JOURNAL OF AGRICULTURAL AND FOOD CHEMISTRY

J. Agric. Food Chem. **2007,** *55,* 3517−3522 **3517**

Available (Ileal Digestible Reactive) Lysine in Selected Pet Foods

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A recently developed assay for determining available lysine (true ileal digestible reactive lysine) in foods and feedstuffs was applied to 20 commercially available cat foods. Semisynthetic diets, containing cat food as the sole protein source, were prepared. Titanium dioxide was included as an indigestible marker. The diets were fed to growing rats and digesta from the terminal ileum collected and analyzed, along with the diets, for reactive lysine. True reactive lysine digestibility was determined after correction for endogenous lysine loss at the terminal ileum of rats fed an enzyme-hydrolyzed casein-based diet. The amounts of digestible total lysine (conventional method) were also determined. Ileal total lysine digestibility significantly ($P < 0.05$) underestimated (3.6−10.2%) lysine availability (ileal reactive lysine digestibility) for most of the cat foods tested. Ileal digestible total lysine significantly ($P < 0.05$) overestimated the amount of dietary available lysine for all of the cat foods tested by between 38 and 143%. Total lysine digestibility determined using the conventional method of lysine analysis was inaccurate when applied to commercially available cat foods.

KEYWORDS: Lysine; availability; cat food; processing

INTRODUCTION

Both moist and dry cat foods are subjected to high temperatures for considerable periods of time during processing to sterilize the food, achieve an acceptable form, and enhance palatability (*1*). When a food is heated, the ϵ-amino group (side chain) of lysine can react with other compounds present to produce derivatives that are nutritionally unavailable to the animal that consumes the food (*2*). Furthermore, traditional digestibility and chemical analysis techniques (digestible total lysine) overestimate the available lysine content of such foods, because some of the lysine derivatives revert to lysine during amino acid analysis, a key step in the amino acid digestibility procedure (*3*).

A new method (BIOLYSINE) that can accurately determine the available lysine content of processed foods has been developed and described (*4*). With the assay, chemically reactive (underivatized) lysine in both the diet and ileal digesta of a test animal that has consumed the food are determined, and digestible reactive lysine (available lysine) is calculated. The assay has been applied to several types of protein source, including milk products (*5*), breakfast cereals (*6*), and a small selection of feedstuffs used in the pig and poultry industry (*7*), but has not been applied to pet foods.

Ileal digestibility measurements are superior to fecal digestibility because fecal digestibility is confounded by activity of the hindgut microflora (*8*). From an ethical standpoint, however, determining ileal digestibility in cats is undesirable because sacrifice of the animal is usually required. An alternative is to use a laboratory animal model. The laboratory rat was used as a model animal for the cat in this study for determining true ileal amino acid digestibility. Although there are some obvious differences between the two species, the main one being that the cat is an obligate carnivore whereas the rat is an omnivore, there are also similarities. The gut mucosal areas are similar between the two species when related to body weight (*9*). The laboratory rat has been used previously as a model animal (*1*) to investigate the effect of heat treatment on processed canned cat foods.

Cat foods, being predominantly meat based, are unlikely to contain high levels of reducing sugars but do contain elevated amounts of fatty acids and their oxidation products. During the processing that cat diets are exposed to, these compounds may react with lysine, leading to a reduction in the available lysine content. Meat offals, which are commonly used as an ingredient in cat foods, also contain significant amounts of collagen (*10*), which is a natural source of ϵ-amino bound lysine (*11, 12*).

Hendriks et al. (*1*) reported true ileal amino acid digestibility values (based on conventional total lysine analysis) for a canned cat food heated for different times, but to date no one has examined the available lysine content of commercially available cat foods. The aim of this study was to compare the digestible total lysine (traditional digestibility assay) with the digestible

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10.1021/jf062919t CCC: $37.00
Published on Web 03/29/2007

reactive lysine content (new assay) for a range of commercial cat foods, to highlight the potential inaccuracy of the traditional assay with respect to this type of food product.

MATERIALS AND METHODS

Materials. *O*-Methylisourea was obtained from Sigma Chemicals, St. Louis, MO, and barium hydroxide octahydrate from BDH Laboratory Supplies, Poole, U.K. Twenty commercially available cat foods were purchased locally. These included 10 moist canned cat foods and 10 dry biscuit cat foods. The moist cat foods were freeze-dried, and the dried material, along with the samples of dry biscuits, was ground using a standard kitchen food processor. The finely ground material was then stored at −20 °C prior to analysis and incorporation into the experimental diets.

Digestibility Study. Ethics approval for the animal trial was obtained from the Animal Ethics Committee, Massey University, Palmerston North, New Zealand.

One hundred entire male Sprague−Dawley rats (150−200 g of body weight) were housed individually in wire-bottomed cages designed to prevent the rats from practicing coprophagy. The rats were kept in a room maintained at 22 ± 2 °C, with a 12 h light/dark cycle. Twenty experimental diets were formulated to each contain 100 g/kg protein, such that each cat food was the sole source of protein in the respective diet. The respective inclusion rates for the 20 cat foods (diets 1−20) were 236, 221, 235, 172, 217, 215, 224, 295, 224, 216, 287, 411, 350, 293, 342, 260, 285, 308, 340, and 243 g/kg. Other dietary ingredients were 50 g/kg purified cellulose, 100 g/kg sucrose, 50 g/kg soybean oil, 50 g/kg proprietary vitamin mix, and 50 g/kg proprietary mineral mix. The vitamin and mineral mixes were formulated to meet the requirement of the growing rat for vitamins and minerals, respectively, in the final diets (*13*). Purified corn starch was added as necessary to make the diets up to 1 kg. Titanium dioxide was included (3 g/kg) in each diet as an indigestible marker. The rats were randomly allocated to the diets such that there were five rats per diet. The experimental period lasted 14 days, during which time each rat had unrestricted access to its respective diet from 8:30 a.m. to 11:30 p.m. Water was available at all times. On the final day of the study, between 3 and 4 h after the start of feeding, the rats were asphyxiated using carbon dioxide gas and then decapitated (*14*). The 20 cm of ileum immediately anterior to the ileo−cecal junction was dissected out. The dissected ileum was washed with distilled deionized water to remove any blood and hair and carefully dried on an absorbent paper towel. The digesta were gently flushed from the ileum section with distilled deionized water from a syringe. The digesta were then freeze-dried for chemical analysis.

Chemical Analysis. The nitrogen content of the 20 cat food products was determined on a LECO analyzer based on the Dumas method (*15*).

Amino acid contents were determined using a method based on that reported by the AOAC (*15*). Duplicate 5 mg diet and digesta samples were analyzed using a Waters ion-exchange HPLC system, utilizing postcolumn ninhydrin derivatization and detection using absorbance at 570 and 440 nm (for proline), following hydrolysis in 6 M glass-distilled HCl containing 0.1% phenol for 24 h at 110 ± 2 °C in evacuated sealed tubes. Cysteine and tryptophan were not determined as they are destroyed during acid hydrolysis. The weight of each amino acid was calculated using free amino acid molecular weights.

Reactive lysine contents were determined in duplicate 5 mg cat food, test diet, and digesta samples after incubation for 7 days in 0.6 M *O*-methylisourea, pH 10.6 (pH 11.0 for the digesta samples), at 21 °C in a shaking water bath, with the reagent to lysine ratio being greater than 1000 (*4*). The 0.6 M *O*-methylisourea solution was prepared as described by Moughan and Rutherfurd (*4*). After incubation, the samples were dried using a Speedvac concentrator (Savant Instruments, Inc., Farmingdale, NY) and analyzed for amino acids as described above.

Titanium was determined according to the method of Short et al. (*16*). Essentially, samples were ashed before being digested in 60% (v/v) sulfuric acid. The mixture was then incubated with 30% H_2O_2 and the absorbance read at 405 nm.

Data Analysis. Ileal amino acid flows were calculated using the following equation [units are μg g^{-1} dry matter intake (DMI)]:

$$\text{ileal amino acid flow} = \text{ileal amino acid content} \times \frac{\text{diet titanium}}{\text{ileal titanium}}$$

True ileal amino acid (AA) digestibility was calculated as follows (units are μg g^{-1} DMI):

$$\text{true digestibility (\%)} = \frac{\text{dietary AA intake} - (\text{ileal AA flow} - \text{endogenous AA flow})}{\text{dietary AA intake}} \times 100$$

[Endogenous AA flow is based on endogenous amino acid flows for the growing rat as reported by Rutherfurd and Moughan (*17*).]

True ileal reactive lysine (RL) digestibility was calculated as follows (units are μg g^{-1} DMI):

$$\text{true ileal RL digestibility (\%)} = \frac{\text{dietary RL intake} - (\text{ileal RL flow} - \text{endogenous lysine flow})}{\text{dietary RL intake}} \times 100$$

[Reactive lysine was determined using the guanidination method. Endogenous lysine flow is the endogenous lysine flow as reported by Rutherfurd and Moughan (*17*).]

True ileal digestible reactive lysine content of the cat foods was calculated as follows:

$$\text{true ileal digestible RL content (g/kg)} = \text{RL content (g/kg)} \times \text{true ileal RL digestibility (\%)}$$

True ileal digestible amino acid content of the cat foods was calculated as follows:

$$\text{true ileal digestible AA content (g/kg)} = \text{AA content (g/kg)} \times \text{true ileal AA digestibility (\%)}$$

The amino acid digestibility data were subjected to a one-way analysis of variance for each cat food singly (*18*).

RESULTS

Crude Protein and Total and Reactive Lysine Contents. The determined crude protein contents of the 20 cat foods are shown in **Table 1**. For the moist cat foods, the crude protein content ranged from 34 to 58% with a mean value of 45%, whereas for the dry diets, the crude protein content ranged from 24 to 41% with a mean value of 33%. Overall the mean crude protein content was 39%.

The total and reactive lysine contents of the 20 cat foods were determined and are also shown in **Table 1**. Total lysine content ranged from 1.0 to 3.3 g/100 g, whereas the ranges for the moist and dry cat foods were 1.2−3.3 and 1.0−2.0 g/100 g, respectively. On average, total lysine overestimated reactive lysine content by 87% across all diets, 100% across the moist diets, and 75% across the dry diets.

True Ileal Total and Reactive Lysine Digestibility. True ileal total lysine digestibility, based on conventional amino acid analysis of both diets and digesta, was determined for the 20 commercially available cat foods and compared to true ileal reactive lysine digestibility, based on using the guanidination reaction to determine the reactive lysine contents in both diets and digesta (**Table 2**). The mean reactive lysine digestibility (lysine availability) across all cat foods was 91% but ranged

Table 1. Crude Protein and Total and Reactive Lysine Contents (Grams per 100 g of Freeze-Dried Matter) for 20 Selected Commercial Cat Foods

cat food	crude protein[a]	lysine		over-estimation (%)
		total[b]	reactive[c]	
moist				
1	42	3.1	1.4	127
2	45	2.7	1.4	103
3	43	2.1	1.7	96
4	58	3.3	1.8	81
5	46	3.1	1.4	119
6	47	3.3	1.3	163
7	45	2.8	1.6	61
8	34	1.2	0.7	64
9	45	2.9	1.3	117
10	46	3.1	1.9	66
dry				
11	35	1.7	0.9	88
12	24	1.0	0.6	84
13	29	1.5	1.0	58
14	34	1.5	0.9	72
15	29	1.4	0.8	83
16	38	1.8	1.0	76
17	35	2.0	1.0	95
18	32	2.0	1.3	48
19	29	1.0	0.5	91
20	41	2.0	1.6	60

[a] Crude protein was calculated as total nitrogen multiplied by 6.25. [b] Total lysine was determined using traditional amino acid analysis. [c] Reactive lysine was determined using guanidination and subsequent homoarginine analysis.

Table 2. Mean ($n = 5$) True Ileal Total and Reactive Lysine Digestibility (Percent) for 20 Selected Commercial Cat Foods

cat food	lysine digestibility		overall SE	significance[c]
	total[a]	reactive[b]		
moist				
1	85	88	1.6	NS
2	78	85	1.5	*
3	82	80	1.0	NS
4	82	86	1.3	*
5	80	89	0.7	**
6	82	89	0.9	**
7	79	86	1.7	***
8	84	93	1.5	***
9	87	88	1.0	NS
10	93	97	0.9	***
dry				
11	93	98	0.9	**
12	85	93	1.0	***
13	89	92	0.8	*
14	87	95	0.8	***
15	92	96	1.2	**
16	92	97	0.9	***
17	88	90	1.3	NS
18	90	96	0.8	***
19	90	95	0.5	***
20	91	96	0.5	***

[a] Total lysine digestibility was determined using the true ileal amino acid digestibility assay in the rat using traditional amino acid analysis to determine the total lysine content of the diets and digesta. [b] Reactive lysine digestibility was determined using the true ileal amino acid digestibility assay in the rat using guanidination and homoarginine analysis to determine the reactive lysine content of the diets and digesta. [c] NS, not significant; $P > 0.05$; *, $0.05 > P > 0.01$; **, $0.01 > P > 0.001$; ***, $P < 0.001$.

from 80% for cat food 3 (moist cat food) to 98% for cat food 11 (dry cat food). When the moist and dry diets were examined separately, the lysine availability ranged from 80 to 97% for the moist cat foods (mean = 88%) and from 90 to 98% for the dry foods (mean = 95%). For 16 of the 20 cat foods, true ileal reactive lysine digestibility was significantly ($P < 0.05$) higher than true ileal total lysine digestibility determined using conventional amino acid analysis. For these cat foods, total lysine digestibility underestimated lysine digestibility by between 3.6 and 10% with the average degree of underestimation being 6.6%. For the moist and dry cat foods, total lysine digestibility underestimated lysine availability by 8 and 6%, respectively.

Table 3. Mean ($n = 5$) Digestible Total and Reactive Lysine Contents (Available Lysine) (Grams per Kilogram of Freeze-Dried Matter) for 20 Selected Commercial Cat Foods

cat food	digestible lysine		overall SE	significance[c]
	total[a]	reactive[b]		
moist				
1	26.4	11.9	0.31	***
2	21.5	11.6	0.28	***
3	17.1	9.6	0.12	***
4	27.4	15.8	0.31	***
5	25.0	12.7	0.18	***
6	27.0	11.1	0.17	***
7	22.3	14.0	0.32	***
8	10.3	7.0	0.14	***
9	16.3	11.6	0.13	***
10	28.9	18.2	0.22	***
dry				
11	15.7	8.8	0.11	***
12	8.9	5.3	0.07	***
13	13.4	8.8	0.09	***
14	13.4	8.5	0.09	***
15	12.7	7.2	0.12	***
16	16.6	10.0	0.11	***
17	17.5	9.2	0.18	***
18	18.1	12.4	0.12	***
19	9.1	5.1	0.04	***
20	18.5	15.7	0.08	***

[a] Digestible total lysine was calculated from the true ileal total lysine digestibility determined using the true ileal amino acid digestibility assay (rat) using traditional amino acid analysis to determine the total lysine content of the diets and digesta and from the total lysine content of the cat food also determined using traditional amino acid analysis. [b] Digestible reactive lysine was calculated from the true ileal reactive lysine digestibility determined using the true ileal amino acid digestibility assay (rat) using guanidination and amino acid analysis to determine the reactive lysine content of the diets and digesta and from the reactive lysine content of the cat food also determined using guanidination and amino acid analysis. [c] ***, $P < 0.001$.

True Ileal Digestible Total and Reactive Lysine Content. The true ileal digestible total lysine content was determined and compared with the true ileal digestible reactive lysine (available lysine) content for the 20 selected cat foods (**Table 3**). For all of the cat foods tested, digestible total lysine content significantly ($P < 0.05$) overestimated digestible reactive lysine content (available lysine). This overestimation ranged from 41 to 143% (mean = 79%) for the moist food and from 51 to 90% (mean = 66%) for the dry foods.

True Ileal Amino Acid Digestibility. True ileal amino acid digestibility values for the amino acids other than lysine for the 20 cat foods are given in **Table 4**. The overall true ileal amino acid digestibility across amino acids ranged from 71% for cat food 7 (moist food) to 93% for cat food 11 (dry food) with a mean overall digestibility of 84%. When the moist and dry cat foods were examined separately, the mean digestibility across amino acids ranged from 71 to 89% (mean = 79%) for the moist foods and from 84 to 93% (mean = 89%) for the dry foods. The least digestible amino acids across all cat foods were aspartic acid and glycine (72%), and the most digestible amino acid was arginine (91%). For the moist diets, the least digestible

Table 4. Mean ($n = 5$) True Ileal Amino Acid Digestibility (Percent) for 20 Selected Commercial Cat Foods[a]

	cat food																				
	moist										dry										
amino acid	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	overall SE
aspartic acid	72	58	60	58	55	61	55	73	68	84	87	77	77	79	78	83	75	79	81	84	1.9
threonine	80	71	78	77	73	76	68	84	84	92	94	85	86	88	90	90	81	89	90	90	1.4
serine	80	71	80	76	75	76	67	85	83	91	94	86	85	89	88	92	81	89	91	91	1.5
glutamic acid	84	77	87	78	77	80	75	87	84	92	94	91	90	90	93	94	84	89	95	92	1.0
proline	82	76	85	72	74	76	70	82	83	90	93	87	86	86	89	92	86	87	92	89	1.3
glycine	70	60	68	59	59	61	56	72	75	83	84	76	77	76	81	78	78	78	82	77	2.2
alanine	85	76	85	79	80	81	77	82	86	92	96	88	88	88	90	92	88	89	91	91	1.1
valine	82	76	83	78	78	80	73	87	85	93	95	88	88	89	91	92	87	90	93	92	1.2
isoleucine	84	75	83	80	79	82	74	90	87	92	95	90	90	91	92	94	85	92	95	93	1.1
leucine	85	78	88	82	81	83	76	88	87	92	91	90	90	92	93	95	84	92	94	94	1.0
tyrosine	84	78	85	82	80	83	73	87	86	92	95	91	91	92	93	94	87	91	94	94	1.1
phenylalanine	86	78	88	83	82	84	76	91	88	92	95	92	91	93	93	95	86	93	96	94	0.9
histidine	76	65	77	72	72	75	66	83	80	69	90	84	84	85	89	88	79	86	90	88	1.5
arginine	93	88	91	91	89	89	84	88	92	95	94	91	94	93	92	95	91	92	93	94	0.9

[a] Values were corrected for endogenous amino acid flow using the enzymatically hydrolyzed casein method (*24*, *25*) reported by Rutherfurd and Moughan (*17*).

Table 5. Mean ($n = 5$) True Ileal Digestible Amino Acid Contents (Grams per 100 g of Freeze-Dried Matter) for 20 Selected Commercial Cat Foods

	cat food																				
	moist										dry										
amino acid	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	overall SE
aspartic acid	2.9	2.2	1.8	2.4	2.3	2.9	1.9	1.6	2.5	3.1	2.7	1.4	1.7	2.2	1.6	2.2	2.0	2.1	1.5	2.8	0.05
threonine	1.6	1.2	1.2	1.6	1.4	1.6	1.2	0.9	1.5	1.6	1.2	0.7	0.8	1.0	0.9	1.2	1.1	1.1	0.9	1.3	0.02
serine	1.6	1.3	1.5	1.7	1.6	1.8	1.2	1.5	1.5	1.6	1.5	0.8	0.9	1.3	1.2	1.6	1.1	1.2	1.4	1.7	0.02
glutamic acid	4.9	4.3	5.9	4.6	5.0	5.8	3.7	4.4	4.3	4.7	5.8	4.0	4.1	4.8	4.9	7.2	3.3	3.9	6.5	6.1	0.05
proline	2.4	2.1	2.7	2.7	2.2	2.6	1.7	2.5	1.8	2.0	2.5	1.7	2.0	2.2	2.2	3.1	1.8	1.8	2.8	2.7	0.03
glycine	2.5	2.0	2.2	2.7	1.9	2.5	1.7	2.1	2.5	2.8	1.7	1.3	1.8	1.8	2.0	1.6	2.1	1.8	1.4	1.9	0.06
alanine	2.6	2.0	1.9	2.8	2.4	2.8	2.1	1.5	2.3	2.5	2.4	1.3	1.5	1.8	1.5	2.5	1.8	2.0	1.4	2.5	0.03
valine	2.1	1.7	1.6	2.2	2.1	2.5	1.6	1.3	0.7	2.1	1.6	1.0	1.1	1.3	1.2	1.7	1.6	1.4	1.3	1.7	0.02
isoleucine	1.5	1.2	1.3	1.3	1.6	1.8	1.3	1.0	2.8	1.6	1.3	0.8	0.9	1.1	1.0	1.4	1.0	1.1	1.1	1.4	0.02
leucine	3.3	2.6	2.6	3.1	3.1	3.5	2.4	1.8	1.2	2.9	3.3	1.8	1.7	2.5	2.0	3.8	2.1	2.3	2.1	3.6	0.03
tyrosine	1.4	1.1	1.2	1.3	1.3	1.6	1.0	0.8	1.6	1.3	1.4	0.7	0.7	1.0	0.9	1.5	0.9	0.9	0.9	1.4	0.01
phenylalanine	1.9	1.5	1.6	1.9	1.9	2.1	1.3	1.2	0.1	1.7	1.8	1.0	1.0	1.4	1.2	1.9	1.2	1.3	1.4	1.8	0.01
histidine	1.2	0.9	0.8	1.1	1.1	1.2	1.0	0.5	2.5	0.1	0.8	0.5	0.6	0.7	0.6	0.8	0.8	0.8	0.6	0.9	0.01
arginine	3.1	2.7	2.4	3.3	3.1	3.5	2.4	2.1	2.9	2.8	2.2	1.4	1.9	2.1	1.8	2.1	1.9	2.1	1.7	2.6	0.02

amino acid was aspartic acid (64%) and the most digestible arginine (90%). For the dry diets, the least digestible amino acid was glycine (79%), and the most digestible were arginine and phenylalanine (93%).

True Ileal Digestible Amino Acid Contents. The true ileal digestible amino acid contents for the 20 commercially available cat foods are presented in **Table 5**. There was variation in digestible amino acid content among the 20 cat foods, with a 1.8−3.1-fold range in digestible amino acid content across cat foods.

DISCUSSION

When foodstuffs are processed, lysine is susceptible to chemical modification through reaction with reducing sugars, fats and their oxidation products, polyphenols, and some food additives (*2*). Modified lysine is generally nutritionally unavailable, and its presence leads to an overestimation of determined available lysine in foodstuffs when traditional techniques such as the true ileal amino acid digestibility assay are used (*5*−*7*, *19*). Cat foods, both moist and dry, are processed during manufacture, to sterilize the diet, modify functionality, or increase palatability (*1*), and as such the lysine present is susceptible to modification. Recently, a new assay (BIOLYSINE) has been developed that accurately determines the available lysine (true ileal digestible reactive lysine) content of processed foods or feeds (*4*, *20*). This assay has been applied to milk products (*5*), breakfast cereals (*6*), and selected animal feeds (*7*). In this study, the assay was applied to 20 commercially available cat foods.

True Total and Reactive Lysine Contents. In processed foods such as cat foods, a proportion of the lysine will have inevitably been chemically modified to form Maillard products (*2*, *3*) or cross-linked in the form of collagen. Hendriks et al. (*1*) found differences (13−21%) between total lysine and reactive lysine contents of a canned cat food that had been autoclaved at 121 °C for 80−120 min, suggesting the presence of acid-labile lysine derivatives. In the present study, total lysine considerably overestimated (by 60−163%) the actual lysine content (reactive lysine) of all the cat foods tested. This would suggest considerable processing damage to lysine has occurred and/or the presence of high levels of collagen in the cat foods (*11*, *12*).

True Ileal Total and Reactive Lysine Digestibility. Overall, reactive lysine digestibility was high, but less than complete. It is interesting to observe that the overall reactive lysine digestibility was 7% units lower in the moist canned diets compared to the dry diets. This difference may result from variation in ingredient composition or differences in the processing methods for moist and dry cat foods. However, further conclusions cannot be drawn because we do not know the details of the manufac-

turers' processing conditions used to produce the cat foods tested in this study.

Conventional true ileal total lysine digestibility significantly underestimated lysine availability (true ileal reactive lysine digestibility) for most of the cat foods tested, but the mean underestimation (6.6%) was not large. For the dry cat foods, there were more diets for which total lysine digestibility underestimated lysine availability than for the moist foods, but the absolute degrees of underestimation were similar between moist and dry cat foods.

There have been few reports describing the lysine bioavailability of cat foods. Hendriks et al. (*1*) investigated the effects of processing on amino acid digestibility using the rat as a model for the cat, but did not examine available lysine. Larsen et al. (*21*) investigated the effect of processing on the lysine bioavailability of casein-based kitten diets. Using a kitten growth assay, they found that heat treatment of the diets resulted in a 41% decrease in lysine bioavailability when compared to an unheated diet. Rutherfurd et al. (*7*) determined the true ileal total and reactive lysine digestibility of a meat and bone meal using an assay similar to that which has been used in this study. They found that the total and reactive lysine digestibilities of the meat and bone meal were 92 and 88%, respectively. These values were similar to those observed for several of the cat foods tested in this study. This is not unexpected because both meat and bone meal and cat foods are largely derived from byproducts of the meat industry.

True Ileal Digestible Total and Reactive Lysine Contents. True ileal digestible total lysine overestimated available lysine (true ileal digestible reactive lysine) content for all of the cat foods tested. The degree of overestimation was considerable, being >38% and as much as 143%. There appears to be considerable lysine damage in the cat foods tested. Furthermore, the traditional assay for determining available lysine is inaccurate for processed cat foods. This is of concern given that commercial cat foods are often the only source of nutrition for many cats. For those cat foods tested in this study, lysine is likely to be limiting, leading to a surplus of the nonlimiting amino acids in the bodies of cats consuming these diets. Excess amino acids are excreted in the urine, placing increased load on the kidneys, and it is known that renal failure is a common cause of death for domestic cats.

True Ileal Amino Acid Digestibility. The true ileal digestibility of the acid stable amino acids (apart from lysine) was determined. Overall, the average amino acid digestibility across all amino acids tested (except lysine) was moderate (84%) but was similar to values reported for some processed meat and bone meals (*22*, *23*). Although meat and bone meal and cat foods are not strictly the same, they are both derived from meat industry byproducts.

When the moist and dry diets were examined separately, the dry diets appeared to be considerably more digestible than the moist cat foods. This difference most likely reflects the different processing methods used to produce the two product types. The mean amino acid digestibility for the moist cat foods was similar to that of an unheated moist canned cat food tested by Hendriks et al. (*1*) for which the mean amino acid digestibility was 78%. However, when the latter workers heated the diet for 120 min at 121 °C, the digestibility decreased to 67%, which was similar to the least digestible (71%) cat food tested in this study. For the moist cat foods, aspartic acid was the least digestible amino acid. Hendriks et al. (*1*) observed that for an unheated moist canned diet aspartic acid was not the least digestible amino acid but that once the can had been heat-treated, even for a short time, aspartic acid digestibility decreased markedly and became least digestible. Why heat treatment would reduce aspartic acid digestibility to a much greater extent that other amino acids is unknown, but it may be related to the amino acid sequence of the meat byproduct proteins and the potential for aspartic acid placement in limit peptides.

Overall, it is likely that the type of processing method used and differences in the ingredient composition resulted in the differences in lysine damage and the varying amino acid digestibility observed here for the cat foods.

True Ileal Digestible Amino Acid Content. Overall, there was a high degree of variation (2−3-fold difference) in the true ileal digestible amino acid content for each amino acid across the cat foods. This variation was most likely a result of the types of meat byproducts used and inclusion rate of these into the cat foods. Overall, the amino acid patterns across cat foods were similar, with glutamic acid, leucine, and arginine being the amino acids in greatest amounts across all diets and histidine being the least abundant amino acid. A similar amino acid pattern across all cat foods is expected because a similar protein base (meat byproducts) was most likely used for all of the cat foods tested.

Conclusion. True ileal total lysine digestibility, based on conventional amino acid analysis of diets and digesta, is an inaccurate measure of lysine availability in processed protein sources (*19*). The reactive lysine digestibility assay used in this study and based on the guanidination of lysine in both diets and digesta is an alternative accurate measure of lysine availability (*4*). For most of the cat foods tested in this study, the traditional measure of true ileal digestible total lysine considerably overestimated available lysine. Consequently, the amino acid pattern relative to lysine in processed cat foods may be quite different from that assumed. This has nutritional and health implications for the domestic cat, and closer examination of the amino acid pattern in processed cat foods in relation to the amino acid requirement of the cat is warranted.

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Received for review October 11, 2006. Revised manuscript received January 22, 2007. Accepted February 28, 2007. This work was supported by the Foundation for Research Science and Technology, New Zealand (Contract MAUX0201).

JF062919T