improving the production performance of guinea pigs in peasant environments.

Keywords: Cavia porcellus; Growth; Moringa oleifera; Stylosanthes guianensis

Abbreviations

TG: Total gains

ADG: Average daily earnings

FERAVI T3F: Tegang, Fossi, Fokam and Foyang poultry farm

Introduction

Food security and meeting protein needs in particular is a real challenge in Africa [1]. The development of mini-livestock farming appears more and more as an essential solution for the fight against protein malnutrition [2]. Caviculture, born in Latin America and widely practiced in Cameroon, has the characteristics of an economically profitable mini-livestock that can participate effectively in food security and the satisfaction of animal protein needs [3-4]. Indeed, cavy is a herbivorous monogastric of small size, very prolific, easily handled which better values the fibers and provides meat of good quality (rich in protein, B vitamins and low fat) depending on the type of diet given [5]. Its carcass yield varies from 50 to 70 % [6]. In addition, this easy-to-practice livestock farming is an important source of income for Cameroonian populations [7-8]. Despite its many advantages, the productivity of cavy remains low. Indeed, this breeding still traditional and practiced by women and children, suffers from lack of follow-up and technicality .Its optimal use as a source of protein and income therefore requires an increase in its production and productivity, which necessarily involves improving livestock strategies on one hand and better rational methods of managing its production on the other hand [9]. However, its diet is one of the main handicaps to its production in Africa and Cameroon in particular; since most of its diet comes from household waste, crop residues and grasses

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harvested along roads often deficient in essential nutrients such as proteins and minerals [10-13]. This quantitative and qualitative insufficiency of food resources does not allow a good coverage of nutritional needs. In this situation, the animal cannot express its genetic potential, and the resulting production performance is poor. This results to stunted growth, decreased fertility, abortions, pups with low birth weights and high pre-weaning mortality [14]. The intensification of this species can be done, among other things, by a balanced diet taking into account their nutritional needs [15]. Therefore, to solve the problem, farmers have resorted to the use of commercial feed, but the high cost and competition between humans and animals for some conventional protein ingredients of high biological value, such as soy, make them inaccessible to small farmers [16]. According to one of the solutions would be to maximize the contribution of forages, including legumes, in the feed of these animals. Several research studies have therefore been initiated in the use of alternative sources of protein, including fodder legumes easily assimilated into cavy feed [17] but very little work such as that of [18] has been carried out on the comparative and synergistic effects of several forage legumes in order to assess or not the variability of different nutrients and the diversity of protein sources in the ration by cavies. Some forage legumes including Moringa oleifera and Stylosanthes guianensis are famous for excellent growth potential in tropical Africa [19]. Moringa oleifera leaves are known to be a good source of vitamins (A, B2, C, and E) and protein (22 to 30% DM) with a lysine content of 1.5g/100g of total nitrogenous matter [20] They are used for food and feed and the work carried out by [4] has shown that it is possible to improve the postpartum and pre-weaning growth performance of guinea pigs with multi-nutritional blocks containing Moringa oleifera leaves. With a large plant cover, very productive (on all soils) Stylosanthes guianensis is a "good fodder" (chemical composition) whose association with certain grasses would best meet the needs of animals. Its high fiber content (30-38%) offers the flexibility of choice in feed ingredients as it can replace both energy and protein sources [21,22]. But its low lysine content can give way to an amino acid imbalance [23].The combination of these forages could therefore represent an interesting alternative for supplementing guinea pig rations. This is how the present work was initiated and proposes to contribute to the improvement of cavy feeding through the use of the leaves of Moringa oleifera and / or Styloxanthes guianensis in ration on growth performance and characteristics of carcass of post-weaned guinea pigs.

Materials and Methods

Study site

The study was conducted between November 2020 and January 2021 at the T3F Batseng'la Poultry Farm (FERAVI T3F) and the Animal Production and Nutrition Research Unit of the Faculty of Agronomy and Agricultural Sciences (FASA) of the University of Dschang. Dschang is located at the 15th degree of the East meridian, at latitude 5° 26' 27" North and longitude 10° 26' 29" East and culminating at an average altitude of 1420 m. The climate of the region is equatorial of Cameroonian type modified by altitude. Apart from commercial activities, the area is strongly agro-pastoral. In the locality, rainfall varies between 1500 and 2000 mm per year [24,25]. The average annual temperature is around 20°C, the total annual insolation at 1800 hours and an average relative humidity varying between 40 and 90%. The rainy season that corresponds to the growing season is from mid-March to mid-November. February and March are usually the hottest, and July and August the coldest. The original vegetation of the region is shrubby savannah with gallery forests in places [26].

Vegetable material

It consisted of moringa (Moringa oleifera) and pen (Stylosanthes guianensis) leaves. The Moringa had been harvested from a farm located in the town of Mora in the Far North of the country in the Department of Mayo-Sava and the Stylosanthes in the fodder field of the FASA Application and Research Farm. A 100 g sample of each experimental plant was taken, transported to the Animal Production and Nutrition Laboratory to be dried in an oven at 60°C for 12 hours (up to constant weight), then crushed with a tri-hammer mill equipped with a 1 mm mesh sieve and stored in plastic bags for the evaluation of their dry matter (DM), organic matter (OM), crude protein (CP), and crude fibre (CF) content according to the method described by AOAC (2000). Table 1 presents the nutritional value of the forages used as shown in (Table 1).

	DM (%)	OM (% DM)	Ash (% DM)	CF (% DM)	CP (% DM)	Lipids (% DM)	DE (KCAL / kg)
Moringa oleifera	90,01	94,17	5,83	11,06	23,79	1,98	2839, 12
Stylosanthes guianensis	87,81	92, 34	7,77	13,50	19,47	5,33	2726, 31

Table 1: Nutritional value of the fodder used.

DM : Dry matter, **OM :** Organic matter, **CF :** Crude fibre, **CP:** Crute proteins, **DE:** Digestible energy.

Formulation of rations

With the exception of Moringa oleifera and Stylosanthes guianensis, which were individually harvested, dried and crushed, all other ingredients used in the manufacture of rations were purchased from agricultural by-product dealers in the city of Dschang. The combination of these different ingredients added to plants will make it possible to formulate four iso-nitrogen experimental rations (RMS0; RM30; RS30 and RMS15) summarized in the (Table 2) below.

Ingredients (%)	**Different rations**			
	RMS0	**RM30**	**RS30**	**RMS15**
Remoulding	33	25	28	29
Corn	27	12	5	6
Cotton seed cake	4	1	3	1,5
Palm kernel cake	26	25	26	26
Soybean meal	2	1	2	1,5
Fishmeal	3	1	2	1,5
Shell powder	2	2	1,5	2
Premix	1	1	1	1
Kitchen salt	1	1	1	1
Red oil	1	1	0,5	0,5
Moringa oleifera **Stylosanthes guianensis.**	**0** **0**	**30** **0**	**0** **30**	**15** **15**
Total	**100**	**100**	**100**	**100**

Table 2: Centeimal composition of experimental rations.

RMS0: control ration, **RM30:** 30% of Moringa oleifera leaves, **RS30:** 30% of Stylosanthes guianensis leaves and **RMS15: 15%** of Moringa oleifera leaves + 15% of Stylosanthes guianensis leaves

A 100 g sample of each experimental ration was taken, transported to the animal production and nutrition laboratory to be dried in an oven at 60 °C for 12 hours (up to constant weight), then ground with a tri-hammer mill fitted with a 1 mm mesh sieve and stored in plastic bags for the assessment of their dry matter (DM) content, organic matter (OM), crude protein (CP), and crude fibre (CF) according to the method described by AOAC (2000). Table 3 presents the nutritional value of experimental rations (Table 3).

	DM (%)	OM (% DM)	Ash (% DM)	CF (% DM)	CP (% DM)	Lipids (% DM)	DE (KCAL / kg)
RMS0	86,65	95,30	4,88	13,10	17,02	2,94	2789, 30
RM30	86,76	92,73	7,31	10,12	17, 63	2,17	2873, 67
RS30	86,44	93,22	6,75	14,17	16, 21	1,80	2517, 39
RMS15	83,63	93,04	6,97	13,01	17, 53	2,16	2630, 56

Table 3: Nutritional value of experimental rations and fodder used.

DM: Dry matter, **OM:** Organic matter, **CF:** Crude fibre, **CP:** Crute proteins, **DE:** Digestible energy. **RMS0:**control ration, **RM30:** 30% of Moringa oleifera leaves, RS30: 30% of Stylosanthes guianensis leavesand **RMS15: 15%** of Moringa oleifera leaves + 15% of Stylosanthes guianensis leaves

Animal Equipment and Housing

After weaning, 77 pigs consisting of 36 females and 41 males all aged 3 weeks and weighing an average of 151.19 ± 50g were used for the evaluation of growth performance. These animals were divided into the same batches as their mothers' and subjected to the same experimental rations up to 16 weeks of age. After 8 weeks of age, each lodge was subdivided into two sub-compartments according to sex to allow the animals to easily complete their growth. The boxes were made of plywood (1 m x 0.8 m x 0.6 m) mounted on the ground, equipped with lighting, two wooden feeders, two concrete drinkers and a mesh lid to prevent the intrusion of mice or possible predators. The animals were housed on a floor lined with untreated white wood chip litter renewed every week. Complete cleaning of the building followed by the disinfection of the cages and compartments was done with bleach at a dose of 125 ml per 15 l of water before the introduction of the animals. The anti-stress (total amine is 1g per 1 L of water) was administered in drinking water three days before and after any manipulation. To avoid possible vitamin C deficiency, one 240 mg tablet of vitamin C was diluted in 1.5 L of drinking water and served at will from the introduction of the animals until the end of the test.

Experimental Design

Evaluation of growth performance

Weaned young animals were sexed, identified (with the number of the buckle worn in its ear) and kept in their mothers' compartments and subjected to the various experimental starting rations. Each batch of the animals received 50g of feed/animal/day between 6 and 8 hours every day, corresponding to its batch. Refusals were collected and weighed before any new services. This made it possible to determine food consumption. Weight gain was followed by weighing the pups at the beginning of the trial and then once a week until week 16. The weights recorded made it possible to evaluate the post-weaning weight evolution from the 3rd to the 16th week as well as the corresponding total gains (TG) and average daily gains (ADG). All weighings were done using a sensitive electronic digital balance (laboratory balance) with a capacity of 7kg and a precision of 1g.

Evaluation of the characteristics of carcass and organs of the digestive tract

At the end of the feeding trial, 6 animals per treatment aged 16 weeks, taken at random and fasted for 12 h, were slaughtered by cervical dislocation and then bled through the throat for evaluation of carcass characteristics, weighing and organ measurements. The carcass (carcass yield) and the proportion of different organs (intestine, liver and cecum) to live weight at slaughter were evaluated. All weighings were carried out using a digital scale with a capacity of 7 kg and an accuracy of 1 g. Bowel length was measured using a 1 mm precision tape measure.

Calculated Parameters

Feed consumption = Served -Refusal

TG (g) = Final weight –Initial weight

ADG (g/d) = TG/ test duration

CI = amount of feed consumed (kg) / live weight at slaughter (kg)

Cost of production (CP) = total intake x by the price per kg

Carcass yield without head or skin (Rtd Cco):

$$\text{RDTCCO (\%)} = \frac{\text{Commercial carcass weight (G)}}{\text{Weight weight tothe'slaughter (g)}} \text{X100}$$

Carcase weight with head + skin = live weight at slaughter + weight (head + legs + viscera -blood)

Carcass yield with head + skin (RdtCcl):

$$\text{Rdtccl(\%)} = \frac{\text{Classic carcass weight(g)}}{\text{Weight weight tothe'slaughter(g)}} \text{X 100}$$

The relative weight or proportion of liver, cecum and small intestine to live weight at slaughter was calculated according to the following formula:

$$\textbf{Proportion of the organ or part}(\%) = \frac{\text{Organ Weight(g)}}{\text{live weight at slaughter(g)}} \text{x100}$$

$$\textbf{Bowel density } \left(\frac{g}{cm}\right) = \frac{\text{Bowel weight (g)}}{\text{Bowel length (cm)}}$$

Statistical analysis

Post-weaning growth data were subjected to analysis of variance with two factors (ration and animal sex) following the General Linear Model (MLG). The statistical model used is as follows:

$Yijh = \mu + \alpha i + \beta j + \delta h + (\alpha\beta)ij + eijh$

where Yijh = observation on the animal h having received factors i (ration) and j (sex)

μ = overall average

αi = effect of ration i

βj = effect of sex j

δh = effect of animal h

eijh = residual error on animal h having received factors i and j

(αβ)ij = effect of the interaction between factors i and j

Where differences existed between treatments, the means were separated by the Waller Duncan test at the 5% significance level (Steel and Torrie, 1980). SPSS software version 20.0 has been used.

Results

Effects of Moringa oleifera and/or Stylosanthes guianensis leaves on the dietary intake of fattening guinea pigs depending on rations

The feed intake of guinea pigs according to rations is illustrated by Figure 1, it appears from this figure an increase in the quantities ingested with age and independently of the ration. Supplementation of rations with fodder legumes did not significantly influence ($p < 0.05$) the quantities ingested of the different rations. However, animals fed the RMS15 ration containing 15% Moringa oleifera and 15% Stylosanthes guianensis recorded the highest weekly intakes throughout the trial with inflation from the 9th week; and the lowest were obtained in animals receiving the control ration as shown in (Figure 1).

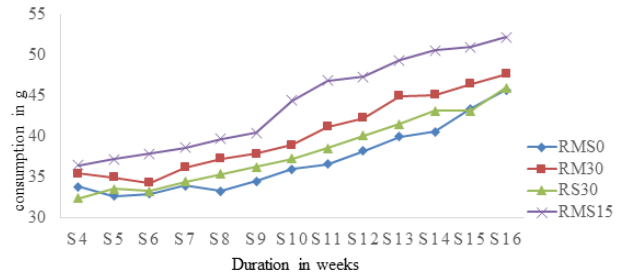

Figure 1: Evolution of the feed intake of guinea pigs according to rations.

Effects of Moringa oleifera and/or Stylosanthes guianensis leaves on the weight evolution of post-weaned female guinea pigs from the 3rd to the 16th week of age depending on the rations

Animal weights were increasing from weaning to 16th week of age regardless of the type of experimental ration (Figure 2). However, supplementation had no significant effect ($P > 0.05$) on the weight of female guinea pigs. There was an increase in weight in guinea pigs receiving the ration containing 15% Moringa oleifera and 15% Stylosanthes guianensis (RMS15) and those receiving the control ration (RMS0) had the lowest weights throughout the trial as shown in (Figure 2).

Effects of Moringa oleifera and/or Stylosanthes guianensis leaves on the weight evolution of post-weaned male guinea pigs from the 3rd to the 16th week of age depending on the rations

Animal weights were increasing from weaning to 16th week of age regardless of the experimental ration type (Figure 3). However, the highest weights were recorded in guinea pigs receiving a ration containing 15% Moringa oleifera and 15% Stylosanthes guianensis (RMS15) and the lowest with the ration containing 30% Stylosanthes guianensis (RS30) throughout the trial. Those receiving the control ration had weights comparable to other rations shown in (Figure 3).

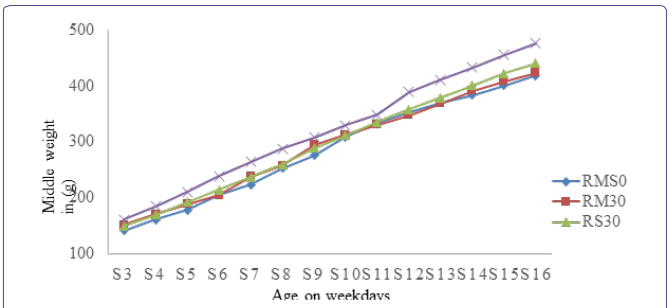

Figure 2: Post-weaning weight evolution of females according to rations.

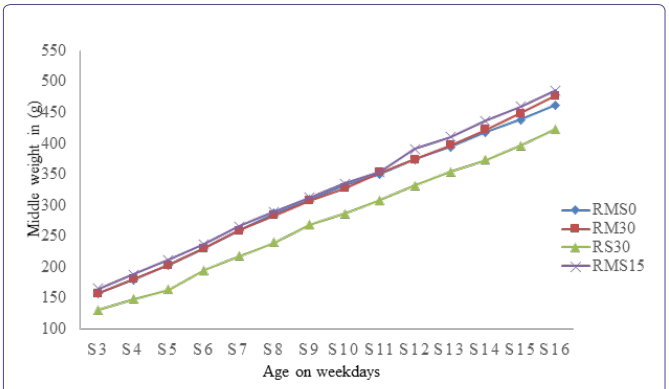

Figure 3: Post-weaning weight evolution of males as a function of rations.

Effects of Moringa oleifera and/or Stylosanthes guianensis leaves on the weight evolution of post-weaned guinea pigs from the 3rd to the 16th week of age depending on the rations

Animal weights showed a continuous increase in all rations throughout the test (Figure 4). However, guinea pigs in the RMS15 ration containing 15% Moringa oleifera and 15% Stylosanthes guianensis had the highest weight (481.61g) and those receiving the RS30 ration containing 30% Stylosanthes guianensis had the lowest weight (431.1g), although no significant differences ($P > 0.05$) were observed with pigs not receiving legumes as a protein source (control ration) shown in (Figure 4).

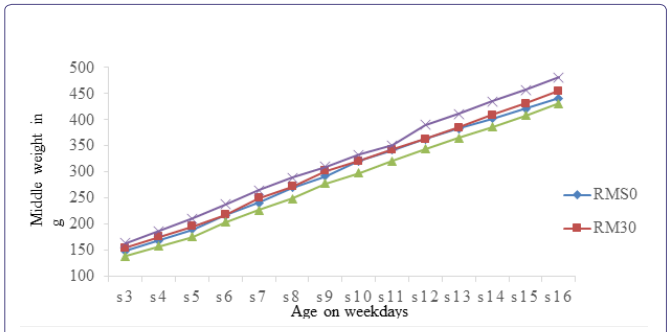

Figure 4: Post-weaning weight evolution of pigs according to rations.

Effects of Moringa oleifera and/or Stylosanthes guianensis leaves on comparative growth between post-weaned male and female pigs from 3rd to 16th week of age according to experimental rations

The comparative growth between males and females according to experimental rations. Males showed higher growth than females, except those receiving the RS30 ration containing 30% Stylosanthes guianensis. In addition, no significant differences ($P > 0.05$) were observed with pigs in the control ration and other groups. Similarly, males and females receiving the RMS15 ration containing 15% Moringa oleifera and 15% of Stylosanthes guianensis showed a higher growth than male and female pigs receiving the control ration and other experimental rations but remained comparable with each other as showin in (Figure 5).

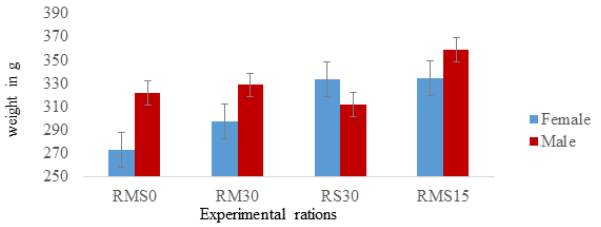

Figure 5: Comparative growth between male and female according to experimental rations.

Effects of Moringa oleifera and/or Stylosanthes guianensis leaves on weaning weight, weight at 16 weeks, TG and ADG, total intake, CI and PC of post-weaned pigs according to experimental rations (Table 4).

Caracteristics Sex	Traitements				SEM	P-value
	RMS0	RM30	RS30	RMS15		
Weight 3 weeks (g)						
♂ ♀ ♂♀	170,67(9)	158, 00(9)	144,33(9)	169,33(9)	4,163	0,57
	156,67(9)	162,33(10)	156,33(11)	181,67(11)	4,606	0,16
	163,67(18)	160,16(19)	150,33(20)	175, 50(20)	4,384	0,37
Weight at 16 weeks (g)						
♂	492,67(7)	486,67(7)	456,00(9)	528,33(8)	12,790	0,28
♀	430,00(8)	459,33(10)	489,67(10)	516,33(10)	12,724	0,06
♂♀	461,33(15)	473,00(17)	472,84(19)	522,33(18)	12,757	0,18
Total gain (g)						
♂	322,00	328,67	311,67	359,00	11,566	0,57
♀	273,33	297,00	333,33	334,67	12,183	0,22
♂♀	297,66	312,83	338,84	346,84	11,874	0,39
Average daily gains (g / d)						
♂	3,54	3,61	3,42	3,95	0,13	0,57
♀	3,00	3,26	3,66	3,68	0,13	0,22
♂♀	3,27	3,43	3,54	3,81	0,13	0,39
Ingestion total (kg)	3,38b	3,67a	3,49ab	3,99a	0,07	0, 00
Price kg (FCFA)	185b	265a	203ab	232a	9,37	0,00
CI	7, 33a	7,75b	7,39a	7,64b	0,151	0, 00
PC	625,67b	976a	710ab	929,67a	44,63	0, 00

Table 4: Average weaning weights at 16 weeks and weight gain (TG and ADG) of guinea pigs by experimental rations and sex.

a, b: Averages with the same letters on the same line are not significantly different at the 5% threshold ; **SEM :** Standard error of mean ; **P-value :** Probability ; **CI:** Consumer Index; **PC :** Production cost ; ♂: male; ♀: female; ♂♀: male and female ; **RMS0,RM30, RS30, RMS15 :** Compound food containing either 0, 30, 30 and 15% Moringa oleifera and / or Stylosantes guianensis, (): effective

Weaning and 16-week weights, TG and ADG were comparable in both males and females and regardless of sex (Table 4). It is also noted in this table that the use of Moringa oleifera and Stylosanthes guianensis leaves had significant effects ($p < 0.05$) on total dietary intake, IC and PC. Guinea pigs fed the RMS15 ration containing 15% Moringa oleifera and 15% Stylosanthes guianensis had a higher weight (528.33g, 516.33g and 522.33g) at 16 weeks respectively in males, females and regardless of sex. Nevertheless, these remained comparable with guinea pigs receiving the ration containing no legumes (control ration) and other rations. The same observation was made with thesame ration for TG (359g, 334.67g and 346.84g) and ADG (3.95g, 3.68g and 3.81g) respectively in males, females and regardless of sex, although no significant differences were observed. However, the lowest mean weight, TG and ADG (456g, 311.67g and 3.42g respectively) in males were obtained with the RS30 ration supplemented with 30% Stylosanthes guianensis; and in females and regardless of sex, the weakest (430g and 461.33g; 273.33g and 297.66g; 3g and 3.27g respectively) were obtained with the control ration. cavy fed the control ration had consumption indices, production costs and total intake comparable to those receiving the RS30 ration but statistically ($p < 0.05$) lower than those of animals fed the RM30 and RMS15 rations as shown in (Table 5).

The effect of Moringa oleifera and/or Stylosantes guianensis leaves on guinea pig weight and carcass yields (Table 5) shows that the ration had no significant effect ($p > 0.05$) on slaughter animal weight, head + skin carcass weight (carcase I), headless and skinless carcass weight (carcase II) and carcass yields. However, guinea pigs fed the RMS15 ration containing 15% Moringa oleifera and 15% Stylosanthes guianensis showed carcass yields higher than the control and other rations but is comparable ($p > 0.05$) to those of guinea pigs fed with other rations (Table 6).

The effect of Moringa oleifera and/or Stylosantes guianensis leaves on organ weights, bowel length and density of guinea pigs (Table 6) shows that supplementation with legumes in the ration had

Features carcass (no = 6)	Experimental rations				SEM	P-value
		RM30	RS30	RMS15		
Weight (g)						
Live weight at slaughter		449,50	439,67	418, 33	13,13	0,85
Car-casse I		301,50	301,33	300,67	8,77	0, 98
Carcass II		162,17	161,67	161,67	5,55	0,97
Yield (%						
Car-casse I		67,07	68,53	71,87	1,24	0,25
Carcass II		36,07	36,77	38,64	0,80	0,34

Table 5: Effect of Moringa oleifera and Stylosanthes guianensis leaves on Carcass weight and yield of guinea pigs according to of ration

SEM: Standard error of mean; **P-value :** Probability ; **RMS0, RM30, RS30, RMS15 :** Compound food containing either 0, 30, 30 and 15% Moringa oleifera and / or Stylosantes guianensis, (): effective

Big digital bodies (no = 6)	Experimental ration				SEM	P-value
	RMS0	RM30	RS30	RMS15		
Liver weight (g)	12,45a	12,37a	11,71a	11,62a	0,33	0,76
Weight of cecum (g)	27,73b	34,34a	31,62ab	30,64ab	1,00	0,04
Small intestine						
Weight (g)	16,52a	16,76a	15,06a	14,68a	0,53	0,44
Length (cm)	147,67a	144,17a	149,50a	139,67a	2,04	0,35
Density	0,11a	0,11a	0,10a	0,10a	0,00	0,36

Table 6: Effect of leaves of Moringa oleifera and of Stylosanthes guianensis on the weight of the organs, the length and the density of the intestine in the cavy.

a,b: Averages with the same letters on the same line are not significantly different at the 5% threshold ; **ESM :** Standard error of mean ; **P-value :** Probability ; **RMS0,RM30, RS30, RMS15 :** Compound food containing either 0, 30, 30 and 15% Moringa oleifera and / or Stylosantes guianensis, (): effective

no significant effect on liver, small intestine weight, small intestine length and density. In addition, guinea pigs fed the RMS30 ration containing 30% Moringa oleifera had significantly higher cecum weights ($p < 0.05$) than guinea pigs fed the control ration, but remained comparable ($p > 0.05$) to those of animals fed with other rations.

Discussion

Effects of Moringa oleifera and/or Stylosanthes guianensis leaves on the dietary intake of guinea pigs according to rations

The best intake was obtained with the RMS15 ration containing 15% Moringa oleifera and 15% Stylosanthes guianensis and this could be explained by the complementarity between the proteins of Stylosanthes and Moringa to provide the animal with a good quality protein that would promote a sufficient proliferation of intestinal microorganisms involved in digestion in herbivores and subsequently would promote the increase of food fermentation and digestive transit which would thus declutter the cecum with the consequence of increasing food intake . The high intake of foods supplemented with legumes compared to control ration could be explained by the fact that supplementation with Moringa and Stylosanthes would have improved acceptability, palatability and digestibility as when animals received Arachis glabrata in their ration as a protein supplement.

Effects of Moringa oleifera and/or Stylosanthes guianensis leaves on the weight growth of post-weaned guinea pigs from 3rd to 16th week of age depending on rations

From the 3rd to the 16th week, the post-weaning weight evolution of the pigs according to the different rations during this trial revealed that the inclusion of legumes in the ration had no significant effect on guinea pig weights compared to the control ration. This lack of difference could be explained by the fact that the animals converted nutrients with the same efficiency regardless of the ration. -These results are similar to those obtained by Ntsafack. when animals were subjected to rations containing the leaves of Stylosanthes guianensis and/or Ipomea batatas and contrary to those of who observed a significant increase in weight of guinea pigs at 8 weeks of age with increasing level of Arachis glabatra. In addition, animals fed the RMS15 ration containing15% Moringa oleifera and 15% Stylosanthes guianensis had the highest weights (175.50g and 522.33g respectively at the 3rd and 16th week); this observation could be attributed to the fact that guinea pigs are herbivorous animals and they would value proteins of plant origin better. The lowest weights (163.67g and 461.33g respectively at week 3 and 16) were obtained with the control ration containing no fodder legumes. Also, drying and incorporation of the legume into the compound feed would have mitigated the effect of anti-nutritional factors. Apart from those in the ration containing 30% Stylosanthes guianensis, males receiving the RMS15 ration containing 15% Moringa oleifera and 15% of Stylosanthes guianensis were heavier than females. This difference was not significant with the control ration (RMS0) and RM30 when comparing weight between sex. This is consistent with observations made by Noumbissi and Zougou et al who reported that males grow faster than females. This would also be due to the low growth potential of females compared to that of males. In addition, by comparing the measurements of young weaned guinea pigs under the same rearing conditions, Egena et al and Ntsafack et al. noticed that males grew faster than females.

Effects of Moringa oleifera and/or Stylosanthes guianensis leaves on weight gain (TG and ADG) at 16 weeks, CI, PC of post-weaned guinea pigs as a function of rations

Weight gains (TG and ADG) increased significantly between weeks 3 and 16 with the addition of forage legumes to the ration in female, male and sex-independent guinea pigs. These results are similar to those obtained by Ntsafack et al when animals were fed rations containing the leaves of Stylosanthes guianensis and/or Ipomea batatas. This could be explained by the herbivorous diet of guinea pigs, which therefore tend to value plant proteins better .From the 3rd to the 16th week the highest GT (346.84g) obtained in the batch supplemented with 15% Moringa oleifera and 15% Stylosanthes guianensis was higher than that of the control ration and other lots. The same observation is made with the GMQ. The highest mean daily

gain (3.95g/d) was achieved in males receiving the RMS15 ration and is less than 6.38g/dr reported by Nguedia et al. (2019) in male guinea pigs 8 weeks of age. Similarly, it was higher than that obtained by Ntsafack et al. (2020) (2.92g/d) and Nguedia et al. (2019)(1.62g/d) in male guinea pigs aged 16 and 24 weeks respectively. This difference would be related to the age of the animals. Because these results are similar to those obtained by Noumbissi et al. (2013) and Zougou et al. (2017a) who reported that males grow faster than females but contrary to those of Miégoué et al. (2016) and Ntsafack et al. (2020) who showed that at the same age females grow faster than males. However, the inclusion of forage legumes (Moringa oleifera and Stylosanthes guianensis) in the ration influenced the total gains (TG) and average daily gains (ADG) of males and females. The highest CI (7.75) in this trial recorded in guinea pigs fed the ration containing Moringa oleifera would result from the quality and content of proteins that would have induced a large food intake and consequently under utilization of the ration. These results are contrary to those of Ntsafack (2021) and Gidienne et al. (2009) who observed an increase in CI of 10 and 26% during an increase in ADF level of 39.7% in guinea pig feed and 12 to 20% in rabbit feed respectively.

Effects of Moringa oleifera and/or Stylosanthes guianensis leaves on carcass characteristics and some organs involved in digestion

The highest carcass weights with or without head and skin recorded in guinea pigs fed the RM30 ration containing Moringa oleifera leaves could be explained by the high digestibility of proteins and a better valorization of the nutrients present (Giang et al., 2004; Husson et al., 2008). However, supplementation with forage legumes had a positive influence on carcass weights. This weight superiority can be attributed to the easily digestible forage legumes proteins contained in the rations. Indeed, according to Zougou et al. (2017), Ntsafack et al. (2020) and Nkana et al. (2020), carcass characteristics can be improved by increasing the rate and quality of protein in the diet. The highest commercial carcass yield (38.64) was obtained in animals aged 16 weeks and fed the RMS15 ration containing 15% Moringa oleifera and 15% Stylosanthes guianensis in this study. This value is lower than the value (49.28%) obtained by Nkana et al. (2020), (40.12%) obtained by Ntsafack et al. (2020) and (42.4%) observed by Zougou et al. (2017b) when animals were fed rations containing Desmodium intortum, 20% powder from Ipomea batatas leaves and in 23-week-old guinea pigs fed a ration containing 16% BP and weighing an average of 526 g at slaughter respectively. That difference is due, inter alia, to the difference in live weight, age at slaughter of the animals and the types of legumes used. Indeed, according to the remark made by Liméa (2009), the increase in slaughter weight improves the true yield of the carcass. The liver weight of guinea pigs in the legume rations was lower than in the control ration. This result would be due to the low lipid and toxin content in the legume supplemented rations compared to that of the control ration. Indeed, the liver plays a role of purifier of toxins in the blood and its cells produce bile which has the role of emulsifying fats (Sendensky and Dufour, 2011). Thus a high content of toxins and fat would solicit more the production of bile and therefore the activity of the liver. The highest liver weight (12.45g) obtained in this study with the control ration (in guinea pigs of 425.33g) is comparable to the 12.91g reported by Ntsafack et al, (2020) as mean liver weight in adult guinea pigs weighing about 430.67g and also receiving the control ration, but greater than 10.7 and 10.20 reported by Zougou et al, (2017b), Miégoué et al, (2018c), in guinea pigs aged 8 weeks and weighing 214g and 326.36g respectively. This difference would be due to the weight and age of the animals. Indeed, according to Ayssiwede et al. (2012), organ development is proportional to the live weight or age of the subjects at slaughter. Caecal weight increased significantly with the addition of forage legumes to the rations. This difference is thought to be related to the high protein content associated with fibre and anti-nutritional factors in the rations containing the forages. Indeed, the cecum in guinea pigs as in most pseudo-ruminants, is the organ strongly involved in the digestion of cellulose. Thus, the more fibrous the food is and more or less rich in antinutritional factors, the more microorganisms are solicited and reciprocally the development of the cecum follows (Miégoué, 2016; Zougou et al., 2017b; Miégoué et al., 2018c). The cecum is the equivalent of the rumen in ruminants (Lormeau 2010). It is the preferred site for the digestion of fibers not degraded by enzymes, since it houses the microbial flora capable of digesting cellulose (Picron, 2007). The more fiber the food provides, the more microorganisms are solicited and the more the cecum that houses them develops.

Conclusion

- At the end of this study on the effect of Moringa oleifera leaves and/or Stylosanthes guianensis on the ingestion and growth performance of post-weaned pigs as a function of experimental rations, the following conclusions were drawn:
- The use of Moringa oleifera and/or Stylosanthes guianensis as alternative sources of protein in pig rations has improved the feed intake of animals.
- Supplementation with 15% Moringa oleifera and 15% Stylosanthes guianensis in the RMS15 ration resulted in the best average weight and weight gain of young post-weaned guinea pigs from 3rd to 16th weeks of age.
- The use of Moringa oleifera and/or Stylosanthes guianensis as alternative sources of protein in the ration improved the characteristics of the carcass and the characteristics of the organs involved in the digestion of pigs.

Recommendation

We recommend to producers or future producers the use in their ration of 15% Moringa oleifera and 15% Stylosanthes guianensis improving feed intake, weight gains and carcass characteristics of their animals.

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