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COMPOSITION, DIGESTIBILITY, AND ENERGY EVALUATION OF FOOD WASTE PRODUCTS FOR SWINE IN HAWAII

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The importance of garbage as feed for swine in Hawaii is well established. This can be attributed to the local demand for fresh "soft pork," which is characteristic of pork from swine fed garbage.

Oahu comprises the major portion of hog farms that feed garbage. This is due to the large supplies of garbage readily available from military establishments and tourist related industries. As expressed in Section 33, Public Health Regulations, Department of Health, State of Hawaii, "All garbage, offal and swill, regardless of previous processing, shall, before being fed to any swine, be thoroughly boiled at least thirty (30) minutes, and then cooled slowly so that every part thereof shall have been at the boiling point of water for at least thirty (30) minutes, unless treated in some other manner which shall have been approved in writing by the Board as being as effective as such boiling and cooling, to protect the public health."

Although Hawaii ranks sixth nationally in the number of swine that are fed garbage; the latest island study dealing with the composition of this material was conducted over 20 years ago (Willet et al., 1948). Changes in eating habits and food processing along with the advent of large-scale tourism have undoubtedly changed the composition of garbage. The source of garbage has changed to some extent also, with less emphasis today being placed on the use of residential garbage. Garbage being fed by local swine producers is primarily a composite mixture originating from military establishments, restaurants, hotels, supermarkets, and institutions rather than from a single source.

Since changes in the composition of garbage have taken place, there is a need for composition data so that supplemental nutrient needs can be determined. The objectives of this study were (i) to determine the proximate composition, digestibility, and energy content of cooked garbage and (ii) to determine the fatty acid composition of garbage fat.

EXPERIMENTAL METHOD

Six representative commercial garbage feeding operations on the island of Oahu were selected for sampling. These farms used a mixture of garbage from various sources. Common sources from which garbage was collected by the producers included restaurants, school cafeterias, military bases, fish markets, bread and bakery companies, and wholesale produce markets. Municipal or household garbage was not included in these collections.

The material was picked up by the producer in 50-gallon drums and transported by truck to the cooking-feeding units on the farm. Five of the operations used direct-fire cookers and one utilized steam injection. Garbage was cooked on the day prior to feeding.

Six weekly samples of cooked garbage were taken from each farm. The weekly samples were taken on a rotating day basis; i.e., the first week samples were taken on Monday, the second week samples were taken on Tuesday, etc. No Sunday collections were made. Sampling was done prior to any fat skimming from the garbage or addition of water for cooling or extending purposes. In order to obtain a representative sample of the garbage being cooked, the cooked material was stirred thoroughly prior to sample collection. By means of a half-gallon dipper with a 5-foot handle, collections were taken randomly from various locations and depths of the cooker. Each sample totaled 3 gallons.

The 3-gallon sample was returned to the laboratory and then poured into a shallow kitchen sink equipped with a waste-disposal unit (Kenmore model). Inedible materials such as paper, hard bones, etc., were removed from the material. The remaining material was ground, remixed, and then ground and remixed a second time. The pH of each fresh wet garbage sample was recorded using a Corning Model 7 pH meter. A 32-ounce random sample was then taken from each of the 3-gallon samples of homogenous material, capped, frozen, and stored at —4 C for future analysis. The remaining garbage was poured into 20-gallon containers, frozen, and saved for the digestion study using the composite material.

After the 6-week farm collection period was completed, each 32-ounce sample was removed from the freezer and allowed to thaw. Each sample was then placed in a Waring blender and homogenized for 4 minutes. After blending, the sample was poured into a weighed, aluminum foil pan, reweighed, and placed in a forced-air drying oven at 70 C for a period of 48 hours or until no further weight loss occurred. The dried material was then weighed, and crushed and ground with a mortar and pestle until it had the consistency of fine meal. Because of the high fat content, the dried garbage could not be ground with an electric grinder. Duplicate samples of the dried material were then used for determination of total nitrogen, ether extract, crude fiber, and ash, according to methods described by the Association of Official Agricultural Chemists (A.O.A.C.) (1965).

Duplicate samples of each dried garbage sample were weighed and used for gross energy determinations. Measurements were made using the Parr Adiabatic Calorimeter Series 1200 utilizing the No. 1101 double-valve self-sealing oxygen bomb. Procedures and calculations were carried out according to Parr (1960).

Duplicate samples of ash residues were analyzed for calcium, phosphorus, magnesium, and copper. Analyses for calcium, magnesium, and copper were made using the Perkin-Elmer Model 290 atomic absorption spectrophotometer. Standard curves and instrument conditions used were similar to those suggested in the Perkin-Elmer analytical methods book (1966). Phosphorus determination was made by the HNO_3-vanadomolydate method as described by Jackson (1958) and absorbance was read at 470 mμ in a Beckman Model B spectrophotometer.

Garbage fat was extracted with ether using the Goldfisch apparatus. Methyl esters were prepared from these samples, following the method described by Hilditch (1956). Proportions of fatty acid esters were determined by gas chromotography as described by Brooks (1967).

A digestibility trial was carried out using five crossbred barrows averaging 106 pounds liveweight. Dried technical-grade chromium oxide was added to the composite garbage at the rate of 0.4% of the dry matter. The ground garbage and marker were thoroughly mixed and the material was drained out into 3-gallon containers and stored in a cooler. Each morning the number of containers needed for that day were removed and slowly heated before feeding. A mixture of 50% grain and 50% garbage was fed for the first 3 days. This was done to bring about an adjustment to the garbage fed. After the third day, pigs were fed all the garbage they would readily consume each day. Water was supplied in a drinking fountain. On the 11th day, fecal samples were collected and dried in a forced-draft oven at 70 C for 72 hours. The samples were then finely ground and used for proximate analysis. Duplicate samples of garbage and feces from the digestibility trial were analyzed by proximate analysis according to the methods described by the A.O.A.C. (1965).

Ash samples of the feed and feces were analyzed for chromic oxide in a manner similar to that described by Carter et al. (1960). Percent digestibility was calculated using the formulas described by Carter et al. (1960).

Analysis of variance was carried out on the data using the methods described by Snedecor and Cochran (1968). Duncan's multiple range test (1955) was used to locate significant differences between producers and day of the week sampled.

TABLE 1. Composition of cooked garbage by source

Producer	Sample size	Percent dry matter	Percent of dry matter: Crude protein	Ether extract	Crude fiber	Nitrogen-free extract	Gross energy kcal/gm of dry matter
A	6	$11.1^{a,b} \pm 0.6$	$18.0^{a,b} \pm 3.5$	$30.3^{a,b} \pm 7.4$	$4.3^{a} \pm 1.2$	$44.5^{c} \pm 6.3$	$5.59^{a} \pm 0.38$
B	6	$16.8^{c} \pm 4.1$	$18.6^{a,b} \pm 2.8$	$22.2^{a} \pm 5.1$	$7.4^{b} \pm 2.8$	$45.4^{c} \pm 4.1$	$4.72^{b} \pm 0.27$
C	6	$16.1^{c} \pm 2.8$	$20.5^{b} \pm 3.7$	$34.1^{b} \pm 7.4$	$4.5^{a} \pm 1.7$	$34.4^{b} \pm 7.8$	$5.57^{a} \pm 0.57$
D	6	$13.8^{b,c} \pm 3.3$	$18.8^{a,b} \pm 2.1$	$28.8^{a,b} \pm 10.1$	$4.8^{a} \pm 0.5$	$41.0^{c} \pm 8.5$	$5.46^{a} \pm 0.55$
E	6	$8.7^{a} \pm 1.9$	$27.3^{c} \pm 4.3$	$34.4^{b} \pm 5.4$	$5.6^{a,b} \pm 1.6$	$24.2^{a} \pm 3.4$	$5.47^{a} \pm 0.45$
F	6	$12.6^{b} \pm 4.1$	$15.1^{a} \pm 3.4$	$54.5^{c} \pm 9.1$	$5.1^{a} \pm 0.9$	$20.1^{a} \pm 6.2$	$6.38^{b} \pm 0.31$
Average	36	13.2 ± 2.6	19.7 ± 3.6	34.1 ± 7.5	5.3 ± 1.5	35.0 ± 6.3	5.53 ± 0.37

a,b,c = means in the same column bearing the same superscripts are not significantly different at $P<.05$. Values following $\pm$ are standard deviations.

RESULTS AND DISCUSSION

Composition of the cooked garbage from the six farm sources is summarized in Tables 1 and 2. Considerable variation in garbage composition due to source is indicated.

The average moisture content for all garbage sampled was 86.8%. This high moisture content is undoubtedly the result of the addition of large amounts of water for cooking purposes. The 13.2% dry matter content is comparable to that of institutional garbage as reported by Kornegay et al. (1965) or household material as reported by Engel et al. (1957). According to the intake estimates developed by Kornegay et al. (1965), pigs weighing 100 pounds would not be able to consume sufficient quantities of the garbage sampled in the current study to meet their nutritive requirements.

The protein value of the dry matter (19.7%) in the current study is higher than values reported by Engel et al. (1957) or Kornegay et al. (1965), but was comparable to the military garbage (20.4%) as reported by Woodman and Evans (1942) and only slightly lower than the average values (21.5%) as reported by Willett et al. (1948). The higher protein value of garbage from farm *F* is likely attributable to the inclusion of fish wastes that consistently comprised part of the garbage used on the farm. The average level of protein in garbage from some farms appeared to be adequate for growing-finishing swine. However, due to the high energy levels of the dry matter and the within-source variation, the pigs on some farms would probably benefit from protein supplementation.

The high ether extract contents of the garbage were comparable to those reported by Woodman and Evans (1942), Engel et al. (1957), Kornegay et al. (1965), and Willett et al. (1948). The source of the high level of fat in the garbage from farm *F* (54.5%) could not be determined. Due to the low dry matter content of garbage, hence low dry matter intake of all the garbage sampled, the practice by producers of skimming off the fat before feeding seems undesirable. This removed fat could best serve as a valuable energy source of growing-finishing pigs even if supplementation of protein or other dry feed is needed in order to efficiently utilize this high fat content.

Crude fiber level of the garbage evaluated in the current study approximated the high level reported by Engel et al. (1957) in household material and Kornegay et al. (1965) in municipal garbage. The fiber content of military garbage has generally been reported to be lower than that found in the current study. The fiber content of the garbage in this study appears high enough to reduce efficiency in feed utilization by the pig.

Gross energy values for the dry matter of garbage are similar to those reported by Kornegay et al. (1965). The energy value of the garbage dry mat-

TABLE 2. Mineral composition of cooked garbage by source

Producer	Sample size	Percent of dry matter				Copper ppm of dry matter	pH wet material
		Ash	Calcium	Phosphorus	Magnesium		
A	6	$5.9^{a} \pm 1.3$	0.64 ± 0.30	$0.43^{a} \pm 0.15$	$0.07^{a} \pm 0.02$	2.6 ± 2.2	$4.7^{b,c} \pm 0.4$
B	6	$6.4^{a} \pm 1.5$	0.65 ± 0.41	$0.42^{a} \pm 0.19$	$0.12^{b} \pm 0.03$	2.9 ± 0.5	$4.6^{a,b} \pm 0.1$
C	6	$6.2^{a} \pm 0.8$	0.66 ± 0.19	$0.49^{a} \pm 0.08$	$0.10^{a} \pm 0.02$	2.1 ± 2.4	$4.9^{c} \pm 0.1$
D	6	$6.6^{a} \pm 0.8$	0.71 ± 0.13	$0.44^{a} \pm 0.04$	$0.09^{a} \pm 0.01$	2.7 ± 1.1	$4.4^{a} \pm 0.2$
E	6	$8.5^{b} \pm 1.5$	1.16 ± 0.56	$0.76^{b} \pm 0.27$	$0.20^{c} \pm 0.02$	2.7 ± 0.6	$4.9^{c} \pm 0.4$
F	6	$5.2^{a} \pm 1.5$	0.60 ± 0.12	$0.35^{a} \pm 0.08$	$0.09^{a} \pm 0.03$	1.4 ± 0.9	$4.8^{b,c} \pm 0.2$
Average	36	6.5 ± 1.3	0.73 ± 0.35	0.49 ± 0.17	0.11 ± 0.02	2.4 ± 1.9	4.7 ± 0.2

a,b,c = means in the same column bearing the same superscripts are not significantly different at $P < .05$. Values following $\pm$ are standard deviations.

TABLE 3. Analysis of variance of composition data of cooked garbage

Source of variation	df	Dry matter	Crude protein	Ether extract	Crude fiber	Nitrogen-free extract	Gross energy	Ash	Calcium	Phos-phorus	Mag-nesium	Copper	pH
Day of week	5						*						**
Producer	5	**	**	**	*	**	**	**		**	**		**
Error	25	6.8	12.7	56.5	2.4	39.8	0.14	1.6	0.12	0.03	0.0005	3.6	0.04

*Significant at 5% level.
**Significant at 1% level.

ter is higher than normally found in standard grain rations and reflects the high fat content of the material. The low standard deviations for gross energy values indicate that this constituent was quite consistent within source. This is in agreement with work by Kornegay et al. (1965), who reported gross energy as the least variable component in garbage.

Ash content of the garbage was similar to values reported in earlier studies by Kornegay et al. (1965), Woodman and Evans (1942), Willett et al. (1948), and Engel et al. (1957). The mean calcium and phosphorus levels of 0.73% and 0.49%, respectively, are adequate to meet the National Research Council (N.R.C.) (1968) requirements for growing-finishing pigs, although the levels were quite variable between different samples. The magnesium level of 0.11% exceeded the highest level reported by Barth et al. (1966) and, in each sample analyzed, it exceeded the minimum requirement as stated by the N.R.C. (1968) of 0.04% for growing pigs.

The copper content of 2.4 ppm was less than 50% of the N.R.C.-recommended level of 6 ppm for swine. The reason for the low copper content found in garbage sampled is unknown. Engel et al. (1957) reported that hospital garbage had the lowest copper content of any garbage in their study. However, this was still three times the level found in the present study. Barth et al. (1966) reported a level of copper in military garbage amounting to nine times the level found in the garbage sampled in this study.

The pH values of wet garbage are almost identical with those found by Engel et al. (1957) for military garbage.

Data from the weekly samples collected at the six farms were analyzed statistically using analysis of variance. The outline of the analysis and the significant effects observed are summarized in Table 3. Differences between farms were significant for all constituents except calcium and copper. Day-of-week sampling differences existed only for gross energy and pH.

Composition of garbage by weekday sampled is presented in Tables 4 and 5. The low relationship between composition and day of week sampled is in agreement with results reported by Kornegay et al. (1965) and Engel et al. (1957). Garbage collected on Monday contained the highest gross energy on a dry matter basis. This was probably due to the high fat content of this garbage.

Garbage sampled on Thursday had the highest pH, but these differences were significant only when compared to the garbage sampled Monday, Tuesday, and Saturday. The cause for the variation in pH due to day of the week could not be explained.

The mean dry matter of the garbage collected on Saturday was 16.5% while that of garbage collected on other days varied from 11.8% to 13.2%. These differences were not significant nor was the higher mean ether extract

TABLE 4. Composition of cooked garbage by day of the week sampled (dry matter basis)

Item	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Dry matter, %	12.6	12.8	11.8	12.2	13.2	16.5
Crude protein, %	19.6	17.4	19.5	20.0	21.3	20.5
Ether extract, %	39.2	33.5	34.9	33.3	29.4	34.1
Crude fiber, %	5.0	5.5	5.7	5.0	5.7	4.6
Nitrogen-free extract, %	30.2	37.6	35.8	34.3	36.5	35.2
Gross energy, kcal/gm	5.94^{b}	5.27^{a}	$5.72^{a,b}$	5.40^{a}	5.31^{a}	$5.56^{a,b}$

a,b,c = means on the same line bearing the same superscripts are not significantly different at $P<.05$.

TABLE 5. Mineral composition of cooked garbage by day of the week sampled (dry matter basis)

Item	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Ash, %	6.1	6.0	6.9	7.4	7.1	5.6
Calcium, %	0.67	0.53	0.72	0.94	0.93	0.62
Phosphorus, %	0.43	0.38	0.48	0.59	0.57	0.45
Magnesium, %	0.11	0.11	0.12	0.12	0.12	0.09
Copper, ppm	3.1	1.9	2.6	1.3	3.3	2.3
pH	4.5^{a}	4.5^{a}	$4.9^{b,c}$	5.0^{c}	$4.7^{a,b,c}$	$4.6^{a,b}$

a,b,c = means on the same line bearing the same superscripts are not significantly different at $P<.05$.

of the garbage collected on Monday. In contrast, the means for crude protein and crude fiber were relatively constant for each day of the week sampled.

A summary of the average for each producer of six major and six minor fatty acids in garbage fat is shown in Tables 6 and 7. The proportions of myristic, palmitic, and stearic acid (2.9%, 23.3% and 10.0%, respectively) in the garbage fat were higher than those found in the fat of corn-soybean oil meal rations (Brooks, 1967). Also, a larger percentage of the unsaturated fatty acids, palmitoleic and oleic, were present in the garbage fat (4.5% and 39.6%, respectively). The mean percentage value for linoleic acid was considerably lower than the content found in the lipids of soybean oil meal or corn. Brooks (1967) showed that the level of linoleic acid in pork tissue varied more directly with its total intake than with its ratio in the fat of the feed. Because of the exceptionally high fat content of garbage when compared to grain rations for swine, the total amount of linoleic acid received by a pig eating garbage would be three times that of a pig consuming a corn-soybean oil meal ration.

The analysis of variance for fatty acid composition, by farm source and day of week collected, is presented in Table 8. The variation between farms was found to be significant for each fatty acid except palmitic. No significant variation was found due to day of the week collected.

The chemical composition and coefficients of digestibility of the garbage used in the digestion trial are presented in Table 9. Apparent digestion coefficients for dry matter and crude protein were between the values reported by Woodman and Evans (1942) for military and processed urban swill and between values reported by Kornegay et al. (1965) for municipal and institutional material. This seems logical since the garbage in this study was collected from many different sources.

The high digestibility of fat found in this study was similar to that reported for military garbage by Kornegay et al. (1965) and Woodman and Evans (1942). Digestion coefficients of this magnitude for fat would be expected only in high-fat diets. Clawson et al. (1962), Greeley et al. (1964), and Lowrey et al. (1962) showed that an increase in the digestibility of fat occurred when the level in the ration was increased.

The average values for the digestibility of crude fiber resembled those reported by Kornegay et al. (1965) for institutional garbage, and Woodman and Evans (1942) for urban swill.

Digestion coefficients found in the current study for nitrogen-free extract (NFE) were lower than values reported for military and institutional materials and higher than the values reported for municipal garbage by Kornegay et al. (1965). Woodman and Evans (1942) also reported high NFE digestibility in military and urban swill (98.7% and 95.8%, respectively).

TABLE 6. Proportion of major fatty acids of garbage fat (percent by weight)

Producer	Sample size	Myristic (C14)	Palmitic (C16)	Palmitoleic (C16:1)	Stearic (C18)	Oleic (C18:1)	Linoleic (C18:2)
A	6	$2.3^{a} \pm 0.1$	24.8 ± 2.2	$5.5^{c} \pm 2.5$	$8.9^{a} \pm 0.9$	$39.1^{a,b} \pm 1.8$	$16.1^{a,b,c} \pm 1.9$
B	6	$3.2^{b} \pm 0.5$	23.2 ± 1.5	$4.0^{a,b} \pm 0.6$	$9.6^{a,b} \pm 1.0$	$36.7^{a} \pm 3.6$	$19.4^{c} \pm 5.2$
C	6	$3.1^{b} \pm 0.5$	22.9 ± 0.8	$4.5^{a,b,c} \pm 0.6$	$11.9^{c} \pm 0.9$	$39.7^{a,b} \pm 2.1$	$14.5^{a,b} \pm 3.2$
D	6	$2.9^{a,b} \pm 0.5$	22.6 ± 1.8	$3.6^{a} \pm 0.5$	$9.8^{a,b} \pm 0.8$	$40.5^{b} \pm 2.3$	$17.7^{b,c} \pm 2.4$
E	6	$3.4^{b} \pm 0.7$	22.5 ± 0.7	$5.3^{b,c} \pm 0.6$	$9.4^{a,b} \pm 1.8$	$39.2^{a,b} \pm 2.3$	$14.2^{a,b} \pm 1.3$
F	6	$2.8^{a,b} \pm 0.4$	23.8 ± 1.2	$4.2^{a,b,c} \pm 0.4$	$10.7^{b} \pm 0.9$	$42.1^{b} \pm 1.7$	$12.1^{a} \pm 2.7$
Average	36	2.9 ± 0.5	23.3 ± 1.6	4.5 ± 1.1	10.0 ± 1.2	39.6 ± 2.5	15.7 ± 3.4

a,b,c = means in the same column bearing the same superscripts are not significantly different at $P<.05$. Values following $\pm$ are standard deviations.

TABLE 7. Proportion of minor fatty acids of garbage fat (percent by weight)

Producer	Sample size	Capric (C10)	Dodecenoic (C12:1)	Tetradecenoic (C14:1)	Pentadecylic (C15)	Heptadecylic (C17)	Iso-oleic
A	6	$0.3^{a} \pm 0.1$	$0.5^{a,b} \pm 0.2$	$0.4^{a} \pm 0.1$	$0.3^{a} \pm 0.1$	$0.5^{a} \pm 0.3$	$0.3^{a} \pm 0.1$
B	6	$0.8^{b} \pm 0.4$	$1.1^{c} \pm 0.4$	$0.6^{a,b} \pm 0.2$	$0.4^{a,b} \pm 0.1$	$0.7^{a} \pm 0.3$	$0.3^{a} \pm 0.1$
C	6	$0.6^{a,b} \pm 0.2$	$0.9^{b,c} \pm 0.3$	$0.8^{b} \pm 0.3$	$0.6^{b,c} \pm 0.2$	$1.2^{b,c} \pm 0.4$	$0.7^{a,b} \pm 0.3$
D	6	$0.9^{b} \pm 0.3$	$0.9^{b,c} \pm 0.2$	$0.5^{a} \pm 0.1$	$0.5^{a,b,c} \pm 0.2$	$0.7^{a} \pm 0.3$	$0.3^{a} \pm 0.2$
E	6	$0.8^{b} \pm 0.3$	$1.2^{c} \pm 0.6$	$0.8^{b} \pm 0.3$	$0.8^{c} \pm 0.3$	$1.5^{c} \pm 0.4$	$1.0^{b} \pm 0.4$
F	6	$0.3^{a} \pm 0.1$	$0.3^{a} \pm 0.1$	$0.5^{a} \pm 0.2$	$0.4^{a,b} \pm 0.1$	$0.8^{a,b} \pm 0.3$	$0.6^{a} \pm 0.2$
Average	36	0.6 ± 0.3	0.8 ± 0.4	0.6 ± 0.2	0.5 ± 0.2	0.9 ± 0.3	0.5 ± 0.3

a,b,c = means in the same column bearing the same superscripts are not significantly different at $P<.05$. Values following $\pm$ are standard deviations.

TABLE 8. Analysis of variance of data on six major and six minor fatty acids of garbage fat

		Major fatty acids					
Source of variation	df	Myristic	Palmitic	Palmitoleic	Stearic	Oleic	Linoleic
Day of the week	5						
Producer	5	*		**	**	*	*
Error	25	0.3	2.6	1.2	1.6	6.1	11.5

		Minor fatty acids					
		Capric	Dodecenoic	Tetradecenoic	Pentadecylic	Heptadecylic	Iso-oleic
Day of the week	5						
Producer	5	**	**	*	**	**	**
Error	25	0.1	0.2	0.1	0.1	0.1	0.1

*Significant at 5% level.
**Significant at 1% level.

These values probably reflected the higher NFE content in the feed (43.6% and 57.9%, respectively) and also the nature of the material.

The digestion coefficients for gross energy reported in the current study were between the low found in municipal and the average found in institutional garbages reported by Kornegay et al. (1965).

TABLE 9. Apparent digestion coefficients and chemical composition of composite cooked garbage (dry matter basis)

Dry matter	
Composition, %	11.4
Digestion coefficient, %	87.3
Coefficient of variation	—
Crude protein	
Composition, %	16.3
Digestion coefficient, %	83.1
Coefficient of variation	1.0
Ether extract	
Composition, %	35.9
Digestion coefficient, %	94.1
Coefficient of variation	1.7
Crude fiber	
Composition, %	3.1
Digestion coefficient, %	72.5
Coefficient of variation	4.0
Nitrogen-free extract	
Composition, %	38.1
Digestion coefficient, %	88.6
Coefficient of variation	1.47
Ash, %	6.6
Total digestible nutrients, %	125.6
Energy	
Gross, kcal/gm	6.49
Digestion coefficient, %	87.8
Digestible energy, kcal/gm	5.70
Coefficient of variation	1.1

SUMMARY AND CONCLUSIONS

The chemical composition of cooked garbage was determined from samples taken from six hog farms that were feeding garbage on the island of Oahu.

Dry matter content of garbage sampled was extremely low and highly variable. Differences between farms ranged from 8.7% to 16.8%.

The protein level of garbage varied significantly between farm sources. The mean protein content by farm ranged from 15.1% to 27.3% on a dry matter basis. Protein levels of garbage dry matter on some farms appeared to be adequate for growing-finishing swine. When the high energy of garbage dry matter is considered along with the great within-farm variation in protein content, it would appear that the garbage used on some farms, on the other hand, would need protein supplementation.

The level of fat in the dry matter of garbage was high (22.2% to 54.5%). Significant variation in fat level existed between farms. High digestion coefficients (93.0% and 94.1%) were found for this material.

Crude fiber content of garbage sampled (4.3% to 7.4%) was generally higher than that reported in other studies on garbage. Significant variation existed between the six producers.

Nitrogen-free extract was generally lower than that reported in other studies on garbage. Significant variation between producers existed with a mean range of 20.1% to 45.4%. The 88.6% digestion coefficient was slightly lower than that reported by other workers.

Means for gross energy were large, with significant differences between producer and day of the week. Means for farm sampled ranged from 4.72 kcal/gm to 6.38 kcal/gm and the means for day of the week sampled were from 5.27 kcal/gm to 5.94 kcal/gm. Gross energy and digestible energy were higher in garbage than in grain rations for swine when compared on a dry matter basis.

Calcium content was not significantly different between farms. Average calcium content of garbage from all farms was adequate for growing swine, but large within-source variation did exist.

Phosphorus content of garbage sampled was significantly different between producers. Except for the garbage sampled at one of the farms, mean phosphorus values exceeded the N.R.C. (1968) requirement of 0.4% for growing-finishing swine.

Magnesium content of the garbage from all farms was high and variable. The means exceeded all values reported for garbage in the literature.

Copper content was low and did not vary significantly between farms sampled. None of the samples tested met the N.R.C. requirement of 6 ppm for growing swine.

The pH value as determined for each wet garbage was significantly different between farms and day of the week sampled.

Of the 12 fatty acids examined from the garbage fat, the proportions of 11 were significantly different among farms. The variation in palmitic acid was not significant. Differences between day of the week were small and nonsignificant. The proportions of myristic, palmitic, palmitoleic, stearic, and oleic acids found in garbage fat were higher than those found in fat from common grain rations for swine. Linoleic acid content was lower in the garbage fat than that reported for grain rations. However, total intake of linoleic acid by swine eating garbage alone would be much higher than for swine eating grain rations, because of the high fat content.

Under the conditions of this experiment, the following conclusions appear justified for field use of garbage:

1. Dry matter content of garbage could be increased by curtailing the amount of water added prior to cooking. The addition of more water prior to feeding cannot be justified.
2. For young swine, protein supplementation of garbage would be necessary to assure protein adequacy at all times.
3. Because of the deficiency of copper in garbage, supplementation of this mineral should be made when high-garbage rations are fed.
4. Fiber content of the garbage analyzed is near the maximum limit for growing swine. Efforts should be made to remove paper and other fibrous materials from the garbage before cooking.
5. Ether extract content of garbage is high, but the removal of fat prior to feeding does not appear justified.
6. Pigs fed garbage will develop "soft" carcasscs which are high in unsaturated fat. This is due to the high fat content of garbage which causes a large linoleic acid intake. This should not be considered undesirable in view of the present trend toward less saturated fats in human diets.

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