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National Animal Production Research Institute
Ahmadu Bello University
P.M.B 1096, Shika-Zaria,
Kaduna State, Nigeria.
Email:japr@napri.gov.ng Url:journals.napri.gov.ng

EFFECTS OF FEEDING DIETS CONTAINING UNDELINTED UNDECORTICATED COTTONSEED CAKE ON DIGESTIBILITY AND NITROGEN BALANCE OF WEANER PIGS

[*1]Jegede, J. O., [2]Tegbe, T. S. B., [2]Ogundipe, S. O., [1]Rekwot, P. I. and [1]Lasisi, T. O.
[1]National Animal Production Research Institute, Ahmadu Bello University, Zaria.
[2]Department of Animal Science, Ahmadu Bello University, Zaria.
**Corresponding Author's E-mail: jojegede@gmail.com*

ABSTRACT

The apparent digestibility and nitrogen balance of nutrients in isonitrogenous 18% crude protein diets containing 0, 10, 20 and 30% undelinted undecorticated cottonseed cake (UUCSC) was studied in a 28-day trial involving twelve weaner pigs of average initial weight of 12.0 kg. The treatments were replicated three times in a randomized block design trial. There were two periods of 14 days each and pigs were fed at 4 and 6% of their body weights respectively. Each period consisted of a 7-day adjustment period followed by a 7-day total collection period of faeces and urine. Feed intake, dry matter intake and feed to gain ratio were similar while weight gain decreased significantly ($P<0.05$) as the level of UUCSC increased in the diets. Nitrogen free extract digestibility was similar while apparent digestibilities of dry matter, crude protein, ether extract and crude fibre were all significantly ($P<0.05$) depressed as UUCSC level increased in diets. Apparent nitrogen retention was significantly ($P<0.01$) higher in pigs fed the control diets compared to those on UUCSC based diets. It is therefore concluded that, UUCSC based diets depressed growth rate, nutrient digestibility and nitrogen retention of young pigs. Weaner pigs can be fed up to 10% UUCSC diet.

Key words: Weaner pigs, Undelinted undecorticated cottonseed cake, Nutrient digestibility, Nitrogen retention.

INTRODUCTION

The provision of protein sources for feeding livestock, especially the monogastric animals poses a lot of problems to the livestock producers and feed millers in Nigeria and other developing countries. In these countries, the two major sources of protein, groundnut cake and soya bean meal, are expensive. In order to keep the livestock industry in operation, cottonseed cake is often used as a dietary protein supplement by livestock producers (Nzekwe and Olomu 1984; Ikurior and Fetuga 1984; Balogun *et al*. 1990; Ogundipe *et al.* 1990; Fombad and Bryant 2004; Adeyemo and Longe 2007). Cottonseed cake is a by-product of the textile industry which is in abundance in cottonseed producing areas. It has been used widely in ruminant nutrition and to a limited extent in monogastric nutrition. The use of undelinted undecorticated cottonseed cake (UUCSC) as a dietary source of protein for swine and other monogastric animals is limited because of the sensitivity of these animals to gossypol which is a polyphenolic pigment occurring naturally in cottonseed and cottonseed plants (Morgan 1989; Clawson and Smith 1966; Randel *et al*. 1992). Also, the UUCSC is very high in fibre.

However, several authors have shown that the performance of pigs is not adversely affected when dietary level of free gossypol is lower than 250 mg/kg of feed. Addition of Ferrous Sulphate to pig diets has also been reported to reduce the adverse effects of gossypol on the animals (Buitrago *et al*. 1970; Ricon *et al*. 1978; Randel *et al.* 1992).

Other investigators have shown that several factors such as fibre content, protein quality, amino acid profile and age have direct bearings on the performance of swine when fed cottonseed cake based diets (Blair *et al*. 1969; Jones and Smith 1977; Frank *et al.* 1984, Ikurior and Fetuga 1985; Degen *et al*. 2007). The objective of this study therefore was to evaluate the nutrient digestibility and nitrogen balance of weaner pigs fed UUCSC based diets.

MATERIALS AND METHODS

Study location

This trial was carried out at the Ahmadu Bello University Teaching and Research Farm, Shika – Zaria. It is located within the Northern Guinea Savannah ecological zone of Nigeria between latitudes 11^{o} and 12^{0} and longitudes 7^{0} and 8^{o} (Google Earth, 2011).

The zone has two seasons: the wet season starts in April/May and stabilizes by June and ending in mid-October. The mean annual rainfall is 1100 mm and the maximum temperature varies between 27 and 35^{o}C depending on the season with a mean relative humidity of 72%. The dry season lasts from November to April with mean daily temperatures ranging from 14 to 36^{o}C and a mean relative humidity between 20 and 37% (Google Earth, 2011).

Animals and experimental design

Twelve crossbred Large White X Hampshire weaner pigs of average initial weight of 12.0 kg were obtained from the herd of Swine Research Programme, National Animal Production Institute located at the Ahmadu Bello University Teaching and Research Farm, Shika – Zaria, Kaduna State. Pigs were randomly allotted to metabolism crates and blocked based on their litter and initial weight-groups. Treatments were randomly assigned to the crates. There were three replications of the four treatments. One pig was housed per crate in a randomized block design trial.

The design of the experiment was a randomized block design. The model for the analysis of variance was:

$$Y_{ij} = \mu + t_i + e_{ij}$$

Where, Y_{ij} = observation
μ = overall means of observations of interest
t_i = The fixed effect of $_{ith}$ treatment ($_i$ = 1,2,3,4)
e_{ij} = Random error (identical and independently normally distributed with zero mean and constant variance).

Experimental diets and management of animals

The feed ingredients used in this study were obtained from the store of the National Animal Production Research Institute, Shika, Zaria. Four isonitrogenous diets were formulated to contain 18% crude protein. Undelinted undecorticated cottonseed cake (UUCSC) was incorporated in the diets at 0, 10, 20 and 30% levels with the diet containing 0% UUCSC serving as the control diet (Table 1). The chemical compositions of the diets and the major feed ingredients used in the rations are shown in Table 2. All the dietary treatments were formulated to meet the minimum nutrient requirements for weaner pigs as recommended by NRC (1998). The diets were mixed in the Feed Mill in NAPRI, Shika, Zaria.

Pigs were kept in individual metabolism crates which allowed for separate collection of faeces and urine. Each crate (131cm x 71 cm) had a slatted metal floor to allow urine drain through into a big funnel that led urine into a collection bucket. Directly below the slatted metal floor was a metal screen (131 cm x 71 cm) on which faeces dropped and prevented it from getting into urine collecting bucket. The crates were equipped with feed and water troughs. The weaner pigs were dewormed with Ivomec® at 1ml per 33 kg of body weight prior to the commencement of the trial. The route of administration of the ivomec was intra-muscular. The experimental diets were

offered at 4% and 6% of the body weight daily during the first and second periods respectively. Feed was offered twice daily with one-half of the daily allotment given at 8.00 hour and the second half at 16.00 hour. The feed was fed as gruel by mixing with 1 ½ times the weight of water. Refused or left-over feeds were collected and oven-dried at 52^{o}C for 24 hours, cooled to room temperature and the weights recorded. There were two collection and two adjustment periods of 7 days each of total collection of faeces and urine. Faeces were collected daily in the morning and the weights recorded. The faeces were oven-dried at 40^{o}C for seventy two hours weighed and bulked for each period. Urine was collected into plastic buckets containing 25ml Toluene and 25ml Concentrated Hydrochloric acid. Urine collected was pooled for each collection period, thoroughly mixed and an aliquot taken for later analysis. Pigs were weighed at the beginning and at the end of each adjustment and collection periods. The performance of the pigs was monitored in terms of feed intake, weight gain and feed to gain ratio.

Table 1: Ingredient composition of weaner diets containing undelinted undecorticated cottonseed cake (UUCSC)

	Levels of UUCSC (%)			
Ingredients (%)	**0**	**10**	**20**	**30**
Maize	43.45	38.20	32.96	27.71
Groundnut cake	22.15	17.40	12.64	7.89
Cotton seed cake	-	10.00	20.00	30.00
Maize offal	15.00	15.00	15.00	15.00
Wheat offal	16.00	16.00	16.00	16.00
Bone meal	2.50	2.50	2.50	2.50
Salt	0.35	0.35	0.35	0.35
Premix*	0.25	0.25	0.25	0.25
Lysine	0.20	0.20	0.20	0.20
Methionine	0.10	0.10	0.10	0.10
Total	**100.00**	**100.00**	**100.00**	**100.00**
Calculated analyses				
Crude protein (%)	18.00	18.00	18.00	18.00
ME (kcal/kg)	3240	3188	3068	2980
Crude fibre (%)	6.76	8.90	11.05	13.42
Calcium (%)	0.81	0.82	0.83	0.84
Phosphorus^{+} (%)	0.76	0.83	0.85	0.88
Lysine (%)	0.74	0.80	0.84	0.86
Meth + cyst (%)	0.52	0.57	0.62	0.66
Diet cost/kg (N)	57.02	55.46	54.07	52.60

*Biomix grower premix contributed the following per kg of diet: vitamin A, 8,000 iu, vitamin D3, 1,500 iu, vitamin E, 7.0, mg, niacin, 15 mg, vitamin B1, 2.0 mg, vitamin B2, 2.5 mg, vitamin B12, 0.01 mg, vitamin K3 1.5 mg, pantothenic acid, 5.5 mg, folic acid, 0.5 mg, choline chloride, 175 mg, cobalt, 0.2 mg, copper, 3.0 mg, iodine, 1.0 mg, iron, 21 mg, manganese, 40 mg, selenium, 0.2 mg and zinc, 31 mg.

Met + cyst = methionine + cystine

ME = metabolizable energy

$^{+}$ = Available phosphorus.

Proximate analyses

Samples of major feed ingredients, experimental diets, faeces and urine were analyzed for proximate composition and gross energy according to the Methods of AOAC (1995). The proximate analyses were carried out in the Central Laboratory Services, NAPRI, Shika-Zaria.

Statistical Analysis

All the data collected were analyzed using the General Linear Model (GLM) procedure ofthe Statistical Analysis System (SAS, 2000) software package. The means were separated using using Duncan's Multiple Range Test of the same SAS software package (Duncan, 1955).

RESULTS

Proximate composition of the major feed ingredients and weaner experimental diets

The proximate compositions of the major ingredients and experimental diets fed to weaner pigs in experiment 2 are presented in Table 2. The determined analysis showed that the samples of undelinted undecorticated cottonseed cake (UUSC) contained dry matter, 93.82; crude protein, 26.02; ether extract, 8.50; crude fibre, 13.15; ash, 6.51; nitrogen free extract,

39.72% and gross energy, 4160 kcal per kg. The crude protein contents of maize, groundnut cake, maize offal and wheat offal were 8.80, 44.88, 11.20 and 16.10% respectively.

The chemical compositions of the diets (Table 3) showed that the following ranges of dry matter, 91.60 – 93.00; crude protein, 18.01 – 18.50; ether extract, 7.42 – 7.95; crude fibre, 4.40 – 10.00; ash, 5.70 – 6.75; nitrogen free extract, 48.84 – 57.38% and gross energy, 4120 – 4301 kcal per kg. There were significant increases in crude fibre, ash, and gross energy contents but nitrogen free extract decreased as the level of UUCSC increased in the diets.

Performance characteristics of weaner pigs

The performance characteristics of young pigs fed diets containing UUCSC during the two periods of the trial are presented in Table 3. Average daily feed intake was not significantly different between dietary treatments. However, pigs fed cottonseed cake diets required slightly more feed per unit gain in weight. The weight gain of the pigs decreased linearly ($P<0.05$) as the levels of cottonseed cake increased in the diets. However, there were no significant differences between the 0 and 10% dietary treatments and between the 10 and 20% dietary level. Pigs fed 30% UUCSC diet had the least significant ($P<0.05$) growth rate. The feed conversion ratios (FCR) were similar across the dietary treatments.

Nutrient intake

The nutrient intake of the various nutrients by weaner pigs fed graded levels of UUCSC is presented in Table 4 The daily intake of dry matter did not show any significant differences between treatment means.

Nitrogen intake was similar across the dietary treatments. Ether extract intake was not significantly ($P>0.05$) affected by dietary treatments. As would be expected, daily crude fibre intake increased significantly ($P<0.01$) as the level of cottonseed cake increased in the diets. There was a significant linear ($P<0.01$) increase in crude fibre intake as the level of cottonseed cake increased in the diets. Nitrogen free extract intake did not show any significant difference across dietary treatments.

Table 2: Proximate composition of the major ingredients used in the weaner experimental diets

	Ingredients (%)								
Parameters (%)	**Maize**	**Groundnut Cake**	**Cottonseed Cake**	**Maize Offal**	**Wheat Offal**	**Diet 1**	**Diet 2**	**Diet 3**	**Diet 4**
Dry matter	91.55	91.71	93.50	90.92	91.10	93.00	92.19	91.60	92.04
Crude protein	8.80	44.88	26.02	11.20	16.10	18.01	18.10	18.40	18.50
Ether extract	5.20	7.35	8.50	6.15	4.50	7.42	7.61	7.85	7.95
Crude fibre	2.15	4.65	13.15	10.60	12.00	4.40	7.20	9.16	10.00
Ash,	7.15	4.40	6.50	1.20	7.25	5.70	6.40	6.65	6.75
Nitrogen free extract	68.95	31.20	39.22	61.77	51.24	57.38	52.98	49.54	48.84
Gross energy (kcal/kg)	4430	4090	4240	4090	3960	4150	4280	4250	4360

Table 3: Performance characteristics of weaner pigs fed graded levels of undelinted undecorticated cottonseed cake (UUCSC)

Period	Levels of UUCSC in diets (%)				SEM	Level of Significance
	0	10	20	30		
	Average daily feed intake (g)					
I	676.19	666.67	692.86	680.95	27.17	NS
II	1528.57	1523.81	1504.76	1542.95	46.57	NS
Average	1102.40	1095.20	1180.00	1112.40	91.12	NS
	Average daily gain (g)					
I	495.19^{a}	480.95^{b}	476.14^{b}	461.90^{c}	6.80	*
II	504.76	500.00	495.24	485.71	8.91	NS
Average	499.98^{a}	490.48^{ab}	485.69^{b}	473.81^{c}	6.73	*
	Feed Conversion Ratio					
I	1.37	1.39	1.46	1.47	0.09	NS
II	3.03	3.05	3.04	3.18	0.12	NS
Average	2.20	2.22	2.25	2.33	0.37	NS

a, b, c: Means within the same row bearing different superscripts are significantly different ($P<0.05$)
* = $P<0.05$.
NS = Not significant
SEM = Standard Error of Mean

Table 4: Nutrient intake of diets containing undelinted undecorticated cottonseed cake (UUCSC) fed to weaner pigs.

	Levels of UUCSC in diets (%)					
Measurements	**0**	**10**	**20**	**30**	**SEM**	**Levels of Significance**
Average nitrogen intake (g/pig/day)	32.53	32.27	32.14	32.67	0.24	NS
Average ether extract intake (g/pig/day)	85.25	87.21	88.78	92.76	15.36	NS
Average crude fibre intake (g/pig/day)	44.57^{a}	72.59^{a}	91.38^{b}	111.14^{b}	14.39	L**
Average NFE intake (g/pig/day)	500.80	500.50	477.50	466.70	84 .11	NS

a, b, c: Means within the same row bearing different superscripts differ significantly (P<0.01).
L** = Significant linear, (P<0.01)
NS = Not significant
SEM = Standard Error of Means
NFE = Nitrogen free extract

Faecal nutrient output

The faecal outputs of the various nutrients by young pigs were as presented in Table 5. There were significant differences (P<0.01) among treatments in terms of daily dry mater

output. The young pigs fed 30% diet had the highest significant (P<0.01) dry matter output while the pigs fed the control diets (diet 1) had the least value. The result of nitrogen output showed

that pigs on diets of 20% and 30% UUCSC had significantly higher (P<0.05) nitrogen output compared to those fed 0 and 10% cottonseed cake.

There were no significant differences among dietary treatments in terms of faecal ether extract output. Crude fibre output increased linearly (P<0.01) as the level of UUCSC increased in the diets. There were however no significant differences between 10% and 20% diets in terms of crude fibre output. In terms of faecal nitrogen free extract output, the weaner pigs fed 20 and 30% UUCSC diets had significantly higher (P<0.05) faecal nitrogen free extract output compared with the pigs fed 0 and 10% UUCSC diets.

Apparent nutrient digestibility coefficients

The results of the effect of feeding diets containing undelinted undecorticated cottonseed cake on apparent digestibility of dry matter, crude protein, ether extract, crude fiber and nitrogen free extract by weaner pigs are presented in Table 6. Apparent average dry matter intake by the weaner pigs was similar across the dietary treatments. Apparent dry matter digestibility decreased significantly across the dietary treatments. There were no significant differences between the pigs fed 0 to 10% and 10 to 20% cottonseed cake diets in terms of the dry matter digestibility. The weaner pigs fed the 30% UUCSC dleast dry miets had the atter digestibility and this was significantly lower UUCSC diets had the least dry matter digestibility and this was significantly lower (p<0.01) than that of other dietary treatments.

Apparent crude protein digestibility decreased linearly (p<0.01) as the level of cottonseed cake inclusion increased in the diets. Apparent ether extract digestibility followed the same trend as the crude protein digestibility. As the level of UUCSC increased, ether extract digestibility significantly decreased (p<0.01) across the dietary treatments. There were significant differences among the dietary treatments in terms of crude fiber digestibility. The pigs fed the control diet had higher (p<0.01) apparent crude fibre digestibility compared with those fed 20 and 30% cottonseed cake diets. The pigs fed 10% UUCSC diets also had higher apparent crude fiber digestibility than the pigs fed 30% UUCSC diets.

There were no significant differences in apparent nitrogen free extract across the dietary treatments.

Table 5: Faecal nutrient output of diets containing undelinted undecorticated cottonseed cake (UUCSC) fed to weaner pigs.

	Levels of UUCSC in diets (%)					
Measurements	**0**	**10**	**20**	**30**	**SEM**	**Level of Significance**
Average dry matter output (g/pig/day)	183.14^{c}	199.95^{b}	212.23^{b}	257.00^{a}	20.60	**
Average Nitrogen output (g/pig/day)	3.27^{b}	3.75^{b}	4.18^{a}	5.39^{a}	0.52	*
Average ether extract output (g/pig/day)	15.31^{b}	17.77^{ab}	19.02^{ab}	21.61^{a}	2.26	*
Average crude fibre output (g/pig/day)	10.05^{c}	17.60^{b}	23.46^{b}	30.66^{a}	3.04	L**
Average NFE output (g/pig/day)	67.11^{b}	70.67^{b}	78.38^{a}	78.13^{a}	3.88	*

a, b, c, d: Means within the same row bearing different superscripts differ significantly (P<0.05), (P<0.01)
* = (P<0.05), ** = (P<0.01)
NS = Not significant
L** = Significant linear, (P<0.01)
NFE = Nitrogen free extract
SEM = Standard Error of Means

Table 6: Apparent nutrient digestibility coefficients of diets containing undelinted undecorticated cottonseed cake (UUCSC) fed to weaner pigs.

	Levels of UUCSC in diets (%)					
Parameters	**0**	**10**	**20**	**3 0**	**SEM**	**Levels of Significance**
Average dry matter intake (g/pig/day)	1012.40	1008.30	1007.60	1015.80	4.74	NS
Average dry matter digestibility (%)	81.91[a]	80.17[ab]	78.91[b]	74.70[c]	0.80	**
Apparent crude protein digestibility (%)	92.70[a]	91.21[b]	86.21[c]	81.98[d]	0.44	L**
Apparent ether extract digestibility (%)	81.44[a]	79.69[b]	78.44[c]	75.66[d]	0.52	L**
Apparent crude fibre digestibility (%)	77.44[a]	75.75[ab]	74.33[bc]	72.48[c]	1.34	**
Apparent NFE digestibility (%)	86.66	85.88	85.68	83.26	1 .82	NS

a, b, c, d: Means within the same row bearing different superscripts differ significantly (P<0.01)
** (P<0.01)
L** = Significant linear, (P<0.01)
NS = Not significant
NFE = Nitrogen free extract
SEM = Standard Error of Mea

Nitrogen balance

The effects of feeding diets containing undelinted undecorticated cottonseed cake on the nitrogen intake, apparent nitrogen excreted and retention by weaner pigs are shown in Table 7. There were no significant differences among the pigs fed 0, 10, 20 and 30% undelinted undecorticated cottonseed cake in terms of average daily nitrogen intake. The pigs fed 30% cottonseed cake had significantly higher (P<0.05) faecal nitrogen excreted (5.39g per day) when compared to the weaner pigs fed any of the dietary treatments. There were no significant differences among the pigs fed 0, 10 and 20% UUCSC diets in terms of faecal nitrogen excreted. The weaner pigs fed 30% UUCSC diet had significantly higher (P<0.05) urinary nitrogen excreted when compared to the pigs fed any of the other dietary treatments. The values of the feacal nitrogen excreted across dietary treatments were generally higher than the values of the faecal nitrogen excreted across dietary treatments. The pigs fed 30% UUCSC diets had significantly higher (P<0.01) total nitrogen excreted than those pigs on 0, 10 and 20% cottonseed cake.

Nitrogen retention decreased as the level of cottonseed cake increased in the diets. Weaner pigs fed the control diet had significantly (P<0.01) higher nitrogen retention compared with those fed 10, 20 and30% cottonseed cake diets. There were no significant differences among the pigs fed 10, 20 and 30% UUCSC diets. Apparent nitrogen loss increased as the level of cottonseed cake increased in the diets of the pigs. The pigs fed 0, 10 and 20% UUCSC had similar apparent nitrogen loss but these (31.94, 35.30 and 35.30%) were significantly lower (P<0.01) than for the pigs fed 30% UUCSC diet. Apparent nitrogen retained was significantly higher (P<0.01) for pigs fed the control diet (68.06%) compared with those of pigs fed 10, 20 and 30% UUCSC diets. The pigs fed 30% UUCSC diets had the least value (58.03%) of apparent nitrogen retention.

Table 7: The effect of feeding diets containing undelinted undecorticated cottonseed cake (UUCSC) on nitrogen balance by weaner pigs

	Levels of UUCSC in diets (%)					
Parameters	**0**	**10**	**20**	**30**	**SEM**	**Levels of Significance**
Feacal nitrogen excretion (g/pig/day)	3.27[b]	3.75[b]	4.18[b]	5.39[a]	0.52	*
Urinary nitrogen excretion (g/pig/day)	7.12[b]	7.64[b]	8.12[b]	8.32[a]	0.54	*
Total nitrogen excretion (g/pig/day)	10.39[b]	11.38[b]	12.30[b]	13.71[a]	1.22	**
Average daily nitrogen retained (g/pig/day)	22.14[a]	20.88[b]	19.84[b]	18.96[b]	1.24	**
Apparent daily nitrogen loss (%)	31.94[b]	35.30[b]	38.27[b]	41.97[a]	3.70	**
Apparent daily nitrogen retention (%)	68.06[a]	64.70[b]	61.73[b]	58.03[b]	3.60	**

a b: Means within the same row bearing different superscripts differ significantly (P<0.05), (P<0.01)
* = P<0.05; ** = P<0.01
NS = Not significant
SEM = Standard Error of Means

DISCUSSION

Apparent nutrient digestibility

The similar dry matter intake of pigs across dietary treatments could be a reflection of similar feed intake of the pigs (Tables 3 and 6). This view is supported by Ikurior and Fetuga (1985) and Fombad and Bryant (2004) who reported similar feed and dry matter intake by pigs fed cottonseed cake based diets. The observed significant ($P<0.05$) decrease in dry matter digestibility across dietary treatments (Table 6) might be due to the increase in the dietary fibre as the levels of UUCSC increased in the diets of the weaner pigs. Frank *et al*. (1984), Yaakugh *et al.* (1988) and Bawa (2003) have earlier shown that as cell wall increased, apparent digestibility of organic nutrients also decreased.

The significant ($P<0.05$) linear depression in crude protein digestibility observed across dietary treatments as the levels of the UUCSC increased, might be due to the corresponding increases in the levels of dietary fibre in the diets of the pigs. The average nitrogen loss also increased progressively from control to 30% UUCSC diets. Kuan *et al.* (1983), Frank *et al.* (1984) and Degen *et al.* (2007) also reported linear decreases in the apparent crude protein and energy digestibility coefficients with increased fibre levels in the diets of pigs (4.40% in the control to !0.0% in thr diet containing 30% UUCSC. In this trial, the increased fibre content of the diets was observed to depress the digestibility of these nutrients.

The significant reductions in the apparent crude fibre and ether extract digestibility might be as a result of the dietary increases in the fibre content of the diets as UUCSC increased in the diets (Table 6). The observation made in this study is in agreement with the findings of Pollman *et al*. (1979) and Cunha (1997) who noted linear decreases in the apparent nutrient digestibilities of ether extract and crude fibre as fibre increased in the diets of gravid swine. Other workers (Gargallo and Zimmerman, 1980 and Frank *et al.*, 1984) also reported significant linear reductions in crude fibre digestibility which they said might be due to similar intake of dry matter across the dietary treatments. This observation was made by Ikurior and Fetuga (1985) and Fombad and Bryant (2004).

The observations made in this study are in agreement with the findings of Cunha (1997) in terms of ether extract, nitrogen free extract and crude fibre digestibility coefficients. Cunha (1997) observed that the cellulose and lignin represent most of the fibre in swine feeds and both have low digestibility coefficients for the pig. In this study, it is assumed that the increased proportion of the fibre components depressed crude fibre digestibility of the UUCSC diets. Other workers, Gargallo and Zimmerman, (1980), Frank *et al.*, (1984) and Low, 1985) have also reported significant linear decreases in crude fibre digestibility with increased concentration of dietary fibre.

Nitrogen balance

The observed insignificant differences across the dietary treatments in terms of nitrogen intake might be due to non-significant differences in feed intake and dry matter intake among the dietary treatments (Tables 3 and 7). Frank *et al.* (1984) observed that differences in nitrogen intake by growing pigs were largely due to differences in daily dry matter intake.

These workers also indicated that the relationship between voluntary feed intake and energy content of a diet is that pigs eat more of low energy diet than the high energy diet in an attempt to satisfy their energy requirements. Hence, in this trial the weanling pigs fed the 30% UUCSC diet consumed slightly more of this diet and thus the slightly higher nitrogen intake.

Faecal nitrogen is a product of nitrogenous substances that escape digestive activities along the gastrointestinal tract. The more these nitrogenous substances escape from

the activities of the digestive enzymes, the higher the faecal nitrogen. In this study, fecal nitrogen increased gradually from 3.27 and 3.75 g per pig per day in the control and diet with 10% UUCSC respectively to 4.18 and 5.39 g per pig per day in the 20 and 30%UUCSC diets respectively. The control diet up to 20% UUCSC diet but the 30% UUCSC diet was significantly the highest. The high levels of dietary crude fibre in the diets of the growing pigs have resulted in increased metabolic faecal nitrogen (Low, 1985 and Morgan and Whittemore, 1988). Hence, the significant increase in faecal nitrogen output of the 30% UUCSC diet. Malmlof and Hakansson (1984) reported that the fermentation of fibre in the caecum of the pig is affected by a proliferation of bacteria which retain nitrogen during their growth and are passed out in faeces resulting in faecal nitrogen loss.

The significantly ($P<0.05$) higher apparent nitrogen retention by weaner pigs in the control diet (22.14g/pig/day) compared with those fed the UUCSC (19.89g/pig/day being the average of diets with 10-30% UUCSC) might be due to the quality and the availability of amino acids of the diet. Frank *et al*. (1984) and Morgan and Whittemore (1988) have earlier linked nitrogen retention of a diet to its crude fibre content. These workers observed that nitrogen retention and protein digestibility declined with increasing levels of dietary fibre. In the present study, the apparent nitrogen retention was significantly affected by the levels of cottonseed cake fed to the pigs and hence the significantly better performance in terms of weight gain on the control diet compared to the 20 and 30% UUCSC diets.

In summary, the results of this trial suggest that the feeding of diets containing undelinted undecorticated cottonseed cake to weanling pigs depressed the digestibilities of most nutrients (dry matter, crude protein, ether extract and crude fibre) and this must have been responsible for the poor growth rates of the pigs at the 20 and 30% levels of inclusion of undelinted undecorticated cottonseed cake compared with other levels of feeding.

CONCLUSION

In conclusion, feeding of graded levels of UUCSC in diets of weaner pigs depressed apparent nutrient digestibilities of most nutrients (dry matter, crude protein, ether extract and crude fibre) compared to the control and also the nitrogen retention of young pigs. Weaner pigs can however, be fed up to 10% UUCSC diets.

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