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CHEMICAL COMPOSITION AND ENERGY UTILIZATION VALUES OF COMMON SRI LANKAN FEEDSTUFFS FOR GROWING PIGS

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Abstract: Thirteen balance trials, each involving eight growing pigs (average body weight, 32 ± 4 kg), were conducted to determine the digestible energy values of commonly available local pig feedstuffs. The digestible energy values (Kcal/g) of the feedstuffs on an as-fed basis were : maize, 3.64; sorghum, 3.53; rice bran no:1, 2.40; rice bran no:2, 2.09; cassava root meal, 3.69; coconut poonac, 2.54; gingelly poonac, 2.79; soybean meal, 3.16; cassava leaf meal, 2.13; ipil-ipil leaf meal, 1.54; poultry litter, 1.92 and fish meal (imported), 3.01. The energy utilization value of the local fish meal sample could not be determined, owing to its adverse effects on the animals. The proximate composition and mineral contents of the feedstuffs are also reported.

Introduction

Digestible energy (DE) is the widely used term for expressing the available energy in pig feedstuffs. Since available energy content is a major determinant of the nutritive value of a feed, its assessment is of importance for efficient diet formulations.

While composition and energy values of common feeds in the temperate regions are well documented, corresponding data on materials indigenous to the tropics are limited. In Sri Lanka, digestible energy values of local feedstuffs for pigs have never been investigated. With the current interest in expanding the pig industry, such an evaluation would be timely. The aim of the present study was to determine the DE contents of thirteen local feedstuffs used for growing pigs. The composition and mineral profiles of these ingredients were also determined.

Materials and Methods

Feed Materials

All samples, except cassava (*Manihot esculenta*) root meal, cassava leaf meal, ipil-ipil (*Leucaena leucocephala*) leaf meal and poultry litter were purchased from commercial outlets in Kandy. Cassava root meal, cassava leaf meal and ipil-ipil leaf meal were prepared in bulk using previously reported methods.[1-3] Poultry litter, about 12-month old and paddy husk-based, was collected from the deep litter poultry houses of the University Farm. The litter was sun-dried, heaped in a well ventilated room and allowed to mature for four weeks before use.

Experimental Design

Thirteen separate balance trials, each involving eight growing, castrated male pigs (average body weight, 32 kg; range, 26-40 kg) were conducted. Different experimental designs were employed for the evaluation of energy and protein supplements.

Energy Supplements

In each trial, eight pigs were grouped into two blocks based on body weight and the outcome groups were assigned to either a basal diet or a test diet. The basal diets consisted of 75% maize, 16% soybean meal, 5% fish meal plus 4% mineral and vitamin supplements, and supplied 16% crude protein. The test diet was formulated by replacing (w/w) the basal diet with 30% test feedstuff.

A 2 X 2 Latin Square change-over design was employed. Each experimental period consisted of an adjustment period (5 days), a preliminary period (5 days) and a total collection period (10 days). Thus each trial was of 40-day duration. By the conclusion of the trial, each diet has been fed to all eight pigs.

Protein Supplements

Since evaluation of high-protein feedstuffs at dietary levels far in excess of normal levels of use may underestimate their energy utilization values,[4] a modified design was used for the protein supplements. In each trial, eight pigs were assigned to four outcome groups based on litter and body weight. The outcome groups were then allocated either to a basal diet (similar to that used for evaluation of energy supplements) or to one of the three test diets where the basal diet was replaced (w/w) with 6.6, 13.3 and 20% of the test feedstuff. The only exception was fish meal, where the replacement levels employed were 3.3, 6.6 and 10%.

A 4 X 4 Latin Square change-over disign was utilized. Each experimental period consisted of an adjustment period (5 days), preliminary period (5 days) and a total collection period (5 days). Each trial therefore lasted 60 days. By the conclusion of the trial, each diet had been fed to all eight pigs.

Experimental Procedure

Pigs were housed in individual metabolic cages which had facilities for separation and collection of faeces and urine. During the adjustment period, after being put into the cages, only the basal diet was given. During the preliminary period, the dietary treatments were introduced and the pigs were fed twice daily with an amount calculated at 5% of their body weight. All diets were fed in a wet mash form (1:1 feed:water ratio). During the collection period, faeces were collected daily from each cage, dried at 60^0C for 48 hours and weighed. Faecal and feed samples were bulked, ground to pass through a 60-mesh screen and representative samples were taken for the determination of gross energy by calorimetry.

The analyses on feed samples were conducted according to the methods of the Association of Official Analytical Chemists.[5] Cations were determined by Atomic Absorption Spectrophotometry and phosphorus by colorimetry, as described previously.[6]

Statistical Analysis

Digestible energy contents of the energy supplements were calculated by the difference method, whereas regression analysis was employed for the protein supplements.[7] These calculations assumed that there were no associative effects between the basal diet and the test ingredient.

Results and Discussion

The chemical composition of the test feedstuffs are presented in Table 1. The average values of cereals, cassava root meal and imported fish meal are comparable to those documented by Gohl,[8] but differences were observed for the composition of by-product feeds. Rice bran, coconut poonac and gingelly poonac samples were found to contain relatively lower contents of crude protein and higher contents of crude fibre than those reported from elsewhere in the tropics.[8]

Table 1: Percentage chemical composition of the feedstuffs

Feedstuff	Dry matter	Crude protein*	Crude fat*	Crude fibre*	Ash*	Nitrogen free-extracts*
Energy supplements						
Maize	92.0	9.2	4.0	2.3	1.5	83.0
Sorghum	91.8	10.1	4.2	2.2	2.0	81.3
Rice bran no.1	90.1	13.2	12.8	16.0	15.0	43.0
Rice bran no.2	89.3	8.8	11.7	19.6	23.4	36.5
Cassava root meal	88.6	2.5	0.8	1.8	2.0	92.9
Protein supplements						
Coconut poonac	91.2	21.6	7.0	12.2	7.1	52.1
Gingelly poonac	89.5	32.5	8.2	14.8	10.8	33.7
Soybean meal	92.0	42.4	6.0	8.0	5.6	38.0
Cassava leaf meal	90.3	21.4	6.1	20.2	7.8	44.5
Ipil-ipil leaf meal	90.1	22.2	4.8	17.8	8.1	47.1
Poultry litter	89.3	24.8	3.4	17.3	18.0	36.5
Fish meal (imported)	92.2	70.6	4.6	0.8	13.2	11.8
Fish meal (local)	86.9	41.5	6.5	4.0	24.6	22.4

* per cent of dry weight

The mineral contents of the feedstuffs are presented in Table 2. The calcium and phosphorus contents of the feedstuffs are very similar to those reported elsewhere.[8-10] Data reported in the literature for the trace mineral contents of feedstuffs are often variable, since significant differences can arise depending on soil and climatic conditions. The high levels of iron determined in all ingredients are probably reflective of contamination during post-harvest processing. Feedstuffs originating from plant materials contained very low levels of calcium, with the exception of gingelly poonac and the two leaf meals. These three feedstuffs were also found to be rich sources of trace minerals. The data also highlight the potential usefulness of poultry litter as a mineral supplement. Poultry litter contained 5.26% calcium, 2.40% phosphorus and rather high levels of trace minerals.

Table 2: Mineral contents of the feedstuffs (% dry matter basis)

Feedstuff	g/100 g					mg/kg			
	Ca	Mg	K	Na	P	Cu	Mn	Zn	Fe
Maize	.03	.10	.26	.01	.22	3	14	10	160
Sorghum	.04	.12	.30	.04	.29	6	15	12	112
Rice bran no:1	.07	.10	1.36	.02	1.19	7	18	28	240
Rice bran no:2	.04	.11	1.25	.02	1.08	4	12	22	286
Cassava root meal	.03	.06	.40	.02	.18	2	6	10	102
Coconut poonac	.09	.37	1.90	.08	.55	3	7	20	165
Gingelly poonac	2.14	.46	1.38	.05	1.29	16	46	98	237
Soybean meal	.27	.33	2.10	.04	.72	14	22	45	176
Cassava leaf meal	1.44	.31	1.96	.07	.33	12	31	26	488
Ipil-ipil leaf meal	1.24	.26	1.70	.06	.25	8	20	26	376
Poultry litter	5.26	.48	2.74	.44	2.40	44	248	286	360
Fish meal (imported)	3.02	.29	1.01	1.10	2.36	9	22	86	268
Fish meal (local)	4.36	.26	1.20	12.36	2.18	6	16	55	290

Values for dry matter digestibility, gross energy and DE of the feedstuffs are shown in Table 3. The DE contents of maize and sorghum were determined to be 3.64 and 3.53 Kcal/g, respectively. These values were remarkably similar to those reported by Allen[9] and NRC[10] for samples from North America. Over 85% of the dry matter as well as energy contained in both cereals were digested by growing pigs. Somewhat similar DE contents of maize and sorghum are of some practical relevance in Sri Lanka as sorghum, owing to its drought tolerant ability, can be grown under solely rain-fed conditions to produce moderately good grain yields in areas where maize cannot be successfully cultivated.

Table 3: Dry matter digestibility (DMD), digestible energy (DE) and energy digestibility of the feedstuffs for growing pigs.

Feedstuff	DMD %	Gross energy (Kcal/g)*	DE (Kcal/g)*	Digestibility of energy(%)
Energy supplements				
Maize	88	4.18	3.64 ± 0.24**	87
Sorghum	87	4.10	3.53 ± 0.21	86
Rice bran no.1	64	3.71	2.40 ± 0.33	65
Rice bran no.2	59	3.60	2.09 ± 0.25	58
Cassava root meal	89	4.08	3.69 ± 0.09	90
Protein supplements				
Coconut poonac	63	4.22	2.54 ± 0.17	60
Gingelly poonac	69	4.12	2.79 ± 0.15	68
Soybean meal	82	4.18	3.16 ± 0.20	76
Cassava leaf meal	55	4.10	2.13 ± 0.26	52
Ipil-ipil leaf meal	46	4.03	1.54 ± 0.36	38
Poultry litter	56	3.70	1.92 ± 0.27	52
Fish meal (imported)	84	3.96	3.01 ± 0.10	76

* As fed-basis.
** Mean ± standard error.

In Sri Lanka, large quantities of rice milling by-products are available for use in local animal feed mixtures. Unfortunately, due to inefficient milling techniques, more than 50% of the by-products processed in Sri Lanka are unsuitable for non-ruminant feeding. Most rice mills currently in use are of the out-moded huller type which removes both the husk and the bran in one operation, thus producing a bran with considerable admixture of husk. This is reflected by the high fibre and ash contents in the bran samples available in local feed market as rice bran no.1 and rice bran no.2 (Table 1). The DE contents of rice bran no.1 and no.2 samples were determined to be 2.40 and 2.09 Kcal/g, respectively. Only 58-65% of the energy contained in rice bran was digested by pigs. Digestible energy contents of local rice bran samples were considerably lower than those reported for samples from Australia[11] and North America.[9,10] These lower values are related to the high fibre and ash contents of local samples.

The DE content of cassava root meal was found to be similar to that of maize. This finding is in agreement with that of Aumaitre[12] and highlights the role that cassava root meal could play as a cereal replacer in pig diets.

Among the protein supplements, soybean meal had the highest DE content (3.16 Kcal/g). The DE contents obtained for locally-produced coconut poonac, gingelly poonac and soybean meal were lower than those reported elsewhere.[9,10] This discrepancy is due to the relatively high fibre contents of local samples.

The crude protein content of locally-produced fish meal was analysed to be only 41.5%, far below the level of 70.6% determined for the imported fish meal sample (Table 1). When pigs were fed on diets containing 6.6 and 10% local fish meal, performance was adversely affected. All animals had watery faeces and lost body weight. The balance trial had to be terminated after the first experimental period. The local fish meal used in the study appeared normal in colour and smell, and there was no evidence of putrefacation. Subsequent analysis showed excessive salt content to be the probable cause for the adverse effects. The sample contained 11.2% salt, which was much above the legally accepted level of 7%.[13] The DE content of the imported fish meal was determined to be 3.01 Kcal/g.

The inadequate supplies and rising cost of traditional feedstuffs have focussed attention in the recent past on the need to explore the use of hitherto untapped feed resources. Cassava leaf meal, ipil-ipil leaf meal and poultry litter were evaluated for these reasons. The DE content of these three feedstuffs was estimated to be 2.13, 1.54 and 1.92 Kcal/g, respectively. No comparable data is available on the DE contents of these feed ingredients. Though the nutrient contents of cassava leaf meal and ipil-ipil leaf meal were remarkably similar, the energy digested by pigs was considerably lower (52 vs 38%) for the ipil-ipil leaf meal. The tannin and mimosine contents of ipil-ipil leaf meal may be responsible for this low digestible energy.[3]

The DE contents reported in this study were obtained using growing pigs. It is noteworthy, however, that the digestion coefficients of feedstuffs, particularly of high-fibre materials, could be expected to be higher for older pigs as reported by Fernandez *et al.*[14] in comparative studies with growing pigs and sows. Older pigs have a higher capacity for fermentation and utilization of fibre components in the hindgut than the growing animals.

Published data on the available energy content of feedstuffs of tropical origin are scanty. Consequently pig feed formulations in tropical countries, including Sri Lanka, have traditionally used DE contents that have been estimated for feedstuffs originating from temperate regions. The results of the present study showed that such usage may not be appropriate, in view of the relatively high fibre contents of tropical feedstuffs. This is particularly true for the agro-industrial by-products which form the feed base for pig production in tropical countries. The data presented will have applications in the formulation of accurate and efficient pig rations in Sri Lanka as well as in other tropical areas where these feed ingredients are commonly used.

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