Influence of Level of Cottonseed Cake in the Diet on the Feed Intake, Growth Performance and Carcass Characteristics of Guinea Pigs in Cameroon

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Keywords: Guinea pigs- *Pennisetum purpureum*- *Desmodium intortum*- Cottonseed cake- Growth performance- Carcass

Summary

An eight-week trial was conducted to evaluate the influence of graded levels (0, 25 and 50% denoted R_0, R_1 & R_2) of cottonseed cake (CSC) based diets used as supplement for Pennisetum purpureum *and* Desmodium intortum *basal diets on the feed intake, growth rate and carcass characteristics of guinea pigs. Mean daily feed intake for the treatments R_o, R_1 and R_2 were 15.80 ± 0.70 g/day, 14.33 ± 0.94 g/day, 21.04 ± 1.26 g/day and 15.94 ± 0.77 g/day, 18.03 ± 1.11 g/day, 21.32 ± 1.14 g/day for females and males respectively. Considering the type of feed, there was a highly significant (P< 0.01) difference between consumption of* Pennisetum, Desmodium *and concentrate within the sexes and for all the treatments. Animals showed a high preference for* Pennisetum *followed by* Desmodium *and concentrate. The percent forage dry matter (DM) intake increased from 85.30% for R_o to 88.90% for R_2 for females and 84.90% to 88.50% for males. There were no significant differences (P> 0.05) in the within treatment sex differences in total DM intake. Respective mean weekly weight gains for R_o, R_1 and R_2 were 13.17 ± 1.05 g, 13.42 ± 0.62 g, 10.56 ± 1.56 g for males and 12.14 ± 0.83 g, 10.62 ± 1.13 g, 6.31 ± 0.70 g for females. There were significant differences (P< 0.05) in the within treatment sex differences, for these values in treatments R_1 and R_2. The between treatment variation in sexes for these values was only observed for females between treatment R_2 and the other two treatments. Overall mean weekly weight gain for the treatments (R_o, R_1 and R_2) were 12.65 ± 0.94 g, 12.12 ± 0.88 g and 8.44 ± 1.13 g respectively. Significant (P< 0.05) difference in these values was only observed between treatment R_2 and the preceding treatments (R_o and R_1). Feed efficiency for males and females for the respective treatments were 8.39, 7.47, 13.95 and 9.19, 11.88, 23.65 respectively. Overall feed efficiency values showed a linear increase from R_o (8.78) to R_2 (17.57). Overall mean mortality figures also showed a similar trend with R_o and R_1 having the same value of 6.67% and R_2 having a numerically higher value of 33.33%.*

Résumé

Influence du taux d'incorporation du tourteau de coton dans l'aliment sur la consommation alimentaire, les performances de croissance et les caractéristiques de la carcasse des cobayes au Cameroun

Un essai de 8 semaines a été conduit pour évaluer l'influence de trois niveaux d'incorporation (R_0= 0%, R_1= 25% et R_2= 50%) du tourteau de coton dans un aliment concentré utilisé comme supplément protéinique d'une ration à base de Pennisetum purpureum *et* Desmodium intortum*, sur l'ingestion, les performances de croissance et les caractéristiques de la carcasse chez les cobayes. L'ingestion moyenne quotidienne de la matière sèche (MS) pour les trois traitements R_0, R_1 et R_2 était de 15,80 ± 0,70 g/jour, 14,33 ± 0,94 g/jour, 21,04 ± 1,26 g/jour et de 15,94 ± 0,77 g/jour, 18,03 ± 1,11 g/jour, 21,32 ± 1,14 g/jour respectivement chez les femelles et les mâles. En fonction du type d'aliment et pour des animaux du même sexe, nous avons observé une différence très significative (P< 0,01) entre les consommations de* Pennisetum, *de* Desmodium *et de concentré pour tous les traitements. Les animaux avaient une préférence pour le* Pennisetum *suivi du Desmodium et du concentré. Le taux d'ingestion de la MS fourragère variait de 85,30% pour R_o à 88,90% pour R_2 chez les femelles et de 84,90% à 88,50% chez les mâles. L'ingestion totale de MS chez les femelles n'était pas significativement différente (P> 0,05) de celle des mâles soumis au même traitement. Les gains moyens hebdomadaires (G.M.H.) pour R_o, R_1 et R_2 étaient de 13,17 ± 1,05 g, 13,42 ± 0,62 g, 10,56 ± 1,56 g chez les mâles et 12,14 ± 0,83 g, 10,62 ± 1,13 g, 6,31 ± 0,70 g chez les femelles respectivement. Les G.M.H. des femelles étaient significativement différents (P< 0,05) de ceux des mâles dans les traitements R_1 et R_2. A l'intérieur du même sexe, les femelles soumises aux traitement R_2 ont eu un G.M.H. significativement différent (P< 0,05) de celui des deux autres traitements. Les G.M.H. pour les traitements R_0, R_1 et R_2 étaient de 12,65 ± 0,94 g, 12,12 ± 0,88 g et 8,44 ± 1,13 g respectivement, nous avons observé une diffé-*

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Results for carcass evaluation and gut characteristics show no significant difference (P> 0.05) between the treatment means for carcass weight, viscera weight, liveweight, small and large intestinal weights and dressing percentage. A highly significant difference (P< 0.01) between the treatments was however recorded for the caecal weights between treatment R_2 (44.78 ± 2.60) and the other two treatments being R_o (38.75 ± 1.74) and R_1 (37.44 ± 1.58). Results indicate that CSC can be included in supplemental diets in guinea pigs up to 25% without significant reduction in growth performance and carcass quality.

rence significative (P< 0,05) entre le G.M.H. de R_2 et celui des deux autres traitements (R_o et R_1). Les indices de consommation des différents traitements chez les mâles étaient de 8,39; 7,47; 13,95 et 9,19; 11,88; 23,65 chez les femelles respectivement pour les traitements R_0, R_1 et R_2. Les indices de consommations généraux augmentaient de manière linéaire de 8,78 pour R_o à 17,57 pour R_2. Les données générales sur les mortalités donnaient les mêmes tendances que celles ci-dessus avec des taux de 6,67% pour R_0 et R_1 et 33,33% pour R_2. Les caractéristiques de la carcasse n'étaient pas significativement différentes (P> 0.05) quel que soit le traitement, notamment pour le poids carcasse, le poids des viscères, du foie, du petit et du gros intestin et le rendement carcasse. Toutefois, le poids du cæcum des animaux soumis à R_2 étaient significativement supérieur (P< 0,01) à celui des animaux soumis aux deux autres traitements (44,78 ± 2,60 g pour R_2 contre 38,75 ± 1,74 et 37,44 ± 1,58 pour R_0 et R_1 respectivement). Les résultats montrent que le tourteau de coton peut être incorporé dans un aliment de supplémentation des rations du cobaye jusqu'à hauteur de 25% sans qu'il y ait réduction conséquente de la croissance ou de la qualité de la carcasse.

Introduction

Guinea pigs are promising minilivestock due to the fact that they require little capital or labour, provide an inexpensive readily available, palatable meat, have no odour and are suitable for keeping indoors (16). In addition their low cost and size make them accessible to many landless peasants. More important is their ability to serve as excellent sources of supplementary income for these farmers. In the Western Highlands of Cameroon (WHC) the offtake due to slaughtering for home consumption, cash sales and gifts has been reported (14) to be 40%, 55% and 5% respectively. This relatively high commercial offtake suggests that guinea pig production is an important income generating activity for small farmers in the WHC. The increasing population density (250-300 inhabitants/km^2) in the WHC which is responsible for the continuous decline in the size of smallholder farm holdings has rekindled farmer interest in non-conventional small animal species notably minilivestock such as Guinea pigs, (14, 17) and the African giant rats (11).

While in Latin America production of guinea pigs has been improved with modern production practices, in Cameroon, production of guinea pigs is mainly by the traditional system where the animals scavenge on the floor for their daily needs (14). Most food is provided from kitchen wastes and farm residues and sometimes supplemented with vegetables and forages. This has resulted in a situation where the productivity of these animals has remained low. The utilisation of agroindustrial by-products which are affordable to the farmers could definitely improve the nutrition of these animals, especially during the dry season when conventional forages are hard to find. The present study was designed with a view to investigating the feed intake, growth performance and carcass characteristics of guinea pigs fed graded levels of cottonseed cake.

Materials and methods

Study site

The study was conducted at the teaching and research farm of the University of Dschang. Dschang is situated in the WHC which is in the sudano-guinean zone (latitude 5-7^0 N, longitude 8-12^0 E). The mean annual temperature and relative humidity are 16-17 ^{0}C and 49-97% respectively. The mean annual rainfall is about 2000 mm, the wet season ranges from March to November and the dry season from late November to March.

Trial management

Ninety guinea pigs with an average age of 7 weeks were first separated according to their sexes (45 males and 45 females) and then randomly divided into three groups corresponding to three levels of cottonseed cake inclusion in their diets (0, 25, and 50%). Animals were placed in a completely randomised design with three replicates of 5 animals per sex per treatment. Replicates were housed in identical bamboo cages of 60 by 40 cm corresponding to a space allocation of 0.048 m^2 per animal. Animals were all given a basal diet of forage being *Pennisetum pur-*

pureum and *Desmodium intortum* free choice. Basal diets were supplemented with diets containing 0, 25 and 50% cottonseed cake. These diets corresponded to the three treatments denoted as R_o, R_1 and R_2. The percentage composition of the supplemental diets used in the study are shown in table 1.

Table 1
Percentage composition of supplemental diets

Ingredients	R_o	R_1	R_2
Cottonseed cake	0.00	25.00	50.00
Wheat bran	61.80	60.65	49.50
Soybean cake	37.70	13.85	0.00
Salt	0.25	0.25	0.25
Broiler Premix	0.25	0.25	0.25
Total	100	100	100

The proximate chemical composition of the basal and test diets determined according to the methods described by A.O.A.C. (4) are also shown in table 2.

The gossypol content of the cottonseed cake used in the study had earlier been reviewed by Dongmo *et al*., (10) and indeed the free gossypol content of most of our cottonseed cakes and meals have been reviewed by Heywang and Bird, (12) and McDonald *et al*., (15) who reported the gossypol content of most cottonseed cakes to be within the range of 0.03 to 0.2%.

Animal management

Animals were fed *ad libitum* and cages were cleaned daily. Provision was made for the space for dunging, feeding and drinking. Liveweight measurements were made weekly for males and females while feed consumed was measured indirectly by weighing the feed given and the leftovers. At the end of the study, 10 animals per treatment were fasted for a period of 12 hours and slaughtered by cervical dislocation for carcass evaluation and organ weights.

Data collection and statistical analysis

Mean values of weekly weight gain, feed consumption for the different sexes were computed from raw data collected in the study while only males were used for carcass evaluation. Data collected were subjected to one way analysis of variance while significant differences between means were compared by the Duncan's multiple range test (19).

Results

Feed consumption

Results show mean daily feed intake (Table 3) of females and males for R_o, R_1 and R_2 to be 15.80 ±

Table 2
Chemical composition of feeds (% dry matter)

	Pennisetum purpureum	*Desmodium intortum*	R_o	R_1	R_2
Dry matter	20	16.5	88.3	90.4	88.1
Crude Protein	9.8	17.0	28.1*	26.8*	28.8*
Crude Fibre	29.7	30.4	10.7*	11.1*	11.2*
Ash	14	10.9	8.0	6.6	6.9
Ether extracts	2.6	3	–	–	–
Nitrogen free extracts	43.9	38.7	–	–	–

* Determined by calculation.

Table 3
Effect of sex and type of feed on the mean total dry matter intake (g) of guinea pigs fed different levels of CSC

Sex	Type of feed	Treatment R_o (Mean ± S.E.)*	Treatment R_1 (Mean ± S.E.)	Treatment R_2 (Mean ± S.E.)
Females	*Pennisetum*	478.75 ± 12.84^a	446.84 ± 21.30^a	674.50 ± 26.10^a
	Desmodium	282.45 ± 16.82^b	276.64 ± 18.90^b	372.67 ± 24.12^b
	Concentrate	131.20 ± 9.58^c	120.83 ± 12.22^c	130.81 ± 20.40^c
	% forage DM intake	85.30	85.70	88.90
	Mean daily DM intake/female•	15.80 ± 0.70^a	14.33 ± 0.94^a	21.04 ± 1.26^b
Males	*Pennisetum*	478.98 ± 16.62^a	546.90 ± 28.33^a	666.90 ± 23.21^a
	Desmodium	278.68 ± 16.53^b	311.38 ± 21.33^b	389.93 ± 22.29^b
	Concentrate	135.08 ± 10.19^c	151.49 ± 12.26^c	137.35 ± 18.26^c
	% forage DM intake	84.90	85.0	88.50
	Mean daily DM intake/male•	15.94 ± 0.77^a	18.03 ± 1.11^{ab}	21.32 ± 1.14^b

* Means (± S.E.) bearing different superscripts in the same column and sex differ significantly ($P< 0.01$).
• Means bearing different superscripts within this rows are significant at $P< 0.05$.

0.70, 14.33 ± 0.94, 21.04 ± 1.26 and 15.94 ± 0.77, 18.03 ± 1.11, 21.32 ± 1.14 for the sexes and treatments respectively.

Male animals fed on the R_2 diet consumed significantly higher (P< 0.05) dry matter (DM) as compared to those on the control. There was no significant difference between R_o & R_1 and between R_1 & R_2 males for feed intake. For females, R_2 animals consumed more feed (P< 0.05) than the R_o & R_1 animals.

Table 4 shows the within treatment sex differences in mean total dry matter intake for males and females for the period of study (0-8 weeks).

The mean total DM intake for males was numerically higher in R_2 followed by R_o and R_1. In females these values followed almost the same trend except with the value for R_1 which was numerically better than that in R_o. There were however no significant differences (P> 0.05) between the males and females for all the treatments. The mean DM intake was significantly (P< 0.05) higher for treatment R_2 as compared to the other treatments (Table 5).

Table 4
Within treatment sex differences in total DM intake (g) for guinea fed different levels of CSC

Sex	Treatment R_o (Mean ± S.E.)*	Treatment R_1 (Mean ± S.E.)	Treatment R_2 (Mean ± S.E.)
Males	297.58 ± 30.47[a] (24)	291.71 ± 31.12[a] (24)	398.06 ± 46.60[a] (24)
Females	294.92 ± 29.90[a] (24)	324.73 ± 34.00[a] (24)	392.65 ± 48.17[a] (24)

* Means (± S.E.) bearing the same superscripts within the same row are not significantly different (P> 0.05).
( ) - values in parenthesis represent the number of observations.

Considering the type of feed, there was a highly significant difference (P< 0.01) between consumption of *Pennisetum*, *Desmodium* and concentrate within the sexes and for all the treatments. Animals showed a high preference for *Pennisetum* followed by *Desmodium* and lastly the concentrate.

The percent forage DM intake increased from 85.3 for R_o to 88.9 for R_2 for females and 84.9 to 88.5 for males (Table 3).

Growth performance

Table 6 shows values for the between and within treatment sex differences in mean weekly weight gain. Males for R_1 recorded higher values of 13.42 ± 0.62 while the lowest value was recorded by males of R_2 (10.56 ± 1.56).

Table 5
Effect of level of CSC in the diet on the total DM intake of guinea pigs

Parameter	Treatment R_o (Mean ± S.E.)*	Treatment R_1 (Mean ± S.E.)	Treatment R_2 (Mean ± S.E.)
Total DM intake in grams (0-8 weeks)	296.25 ± 21.12[a] (48)	307.04 ± 22.82[a] (48)	395.36 ± 33.16[b] (48)

* Means (± S.E.) bearing different superscripts within the same row differ significantly (P< 0.05).
( ) - values in parenthesis represent the number of observations.

Table 6
Between and within treatment sex differences in mean weekly weight gain (grams) of guinea pigs fed different levels of CSC

Sex	Treatment R_o (Mean ± S.E.)*	Treatment R_1 (Mean ± S.E.)	Treatment R_2 (Mean ± S.E.)
Males	13.17 ± 1.050^a	13.42 ± 0.62^a	10.56 ± 1.560^a
Feed efficiency(F/G)	8.39	7.47	13.95
Percent mortality (%)	6.67	0.00	33.33
	(14)	(15)	(10)
Females	12.14 ± 0.830^a	10.62 ± 1.130^{ab}	6.31 ± 0.700^b
Feed efficiency(F/G)	9.19	11.88	23.65
Percent mortality (%)	6.67	13.33	33.33
	(14)	(13)	(10)

( ) - values in parenthesis represent the number of observations.
*Means (± S.E.) bearing different superscripts in the same column or row differ significantly (P< 0.05)

On the other hand females for R_o had the highest values (12.14 ± 0.83) for the same parameter meanwhile the value for R_2 was about half of the former (R_o). There was no significant difference in the within treatment sex differences between males and females for treatment R_o. There were significant differences ($P < 0.05$) between males and females in treatments R_1 and R_2 with males recording higher values than females. There were also no significant differences ($P > 0.05$) in the between treatment sex differences by R_o and R_2. In females the feed efficiency in R_o, R_1 and R_2 were 9.19, 11.88 and 23.65 respectively with a better feed efficiency being observed in R_o. Feed efficiency figures within treatment are better for males than females. Overall feed efficiency values show that R_o had a slightly higher efficiency than R_1 which was also higher than R_2.

Corresponding mortality figures (Table 6) during the period of study show a net increase in overall mortal-

Table 7
Effect of level of CSC on the overall mean weekly weight gain of guinea pigs

Parameter	Treatment R_o (Mean ± S.E.)*	Treatment R_1 (Mean ± S.E.)	Treatment R_2 (Mean ± S.E.)
Mean weight gain (grams)	12.654 ± 0.940^a	12.118 ± 0.875^a	8.437 ± 1.130^b
	(28)	(28)	(20)
Feed Efficiency (F/G)	8.78	9.35	17.57
Percent mortality (%)	6.67	6.67	33.33

( ) - values in parenthesis represent the number of observations.
*Means (± S.E.) bearing different superscripts in the same row differ significantly (P< 0.05).

between the males of R_o, R_1 and R_2. Significant difference($P < 0.05$) in the females was only observed between treatment R_2 which recorded a lower value of 6.31 ± 0.7 as opposed to 12.14 ± 0.83 for R_o and 10.62 ± 1.13 for R_1. The overall mean weekly weight gain for the period of study (0-8 weeks) shown in table 7 was highest for R_o (12.654 ± 0.94) and lowest for R_2 (8.437 ± 1.13).

Significant differences ($P < 0.05$) were observed between R_2 which recorded the lowest weight gain as compared to R_o & R_1.

The feed efficiency, calculated as feed/gain (F/G), for males in R_o, R_1 and R_2 were 8.39, 7.47 and 13.95 respectively. R_1 had the best feed efficiency followed ity with increasing levels of CSC in the diet. Considering the sexes (Table 6), mortality figures were similar for males and females for the treatments except in treatment R_1 where the figure was (0%) for males and 13.33 for females.

Carcass and gut characteristics

Results for this parameter (Table 8) show that although R_2 had higher mean values for the live weight (351.11 ± 23.2) than R_o (349 ± 17.62), corresponding values for carcass weight and dressing percentage for R_o (247.8 ± 15.47, 70.61 ± 1.49) were higher than those for R_2 (237.22 ± 19.86, 66.74 ± 2.06).

Table 8
Carcass and gut characteristics of guinea pigs fed different levels of CSC

Parameter (in grams)	Treatment R_o (Mean ± S.E.)*	Treatment R_1 (Mean ± S.E.)	Treatment R_2 (Mean ± S.E.)
Liveweight	349.00 ± 17.62^a	364.00 ± 17.67^a	351.11 ± 23.20^a
Carcass weight+head	247.80 ± 15.47^a	260.00 ± 15.37^a	237.22 ± 19.86^a
Carcass weight	194.06 ± 14.04^a	209.00 ± 14.10^a	186.67 ± 15.94^a
Viscera weight	96.20 ± 3.68^a	97.00 ± 4.25^a	107.98 ± 6.78^a
Liverweight	9.64 ± 0.74^a	10.42 ± 0.55^a	10.60 ± 0.67^a
Small intestinal weight	13.55 ± 0.72^a	15.68 ± 1.29^a	16.64 ± 1.80^a
Large intestinal weight	18.49 ± 1.38^a	16.20 ± 1.40^a	16.42 ± 2.22^a
Caecal weight	38.75 ± 1.74^a	37.44 ± 1.58^a	44.78 ± 2.60^b
Dressing percentage	70.61 ± 1.49^a	71.13 ± 1.33^a	66.74 ± 2.06^a

*Means (± S.E.) bearing different superscripts in the same row differ significantly (P< 0.01).

Treatment means for gut characteristics show R_2 with the highest value for viscera weight (107.98 ± 6.78), liver weight (10.6 ± 0.67), caecal weight (44.78 ± 2.6) and small intestinal weight (16.42 ± 2.22). Values for treatment R_o were lower than those of treatment R_1 for these parameters except for the large intestinal and caecal weights, where they were 18.49 ± 1.38, 38.75 ± 1.74 and 16.20 ± 1.40, 37.44 ± 1.58 respectively.

No significant difference (P> 0.05) were observed between the treatment means for carcass weight, viscera weight, liver weight, small and large intestinal weight and dressing percentage. There was however a highly significant difference (P< 0.01) in the caecal weight in the treatment means between treatment R_2 and the other treatments which recorded lighter caecal weights as compared to the former. Treatment R_1 recorded the highest mean values for live weight (364 ± 17.67), carcass weight with head (260 ± 15.37) and dressing percentage (71.13 ± 1.33).

Discussion

Feed consumption

The mean daily DM intake values observed in this study are lower than the values reported by Ngou Ngoupayou *et al*., (16) who observed a daily forage DM intake of 22.53 g/animal/day. However this differences could be attributable to the fact that their value was solely dependent on forage DM intake and the animals could probably have needed more feed to cover their requirements. However, values for males and females (averaging 21.18 g) in R_2 in which animals consumed the highest percentage of forage as compared to concentrate are very close to the value of 22.53 g reported by these authors. The highly significant preference for forages as opposed to the CSC based supplements for all the treatments and sexes could be due to their adaptability to a forage diet as they normally consume under traditional management.

Pennisetum purpureum which is the highest consumed forage in this study has also been reported (19) to be the most widely used grass species in the region and constitutes the basis of ruminant diets in many parts of the world.

The increase in percentage forage DM intake from R_o to R_2 as shown in table 3 could be attributed to the increase in fibre content and bulkiness in the concentrate diet with increasing levels of CSC as one goes from 0 to 50% CSC inclusion. This would probably have brought about more preference for the basal diet than the concentrate.

The increase in mean daily feed intake with increasing level of crude fibre content of the diet (except for males in R_1) is at variance with a previous report by Alawa and Amadi (3), who reported a decrease in voluntary feed intake with a replacement of the corn portions of diets with highly fibrous components for rabbits. The difference may have resulted from the fact that these authors used different sources of crude fibre as opposed to graded levels of crude fibre from one source at a time. The present results however agrees with the findings of Butcher *et al*., (8), who reported increases in feed intake with graded levels of crude fibre for growing rabbits.

Growth performance

The higher values for mean weekly weight gain for males as opposed to females indicated in table 6 is suggesting the fact that males were better feed utilisers than the females. Corresponding feed intake figures as represented in tables 3, 4 and 5 show a higher value for males. This could therefore suggest that the increase in protein supplementation improved intake for males more than females. The higher growth rate in males may therefore have resulted from increased rate of breakdown and passage of digesta in males more than females. The mean weekly weight gain of females in R_2 was almost half the value for males. This suggests also that females are poor handlers of diets with high fibre content than males.

The feed efficiency of males in all the treatments is an indication of the fact that males utilise feeds better than females especially with regards to high fibre diets as shown from the differences in the feed efficiency values between males and females in R_1 and R_2. Values for feed efficiency in this study are however higher than the recommendations made by Manjeli *et al*.,(14) for guinea pigs in the Western Highlands of Cameroon. Higher figures for feeding efficiencies in this study are probably due to the introduction of CSC in the diet as there seems to be a linear increase in feed efficiency with increasing amount of CSC (Table 7). Values reported by NRC, (16) were also higher than the ones in this study and these values were in the range of 3.2-5.7 kg of forage to produce 1 kg of growth.

The drop in the overall mean weekly weight gain with increasing levels of CSC in the diet as shown in table 7 is pointing to the fact that unlike ruminants, guinea pigs are unable to handle diets with high fibre content. It could also be suggestive of the fact that they, as opposed to ruminants (15), guinea pigs cannot reasonably stand the anti-nutritional factor (gossypol) present in CSC.

Reduction in weight gain as a result of poor utilisation of higher fibre diets and/or diets containing anti-nutritional factors has also been reported in rats (6), in broilers (7) and in rabbits (1).

The overall mean weekly weight gain values observed in this study are lower than figures reported by Manjeli et *al*. *(*14). A possible explanation for this difference could be the fact that these authors investigated the weight gain of their animals from birth to 15 weeks and indeed NRC (16) reported that weight gain is rapid for the first 4-6 weeks after birth and then decreases. The poor growth rate in the present study may also have been attributed to the poor space availability associated to raising in the cages. The presence of anti-nutritional factors in the supplement especially with regards R_2 where poor growth is very evident could also be a possible explanation. The observed increase in overall mortality with increasing level of CSC in the diet could also be implicating the deleterious effects of anti-nutritional factors on these animals.

Carcass characteristics

Since carcass yield is an indication of the quality and utilisation of the ration, it was therefore not surprising that parameters for carcass yield such as carcass weight and dressing percentage were lower for R_2 than R_o and R_1. Values for feed efficiency, carcass weights and dressing percentage for males in R_1 are in conformity with this assertion. Males in R_1 which had the best feed efficiency had the highest numerical value for growth rate, carcass weights and dressing percentage. This is a clear indication of the fact that the quality of the diet was reflected in a higher empty body weight rather than an increase in viscera components. Values for males in R_o also follow the same trend.

Despite the relatively higher mean liveweight of treatment R_2 than R_o values for carcass weight were lower for R_2 than R_o. There was an increasing tendency for viscera components with increasing levels of CSC in the diet. This could be observed in R_2 where there was a highly significant difference in the caecal weight between this treatment and the other treatments. The significant increase which was observed only for the caecal weights is an indication of the fact that the caecum in the guinea pig just like in other pseudo-ruminants (rabbits and horses) is highly implicated in the digestion of especially cellulose by the animal. Increases in gut size with particular reference to caecal weight has been reported in layers by Longe and Adetola (13). They further stated that the effect of exertion on gut size in layers depended on the nature of the fibre. The increases in the viscera weight and in the relative weights of the gut parts observed from treatment R_o to R_2 although not significant is also associated with the higher fibre content and bulkiness of the diets. This has also been clearly demonstrated in broilers (5, 7) and in cockerels (2). The linear increase in liver weights from R_o to R_2 is suggesting the toxicity of CSC at certain levels of inclusion in the diet. Similar observations have also been made in poultry (5, 18). Values for dressing percentage reported in this study are higher than the observations of NRC (16), who reported a value of 65% including skin and legs. However these values are slightly lower than values for dressing percentage in rabbits (74%) reported for rabbits in Nigeria (1). Values reported for this study are also slightly higher than the range (54%-67%) reported by Cicogna (9), for guinea pigs in South America.

Conclusion

It can be adduced from the results that cottonseed cake can be used as supplement to improve forage based diets for guinea pigs up to 25% inclusion in the diet without any significant reduction in performance. The utilisation of CSC and other agro-industrial by-products in guinea pig nutrition is therefore important in the improvement of their growth performance and consequently their carcass yield although higher levels seem to have a detrimental effect on the animal. Males seem to be more adapted to the utilisation of these by-products than females. Further studies in feeding and nutritional requirement trials, especially with supplements suitable for resource poor farmers as well as during seasons when conventional forages are hard to get is recommended. Management practices such as space requirement and housing which could improve feed utilisation are also of paramount importance.

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