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Comparison of the Guaranteed Analysis with the Measured Nutrient Composition of Commercial Pet Foods

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Abstract

Objective – To compare the guaranteed and measured concentrations of nutrients in pet foods.

Data Sample – Annual inspection reports of pet food analyses from South Dakota (2003-2005), Indiana (2004-2005), Rhode Island, New York and New Jersey (2005-2006), .

Procedures - The guaranteed and measured concentration of crude protein, crude fat, crude fiber, moisture and ash were compared among pet foods. The difference for each nutrient was compared among types of food, between dog and cat foods, among target life-stages, manufacturers and state laboratories.

Results – The guaranteed and measured concentrations of nutrients in pet foods were significantly different. For all foods, the mean±one standard deviation of the difference was 1.5±2.0% for crude protein, 1.0±1.7% for crude fat, -0.7±1.3% for crude fiber, -4.0±3.3% for moisture, and -0.5±1.0% for ash. The crude protein difference was significantly larger for treats than for dry and canned foods. Crude fat difference was significantly less for dry foods than for canned foods and treats. Crude fiber and moisture differences were significantly less for canned foods than for dry foods and treats. Only crude fiber differences differed among target species, life-stages, manufacturers or laboratories.

Conclusions and Clinical Relevance – Adding 1.5% and 1% to the guaranteed minimums for crude protein and crude fat, respectively, and subtracting 0.7%, 4% and 0.5% from the guaranteed maximums for crude fiber, moisture and ash, respectively, provides a more accurate estimate of the nutrient and calculated metabolizable energy content of commercial pet foods. Nevertheless, the actual composition of a food should be determined where possible.

Introduction

The FDA amendments act of 2007 mandates that the Federal Drug Administration should develop ingredient, processing, and labeling standards to ensure the safety of pet food. It is of immediate concern, therefore, whether the major nutrient composition of pet foods is accurately reported on pet food labels. Some manufacturers provide the actual or average proximate analysis of commercial pet foods on a website or in pamphlets[1-3] but a guaranteed analysis on the label represents the only numerical description of the nutrient composition of most pet foods sold in the United States. This guaranteed analysis reports the guaranteed minimum as fed percentage of crude protein and crude fat and the guaranteed maximum as fed percentage of crude fiber and moisture.[4] Some manufacturers also provide a guaranteed maximum as fed percentage of ash and a few other nutrients.

The ME density of a pet food is also not reported on the label. A few pet food manufacturers report the ME density on a website or in pamphlets[1-3] but the ME density of most pet foods can only be estimated by calculation from the guaranteed analysis. Some authors have suggested using the guaranteed analysis directly to estimate ME density when the actual analysis is not known[5] and one website currently uses this approach.[6] Nevertheless, using the guaranteed analysis directly assumes that there is no difference between the guaranteed and actual analysis of a food. If this assumption is false then the resulting estimate of ME density is likely to be inaccurate and could lead to inappropriate recommendations as to how much and what to feed an animal.

The size of the difference between the guaranteed and actual analysis of pet foods has not been reported. Several states run a 'sample check program'[4] to determine whether the actual analysis conforms to the label guarantee but these states do not report a statistical summary of the differences measured. When the analysis of a food suggests that the food does not conform to the guarantee then further testing of the food is undertaken and regulatory action may be instigated against the manufacturer by the state feed control officials. Most manufacturers would be expected, therefore, to keep nutrient composition above guaranteed minima and below guaranteed maxima but differences between the guaranteed and actual

analyses might vary among foods intended for different species, life stages or among manufacturers. Differences above minima would be expected to be small where adding nutrients increases costs but larger where additional nutrients have to be included to provide a safety margin that allows for differences in ingredients and manufacturing conditions.

The purpose of this study, therefore, was (1) to determine whether the manufacturer's guaranteed analysis differed from the measured proximate analysis of commercial pet foods, (2) to ascertain the size and variability of this difference and (3) to compare this difference among different types of food, among foods intended for dogs or cats or different life-stages, and among manufacturers and laboratories undertaking the analyses. We also wished to ascertain how much the difference between the guaranteed and actual analysis might affect an estimate of ME density.

Methods and Materials

The agencies in each state listed by Association of American Feed Control Officials (AAFCO) as being responsible for testing commercial pet foods were asked for copies of the annual reports of pet food test results. Many states did not reply, did not perform regular testing or requested a fee for their report. The most recent reports from the five states that provided reports free of charge were used for this study. These reports included the South Dakota Annual Report on Commercial Feeds and Animal Remedies for 2003, 2004, and 2005, the Indiana Feed Inspection Report for 2004 and 2005, the New York State Department of Agriculture and Markets Commercial Feed Analysis Annual Report for 2005 and 2006, the New Jersey Animal Feeds Key for 2005 and 2006 and the Rhode Island Report of the Inspection and Analysis of Commercial Feeds, Fertilizers, and Liming Materials for 2005 and 2006. Three annual reports from South Dakota were included because South Dakota reported ash analyses, whereas the other States did not. The difference between the guaranteed and measured composition of crude protein, crude fat, crude fiber, ash, and moisture was calculated for each food. The change from guaranteed to measured amount was also calculated as a percentage of the guaranteed amount. Foods were categorized by type of

diet (canned, dry, treat, liquid, soft-moist/soft-dry or supplemental food or food in a pouch), intended species (dog or cat), intended life-stage (growth, adult, senior or for weight loss), and manufacturer. Manufacturers for which fewer than fifty foods were analyzed were grouped together. These grouped manufacturers were mostly private-label manufacturers. There were very few soft-moist, soft-dry, liquid or supplemental foods and foods in a pouch so differences were compared only among foods identified as being either canned, dry or treat foods.

Statistical analyses were performed using a computer statistics program.[a] Data were assessed for normality both visually and using the Shapiro-Wilk test. Most data failed the Shapiro-Wilk test and variances were not equal so data were log transformed prior to analysis. The guaranteed and measured nutrient compositions were compared using a paired T test. The actual nutrient composition and difference between the guaranteed and measured nutrient composition were compared among types of food (canned vs. dry vs. treat) using a general linear models procedure. Differences were then compared, within each diet type, with intended species, life-stage, manufacturer and laboratory as factors in the model. Interactions among these factors were also included in the model. A Bonferroni correction was used for post-hoc multiple comparisons. A type 1 error of less than 0.05 for the whole experiment was considered significant. Results are presented as means ± one standard deviation.

Results

The guaranteed and measured nutrient analyses of 2208 foods manufactured by 204 companies were compared. There were 1158 canned foods, 750 dry foods, 258 treats, 32 other types of food (soft-moist, soft-dry, liquid, supplemental foods or foods in pouches) and 21 foods of unidentified type. The guaranteed analysis was different from the measured analysis for all nutrients ($p<0.0001$). The mean difference between the guaranteed and actual analysis of all these foods was 1.5% for crude protein, 1.0% for crude fat, -0.7% for crude fiber, -4.0% for moisture, and -0.5% for ash (table 1).

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The difference between the analyses of crude protein, crude fat, crude fiber and moisture varied among canned, dry and treat foods ($p<0.0001$; Table 2): the difference between the crude protein analyses of treats was twice that of canned and dry foods ($p<0.0001$); the difference between the crude fat analyses of canned foods and treats was larger than that of dry food ($p=0.0001$); the difference between the crude fiber analyses of dry foods was larger than that of treats, which was larger than that of canned foods ($p<0.0001$); and, the difference between moisture analyses of dry foods and treats was slightly more than that of canned foods ($p<0.003$).

For each food type, there was no evidence of an effect of intended species or life-stage, manufacturer or laboratory on the difference between the analyses of crude protein, crude fat, moisture or ash. In canned foods, however, the difference between crude fiber analyses was less in adult foods (-0.3±0.6%) and growth foods (-0.1±0.4%) than in foods for weight loss (-1.0±1.2%; $p<0.0003$), was larger in foods manufactured by Iams (-0.9±2.4%) than in foods manufactured for private labels (-0.2±0.6%; $p\leq0.009$), and there was an interaction between laboratory and manufacturer ($p<0.0001$). In dry foods, the difference between crude fiber analyses was larger in foods analyzed in New York (-2.4±2.0%) than those analyzed in Rhode Island (–0.6±0.3% $p<0.0001$), and there was an interaction between intended species and manufacturer ($p<0.002$).

The nutrient composition varied markedly among canned, dry and treat diets (Table 2). When this variation in composition was taken into account by calculating the change from guarantee to measured amount of nutrient as a percentage of the guarantee, the percentage change in crude protein, crude fat, crude fiber and dry matter analysis differed among types of diet ($p<0.0001$; Table 2) but the pattern of differences among canned, dry and treat foods changed slightly. The percentage change in crude protein analysis for canned foods and treats was more than for dry foods ($p<0.0001$); the percentage change in crude fat analysis for canned foods and treats was more than for dry foods ($p=0.0001$); the percentage change in crude fiber analysis for dry foods and treats was more than for canned foods ($p<0.0001$); and, the percentage change in dry matter analysis in dry foods and treats was less than in canned foods

(p<0.0001). For each food type, there was again no evidence of an effect of intended species or life-stage, manufacturer or laboratory on the percentage change in crude protein, crude fat, dry matter or ash analysis. In canned foods, however, the percentage change in crude fiber analysis was less for growth foods (-15±38%) than for foods for weight loss (-33±31%; p≤0.01) and was less in foods analyzed in New York (-24±87%) than in foods analyzed in Rhode Island (-25±14%; p≤0.01). In dry foods, the percentage change in crude fiber analysis was larger in foods analyzed in New York (-36±128%) than those analyzed in Rhode Island (–17±8% p<0.0001).

Differences in nutrient analyses of liquid foods, soft-moist/soft dry, supplemental foods and foods fed in pouches were within the same range as those of canned, dry and treat foods (Table 3).

Discussion

This study shows that the measured proximate analysis of commercial pet foods is slightly different from the guaranteed analysis and a more accurate estimate of the major nutrient composition of commercial pet foods can be obtained by adding 1.5% and 1%, respectively, to the guaranteed minima for crude protein and crude fat, and subtracting 0.7%, 4% and 0.5%, respectively, from the guaranteed maxima for crude fiber, moisture and ash. Nevertheless, the difference between the guaranteed and measured analysis showed some variation about these mean values so the recommended adjustments should improve the accuracy of the estimate of diet composition on *average*, but may reduce the accuracy of the estimated analysis of *individual* foods where the actual composition is close to the guarantee. Furthermore, within all types of food, there were a few outlying values where actual food analyses diverged markedly from the guarantee. For such foods, the adjusted estimate of composition would remain wildly inaccurate. It is still better, therefore, to ascertain the actual composition of a food either by analysis or from the manufacturer rather than relying on the guarantee as a measure of the actual analysis even after adjustment.

In absolute terms, the mean differences in analysis were mostly small but as a percentage of the amount of each nutrient in the diet the mean changes were substantial (5-30%). Such inaccuracy can

substantially affect any estimate of ME density of the food obtained by calculation. If food is assumed to have a composition described by the mean analyses in table 2 and ME density is calculated using the method recently recommended by the National Research Council for dog foods in 2006,[8] these adjustments would increase the calculated ME density, by 33%, 8% and 8% for canned and dry foods and treats, respectively. Using the older method recommended by the National Research Council that uses modified Atwater factors to calculate ME density,[9] the increase in calculated ME density following adjustment of the guarantee would be 28%, 7% and 8% for canned and dry foods and treats, respectively. Using the guaranteed analysis directly without adjustment to calculate ME directly would result in a substantial overestimate of the amount of food that should be fed to a pet to maintain body weight and could lead to obesity should the owner of that pet follow a recommendation based on this estimate too rigorously.

The analyzed amount of crude protein and crude fat was less than the guaranteed minimum in some foods and the analyzed amount of crude fiber, moisture and ash was greater than the guaranteed maximum in others. Nevertheless, examination of the 5% quantiles for crude protein and crude fat and the 95% quantiles for crude fiber, moisture and ash shows that only 5% of foods were more than 0.7% below the guaranteed minimum for crude protein or 1.1% below the guaranteed minimum for crude fat. Similarly, only 5% of foods were more than 0.4% above the guaranteed maximum for moisture or 0.8% above the guaranteed maximum for ash. Less than 5% failed to conform to the guaranteed maximum for crude fiber. Furthermore, it is possible that analytical variation (AV) could explain why these foods appear to contain less nutrient than stated in the guarantee. To aid in determining whether the discrepancy with the guarantee is sufficient to warrant regulatory action, AAFCO provides guidelines as to what AV should be expected for standard analytical methods used for the analysis of pet foods.[4] For example, the AV guideline for measuring moisture is 12% of the guaranteed moisture content. This would be equivalent to 1.2% for dry food with a guaranteed maximum of 10% moisture. Thus, an actual analysis of up to 11.2% moisture could be explained by analytical variation in the dry food, whereas a measurement above 11.2% would be

considered grounds for further testing or regulatory action. Other AAFCO guideline AVs for major nutrients are also small: the AV guideline for measuring crude protein is (20/x +2)% of the guaranteed percentage (x) of crude protein (0.8% below a guaranteed minimum of 30% protein); the AV guideline for measuring crude fat is 10% of the guaranteed percentage for fat (1% below a guaranteed mimimum of 10% fat); the AV guideline for measuring crude fiber is (30/x+6)% of the guaranteed percentage (x) of crude fiber (0.54% above a guaranteed maximum of 4% crude fiber); and, the AV guideline for measuring ash is (45/x+3)% of the guaranteed percentage (x) of ash (0.63% above a guaranteed maximum of 6% ash). Most foods complied with AAFCO regulations, therefore, and only a few foods would have been subjected to additional testing and/or regulatory action.

The difference between the guaranteed and actual analysis for crude fat, crude fiber and moisture differed in dry and canned foods and in treats. It is possible, therefore, to make different adjustments for dry and canned foods and treats based on the average differences reported in table 2, e.g., adding 1.2% and 0.7% to the guarantee for crude fat in canned and dry diets, respectively and subtracting 3.5% and 4.5% from the guarantee for crude moisture in canned and dry foods, respectively. This more complex adjustment does not confer much advantage, however. Using this more complex adjustment of the guarantee and the 2006 National Research Council method of calculating ME density for dog foods,[7] the increase in calculated ME density would be 26%, 10% and 13% for canned diets, dry diets and treats respectively, which are similar in scale to the changes obtained with the simpler method that does not distinguish the type of diet.

The number of analyses was large (>500) for crude protein, crude fat, crude fiber and moisture but low (39) for ash. This low number is partly because a maximum guarantee for ash is not required in the guaranteed analysis and partly because only the South Dakota laboratory reported measuring ash. The mean difference between the guaranteed and measured analysis for ash is a less reliable estimate, therefore, than the estimate for other nutrients but an accurate estimate of the difference from a guarantee is of limited value because a guarantee for ash is rarely listed on the pet food label. An estimate of the actual ash

content of a pet food is essential, however, for calculating ME density of the many foods as the carbohydrate content of the food can only be estimated by difference, as nitrogen free extract (NFE), after the ash content has been estimated. The mean ash content was 6% in dry and 2% in canned foods. These values can be used directly, therefore, without adjustment when calculating the nutrient and ME density of pet foods for which the ash content is unknown.

A further potential limitation of this study was the method of sampling. The choice of State laboratories was a sample of convenience and the choice of foods was decided by the State laboratories. It is possible, therefore, that the foods chosen may not be representative of all foods sold in the United States and a more extensive body of data obtained more systematically might provide slightly different results. This is especially true for ash because a guarantee is probably mostly provided for foods where the manufacturer wishes to emphasize the lack of ash in the diet. Thus, a more representative sample might discover a mean ash content of pet foods that is higher than that reported here. On the other hand, the values for other nutrients are likely to be more representative as a guarantee is always required for the other nutrients and foods from a large number of manufacturers were tested

In conclusion, the actual analysis of pet foods differs from the manufacturers' guaranteed analysis. An adjustment should, therefore, be made to the guaranteed analysis to obtain a more accurate estimate of the nutrient and ME density of a food when only the guaranteed composition of a diet is known. Nevertheless, variation in the difference between the actual analysis and the guarantee among individual foods suggests that there is no substitute for ascertaining the actual composition of a food.

Footnotes

a: SAS 9.1.3, SAS Institute Inc., Cary, NC

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Table 1 – The difference between guaranteed and measured percent as fed analysis in all pet foods[a].

Nutrient	Mean	Standard Deviation	Median	5% quantile	95% quantile	Minimum	Maximum	N
Crude Protein	1.5	2.0	1.4	-0.7	4.1	-13.9	34.4	2200
Crude Fat	1.0	1.7	0.8	-1.1	3.7	-9.2	16.8	1431
Crude Fiber	-0.7	1.3	-0.4	-3.0	-0.1	-11.0	8.9	695
Moisture	-4.0	3.3	-3.9	-8.8	0.4	-22.2	10.2	573
Ash	-0.5	1.0	-0.5	-2.2	0.8	-4.7	1.4	39

a: Negative values indicate a measured analysis that was less than the guaranteed crude protein and crude fat minimum, and the crude fiber, moisture and ash maximum.

Table 2 – The measured nutrient composition and the difference between guaranteed and measured as fed analyses for canned, dry and treat pet foods

Food type	Crude Protein	Crude Fat	Crude Fiber	Moisture	Ash
Measured % as fed nutrient composition					
Canned	$10.4^{a} \pm 2.2$ (1156)	$6.1^{a} \pm 2.5$ (601)	$1.0^{a} \pm 0.5$ (448)	$74.5^{a} \pm 6.5$ (328)	$2.2^{a} \pm 0.6$ (22)
Dry	$29.3^{b} \pm 5.9$ (739)	$12.6^{b} \pm 4.2$ (646)	$2.7^{b} \pm 1.7$ (139)	$6.7^{b} \pm 3.6$ (150)	$5.9^{b} \pm 0.9$ (12)
Treat	$22.1^{c} \pm 13.8$ (253)	$8.5^{c} \pm 3.0$ (152)	$2.0^{c} \pm 1.3$ (86)	$13.5^{c} \pm 11.7$ (91)	$5.2^{b} \pm 1.8$ (5)
Change in nutrient composition as % of total diet					
Canned	$1.3^{a} \pm 1.2$ (1156)	$1.2^{a} \pm 1.5$ (601)	$-0.3^{a} \pm 0.6$ (448)	$-3.5^{a} \pm 3.4$ (328)	-0.4 ± 0.7 (22)
Dry	$1.6^{a} \pm 2.0$ (739)	$0.7^{b} \pm 1.8$ (646)	$-1.8^{b} \pm 1.8$ (139)	$-4.6^{b} \pm 2.4$ (150)	-0.3 ± 0.9 (12)
Treat (all)	$2.4^{b} \pm 3.6$ (253)	$1.6^{a} \pm 1.8$ (152)	$-1.1^{c} \pm 1.4$ (86)	$-4.9^{b} \pm 3.7$ (91)	-1.6 ± 2.2 (4)
Change in nutrient composition as % of guaranteed composition					
Canned	$15^{a} \pm 14$ (1156)	$25^{a} \pm 29$ (601)	$-17^{a} \pm 53$ (448)	$16^{a} \pm 16$ (328)^{dm}	-10 ± 32 (22)
Dry	$7^{b} \pm 20$ (739)	$9^{b} \pm 42$ (646)	$-30^{b} \pm 104$ (139)	$5^{b} \pm 3$ (150)^{dm}	-5 ± 16 (12)
Treat	$15^{a} \pm 22$ (253)	$36^{a} \pm 64$ (151)	$-25^{b} \pm 44$ (86)	$6^{b} \pm 7$ (91)^{dm}	-15 ± 22 (4)

Values are means ± one standard deviation with N in parentheses. Negative values indicate a measured analysis that was less than the guaranteed crude protein and crude fat minimum, and the crude fiber, moisture and ash maximum

a,b,c- means with different superscripts within a column are significantly different ($p<0.05$)

dm- values are presented as the change in guaranteed to measured dry matter composition as a percent of the guaranteed minimum dry matter content (100- maximum guaranteed moisture content)

Table 3 – The difference between measured and guaranteed percent as fed analysis for liquid, soft moist or soft dry foods, and supplements[a].

Nutrient	Liquid food			Soft-moist or Soft-dry food			Supplemental food		
	Mean	**Range**	**N**	**Mean**	**Range**	**N**	**Mean**	**Range**	**N**
Crude protein	0.4	0.1 to 0.8	2	1.1	-0.3 to 2.6	9	0.9	-10.8 to 6.7	9
Crude fat	-1.8	-4.1 to 0.4	2	1.2	0.9 to 1.5	3	4.9	-1.1 to 10.7	3
Crude fiber			0	0.1		1			0
Moisture	-0.1		1			0	-4.1		1
Ash	-0.3		1			0			0

a: Negative values indicate a measured analysis that was less than the guaranteed crude protein and crude fat minimum, and the crude fiber, moisture and ash maximum.

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