Journal of Veterinary Science & Animal Husbandry
Volume 9 | Issue 1
ISSN: 2348-9790

Research Article Open Access

Reproduction and pre-weaning Growth Performances of Guinea Pigs (*Cavia porcellus*) Fed on the diets containing *Ipomea batatas* Leaves and/or *Stylosanthes guianensis* Meal

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Citation: Ntsafack P, Miegoue E, Noumbissi MNB, Nguedia G, Mouchili M, et al. (2021) Reproduction and pre-weaning Growth Performances of Guinea Pigs (*Cavia porcellus*) Fed on the diets containing *Ipomea batatas* Leaves and/or *Stylosanthes guianensis* Meal. J Vet Sci Ani Husb 9(1): 101

Received Date: January 04, 2021 Accepted Date: April 26, 2021 Published Date: April 28, 2021

Abstract

To contribute to the efficient satisfaction of nutrient needs of guinea pigs, a study on the effect of the inclusion of *Ipomea batatas* leaves and *Stylosanthes guianensis* meal on the reproductive performance of guinea pigs was carried out between October 2019 and January 2020 in the Animal Production and Nutrition Research Unit of the University of Dschang. 80 guinea pigs including 64 females and 16 males weighing 448 ± 50 g and aged between 5 and 6 months were identified and distributed randomly into 4 groups of 20 animals each. Each group was divided in to 4 subgroups of 5 pigs (four females and one male) which were freely cross together. Plants were harvested separately, dried, crushed and incorporated at different levels into the rations as follows: T0 (control), TFp (20% of potato leaves meal), TSt (20% *Stylosanthes guianensis* meal), and TFp + TSt (10% of potato leaves meal + 10% *S. guianensis* meal). Diets were randomly assigned and each group received 60g of feed per animal per day. Left over feed was collected daily before new service for feed intake evaluation. Weight gain was evaluated through weekly weighing. The number of females that have given birth and the number of piglets per birth were recorded. Results shows that females fed with TSt diet had the highest prolificity rate (120%) and birth litter size (1.67 ± 0.33) although no significant difference was observed between diets. The inclusion of forage in diet significantly reduced weight loss in lactating females. The males feed on TFp diet, however, gave significantly lower weight gains (72.00g and 3.42g / day respectively for Total gain and Daily weight gain) compared other diets. In conclusion, TSt and TFp + St diets may be suitable for reproduction and pre-weaned growth in guinea pigs.

Keywords: *Cavia porcellus*; Growth performance; *Ipomea batatas*; Reproductive performance; *Stylosanthes guianensis*

Introduction

The breeding of guinea pigs (caviaculture) constitutes a plausible alternative recognized to conventional breeding for greater accessibility to meat [1]. This livestock has the characteristics of an economically profitable mini-livestock that can participate efficiently in the fight for food security [2]. Indeed, guinea pig farming is also an important source of protein and significant income, especially for the population whose income does not allow easy access to meat or fish [3]. In addition, the meat of guinea pig is tender and high in protein (21% DM). Its carcass yield varies between 45 and 70%, resulting in a true meat animal [4,5]. Despite these advantages, the effectiveness of cavies breeding intensification, and therefore of its participation in protein safety, remains lower. This low contribution of guinea pig farming to protein security results from several constraints, including diet. The challenges of guinea pig's diet remains the efficient satisfaction of its protein needs [6,7]. One of the most widely considered solutions, which remains less expensive, is the use of local fodder resources recognized as having good nutritional value [8]. Among these resources, the choice of *Ipomea batatas* leaves and *Stylosanthes guianensis* is justified by their dual utility as feed for livestock and as a cover crop for crop production. These plants have protein content between 14.4 and 20.6% DM for *I. batatas* and 14 and 20% DM for *S. guianensis*. They are easily cultivable and produce a high biomass [9-11]. The objective of this study was to assess the reproductive and growth performance of guinea pigs fed with diets containing *I. batatas* leaves and *S. guianensis* meal.

Material and Methods

Area of study

The study was carried out between October 2019 and March 2020 at the Animal Production and Nutrition Research Unit (URPRONAN) of the Faculty of Agronomy and Agricultural Sciences (FASA) of the University of Dschang. The city of Dschang is located at the 15th

degree of the East meridian, at latitude 5˚36' - 5˚44' North and longitude 09˚85' - 10˚06' East. The climate of the region is equatorial of Cameroonian type modified by altitude. Rainfall in the locality varies between 1500 and 2000 mm per year. The average annual temperature is around 20 °C, total annual insolation at 1800 hours and average relative humidity varies between 40% and 90%.

Animal material and housing

A total of 80 adult guinea pigs including 64 females and 16 males of average weight 448 ± 50 g of local breed purchased from breeders around the university campus were used. Animals were distributed into four groups of 20 animals each (16 females and 4 males). Each group was then divided into four subgroups of 5 guinea pigs (4 females and 1 male), to constitute comparable groups according to the live weight. The animals were raised in boxes made of plywood (1m long, 0.8m wide and 0.6m high) each equipped with lighting and electric heating tools, 2 woody feeders for compound feed and two concrete water troughs. Animals were raised on the flour, on a litter of 5cm thick made up of untreated dry wood chips. The litter was renewed every 3 days to avoid accu-mulation of feces and urine. The different lodges were equipped with a cover of small mesh to protect animals from mice and other predators that may accidentally enter the livestock building. The complete cleaning of the building followed by the disinfection of boxes was done with an aqueous solution of hypochlorite and sodium chloride, in the presence of excess sodium hydroxide at a dose of 125ml per 15 liter of water before the animals were introduced. Anti-stress (amine total at a rate of 1 g per 1 liter of water) was administered in drinking water three days before and after any manipulation. To avoid a possible vitamin C deficiency, a tablet of 240 mg vitamin C was diluted in 1.5 liter of drinking water and served *ad libitum* from the introduction of the animal to the end of the study. Sweet potato leaves (*I. batatas*) were harvested in a farmer's farm in Santchou agricultural zone and *S. guianensis* was harvested in FASA forage field. Table 1 shows the nutritional value of the forages used.

Components	Forages	
	S. guianensis	***I. batatas***
Dry matter (%)	95.50	90.70
Organic matter (% DM)	86.32	81.20
Ash (% DM)	6.06	9.93
Crude fiber (% DM)	30.52	16.60
Crude protein (% DM)	13.50	14.40
Fat (% DM)	4.57	4.80
Digestible energy (kcal/kg)	1467.76	1048.00

Table 1: Nutritional value of the forages used

Ingredients (kg)	Experimental diets			
	T0	***TFp***	***TSt***	***TFp+St***
Corn	27	30	29	29
wheat bran	32	11	10	13
Cotton seed meal	7	5	9	5
Palm kernel meal	7	6	6	5
Soybean meal	10	7	6	7
Fish meal	3	7	6	7
Molasses	10	10	10	10
Palm oil	4	4	4	4
Ipomea batatas		20		10
Stylosanthes guianensis			20	10
Total	**100**	**100**	**100**	**100**

Chemical Composition				
Dry matter (%)	75.80	88.80	73.00	86.00
Organic matter (% DM)	86.20	93.60	92.84	83.48
Ash (% DM)	13.79	6.39	7.15	6.51
Crude fiber (% DM)	10.46	9.76	14.89	14.62
Crude protein (% DM)	16.27	17.76	16.64	17.72
Fat (% DM)	5.83	8.25	7.44	6.18
Digestible energy (kcal/kg)	2777.71	3273.37	2743.27	2724.79

Table 2: Percentage and chemical composition of the experimental diets

The leaves of each plant were harvested individually, dried, crushed and mixed with 10% sugar cane molasses as well as feed ingredients (corn, wheat bran, cottonseed meal, soybean meal, palm kernel meal, fish meal, and Palm oil) purchased from sellers of agricultural by-products in the city of Dschang to constitute the different diets (T0, TFp, TSt and TFp + St). with T0 constituted with compound feed without leaf meal, TFp with 20% *Ipomea batatas* leaves meal, TSt: with 20% *Stylosanthes guianensis* and TFp+St with 10% *Ipomea batatas* and 10% *Stylosanthes guianensis*. A sample of 100 g of each experimental diet was taken, transported in the animal production and nutrition laboratory to be dried in an oven at 60 °C for 12 hours (until constant weight), then ground using a tri-hammer grinder with 1 mm mesh sieve and stored in plastic bags for the evaluation of dry matter (DM), organic matter (OM), crude protein (CP), and crude fiber (CF) content according to the AOAC, (2000) method. Table 2 shows the percentage and chemical composition of the experimental rations.

T0: Control; TFP: diet with 20% of *I. batatas* leaves meal; TST: diet with 20% of *S .guianensis* meal; TFP + ST: diet with 10% of *I. batatas* leaves meal + 10% of *S. guianensis* meal.

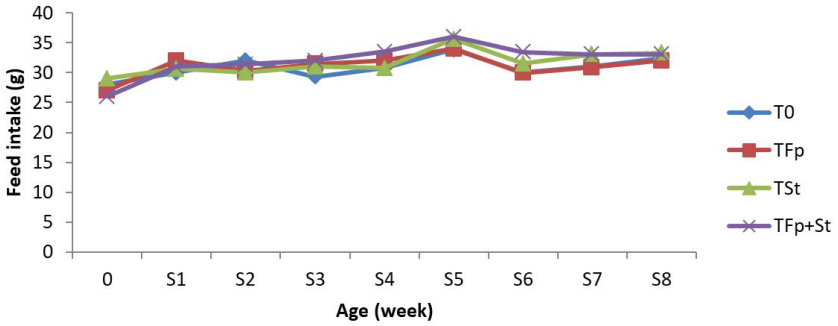
The females were weighed and identified by the numbered ring attached to their ear, and were distributed randomly into 4 groups of 5 animals (four females and one male) each and placed in a completely randomized design comprising four repetitions (females) for each of the diet. Males were randomly assigned (one male per cage) and crosses were free for 31 days. After this period, males were removed from the cage. The diets were randomly assigned to the different cages. Each morning between 6 am and 8 am, each animal received 60g of diet corresponding to its treatment i.e. 300g per day for a group of 5 animals. Left over feed were collected in each group and weighed every morning to determine feed intake. Females were weighed every seven days for the evaluation of weight growth. The number of females brought into reproduction at the beginning of the study, the number of females that have given birth, the date of birth, the number of females that have aborted, the birth range, and the date of birth of each newborn, the number of live piglets at birth and at weaning were recorded. At least 12 hours after birth, the weights of the mother and her piglets were recorded and then weekly until weaning at 3 weeks of age for the evaluation of postpartum growth of lactating mothers and pre-weaning growth of the young guinea pigs. These data were used in calculating parameters such as total gain (TG), average daily gains (ADG), total losses (TL) and average daily losses (ADL) during lactation.

Statistical Analysis

The collected data was subjected to one-way analysis of variance according to the general linear model (MLG). The comparison between males and females during the pre-weaning growth of piglets was subjected to the Student t-test. When the differences existed between the treatments, their means were separated by the Waller Duncan test at the 5% significance level. IBM SPSS Statistics for Windows, version 20.0 (IBM Corp., Armonk, N.Y., USA) analysis software was used.

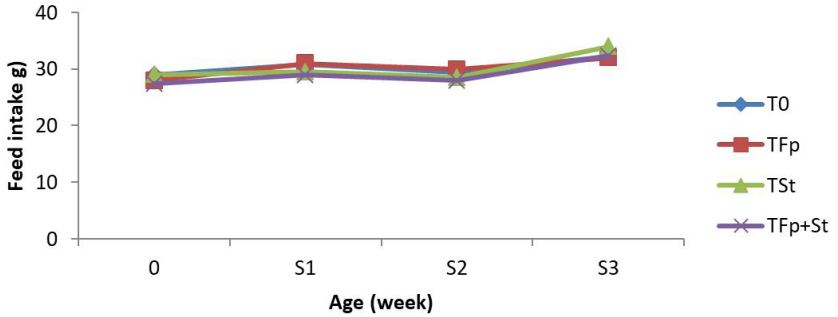
Results

Feed Intake



Fp: potato leaves; St: *S. guianens*

Figure 1: Feed intake of pregnant female according to the diet

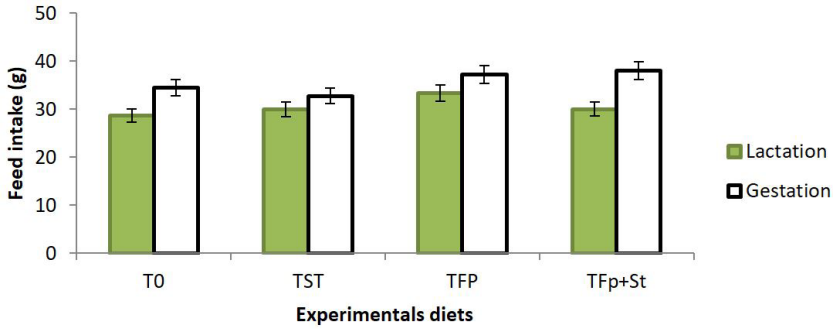


Fp: potato leaves; St: *S.guianens*

Figure 2: EEvolution of feed intake of lactating guinea pigs depending on the diet

Feed intake of pregnant female according to the diet increased during gestation regardless of the ration (Figure 1). However, the TFp + St diet was the most ingested, although no significant (P > 0.05) difference was observed.

Feed intake of lactating guinea pigs depending on the diet slightly increases during the first week and then decreases in the second week (Figure 2). At week 3, feed intake increased regardless of the diet. However, no significant difference (P > 0.05) was observed between diets.



Fp: potato leaves; St: *Stylosanthes guianens*

Figure 3: Comparative feed intake of breeding females during gestation and lactation depending on diet

The feed intake of breeding females during gestation and lactation depending on diet was comparable (P > 0.05) both during gestation and lactation (Figure 3). Apart from the animals fed with TSt diet, all other diets were better ingested during gestation compared to the lactation phase.

Reproductive Parameters of Breeders

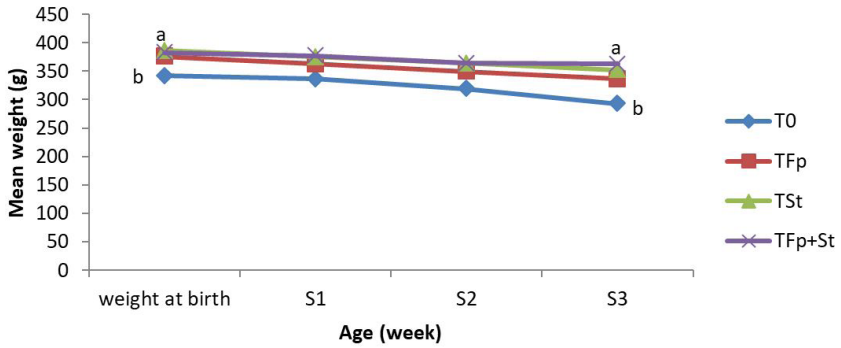
The females of the batch receiving the ration containing both potato leaf and *S. guianensis* meal show the highest fertility rate (Table 3). In addition, the highest fertility rate and net fertility were recorded in breeders fed with diet containing *S. guianensis* meal, followed by the control group with the lowest value recorded in breeders consuming the diet containing sweet potato leaves meal. Diet containing *S. guianensis* meals has the highest prolificity rate and litter size. Although, no significant difference (p > 0.05) was observed between different treatments. On the one hand, the viability at birth was 100% in the group receiving diet containing forage meal with the lowest value obtained with guinea pigs of T0 diet. At weaning, on the other hand, guinea pigs from the TSt group showed lower viability, followed by those from the T0 group.

Characteristics	Treatments			
	T0	TFp	TSt	TFp+St
Fertility rate (%)	71.42	69. 23	71.42	76.92
Fecondity rate (%)	85.71	69.23	87.5	76.92
Net fecondity rate (%)	78.57	69.23	85.71	76.92
Birth rate	1.33±0.33	1.00±0.00	1.67±0.33	1.00±0.00
Prolificity rate (%)	110	100	120	100
Viability at birth (%)	90.90	100	100	100
Viability at weaning (%)	81.81	100	66. 66	100
Post weaning viability (%)	100	100	100	100

Fp: potato leaves; St: *S. guianensis*

Table 3: Reproductive performances of guinea pigs

Postpartum Growth of Lactating Pigs



a,b: The means bearing the same letters on are not significantly different at the 5% level; Fp: potato leaves; St: *S. guianensis*

Figure 4: Weight evolution of lactating pigs from birth to weaning depending on the diet

Figure 4 shows a drop in the weight of lactating pigs regardless of the diet from birth to weaning. However, the weight of the animals was comparable in treated groups but significantly higher ($p \leq 0.05$) compared to that of the control group.

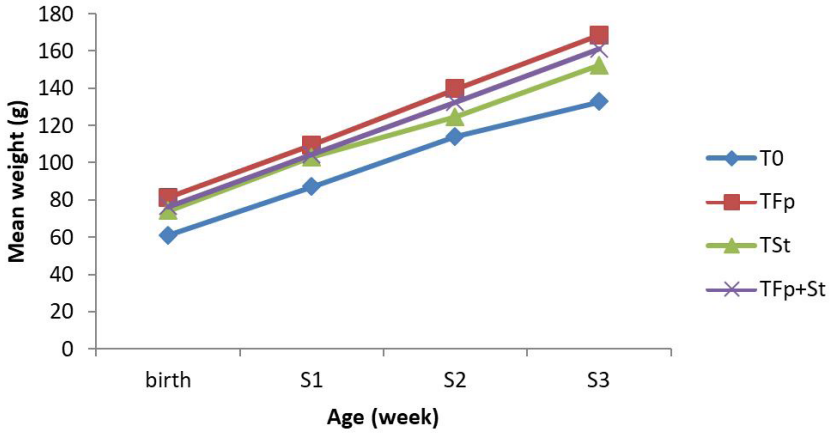
Characteristics	Treatments				*SEM*	P
	T0	TFp	TSt	TFp+St		
Weight at birth (g)	342,45[b]	375,67[a]	385,67[a]	381,36[a]	5,14	0,00
Weaning weight (g)	291.00[b]	332.00[a]	351.00[a]	361.00[a]	8.08	0.03
Total loss (g)	51.45[a]	43.67[b]	34.67[b]	20.36[c]	3.44	0.00
Average daily loss (g/day)	2.45[a]	2.07[b]	1.65[b]	0.96c	0.22	0.02

a,b: The means with the same letters on the same line are not significantly different (p> 0.05); Fp: potato leaves; St: *S. guianensis*; SEM: Standard Error of the Mean; P: Probability

Table 4: Weight at birth, weight at weaning, total loss and average daily weight loss of lactating pigs according to diet

From Table 4, it appears that, from birth to the weaning, the weights of the lactating guinea pigs of the group receiving forages were comparable (p> 0.05) but significantly higher ($p \leq 0.05$) compared to those of the control group. However, from birth to weaning, the nursing mothers from the groups receiving diet containing *S. guianensis* meal showed the highest weights while the lowest were observed in the control group. Addition of forages significantly ($p \leq 0.05$) reduced weight loss in lactating females. The total losses and the highest average daily losses were recorded with the T0 diet and the lowest with TFp + St diet respectively.

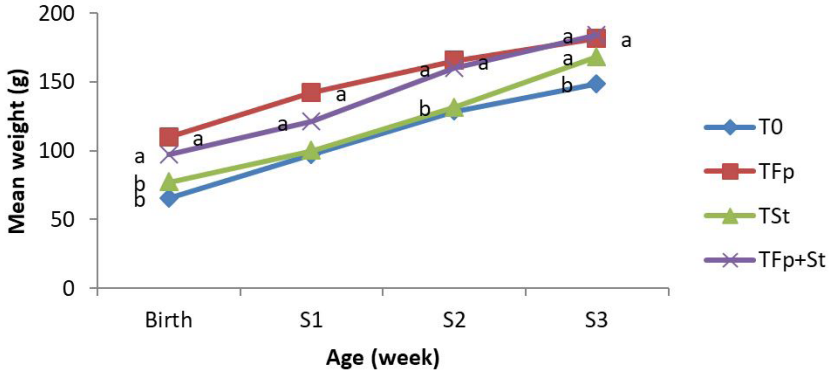
Effect of the incorporation of *I. batatas* leaves and *S. guianensis* meal in diet on pre-weaning growth of guinea pigs



Fp: potato leaves; St: *Stylosanthes guianensis*

Figure 5: Weight evolution of female piglets depending of diet from birth to weaning

The weight of young guinea pigs gradually increases from birth to weaning regardless of the diet (Figure 5). However, the lowest weights were recorded from guinea pigs of the control group although no significant difference ($p > 0.05$) was observed.



a, b: The means with the same letters are not significantly different at the 5% level; Fp: potato leaves; St: *S. guianensis*

Figure 6: Evolution of weight of male piglets from birth to weaning according to diet

The addition of forage powder in diet significantly improved the weight of male piglets from birth to weaning (Figure 6). The weights of pigs from T0 and TSt groups were comparable ($p > 0.05$) but significantly ($p \leq 0.05$) lower than that of pigs from other groups from birth to the end of the second week. At the third week, the weight of the pigs from TSt group significantly ($p \leq 0.05$) increased compared to that of the pigs from T0 group.

From Table 5, it appear that at birth, apart from the piglets from the group fed with diet containing *S. guianensis* meal, which presented a comparable weight (p> 0.05) to that of the control group, the pigs from the TFp group and TFp + St showed comparable weights at birth but significantly (p ≤0.05) greater than the weight of the animals of T0 and TSt groups in males. In females and regardless of sex, incorporation of forages had no significant effect (p> 0.05) on mean birth weights. At weaning, the males of the treated groups presented a significantly higher weight compared to those of the control group. However, the addition of forages had no significant effect (p> 0.05) on female weight regardless of sex. Weight gains were comparable in weaned females as well as regardless of sex, with the highest value recorded with TFp diet. The males from TSt diet presented weight gains comparable to those from T0 and TFp + St diets, but significantly (p ≤0.05) higher compared to the weight gains of TFp group. The same trend was observed for the average daily gain. Apart from TFp diet which gave an inverse trend with the total gain and mean daily gain with females, males presented higher weights and weight gains compared to females regardless of the diet.

Characteristics Sex	Treatments				*SEM*	P
	T0	TFp	TSt	TFp+St		
Birth weight (g)						
♂	65.33^{b}	109.67^{a}	77.00^{ab}	97.00^{a}	5.52	0.00
♀	61.00	81.33	74.00	76.33	4.90	0.56
♂♀	63.16	95.50	75.50	86.66	5.21	0.28
Weaning weight (g)						
♂	148.67^{b}	181.67^{a}	171.33^{a}	184.00^{a}	4.79	0.00
♀	132.67	168.33	152.33	161.00	6.35	0.22
♂♀	140.67	175.00	161.83	172.50	5.57	0.11
Total gain (g)						
♂	83.33^{a}	72.00^{b}	94.33^{a}	87.00^{a}	3.12	0.05
♀	71.67	87.00	79.67	84.67	2.56	0.14
♂♀	77.50	79.5	87.00	85.83	2.84	0.09
Average daily gain (g/day)						
♂	3.96^{a}	3.42^{b}	4.48^{a}	4.13^{a}	0.14	0.05
♀	3.40	4.14	3.79	4.02	0.12	0.13
♂♀	3.68a	3.78^{a}	4.13^{a}	4.07^{a}	0.13	0.09

a, b: The means with the same letters on the same line are not significantly different at (p> 0.05); Fp: potato leaves; St: *S. guianensis*; SEM: Standard Error of the Mean; P: Probability

Table 5: Effect of inclusion of *Ipomea batatas* leaves and *Stylosanthes guianensis* meal on birth weight, weaning weight, total gain and mean daily gain in pigs

Discussion

Feed Intake

The dietary intake was comparable both during gestation and during lactation. The higher consumption recorded by breeders of the diet containing *S. guianensis* meal, during gestation and lactation could be explained by the high cellulose content of this ration. According to [12], an increase in the level of fiber in feed has increased voluntary intake. The level of feed intake of guinea pigs recorded during gestation and lactation is higher than the feed intake observed by [13] during pregnancy and lactation. This difference would be justified by the palatability of the forages used in this study. Indeed, the leaf and especially the stem of the potato have the characteristic of being rich in sugars (6 to 8% for the leaf and> 10% for the stem) which makes them very palatable [14]. In addition, with little palatability at the younger stage, the palatability of *S. guianensis* increases with age [10]. *S guianensis* used in this study was harvested from mature plants.

Reproductive Performance

Inclusion of forages in diet had no effect on reproductive performance. The results of this study are similar to those of [15] who observed no significant difference respective of the diet and the origin of the forages, in the rates of fertility, prolificicy, weaning, and birth rate. The lowest fertility and fecundity rate recorded with the diet containing sweet potato leaves meal may be due to its low content of digestible proteins. According to a study carried by [16], the protein digestibility of potato leaves varies from 20 to 50% against 52 to 62% for *S. guianensis* [9]. The females receiving TFp diet did not have the necessary proteins to meet their reproductive needs. The highest birth rate (1.67) obtained with diet containing *S.guianensis* powder is comparable to the 1.45 reported by [7] with the group supplemented with 6% spirulina. This value was less than 2.17 reported by [13] with the control diet and diet containing 20% *Moringa oleifera* with second cycle breeders (second birth). This difference could be explained by the birth range of the breeding females; in fact, these were first-time mothers, the birth range is linked to birth number of the breeders and

the first one is always smaller. The lowest viability at birth and at weaning was recorded in the pigs of the control group and those of group consuming the diet containing *S. guianensis* flour. This could be explained by the low birth weight obtained in these groups. Because, the weight at birth would be a determining parameter for the survival of young guinea pigs [5].

Postpartum Growth of Female Pigs

Weight of lactating females decreased from birth to weaning. These results are in agreement with the observations of [17]; [6] and [7]. Indeed, during lactation, mothers spend a lot of energy on milk production. To ensure satisfactory milk production, they are obliged to mobilize their body reserves, which would explain the observed weight lost. According to these same authors, this lost is more accentuated in non-supplemented females. This would explain the lost in lactating females from the control group.

Pre-weaning Growth

In general, the males presented the highest weights from birth to weaning, which is consistent with the observations of [5,7,13]. The weight at weaning is strongly linked to the weight at birth [18]. Reported that the birth weight advantage is maintained not only at weaning, but until 12th week of age. The addition of forages improved the weight at birth as well as at weaning of the male piglets. In females, however, and regardless of sex, no effect was observed. The highest weight obtained in the male and female piglets of diet containing *I. batatas* leaves meal at birth, could be due to the small birth rate of the breeders of this group compared to those receiving diet containing *S. guianensis* meal. This is because single birth generally has a higher weight compared to multiple births. The low weight of multiple births is due to the distribution of the mother's nutrients within the different fetus present in the uterus [7]. The highest weight (95.50g) obtained regardless of the sex is greater than the 84.85g reported by [17] with diet containing *Desmodium intortum* used by these authors. This could be explained by the presence of anti-nutritional factors in *D. intortum*. Inclusion of *S. guianensis* meal alone and *S. guianensis* meal + *I. batatas* leaves meal significantly improved weight gain in males compared to that of *I. batatas* leaves alone. In females, however, no significant effect was observed. The highest gain was recorded in male fed with diet containing *S. guianensis* meal while in females the highest weight gain was recorded in group fed diet containing sweet potato leaves meal. The highest average daily gain (4.13g/d) obtained regardless of sex with *S. guianensis* meal (16.64% CP) in this study is greater than 3.5g/d reported by [17] with 16.36% of CP and at 2.02g / d recorded by [5] with 16% CP but close to 4.56g/ obtained by [7] with 19.20% CP. This difference could be due to the quality and the protein level of the diet.

Conclusions

It appear from this study that the inclusion of *Ipomea batatas* leaves and *Stylosanthes guianensis* meal in the diet of guinea pigs had no effect on feed intake, on reproductive performance as well as on pre-weaning growth of animals. However, in view of the results, the associated incorporation of *Ipomea batatas* leaves and *Stylosanthes guianensis* (TFp+St) powder seems to be more appropriate for guinea pigs during gestation, lactation and pre-weaning growth of guinea pigs.

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