EFFECT OF DIETARY SUPPLEMENTATION OF CASSAVA (MANIHOT ESCULENTA CRANTZ) LEAF MEAL AS PROTEIN SUBSTITUTE ON POST-WEANING GROWTH PERFORMANCES AND CARCASS CHARACTERISTICS OF 8 WEEK-OLD MALE GUINEA PIGS IN THE HIGHLANDS OF CAMEROON

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Abstract

The effect of soybean meal substitution by cassava leaf meal (CLM) on growth performance was evaluated during 5 weeks on 20 young male guinea pigs weaned at 3 weeks of age (mean live weight 206.89 ± 22.78g). These animals were placed in a completely randomized design and subdivided into 4 bathes of 5 animals / batch. They were fed ad libitum to Pennisetum purpureum and supplemented with 4 rations in which were incorporated 4 levels of CLM (0, 8, 10 and 12%) corresponding to the 4 batches. Post-weaning growth was measured between 22 and 56 days of age in 20 guinea-pigs (5/batch). Those animals were sacrificed and the carcass yield evaluated at the end of the 56th day. Results showed that the level of CLM incorporation had a significant effect on all growth parameters throughout the test. The 10% CLM incorporation rate gave better performances with respect to weight evolution, Total Gain (TG) and Mean Daily Gain (MDG) (128.06g and 3.67g respectively), Live weight at slaughter (LWs) and carcass yield (334.00g and 74.73% respectively) significantly (P<0.05) higher as compare to those of other animals of other batches. Animals of Control and RC10 rations showed comparable caecum weights and significantly higher (P<0.05) than those of RC8 and RC12 rations. Comparable performances of Control (RC0) and RC12 rations suggest that CLM up to 12% incorporation may advantageously replace soybean meal in guinea pig feed.

Key words: cassava leaf meal, *Pennisetum purpureum,* Post-weaning growth, carcass yield

INTRODUCTION

Guinea pig (*Cavia porcellus* L.) is a guarantee of food security and monetary reserve which has an important socio-cultural value for the rural populations in Cameroon [26]. Under traditional husbandry conditions, the productivity of guinea pigs remains low. Indeed, the dependence on harvest wastes, household scraps, vegetables and forages with low nutritional quality, have adversely impact the reproduction and growth of guinea pigs causing nutritional deficit which is not without consequences on animal performances. Hence food remains one of the major challenges for the success of caviaculture. Although guinea pigs are predominantly dependent on marginal forages, several authors reported that breeding of young animals under concentrates of high nutritional value results in daily weight gains, yields and carcass quality higher than only in a forage system [15, 18, 19]. Moreover, Hango et al. [15] demonstrated that concentrate supplementation reduces slaughter age, increases carcass quality and meat yield.

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Given the high cost of protein supplements commonly used in animal feed, Dahouda et al. [8] surmised that the replacement of expensive conventional feed ingredients (peanut cake, soybean and fish meals) with cheap and available substitutes represents a suitable strategy for reducing feed cost and encouraging production. Among possible sources of cheap protein are leaves from some plants as cassava.

Available throughout the year, cassava leaves which are usually wasted or used as manure during root harvest, are rich in protein 14-40% DM [5, 7, 11, 35, 37] but the existence of cyanogenetic glycosides, linamarin and loutastralin, which on hydrolysis produce poisonous hydrogen cyanide (HCN) are important constraints hampering their use as animal feed ingredient. Fortunately, Dahouda et al. [8] demonstrated that these antinutritionnal factors can be drastically reduced by sun drying with a significant reduction in hydrocyanic level of nearly 90%. Cassava leaves have been the subject of several research studies and have been used as a direct supplement or included in mixtures of concentrates [17, 38] or multi-nutrient blocks [38].

Improvement of knowledge on nutritive values of available forages and crop residues such as cassava leaves with high production and good quality can be determinant for the development of adequate complementation and the improvement of the feeding system of guinea pigs. The aim of this trial is therefore to evaluate growth performance and carcass characteristics of young male guinea pigs fed diets with graded levels of cassava leaf meal during a shorter time.

MATERIAL AND METHOD

Study site. The study took place from November to December 2012 at the Research and Application Farm (R.A.F.) of the University of Dschang. Dschang is located at an average altitude of 1410 m, and between 10°26' East longitude and 5°26' North latitude. It receives between 1500 and 2000 mm of rainfall per year and the temperatures oscillate between 10°C (July-August) and 25°C (February). Climate is equatorial of Cameroonian altitude type, with a dry season that runs from mid-March to mid-November and a rainy season from mid-November to mid-March.

Trial conduct. Twenty (20) weaned male piglets of average weight 206.89 ± 22.78g born at R.A.F. were used for this experiment. They come from 4 batches each consisting of breeding nuclei of local breed and placed in a completely randomized design of 5animals / batch and kept in 4 different boxes of 1.5 m length, 80 cm wide and 60 cm high. These 4 batches corresponded to the 4 levels (0, 8, 10 and 12%) of incorporation of CLM. All animals received *P. purpureum* as base fodder supplemented with rations containing 0, 8, 10 and 12% CLM, designated RC0, RC8, RC10 and RC12 respectively. These rations were formulated in order to meet the nutritional needs of growing guinea pigs [29]. Feed formulation was preceded by chemical composition analysis of different ingredients before their incorporation in the various rations. This CLM was obtained by drowning leaflets from leaves of cassava stems. After 2 days of drying under the sun, they were processed into flour using a 4 mm diameter mesh grinder. The resulting leaf meal was packaged in a bag of about 25 kg and kept until use. Chemical composition of diets is shown in Table 1.

Conduct of animals. Daily, all animals received in addition to *P. purpureum* which was served *ad libitum* in all batches, about 20g of ration / animal / day; which amount of ration correspond to 5% of the body weight of each animal. This quantity was adjusted every 7 days until the end of the trial. The control ration assigned to the animals in batch 1 (RC0) did not contain CLM. Animals in batches 2 (RC8) and 3 (RC10) received a ration in which 8 and 10% CLM were incorporated, while those from batch 4 (RC12) were fed a food containing 12% CLM. Water containing vitamin C was distributed *ad libitum*. Lodges and their equipment were cleaned daily.

Table 1 Chemical composition of experimental diets and *P. purpureum*

Chemical composition	Rations				
	RC0	RC8	RC10	RC12	*P. purpureum*
Dry matter (%DM)	90.85	90.38	91.50	90.61	90.30
Organic matter (% DM)	89.52	86.95	87.69	86.46	86.32
Crude protein (% DM)	19.00	18.75	18.81	17.18	7.89
Crude fats (% DM)	4.66	4.27	6.19	6.13	2.20
Crude fiber (% DM)	7.74	8.51	9.71	10.69	33.46
Ash (% DM)	10.48	13.05	12.31	13.54	9.68
ME (Kcal/KgDM)	2915.65	2896.00	2837.29	3045.51	407.18

** Premix 0.5% flesh: Vit. A = 3000000 UI/kg, Vit. D3 = 600000 UI/kg, Vit. E = 4000 mg/kg, Vit. K3 = 500 mg/kg, Vit. B1 = 200 mg/kg, Vit. B2 = 1000 mg/kg, Vit. B3 = 2400 mg/kg, Biotin = 10 mg/kg, Vit. PP = 7000 mg/kg, Folic acid = 200 mg/kg, Choline chloride=10000mg/kg, Iron sulphate = 8000 mg/kg, Copper (II) sulphate = 2000mg/kg, Manganese oxide = 1400 mg/kg, Calcium iodate = 200 mg/kg, Cobalt carbonate = 200 mg/kg, Sodium selenite = 20 mg/kg, Methionine = 20000 mg/kg, Lysine = 78000 mg/kg, ME: Metabolizable energy; CLM: Cassava Leaf meal*

Data collections. Growth evolution was followed by recording weekly weight from weaning to week 8 and weights registered were used to estimate the weight change and to calculate total gains (TG) and the corresponding Mean Daily Gains (MDG).

At the end of the study, 5 animals per batch were subjected to a fast food for 12 hours after which they were sacrificed by cervical dislocation for carcass evaluation (carcass yield) and the proportion of the parts or organs (whole digestive tract, intestine, skin, liver and caecum) in relation to the live weight at slaughter and the weight of organs.

Calculated or studied parameters

- weekly weight evolution;
- Total Weight Gains (TWG) (g) = weight of the animal at the end of the considered period - weight at the beginning of the considered period;
- Mean Daily Gain (MDG) (g / d) = TG / (duration of the considered period)

The standard carcass yield (CarYld) or South American and African carcass was calculated according to the following formula:

CarYld (%) = ((Commercial carcass weight + (legs + liver + head + skin)) × 100 / (Live weight at slaughter)

With Commercial carcass weight = live weight at slaughter - (blood + head + skin + legs + viscera)

Relative weights or proportions of the skin, head, gastrointestinal tract, liver and caecum in relation to live weight at slaughter were calculated according to the following formula:

Proportion of organ or part (%) = (Weight of organ or part) x 100/ (Weight of slaughter)

Statistical analysis. Data on post weaning weight growth and carcass characteristics were analysed for one-way analysis of variance (ANOVA). The analysis software used was SPSS 17.0. When differences between averages exist, the Duncan test was applied to separate them at the 5% significance level [34].

RESULTS AND DISCUSSIONS

Weight evolution from weaning to week 8

The weight evolution of young males followed an increasing curve from weaning to week 8 (Fig. 1). The incorporation of CLM in the diet significantly improved the weekly average weight of animals in all batches. Indeed, weights of young males of the complemented batches were statistically ($P < 0.05$) greater than the weights of those of the control ration. From week 4 to week 8, highest weights ($P < 0.05$) were recorded with young males of RC10 ration and the lowest weights ($P > 0.05$) recorded with males of Control ration (RC0). At week 7 and 8, the mean weight of young males in the RC10 ration was comparable ($P > 0.05$) to that of young males in RC8 ration. Similarly, young males receiving RC8 and RC12 then RC12 and RC0 rations recorded comparable average weights ($P > 0.05$) at these different periods.

Weight gains of piglets from weaning pigs at week 8

Weight gains of young males' guinea pigs during the fattening trial showed that incorporation of CLM in the diet significantly improved weight gains (Table 2). The TG and

MDG of animals receiving RC10 ration were comparable (P> 0.05) to those of animals receiving RC8 ration and significantly (P <0.05) higher than those of animals receiving RC0 and RC12 rations.

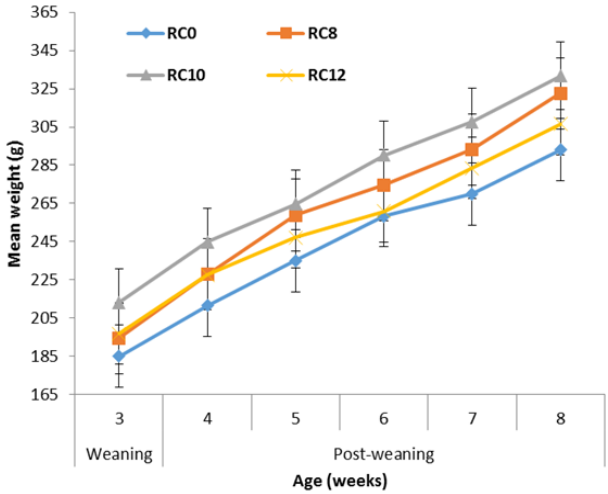

Fig. 1 Dynamics of live weight in relation with age

Table 2 Total gains (TG) and Mean daily gains (MDG) of weaned young guinea pigs according to experimental diets

Parameters	Rations				SEM	Prob.
	RC0	RC8	RC10	RC12		
TG (g)	108.50[b]	113.60[ab]	128.06[a]	106.00[b]	3.13	0.025
MDG (g)	3.10[b]	3.25[ab]	3.67[a]	3.03[b]	0.09	0.025

a, b: Averages bearing same letters on the same line are not significantly different at the 5% threshold; MDG: mean daily gain; SEM: standard error on the mean; Prob: Probability.

Carcass characteristics

Carcass characteristics of males slaughtered at 8 weeks of age showed that the live weight at slaughter (LWs) of animals fed with RC10 ration was significantly (<0.05) higher than that of animals of other rations (Table 3). Moreover, the LWs of animals receiving RC0, RC8 and RC12 rations were comparable (P>0.05). The same trend was observed in the weight of the conventional (classic) carcass. At the level of heads, animals in RC10 diet recorded the highest weight (P<0.05) and those in Control diet had the lowest weight (P<0.05). Animals in RC0 and RC12 diets recorded comparable (P>0.05) skin weights but significantly (P<0.05) lower to those in RC10 ration of which the highest weight (P<0. 05) was comparable (P>0.05) to that of animals in RC8 ration. The gastrointestinal tract of animals in RC10 ration was heavier (P<0.05) than that of animals in RC8 and RC12 rations whose weights were comparable (P>0.05); Animals of RC8, RC12 and RC0 rations on the one hand and those of RC10 and RC0 rations on the other hand recorded comparable digestive tract weights (P>0.05). Animals of complemented batches registered comparable (P>0.05) classic carcass yields and significantly higher (P<0.05) than that of Control batch. However, within the complemented batches, values of this yield recorded in animals of RC12 ration were comparable (P>0.05) to those of animals in Control ration. No significant difference (P>0.05) was recorded for different parameters (proportion of the head and the skin) whatever the diet. Animals receiving Control ration recorded the highest proportion of digestive tract (P<0.05) and those receiving RC8 and RC10 rations had the lowest (P>0.05) but comparable proportions between them (P>0.05). Proportions of the digestive tract of animals receiving RC0 and RC12 rations on the one hand and of RC8, RC10 and RC12 rations on the other hand were comparable (P> 0.05) between them.

Table 3 Carcass characteristics of male guinea pigs according to experimental diets

Parameters	Diets				SEM	Prob.
	RC0	RC8	RC10	RC12		
Weights (g)						
Live weight at slaughter	279.80[b]	292.20[b]	334.00[a]	284.60[b]	6.05	0.000
Head	40.60[c]	44.20[b]	49.80[a]	42.60[bc]	0.915	0.000
Skin	35.20[b]	37.80[ab]	41.00[a]	34.80[b]	0.002	0.007
Gastro-intestinal tract	80.00[ab]	73.00[b]	86.40[a]	76.00[b]	1.60	0.007
Classic Carcass	200.40[b]	218.40[b]	248.60[a]	208.40[b]	5.24	0.001
Yield (%)						
Classic Carcass	71.58[b]	74.40[a]	74.73[a]	73.18[ab]	0.45	0.036
Proportion of organs (%)						
Head	14.51[a]	15.13[a]	14.91[a]	14.99[a]	0.047	0.211
Skin	12.59[a]	12.94[a]	12.27[a]	12.25[a]	0.068	0.306
Gastro-intestinal tract	28.65[a]	25.00[b]	25.86[b]	26.73[ab]	0.46	0.018

[a, b and c]: Means with the same letters on the same line are not significantly different from the 5% threshold. SEM: Standard error on the mean; Prob.: Probability.

Characteristics of some digestive organs

Complementation did not have a significant effect (P>0.05) on weights, lengths and proportion of liver and intestines (Table 4). The weight and the length of the caecum of animals receiving RC0 and RC10 rations were comparable (P>0.05) and significantly (P<0.05) higher than those of animals receiving the RC8 ration. On the other hand, caecum weights of animals who received RC8 and RC12 rations were comparable (P>0.05) and significantly (P>0.05) lower than those of animals receiving RC0 ration.

Table 4 Weight, length and yield of some digestive organs in guinea pigs according to exp. Diets

Parameters	Diets				ESM	Prob.
	RC0	RC8	RC10	RC12		
Weights (g)						
Liver	9.20[a]	9.40[a]	11.20[a]	10.00[a]	0.34	0.140
Intestines	19.80[a]	19.40[a]	22.60[a]	19.80	0.147	0.659
Caecum	28.20[a]	21.00[b]	27.40[a]	24.40[ab]	0.94	0.014
Lengths (cm)						
Intestines	217.60[a]	215.60[a]	215.80[a]	216.00[a]	0.398	1.779
Caecum	17.60[a]	14.40[b]	17.20[a]	16.40[a]	0.37	0.003
Proportion (%)						
Liver	3.29[a]	3.22[a]	3.33[a]	3.52[a]	0.08	0.611
Intestines	7.09[a]	6.66[a]	6.78[a]	7.00[a]	0.261	1.168
Caecum	10.16[a]	7.20[b]	8.20[b]	8.58[ab]	0.37	0.021

[a]: Means with the same letters on the same line are not significantly different from the 5% threshold. SEM: Standard error on the mean; Prob.: Probability.

Discussion

At the end of the 8th week, the mean weight of animals receiving 10% CLM and 2% of soybean meal in their ration (RC10) was significantly higher (P<0.05) than that of animals from other rations. This shows that this association is the combination that gives the right protein value in the feeding of guinea pigs. The positive effect of the association of different protein sources was reported by [28] in cavies fed on some legumes forages [23, 24 in cavies submitted to graded levels of cassava leaf meal in the diet, Miegoué et al. [22] in cavies fed on *Panicum maximum* supplemented with graded levels of *Arachis glabrata* in the diet, Akoutey and Kpodekon [2] in rabbits receiving granulated feed containing *Pueraria phaseoloi*des (0, 18 and 36%), by Ayssiwede et al. [3] in young traditional chickens subjected to increasing levels of incorporation of *Cassia tora* leaf meal (0, 5, 10 and 15%) in the diet. The beneficial effect of the ideal association of protein sources could be explained by the phenomenon of "protein complementarity" which states that when a weak protein in a particular amino acid is associated with a protein rich in this amino acid, the value of the package is improved [1, 2].

Supplementation with CLM improved the ingestion, resulting in increased rates of growth and weight gains of animals as observed in earlier studies [17, 32, 33]. This suggests the positive effect of complementation on growth of young animals and especially the enormous possibilities that these animals can present when they are placed in conditions where they can efficiently exteriorize their potential [20, 29, 31]. On the other hand, these results confirmed the influence of the pre-partum supplementation of mothers on the growth of the young and the postpartum survival of the latter [10, 23, 24, 28]. Indeed, the MDG observed in the young males of the batches complemented was higher than that obtained in those of Control group. On the other hand, it is noted that the MDG decreases with age. This observation corroborates that of Fotso et al. [13], which reported that in guinea pigs, the growth rate decreases after weaning (1.8 ± 0.40 g/d). Ekkers [9] reports that the MDG is 4 g for the first 6 months and then drops to 2.4 g from the 6-10th month. The highest MDG obtained from animals of the RC10 (3.59 g/d) ration was close to the value 3.71 g/d reported by Miegoué et al. [22] in 8-week-old guinea pigs, was greater than that of 1.70 g/d reported by Fonteh et al. [12] in 12-week-old guinea pigs, but lower than that reported by Fransolet et al. [14] (4 to 7 g/d) in 8-week-old "improved breed guinea pigs". This could mean that the breed and the diet could explain this difference.

Live weights of animals at slaughter (LWs) and weights of different carcass types were higher ($P < 0.05$) in complemented animals compared to those of Control. The opposite observation was reported by Dahouda et al. [8] who found a decrease in live weight at slaughter and weights of carcasses with the increase in the rate of incorporation of cassava flour and leaves in the ration of finishing guinea fowl. This superiority in weight can be attributed to the protein quality of the diet.

In this study, the highest LWs obtained from animals of RC10 (334.00 g) ration is higher than the value (295.29g) reported by Miegoué et al. [22] in 8-week-old guinea pigs but lower than those reported by Fotso et al. [13] (402.5g) and Niba et al. [27] (364g) in guinea pigs aged 15 weeks. The difference in age of animals used in these studies would, among other things, justify this difference. The literature reports a relationship between age and carcass weight. Indeed, Liméa [21] reported that weight and age of slaughter are interdependent variables because different fattening times result in different slaughter weights. This corroborates the observations of Baéza et al. [4] who showed that the increase in weight was generally positively correlated with the increase in the age of slaughter. Similarly, Fotso et al. [13] and Ngoupayou et al. [25] found an increase in the weight of the carcass with the age of guinea-pigs: it rose from 275g at 15 weeks, to 383g at 23 weeks. Hedhly et al. [16] support this assertion by saying that extending the slaughter age results in a significant improvement in yields.

The highest classic carcass yield (74.73%) obtained from animals of RC10 ration in this study is greater than the values 67.39 % [36] in guinea pigs aged 20 weeks, 72.7% [13, 25] in guinea pigs aged 23 weeks and weighing 526.3 g at slaughter, 71.13% in males aged 15 weeks [27]. This relatively high value in this study can be explained by taking into account certain parts (head and skin) of the carcass that these authors would probably not have integrated. For example, Olinda [30] reports that in the guinea pig the hair can constitute more than 2% of the total weight of the animal. This yield is less than 76% reported by Cicogna [6] in 15-week-old guinea pigs weighing 750 g. This could be explained by the difference in age and weight of animals at slaughter but also by the diet.

In this study, the highest liver weight in guinea pigs in the RC10 (11.20 g) ration were higher than those obtained by Niba et al. [27] (10.60g) but close to that reported by Tendonkeng et al. [36] (11.60g). This may be due in part to body live weight, diet or age. Indeed, Ayssiwede et al. [3] showed that the development of organs is often proportional to the live weight or age of subjects. The significant decrease in caecum weight with the inclusion rate of CLM in the diet observed in this study contradicts the observations of Niba et al. [27] and Tendonkeng et al. [36]. This reflects the high digestibility of CLM [39] in diets.

CONCLUSIONS

The increasing incorporation CLM in the diet improved the weight evolution, the TG and MDG, the LWs, and the carcass yield of supplemented animals. These parameters were significantly better in animals receiving 10% CLM. With respect to comparable parameters (TG, MDG, LWs, Yld Clc) between young males in the control ration and those receiving 12% CLM, we can say that CLM can completely substitute soybean meal in guinea pig fed up to 12% incorporation without reduction of performances.

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