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Comparative Nutritional Value of Two Varieties of *Mucuna Pruriens (Utilis* and *Cochinchinnensis*) In Guinea Pigs (*Cavia Porcellus*)

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ABSTRACT

The use of Mucuna pruriens seed powder in animal feed as a protein source is limited by the presence of anti-nutritional factors. Therefore, to study the effect of soaking and toasting on the chemical composition, intake, and in vivo digestibility of two varieties of Mucuna pruriens seeds (var cochinchinensis and utilis), 84 local breed guinea pigs including 42 males and 42 females, aged five months were used. They were divided into four batches of 6 males and 6 females each. Each batch was assigned a ration containing 0% (control), and 20% of Mucuna pruriens (var cochinchinensis and utilis) depending on whether it was raw, soaked, or roasted respectively. The results showed that the chemical composition of the Mucuna seed powder changed from one treatment to another depending on the variety. The DM content of the toasted seeds of Mucuna pruriens variety cochinchinensis was higher than that of the soaked or raw seeds, except PB where the opposite effect was observed depending on whether the seeds were raw, toasted, or soaked, especially DM (90.00% DM; 96.33% MS; 93.33% MS), MO (87.00%MS; 92.67%MS; 91%MS), CB (6.33% MS; 13.00%MS; 11.62%MS) and PB (22.00%MS; 24.00%MS; 29%MS). The intake of toasted` seeds of Mucuna pruriens cochinchinensis was significantly higher ($p>0.05$) than that of soaked, or raw seeds. Variety did not significantly ($p>0.05$) influence nutrient intake when Mucuna pruriens seeds were raw. Whereas, the intake of the utilis (black) variety of toasted or soaked Mucuna pruriens seeds was significantly higher than that of the cochinchinensis (white) variety. Similarly, gender significantly affected intake, males had better seed intake than females, and the digestibility of DM, OM, BP, and BC of the different rations were comparable ($p>0.05$). However, the males appreciated the RmtC ration better than the females where the R0, RmCC and RmTC rations were palatable. This study shows that the seeds of both varieties of Mucuna pruriens can be used in the diet of guinea pigs as an alternative source of protein but for better zootechnical performance it would be desirable to use the variety used.

Keywords: *Mucuna pruriens*, chemical composition, *in vivo* digestibility, *Cavia porcelus*, treatment, ingestion, *cochinchinensis*.

INTRODUCTION

To participate in the coverage of the protein needs of the populations in sub-Saharan Africa, the establishment of short-cycle farms is one of the sustainable solutions to food insecurity [1]. Practised in developing countries in general and in Cameroon in particular, caviar farming could be a solution to the problem of food insecurity and the threat to biodiversity since guinea pigs are fast growing, low in fat and their meat is high in protein [2]. Long marginalized, guinea pig farming is now the best way to have access to quality animal protein at a low cost and in a short time. However, the diet of this animal species is essentially based on kitchen waste, which does not allow the animal to express its genetic potential [3].

The search for other lower-cost supplements, widely available is more than necessary, to optimize the use of forage and, maintain the animals' acceptable performance [4, 5]. Thus, the control of locally available feed resources becomes a prerequisite for successful

breeding. Therefore, the search for alternative non-conventional feed ingredients to produce balanced, low-cost feeds is necessary. Among the alternative feed sources available in Cameroon, *Mucuna pruriens*, which is generally very little used, has the advantage of being available in several varieties and has an interesting chemical composition [6]. This chemical composition can vary from one variety to another and according to the treatment applied to the seed. With this in mind, a comparative study of the *cochinchinensis* variety and the *utilis* variety was conducted to reduce the content of anti-nutritional factors to improve its nutritional value, the seeds were either toasted or soaked. These different treatments have the advantage of being easy to perform and can allow in a very short time to reduce the rate of several anti-nutritional substances in the food. The present study aims to contribute to better use of local resources without market value in animal feed, by identifying efficient and adapted preparation practices in rural areas. Specifically, the study will compare the two varieties of Mucuna (*cochinchinensis* and *utilis*) that are treated or not in guinea pig feed.

MATERIALS AND METHODS

Study area

This study was conducted from March to April 2020 at the Teaching and research farm of the University of Dschang. It's located at the 15th degree of the East meridian, at latitude 5° 36'-5° 44 'North and longitude 09° 85'-10° 06' East.

Animal and housing

For this test, 84 local breed animals (42 males and 42 females) aged 5 months with an average weight of 450 grams ± 60 grams were produced at the LAPRONAN Animals were placed in individual wire cages of 10.6 dm^3 (76 cm×46.5 cm×30 cm), each equipped with a feeder trough and a drinker of 100 grams each respectively and a faeces collection device consisting of 1 mm mesh mosquito net and plastic paper. The various cages were covered with a fine-mesh cover to protect the animals from mice and other predators that may be present or enter the building.

Feeding

The different rations thus prepared were served to each animal daily and were made up as follows (Table 1):

Table 1. Percentage and chemical composition of the experimental rations

Ingredients	**Rations**						
	R_0	**RmCC**	**RmCU**	**RmTC**	**RmtC**	**RmTU**	**RmtU**
Maize	21.5	22	21.5	24.5	22.5	22.5	23,5
Moulding	45.5	31	31	31	30	31	32
Cotton seed cake	13	11.5	11	8	11	12	9
M. pruriens.	0	20	20	20	20	20	20
Shell	1	1	1	1	1	1	1
P. purpureum	10	10	10	10	10	10	10
Palm oil	3.5	2	3	3	3	1	2
Iodized salt	0.5	0.5	0.5	0.5	0.5	0.5	0,5
Premix* 2%	2	2	2	2	2	2	2
Total	100	100	100	100	100	100	100
Dry matter (DM in %)	89.61	89.58	89.93	90.43	90.21	90.54	90.64
Organic matter (%DM)	81.72	82.59	82.15	82.47	83.54	83.99	81.29
Crude protein (% DM)	18.63	18.55	18.74	18.84	18.94	18.97	18.7
Fat (% DM)	6.88	6.9	7.96	7.28	10.58	13.04	9.06
Crude fibre (% DM)	10.81	10.35	10.42	10.04	10.74	10.68	10.29
Ash (% DM)	6.57	6.26	6.99	6.79	6.01	5.93	8.47
ED (Kcal/KgDM)	2816.93	2876.37	2889.72	2850.82	2806.01	2830.06	2869.21

Premix 2% flesh: Vit. A=3000000 IU/kg; Vit. D3=600000 IU/kg; Vit. E=4000mg/kg; Vit. K3=500mg/kg; Vit. B1=200mg/kg;Vit. B2=1000mg/kg; Vit. B3=2400mg/kg; Biotin=10mg/kg; Vit. PP=7000mg/kg; Folic acid=200mg/kg; Choline chloride=10000mg/kg; ferrous sulphate=8000mg/kg;Copper (II) sulphate=2000mg/kg; Manganous oxide=1400mg/kg; Calcium iodate=200mg/kg; Basic cobalt carbonate=200mg/kg; Sodium selenite=20mg/kg; Methionine=20000mg/kg; Lysine=78000mg/kg

ED: Digestible energy, R0: Control ration; RmCC: Ration containing 20% raw *Mucuna pruriens var cochinchinnensis*; RmCU: Ration containing 20% raw *Mucuna pruriens var utilis*; RmTC: Ration containing 20% soaked *Mucuna pruriens var cochinchinnensis;* RmtC: Ration containing 20% toasted *Mucuna pruriens var cochinchinnensis*; RmTU: Ration containing 20% soaked *Mucuna pruriens var utilis;* RmtU: Ration containing 20% toasted *Mucuna pruriens var utilis*

With,

- Lot 1:60 g of R0/animal/day (Control ration with 0% *Mucuna pruriens*)
- Lot 2:60 g of RmCC /animal/day (Ration containing 20% raw *M. p.* var *cochinchinnensis*)
- Lot 3:60 g of RmTC /animal/day (Ration containing 20% *M. p. soaked* var *cochinchinnensis*)
- Lot 4:60 g of RmtC /animal/day (Ration containing 20% toasted *M. p.* var *cochinchinnensis*)
- Lot 5:60 g of RmCU /animal/day (Ration containing 20% raw *M. p.* var *utilis*)
- Lot 6:60 g of RmTU /animal/day (Ration containing 20% *M. p. soaked* var *utilis*)
- Lot 7:60 g of RmtU /animal/day (Ration containing 20% toasted *M. p.* var *utilis*)

Trial conduct

Treatment of grains

Figure 1. Seeds of Mucuna pruriens: variety (a) cochinchinensis (b) variety utilis

It consisted of whole seeds of *Mucuna pruriens* varieties *cochinchinnensis* and *utilis* (Figure 1). *Mucuna pruriens* seeds were bought from North Cameroon. Underwent two different treatments including soaking (48 hours) at room temperature + boiling for 1 hour 30 minutes in a pressure cooker for the first treatment and toasting for 45 minutes at 103°C for the second treatment. Then, these seeds were ground and the resulting powder was incorporated at a rate of 20% in the feed to make up the different experimental rations.

Data collection and study parameters

Feed intake evaluation

A total of twelve guinea pigs of which six of each sex were used throughout this trial per treatment and *Mucuna pruriens* variety. These animals were randomly assigned to individual cages, and food was served only once each day between 8 am and 9 am. For intake assessment, the amounts of food served (60 grams) were recorded, and refusals were collected daily and weighed before further distribution. As a prophylactic measure, vitamin C was given daily to all animals in drinking water served ad libitum to avoid any possible deficiency. Food refusals were quantified to determine the quantities of food intake. The food intake was evaluated by the following formula:

Food intake=Daily amount of food served-Amount not consumed (refusal)

In vivo digestibility of rations

The digestibility test was preceded by a period of adaptation of the animals to the digestibility cage and the compound feed, which lasted 10 days. During this period, the quantities of compound food served were adjusted to the animal's consumption, estimated at 60 grams/animal/day. During the data collection period which lasted 7 days, each morning before the distribution of the food, faeces were collected in batches, weighed, and dried at 60°C in the laboratory in a ventilated oven. The animals were weighed individually during this collection period (beginning and end) to assess their weekly gain. Subsequently, their Dry Matter (DM), Organic Matter (OM), Crude Protein (CP), and Crude Fibre (CF) content was analyzed according to the method described by AOAC (2000) [7]. The apparent digestive utilization Coefficients of Dry Matter (CUDaDM), Organic Matter (CUDaOM), Crude Protein (CUDaCP), and Crude Cellulose (CUDaCF) were calculated according to the formula:

CUDaDM (%)=(DM ingested-FecalDM)/(DM ingested)×100

CUDaOM (%)=(OM ingested-FecalOM)/(OM ingested)×100

CUDaCP (%)=(CP ingested-FecalCP)/(CP ingested)×100

CUDaCF (%)=(CF ingested-Fecal CF)/(CF ingested)×100

Statistical analysis

Data on food intake and nutrient digestibility were submitted to a one-factor Analysis of Variance (ANOVA) (food ration) following the General Linear Model (GLM). When significant differences existed between treatments, means were separated by the Waller-Duncan test at the 5% significance level [8]. SPSS 20.0 analysis software was used.

RESULTS

Chemical composition of soaking and toasting Mucuna pruriens seeds

The different treatments performed on *Mucuna pruriens* seeds had a variable influence on their chemical composition (Table 2 and Figure 2), regardless of the variety. Indeed, the DM content of the toasted seeds of *Mucuna pruriens* variety *utilis* was significantly ($p<0.05$) higher than that of the other treated seeds. The same observation was made for OM. Nevertheless, the BP content of the *cochinchinensis*-soaked seeds was significantly ($p<0.05$) higher compared to that of the other seeds. The BC content of *cochinchinensis*-soaked seeds was significantly ($p<0.05$) higher than that of other seeds. The same observation was made for MG. On the other hand, the ash content of the toasted seeds, the raw used, was comparable ($p>0.05$) but significantly ($p<0.05$) higher than that of the other seeds.

Table 2. Chemical composition of *Mucuna pruriens* seeds submitted to different treatments

Chemical composition	*Mucuna pruriens* seeds						ESM	p
	CC	CU	TC	TU	tU	tC		
DM	90,00^{e}	92,00^{d}	93,33^{c}	80,00^{f}	98,00^{a}	96,33^{b}	1,41	0,00
OM	87,00^{e}	89,00^{d}	91,00^{c}	78,00^{f}	94,00^{a}	92,67^{b}	1,27	0,00
CP	22,00^{e}	25,00^{c}	29,00^{a}	20,67^{f}	28,00^{b}	24,00^{d}	3,07	0,00
CF	6,33^{d}	6,00^{e}	11,67^{b}	5,00^{f}	6,67^{c}	13,00^{a}	3,16	0,00
Fat	6,00^{b}	3,00^{f}	5,00^{c}	3,67^{e}	4,00^{d}	7,00^{a}	1,43	0,00
Ash	3,00^{b}	3,67^{a}	2,00^{c}	2,33^{c}	4,00^{a}	4,00^{a}	0,85	0,00

a, b, c, d, e, f: Means with the same letters on the same line are not significantly different at the 5% level; SEM: Standard Error on the Mean; p: Probability; CU: Raw utilis; TU: Soaked *utilis*; tU:toasted utilis , CC:Raw *cochinchinensis*; TC:Soaked *cochinchinensis*; tC: toasted *cochinchinensis*, DM: Dry Matter; OM: Organic Matter; CP: Crude Protein; CF:Crude Fiber; MF:fat.

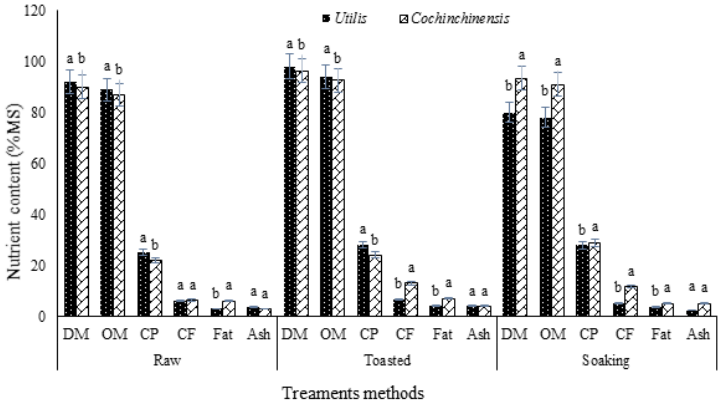

Figure 2. Effect of treatment on the chemical composition of *Mucuna pruriens* seed varieties

Comparative effect of antinutritional factors contained in Mucuna pruriens seeds between the black (Utilis) and white (Cochinchinnensis) Variety

The anti-nutritional factors (phenols and tannins) of *Mucuna pruriens* seeds are presented in Figure 3. In general, according to the treatments, the toasted seeds of Mucuna pruriens variety utilis presented a significantly ($p<0.05$) lower level of anti-nutritional factors (phenols and tannins) than the raw or soaked seeds.

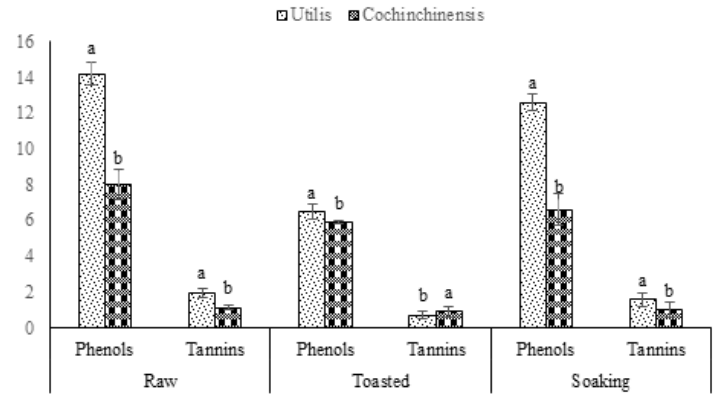

Figure 3. Effect of treatment on antinutritional factors of two varieties of *Mucuna pruriens* seeds (*utilis* and *cochinchinensis*)

Comparative effect of black (utilis) and white (cochinchinnensis) Mucuna pruriens intake in the ration between males and females

In Figure 4 illustrates the comparative effect of the inclusion of treated and untreated utilis and cochinchinensis varieties in the ration on feed intake in guinea pigs. It shows that regardless of the variety, no significant difference ($p>0.05$) was observed in nutrient intake (DM, OM, CP, and CF) for the control ration (R0) and the ration containing the raw seeds. On the other hand, the nutrient intake of the black variety (*utilis*), whether the seeds were toasted or soaked, was significantly ($p<0.05$) higher than that of the white variety (*cochinchinensis*), with the exception of the PB of the ration containing soaked seeds, where the two varieties were comparable.

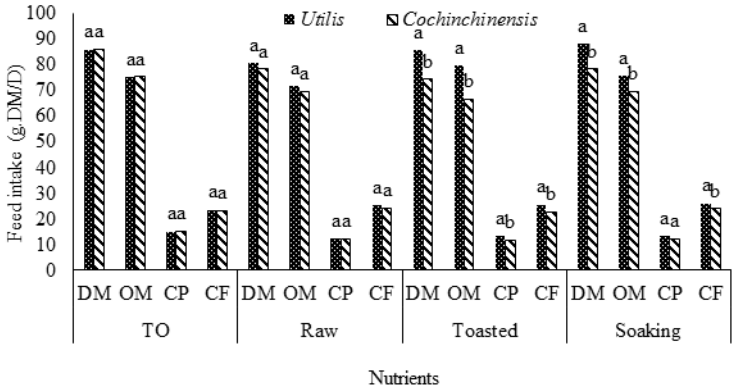

Figure 4. Ingestion of *Mucuna pruriens* variety *cochinchinensis* and *utilis*

Comparative effect of coefficient of utilization CUDa of black (Utilis) and white (Cochinchinnensis) variety of Mucuna pruriens in the ration between males and females

Figures 5-8 shows that the inclusion of *Mucuna pruriens* powder at 20% for all varieties significantly increased ($p<0.05$) the di-gestibility of Dry Matter (DM), Organic Matter (OM), Crude Protein (CP), and Crude Fiber (CF) of the different rations compared to the Control Ration (R0). In addition, dry matter digestibility was comparable ($p>0.05$) during soaking, and the opposite effect was observed with the variety used following soaking or toasting where this digestibility was significantly lower ($p<0.05$). The digest-ible utilization of Crude Fiber (CF) of the different rations was comparable ($p>0.05$) whatever the treatment and significantly higher ($p<0.05$) than that of the Control Ration (R0). On the other hand, the inclusion of *Mucuna pruriens* in the ration significantly ($p>0.05$) influenced the digestibility of the Crude Protein (CP) in the animals, although more effect was observed with the variety used toasted. On the other hand, the coefficients of digestive use of organic matter (CUDaMO) in guinea pigs whatever the ratio was comparable ($p>0.05$) and significantly higher ($p<0.05$) with the variety *cochinchinnensis* whatever the treatment.

Polynomial fitting of DM, OM, CP, and CF digestibility gave the coefficients of determination of DM, OM, CP and CF (R2 = 0.92; R2 = 0.92; R2 = 0.75 and R2 = 0. 93 respectively) for the variety *utilis*, showing that a respective variation of 92% of DM and OM, 75% of PB and 93% of CB; contrary to the variety *cochinchinnensis* which presented a variation of 92% of DM, 94% OM, 99% of PB and 91% of CB.

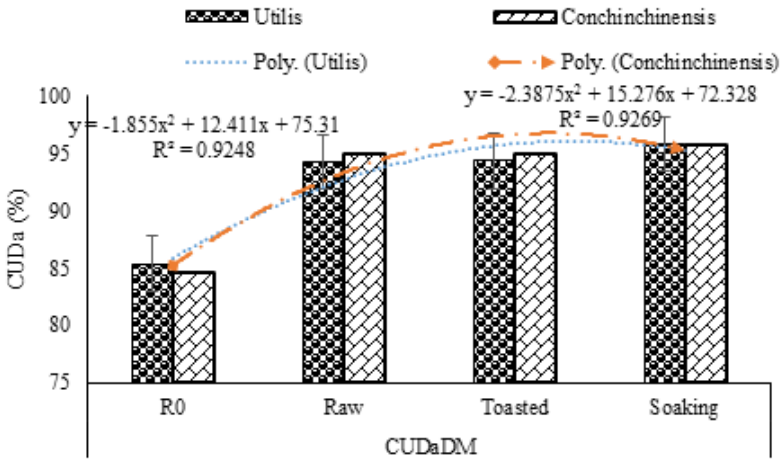

Figure 5. CUDa of Dry Matter

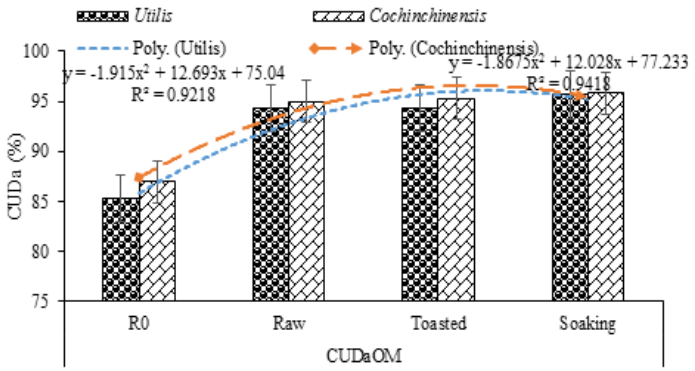

Figure 6. CUDa of Organic Matter

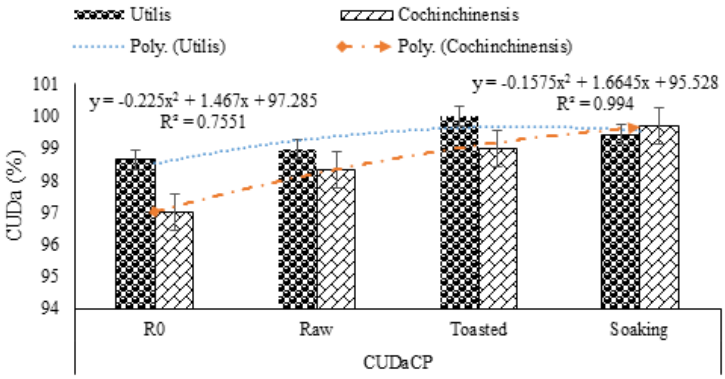

Figure 7. CUDa of Crude Protein

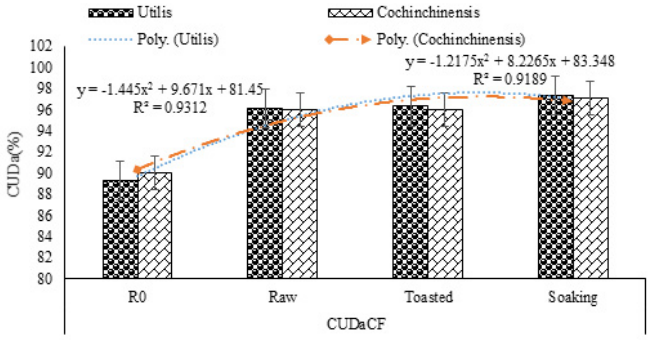

Figure 8. CUDa of Crude Fibre

DISCUSSION

Mucuna pruriens cultivation is not yet intensified in Cameroon. However, *Mucuna pruriens* is available in some regions and is inexpensive locally. The quantity to be used as a protein source is highly available if the population is more interested in it. Also, this use is quite possible because it is one of the most productive legumes in the world 2.9 t/ha to 6.9 t/ha [9].

In this study, the intake of concentrate containing soaked or toasted *Mucuna pruriens* seeds of the *utilis* (black) variety was significantly higher than that of the white variety. This can be explained by their chemical composition which, depending on the variety, presents different levels of anti-nutritional factors. In addition, the palatability of the rations as well as the experimental conditions would also be at the origin of this preference. Indeed, when physical treatments are applied to *Mucuna pruriens* seeds, they significantly reduce the content of condensed tannins and total phenols, thus increasing the bioavailability of proteins. These observations are in disagreement with those found by Musonda who recorded no difference between spotted and yellow variety Mucuna seeds after treatment. This could also be because palatability is animal-dependent and therefore it is difficult to explain in terms of biological processes this nutritional selection [2]. Total dry matter intake DM, OM, CP, and CF were significantly higher in animals receiving Mucuna black variety in their ration. Nguedia obtained the best intake with rations containing spirulina and explained it by the fact that the inclusion of the protein even in small amounts improves intake and therefore *Mucuna pruriens* could have good palatability [10].

The inclusion of toasted or soaked *Mucuna pruriens* seeds significantly affected the intake of CP and CF. This is in disagreement

with the work of David who showed that the daily intake of pelleted compound feed, crude cellulose, and crude protein did not vary significantly with the treatments applied to *M. oleifera* seeds. Variations in these results could be explained by differences in the techniques used (treatment duration, temperature, dose or nature of the additive, etc.) [11].

The highest values of these ingestions were obtained with toasted *M. pruriens.* These results can be explained by the fact that toasting allowed for to reduce of the maximum content of anti-nutritional factors present in the seeds of *Mucuna pruriens* and is capable of limiting the use of proteins. Thus, toasting would have provided good-quality proteins that favoured the ingestion of nutrients. Indeed, according to many authors, protein supplements would promote sufficient proliferation of gut microorganisms involved in digestion in guinea pigs [2,12]. This would promote increased food fermentation and transit with a consequent increase in food intake.

However, no significant differences were observed between the different rations in the CUDa of DM, OM, CP, and CF. This would be related to the small variation in the proportions between the ingredients of the different rations, which accounts for the narrow ranges of variation in bromatological characteristics between the different rations. These results are in agreement with those obtained by Dahouda who reported that the inclusion of black *Mucuna pruriens* seeds in the guinea fowl diet did not significantly affect the apparent digestive utilization coefficient of DM, OM, and PB. This suggests that this legume has the same nutritional characteristics as other protein substitutes.

CONCLUSION

At the end of this study on the comparative effect of the nutritional value of two varieties (*utilis* and *cochinchinnensis*) of *Mucuna pruriens* in guinea pigs (*Cavia porcellus*). It was found that:

- The different treatments on these two varieties of *Mucuna pruriens* seeds significantly influenced intake, chemical composition as well as anti-nutritional factors. However, the variety used showed the best intake regardless of the ratio.
- Regardless of variety, the inclusion of *Mucuna* seeds did not have a significant effect on CUDa.
- The nutrient content of the white variety *Mucuna* was significantly higher than that of the black variety when the seeds were soaked. While with raw and toasted seeds, the opposite effect was observed.

From the above, it can be concluded that *Mucuna pruriens* variety *utilis* (black) gave the best zootechnical performance when the seeds were toasted.

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