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Full Length Research Paper

Seasonal changes in body condition scores of pigs and chemical composition of pig feed resources in a semi-arid smallholder farming area of Zimbabwe

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There are few studies quantifying the productivity of rural pigs and evaluating the nutritive value of non-conventional feeds, such as weeds. The objectives of this study were to determine changes in body condition scores of boars and lactating sows and investigate changes in the chemical composition of commonly used pig feed resources in a smallholder farming area of Zimbabwe. Body condition scores (BCS) were measured monthly between October and April. *Commelina benghalensis* (wandering jew) and *Richardia brasiliensis* (Mexican clover) were collected monthly, between October and March, for proximate and amino acid analysis. Sows had lower BCS than boars (P<0.05). The Neutral detergent fibre (NDF) and acid detergent fibre (ADF) contents of *C. benghalensis* were lower (P<0.05) than those of *R. brasiliensis*. *C. benghalensis* had about twice the amount of crude protein (CP) compared to *R. brasiliensis*. Lysine, methionine and cysteine, which are the most important amino acids in pig nutrition, were similar in groundnut hulls and *R. brasiliensis*. *C. benghalensis* had higher (P<0.05) levels of threonine, tryptophan, isoleucine, leucine, histidine, phenylalanine, tyrosine, valine, arginine, serine, aspartic acid, glutamic acid, glycine and alanine than *R. brasiliensis*. The proportion of essential amino acids (EAA) was significantly higher (P<0.05) in *R. brasiliensis*. A further study to determine the digestibility and growth performance of pigs fed on these non-conventional diets is needed.

Keywords: Rural pig production, body condition scoring, *Commelina benghalensis,* proximate analysis, Richardia brasiliensis

INTRODUCTION

Rural pig farmers in southern Africa rely on locally available feed resources to feed their animals. There is a general perception that feed supplies are seasonal and inadequate to meet pig maintenance and production feed requirements throughout the year in rural areas (Mashatise et al., 2005). However, there have been few attempts to quantify the productivity of local pigs, and the nutritive value of the common feeds that they consume, in order to improve smallholder pig production. It is assumed that animal performance during the wet season is high (Mhlanga et al., 1999; Holness et al., 2005). The influence of the production systems that the farmers use has often been ignored. There has been inadequate re-

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Table 1. Pig body condition scoring system used.

Body condition score	Description	Assessment of fat cover
0	Emaciated	Exposed, no cover on bones
1	Poor	Bones prominent, little cover
2	Moderate	Bones easily felt without palm pressure
3	Good	Bones only felt with firm palm pressure
4	Fat	Bones cannot be felt with firm palm pressure
5	Grossly fat	Further deposition of fat impossible

Source: Holness (1991).

search on locally available, non-conventional feed resources and their potential value as pig feeds (Ly, 1993; Lekule and Kyvsgaard, 2003). Efforts have been put into utilising non-conventional feedstuffs for pigs, including legume tree leaves (Halimani et al., 2005), and maize cobs (Chimonyo et al., 2006; Chimonyo and Dzama, 2007). Attempts should be made to identify locally available feed resources for each area. The lack of information on changes in nutritive value during the growing season, when the bulk of the feeds are available, hampers the development of appropriate conservation strategies to maintain or produce pigs across the dry season, when both feed quantity and quality are low. Use of non-conventional feed resources is particularly impor-tant since cereal grains are needed for human consump-tion and are not readily available for feeding pigs, espe-cially in rural areas of developing countries. There is a need to identify locally available non-conventional feed resources (for example weeds) for pigs and characterise their nutritive value including amino acid profiles. A ba-lanced and optimal proportion of amino acids are required for efficient protein deposition in the pig, along with a sufficient supply of energy (Grala et al., 1999; Kyriazakis and Whittemore, 2006). Nutritional status of rural pigs can be assessed by monitoring body weight changes and nutritionally-related blood parameters. Be-cause scales are often not available in rural areas, adap-tation of the body condition scoring system, widely used in cattle, has been successful in assessing the perfor-mance of pigs (Maes et al., 2004).

The objectives of the current study were to determine changes in body condition scores of boars and lactating sows during the rainy season when feed is not likely to be a constraint, and investigate changes in the chemical composition of commonly used pig feed resources in a smallholder farming area of Zimbabwe during the rainy and post-rainy seasons. The hypotheses tested were that the body condition and chemical composition of the commonly used feed resources do not change with during the rainy ad post-rainy seasons.

MATERIALS AND METHODS

Study site

The study was conducted in Chinyuni Ward of Chirumanzu district, in the Midlands Province, about 30 km to the north of Masvingo, Zimbabwe. It is located 19º34' S and 30º45' E, at an altitude of between 1300 to 1440 m above sea level. The district lies in Natural Region III, a semi-arid agro-ecological zone where farming operations are extensive. The area receives mean annual rainfall of 650 to 800 mm. The mean maximum temperature ranges from 25 to 39ºC in cold (May to August) and hot seasons (September to November), respectively. The area experiences frequent seasonal droughts and severe dry spells during the growing season, which makes it generally unsuitable for cropping. The farming systems are largely based on livestock and drought-resistant fodder and food crop production.

Selection of pigs

Forty-five lactating sows and 11 mature boars were selected for body condition scoring from 38 households. The sows were nursing piglets ranging from one week to three weeks old. Body condition scoring was done during the growing season (October 2005 to April 2006), the period when the majority of the sows are lactating. The selection of households was based on farmers with at least one mature pig. Pig identification was reliant on farmers' knowledge of their pigs, as is common practice in smallholder farming areas. These pigs were mostly free ranging and occasionally offered a supplementary diet of local feed resources when available. No commercial feeds, drugs or medicines were used but there was limited knowledge and use of ethno-veterinary medicine. The body condition scores (BCS) were measured using the scoring system from 0 to 5, as shown Table 1. The assessment was based on the fat cover on the spine and transverse spinal process, and was assessed at the end of the month. One trained person assessed the condition of the pigs throughout the study.

Feed sample collection

In a separate trial, the weeds commonly used by farmers in feeding their pigs were sampled for nutritive evaluation. The weeds, *Commelina benghalensis* (wandering jew) and *Richardia brasiliensis* (Mexican clover), were collected on a monthly basis from five crop fields of one hectare each every month from October 2005 to

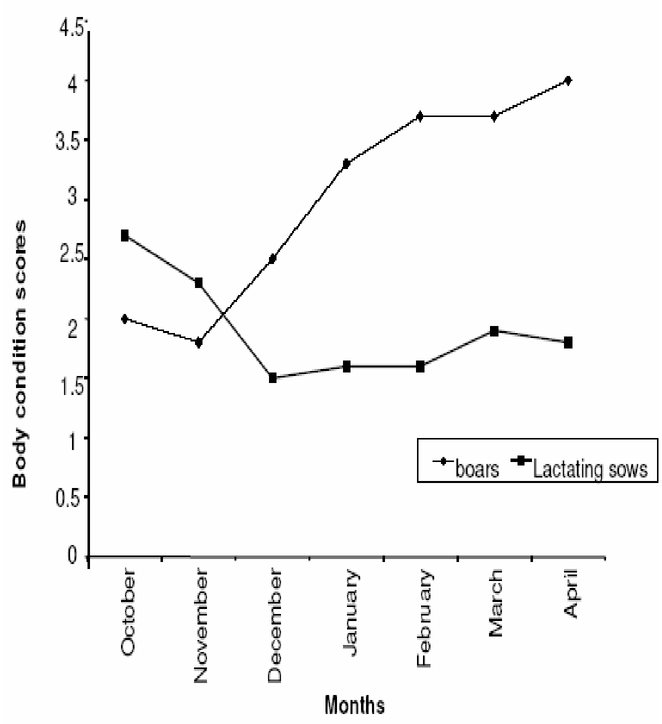

Figure 1. Changes in body condition of pigs over time.

March 2006. Samples were cut at a height of 50 mm above the ground, air dried for 14 days and ground through a 2 mm sieve and stored at air temperature to await analyses. The plants were picked from four quadrants from each of the fields, two at the end and two at the middle of the field. About 100 g of maize dried brewers' grain and groundnut hulls were also collected every month throughout the study period from farmers' households.

Chemical analyses

The dried brewers' grain and groundnut hulls were analyzed for amino acid composition. Weed samples were analysed for dry matter (DM), crude protein (CP), ash and ether extract (EE) as described by AOAC (1990). Neutral detergent fibre (NDF) and acid detergent fibre (ADF) analyses were done according to the method described by Goering and Van Soest (1970). Amino acid profiles of *R. brasiliensis, C. benghalensis* and maize brewers' dried grain and groundnut hulls were conducted at the Agricultural Research Council, Irene, South Africa. Amino acid analyses involved acid hydrolysis, pre-column derivatisation, separation by HPLC and detection using fluorescence detector, as described by Einarsson et al. (1983). Tryptophan was analysed using enzymatic hydrolysis, separation by HPLC and detection using fluorescence detector, as described by De Vries et al. (1980). Cystine was analysed as described by Gehrke et al. (1985). The protein value was estimated by calculating the extent of deficit of each essential amino acid, in relation to that present in the ideal protein, using the egg as the standard.

Gross energy of the feeds was determined using the bomb calorimeter at the Institute of Mining Research, University of Zimbabwe, using methods described by AOAC (1990). All analyses were performed in triplicate.

Statistical analyses

The BCS of the pigs were tested for normality, and were skewed, even after transformation; they were then subjected to the Friedman procedure (SAS, 1996) and analysed using the following linear model:

$Y_{ij} = \mu + M_i + E_{ij;}$

where: Y_{ij} = change in body condition score; μ = overall mean common to all observations; M_i = effect of the i[th] month (October… April); E_{ij} = random error distributed as N $(0, I\sigma^2_E)$.

The nutrient compositions of the feed resources were analysed using the PROC MIXED procedure of SAS (1996). The linear model used was:

$Y_{ijk} = \mu + M_i + W_j + M_i * W_j + E_{ijk};$

where: Y_{ijk} = Response variable (DM, CP, Ash, ADF, NDF and EE, amino acids); μ = Overall mean common to all observations; M_i = fixed effects of the i[th] month (October… April); W_j = fixed effects of the j[th] weed (j = *C. benghalensis* and *R. brasiliensis*); $M_i * W_j$= interaction of month and weed; E_{ijk} = random error distributed as N $(0, I\sigma^2_E)$.

Pair-wise comparisons between least square means were performed using the PDIFF statement in SAS (1996).

RESULTS

Body condition scoring

Figure 1 illustrates the changes in the mean BCS for the lactating sows and boars. During October and November, the BCS of lactating sows were higher (P<0.05) than for boars. However, from December up to the end of the end of April, the BCS was significantly lower for lactating sows than boars. The sows maintained their condition during this period, while boars showed a marked increase (P<0.05) in condition. The main feeds that the pigs received during trial period were groundnut hulls, brewer's dried grain and weeds (*C. benghalensis* and *R. Brasiliensis*). The chemical composition of these feedstuffs was, therefore, evaluated.

Dry matter, ether extract and ash contents

Table 2 shows DM, EE, ash, NDF, ADF and gross energy contents of *C. benghalensis* and *R. brasiliensis*. Both month of sampling and species of weed influenced (P<0.05) chemical composition. Across the six months, *R. brasiliensis* had a significantly higher DM than *C. benghalensis*. Within each weed, DM content was constant (P>0.05) throughout the sampling period.

Ether extract contents were significantly affected by month, weed species and the interactions between the two. As with DM, in *R. brasiliensis* EE content remained constant throughout the monitoring period. The EE content for *C. benghalensis* fluctuated but was consistently higher (P<0.05) than for *R. brasiliensis*. *R. brasiliensis* had treble the amount of ash (P < 0.05) compared to *C.*

Table 2. Dry matter (DM, g/kg), crude protein (CP) and ether extract (EE) content, ash, neutral detergent fibre (NDF), acid detergent fibre (ADF) (g/kg) and gross energy (GE) (MJ/kg) of *Commelina benghalensis* (CB) and *Richardia brasiliensis* (RB) on DM basis**.**

Component	Weed	Month						
		October	**November**	**December**	**January**	**February**	**March**	**SEM**
DM	CB	823.7^{a}	823.0^{a}	820.5^{a}	825.8^{a}	823.3^{a}	821.3^{a}	52.06
	RB	873.4^{b}	872.2^{b}	868.4^{b}	868.5^{b}	872.3^{b}	869.8^{b}	
CP	CB	208.6^{b}	207.9^{b}	218.6^{c}	225.0^{c}	227.3^{c}	237.4^{c}	15.42
	RB	100.8^{a}	106.3^{a}	109.9^{a}	104.8^{a}	111.9^{a}	134.7^{a}	
EE	CB	18.4^{c}	18.5^{c}	18.2^{c}	18.7^{cd}	19.3^{d}	18.5^{c}	0.21
	RB	16.0^{a}	16.2^{a}	15.9^{a}	16.5^{b}	16.4^{b}	16.2^{a}	
Ash	CB	22.6^{a}	25.4^{b}	23.9^{a}	22.6^{a}	23.8^{a}	25.3^{b}	1.90
	RB	75.9^{e}	65.2^{cd}	63.7^{c}	65.5^{d}	62.8^{c}	63.6^{c}	
NDF	CB	408.0^{a}	403.8^{a}	482.8^{d}	401.9^{a}	402.0^{a}	411.6^{a}	24.27
	RB	492.0^{c}	498.3^{c}	471.6^{b}	482.8^{b}	470.0^{b}	467.6^{b}	
ADF	CB	196.1^{a}	195.2^{a}	187.2^{a}	184.8^{a}	185.4^{a}	188.0^{a}	10.25
	RB	389.1^{b}	387.4^{b}	391.9^{b}	387.4^{b}	388.9^{b}	387.6^{b}	
GE (MJ/kg)	CB	13.1^{c}	11.8^{b}	14.4^{c}	7.6^{a}	14.9^{c}	13.9^{c}	1.16
	RB	14.0^{c}	16.0^{d}	10.6^{b}	14.2^{c}	14.8^{c}	15.7^{d}	

^{abcd} Values with different superscripts for each component are different (P < 0.05).

benghalensis. The mean ash contents were 66.1 and 23.9 g/kg for *R. brasiliensis* and *C. benghalensis*, respectively. The ash content, however, did not show consistent patterns within each weed.

Neutral and acid detergent fibre contents and gross energy levels

The NDF and ADF contents of *C. benghalensis* were lower (P<0.05) than those of *R. brasiliensis*. The differences in fibre contents were more marked for ADF than NDF. *R. brasiliensis* had higher (P<0.05) energy levels than *C. benghalensis*. The highest gross energy levels of *R. brasiliensis* were recorded in November, while the highest gross energy levels for *C. benghalensis* were recorded in February. Brewers' dried grain had the highest gross energy (19.3 MJ/kg), which did not vary across the sampling period.

Crude protein and amino acid profiles

As shown in Table 2, *C. benghalensis* had about twice the amount of CP than *R. brasiliensis*. The CP content remained constant at a mean of 108.1 g/kg for R. brasiliensis, but increased (P<0.05) from October to March for *C. benghalensis*. The highest CP content, observed in March, was 237 g/kg. The amino acid content of the feeds (weeds, brewers' dried grain (BDG) and groundnut hulls (GNH) is shown in Table 3. Brewers' dried grain had the highest CP content of 219.5 g/kg, followed by *C. benghalensis*, *R. brasiliensis* and groundnut hulls had the least CP content. Brewers' dried grain had the highest concentration of most of the individual amino acids. Levels of lysine, methionine and cysteine, which are the most important amino acids in pig nutrition, were similar in groundnut hulls and *R. brasiliensis*. *C. benghalensis* had higher (P<0.05) levels of threonine, tryptophan, isoleucine, leucine, histidine, phenylalanine, tyrosine, valine, arginine, serine, aspartic acid, glutamic acid, glycine and alanine than *R. brasiliensis*. The proportion of essential amino acids (EAA) was significantly higher (P<0.05) in *R. brasiliensis*. No differences (P>0.05) existed in the ratio between EAA and non-essential amino acids (NEAA) between *C. benghalensis* and groundnut hulls. Levels of HO-proline were less than all other amino acids in all feedstuffs.

Table 4 shows the protein value of selected essential amino acids in the four feeds. The values for lysine, methionine, cysteine, threonine and isoleucine were highest for brewer's dried grain. The *C. benghalensis* had higher (P<0.05) values for these amino acids than groundnut hulls and the highest tryptophan value of the four feeds.

DISCUSSION

Although the use of body condition scoring in assessing nutritional status of pigs is not common, it has been shown to correlate well with the total amount of body fat (Maes et al., 2004). Measurement of back fat levels constitutes an important tool to evaluate the total amount of

Table 3. Amino acid content (g/kg) for *Commelina benghalensis, Richardia brasiliensis,* brewers' dried grain (BDG) and groundnut hulls (GNH).

Amino acid	*R. brasiliensis*	*C. benghalensis*	BDG	GNH	SEM
Lysine	6.7^{a}	9.0^{b}	11.2^{c}	6.8^{a}	0.76
Methionine + Cysteine	2.9^{a}	3.1^{a}	11.1^{b}	2.2^{a}	1.82
Threonine	3.0^{a}	4.6^{b}	7.4^{c}	2.9^{a}	0.55
Tryptophan	1.1^{a}	2.6^{b}	1.3^{ab}	0.8^{a}	0.08
Isoleucine	3.9^{a}	5.6^{b}	10.3^{c}	3.7^{a}	0.67
Leucine	6.1^{a}	9.0^{b}	30.5^{c}	6.0^{a}	0.85
Histidine	4.2^{a}	5.1^{a}	12.3^{b}	4.1^{a}	0.45
Phenylalanine + Tyrosine	8.1^{a}	11.9^{b}	36.6^{c}	8.7^{a}	0.96
Valine	4.4^{a}	6.1^{b}	11.6^{c}	4.4^{a}	0.53
Arginine	4.2^{a}	7.6^{b}	10.1^{c}	5.6^{a}	1.12
Serine	3.2^{a}	5.3^{b}	9.7^{c}	3.5^{a}	0.62
Aspartic acid	8.9^{a}	21.4^{c}	12.8^{b}	9.6^{a}	1.46
Glutamic acid	7.8^{a}	12.7^{b}	36.7^{c}	8.0^{a}	0.86
Glycine	3.5^{a}	5.3^{b}	7.2^{c}	3.3^{a}	0.37
Alanine	4.0^{a}	6.2^{b}	15.6^{c}	3.2^{a}	0.42
Proline	3.1^{a}	5.0^{b}	16.5^{c}	5.1^{b}	0.53
HO-Proline	0.4^{a}	0.7^{a}	0.7^{a}	2.8^{b}	0.26
EAA: NEAA	1.04^{c}	0.92^{b}	0.84^{a}	0.93^{b}	0.05

^{abcd} Values with different superscripts within row differ ($P < 0.05$).

Table 4. Protein value of *R. brasiliensis* (RB), *C. benghalensis* (CB), and brewers' dried grain (BDG) and groundnut hulls (GNH)**.**

	Protein value					
Amino acid	RB	CB	BDG	GNH	SM[1]	CM[1]
Lysine	9.6^{a}	12.9^{b}	16.0^{b}	9.7^{a}	17.1	25.7
Methionine + Cysteine	7.3^{b}	7.8^{b}	27.8^{c}	5.5^{a}	30.0	30.0
Threonine	6.7^{a}	10.2^{b}	16.4^{c}	6.4^{a}	26.7	31.1
Tryptophan	7.3^{b}	17.3^{c}	8.7^{c}	5.3^{a}	26.7	33.3
Isoleucine	9.8^{a}	14.0^{b}	25.8^{c}	9.3^{a}	35.0	35.0

[1]Protein values for sunflower meal (SM) and cottonseed meal (CM) were derived from Kyriazakis and Whittemore (2006). ^{abcd} Values with different superscripts within row differ ($P < 0.05$).

of body fat, especially in rural areas where weighing scales, among other important equipment, are rarely available. Maes et al., (2004) also showed that the number of stillborn piglets increased with decreasing back fat thickness at the end of gestation.

The marked decline in BCS values for lactating sows from October onwards indicates that most of them receive inadequate nutrient during confinement. During confinement, the pigs were supplied with feed once a day (Chikwanha, 2006). The steady decline in the condition of the lactating sows is as a result of suckling. In Chirumanzu district, as in many other rural areas of southern Africa, pigs scavenge for feeds during the dry season, and are confined during the rainy season to prevent them from destroying field crops (Mashatise et al., 2005; Chikwanha, 2006). The commonly held view that pigs get adequate nutrients during the rainy season does not apply in Chirumanzu. The reasons why boars had low BCS in October is not clear. It could be possible that boars mate more females than is recommended, since the boar to sow ratio is extremely low in rural areas (Chiduwa, 2006). There is a need to conduct more studies in characterizing rural production systems to develop sustainable and profitable pig enterprises that reduce poverty among the poor. The steady increase in condition of boars from December indicates that nutritional status was improving, suggesting that their maintenance and production nutrient requirements were easily met during confinement.

The nutritional quality of the commonly used feed resources was evaluated for their chemical composition. The feed resources that were predominantly fed to pigs throughout the year included *C. benghalensis*, *R. brasiliensis*, maize suckers, kitchen swill, maize cobs, vegetables, groundnut hulls, watermelons, hominy chops, brewers' dried grain, pumpkins and some unidentified weeds. However, the chemical composition and amino acid profiles of the other feed resources are available in the literature, and for this reason only *C. benghalensis*, *R. brasiliensis*, brewers' dried grain and groundnut hulls were collected and analysed.

The observation that *R. brasiliensis* had a significantly higher DM than *C. benghalensis* was expected. *C. Benghalensis* is a watery weed that has no distinct stem. The lack of month effects on the DM content within each weed demonstrates the high potential of these weeds as livestock feeds as most forages show an increase in DM as the season progresses (Soest, 1987). Ether extract contents also remained constant across the trial period. *C. benghalensis* had a consistently higher EE content than for *R. brasiliensis*, suggesting that the former contains a higher capacity to supply energy to pigs. On the other hand, *R. brasiliensis* had markedly higher ash content than *C. benghalensis*. These findings suggest that both weeds can complement each in supplying adequate nutrients to pigs (Halimani et al., 2005).

As expected, there was a considerable increase in fibre content for both weeds as they matured, which can have serious implications on the intake and digestibility of forages (Van Soest, 1987). However, local pigs have the capacity to utilize diets with higher fibre content than European breeds, such as the Large White (Kanengoni et al., 2002; 2004). The marked difference between the two weeds in fibre content should be noted. Differences in gross energy levels were also observed. However, there is need to determine the digestibility and utilization of the nutrients.

The relatively high CP content of the feeds under investigation imply that these weeds can be conserved for dry season of feeding pigs, and be used as protein supplements. This would require harvesting the weeds during the rainy season or to conserve them through silage or hay making. Interestingly, *C. benghalensis* has a relatively higher CP than most leguminous leaf meals.

The high CP levels of BDG agree with the study of Yaakugh and Tegbe (1990), who obtained 21% CP. The high CP levels of BDG agree with the study of Yaakugh and Tegbe (1990), who obtained 21% CP. The resultant amino acid products are either end products of bacteria or or other micro-organisms produced during the fermentation process, or from microbial matter attached to fibres in the brewers' grains. Our findings are consistent with those of Varvikko (1986), who demonstrated that residues of vegetable feed supplements in nylon bags could be markedly contaminated by microbes during rumen incubation. Fermentation during the brewing process mimics rumen fermentation and, therefore, has a better amino acid profile.

Tryptophan quantities in R. *brasiliensis* and brewers' dried grain fall in the lower range of requirements for weight gain and feed efficiency for pigs. The required levels range from 0.13 to 0.19% (NRC, 1998). However, *C. benghalensi*s has a surplus of tryptophan. The amino acid profile for *C. benghalensi*s and *R. brasiliensis* exhibited the usual profile of green plants (D'Mello, 1995), whereby the ratio of glutamic acid and aspartic acid are higher in both weeds in comparison to the other amino acids. The high amino profile was expected since brewers' dried grain is an end product of microbial fermentation and is most likely to have higher nutrient concentration as compared to the other feeds. The quantities of aspartic and glutamic acid were highest in *C. benghalensis*, *R. brasiliensis* and groundnut hulls. Although, the feeds tested have reasonably high levels of CP, all the individual essential amino acids are below the ideal requirements (Holness, 1991). Brewers' dried grain had an essential amino acid to non-essential amino acid (EAA: NEAA) ratio almost similar to that observed by Wang and Fuller (1989) for optimum dietary amino acids for growing pigs.

Yaakugh and Tegbe (1990) reported on the use of BDG as a potential feed for pigs. The high nutritive value of BDG makes it a more appropriate option for farmers and will also serve to reduce the competition for the same feed resources, especially cereals, between humans and pigs. The high protein content of *C. benghalensis* can complement the high-energy content in BDG. The supply of BDG is, however, intermittent since their availability depends on the number of people participating in brewing. Usually each household brews beer about four times a year and produces an estimated 25 kg of brewers' grain each time and, therefore, with these quantities it can only be used to alleviate food shortages. *C. benghalensis* and *R. brasiliensis* are troublesome weeds that need removing. Feeding them to pigs repays the labour involved and provides useful feed. The integration of animal production using agricultural by-products ensures that animals play a complementary role, rather than a competitive role with man in meeting their feed requirements. The use of diverse feed resources will ensure that pigs are able to meet their feed requirements (Kyriazakis and Whitte-more, 2006).

Of the four feedstuffs tested, brewers' dried grain had slightly higher amino acid content than the other fermentation high potential as alternative feed resources for pigs. The low amino acid content does not meet the optimal pattern of essential amino acids required in the diet for efficient protein deposition in the pig (Grala et al., 1999). However, in terms of protein value (PV), the four feeds have relatively lower PVs in comparison to both sunflower meal and cottonseed meal (Kyriazakis and Whittemore, 2006) as shown for some of the individual essential amino acids. From these findings, it can be seen that BDG is close to those of sunflower meal and cottonseed meal. Although weeds have a relatively low PV, under smallholder conditions they are usually fed fresh to the pigs. The only major limitation when fed fresh is the high water content, which can reduce intake (Ly, 1993). There is now a need to conduct further research to assess the performance when pigs are given the weeds fresh, rather than dry.

Conclusions

Lactating sows lost body condition during the rainy season. The feeds tested are not able to meet the amino acids requirements for growth. Therefore, there is a need to include these feeds in least cost feed diet formulation based on the use of locally available feed resources. There is also a need to conduct digestibility and growth performance trials with pigs fed on the non-conventional diets.

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