Comparison of the guaranteed analysis with the measured nutrient composition of commercial pet foods

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Objective—To compare guaranteed and measured concentrations of nutrients in commercial pet foods.

Design—Cross-sectional study.

Sample Population—Annual inspection reports of pet food analyses from 5 states.

Procedures—Guaranteed and measured concentrations of crude protein (CP), crude fat (CF), crude fiber (CFb), moisture, and ash in pet foods were compared. The concentration difference for each nutrient was compared among types of food, target species, target life stages, manufacturers, and laboratories.

Results—The guaranteed and measured concentrations of nutrients were significantly different. For all foods, mean concentration differences were as follows: CP, 1.5%; CF, 1.0%; CFb, –0.7%; moisture, –4.0%; and ash, –0.5%. Crude protein difference for treats was significantly larger than differences for dry and canned foods. Crude fat difference for dry foods was significantly less than differences for canned foods and treats. Crude fiber and moisture differences for canned foods were significantly less than the corresponding differences for dry foods and treats. Only CFb differences differed among target species, life stages, manufacturers, or laboratories.

Conclusions and Clinical Relevance—Addition of 1.5% and 1% to the guaranteed minimums for CP and CF, respectively; subtraction of 0.7%, 4%, and 0.5% from the guaranteed maximums for CFb, moisture, and ash, respectively; and addition of 0.23 kcal/g to the as-fed metabolizable energy value calculated by use of modified Atwater factors from guaranteed analyses provides a more accurate estimate of the nutrient and metabolizable energy content of commercial pet foods. Nevertheless, the actual composition of a food should be determined whenever possible. (J Am Vet Med Assoc 2009;234:347–351)
the resulting estimate of MED is likely to be inaccurate and could lead to inappropriate recommendations regarding how much and what to feed an animal.

To the authors’ knowledge, the size of the difference between the guaranteed and actual analysis of various pet foods has not been reported. Several state authorities determine whether the actual analysis conforms to the label guarantee but 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 guaranteed analysis, then further testing of the food is undertaken and regulatory action may be initiated against the manufacturer by the state feed control officials. Therefore, most manufacturers would be expected to ensure that nutrient composition exceeds guaranteed minima and does not exceed guaranteed maxima. Differences in excess of nutrient composition minima would be expected to be small in situations in which adding nutrients increases costs and also to be larger in situations in which additional nutrients have to be included to provide a safety margin that allows for differences in ingredients and manufacturing conditions. Also, differences between the guaranteed and actual analyses might vary among foods intended for different species or life stages or among foods produced by different manufacturers.

The purpose of the study reported here was to compare guaranteed and measured concentrations of nutrients in commercial pet foods. The intent was to determine whether the manufacturers’ guaranteed analyses differed from the measured proximate analyses of commercial pet foods, ascertain the size and variability of the differences, and compare these differences among types of food, among foods intended for dogs or cats or for different life stages, and among manufacturers and laboratories undertaking the analyses. It was also of interest to ascertain how much the difference between the guaranteed and actual analysis might affect an estimate of MED of a pet food.

Materials and Methods

The agencies in each state listed by the 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 to that request, did not perform regular testing, or requested a fee for their report. The most recent reports from the 5 states that provided reports free of charge were used for the 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 for which both the guaranteed and measured amounts were listed. In instances in which a complete proximate analysis was performed, MED was calculated by use of modified Atwater factors.

Foods were categorized by type of diet (canned, dry, treat, liquid, soft-moist, soft-dry, supplemental food, or food in pouches), intended species (dog or cat), intended life stage as determined from the name of the product (for growth or for adult, senior, or overweight animals), and manufacturer. Manufacturers for which < 50 foods were analyzed were grouped together. These grouped manufacturers were mostly private-label manufacturers. Because data were available for very few soft-moist, soft-dry, liquid, and supplemental foods and foods in pouches, differences were compared only among foods identified as being either canned, dry, or treat foods.

Statistical analysis—Statistical analyses were performed by use of a computer statistics program. Data were assessed for normality both visually and by use of the Shapiro-Wilk test. Most data failed the Shapiro-Wilk test, and variances were not equal; thus, data were logarithmically transformed prior to analysis. The guaranteed and measured nutrient compositions were compared by use of 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) by use of a general linear models procedure. Within each diet type, differences were then compared with intended species, life stage, manufacturer, and laboratory as factors included in the model. Interactions among these factors were also included in the model. A Bonferroni correction was used for post hoc multiple comparisons. For all analyses, a type 1 error < 0.05 was considered significant. Results are presented as mean ± SD.

Results

The guaranteed and measured nutrient analyses of 2,208 foods manufactured by 204 companies were compared. Among these products, there were 1,158 canned foods, 750 dry foods, 258 treats, 32 other types of food (soft-moist, soft-dry, liquid, or supplemental foods or foods in pouches), and 21 foods of unidentified type. The guaranteed analysis was different (P < 0.001) from the measured analysis for all nutrients. 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).

The analyzed amounts of crude protein and crude fat were less than the guaranteed minima in some foods, and the analyzed amounts of crude fiber, moisture, and ash were greater than the guaranteed maxima in others. Nevertheless, examination of the 5% quantiles for crude protein and crude fat revealed that only 5% of foods were > 0.7% less than the guaranteed minimum for crude protein or > 1.1% less than the guaranteed minimum for crude fat. Similarly, examination of the 95% quantiles for crude fiber, moisture, and ash revealed that only 5% of foods were > 0.4% higher than the guaranteed maximum for moisture or > 0.8% higher than the guaranteed maximum for ash; for crude fiber, < 5% failed to conform to the guaranteed maximum.
The difference between the analyses of crude protein, crude fat, crude fiber, and moisture varied among canned, dry, and treat foods (P < 0.001; Table 2). The difference between the crude protein analyses of treats was twice that of canned or dry foods (P < 0.001). The difference between the crude fat analyses of canned foods and treats was larger than that of dry foods (P = 0.001). 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 < 0.001). 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. However, in canned foods, the difference between crude fiber analyses was less for adult foods (−0.3 ± 0.6%) and for growth foods (−0.1 ± 0.4%) than it was for foods for overweight animals (−1.0 ± 1.2%; P < 0.001); also, the difference between crude fiber analyses was greater for foods manufactured by a large corporate manufacturer (−0.9 ± 2.4%) than for foods manufactured for private labels (−0.2 ± 0.6%; P = 0.009), and there was an interaction between laboratory and manufacturer (P < 0.001). In dry foods, the difference between crude fiber analyses was greater for foods analyzed in New York (−2.4 ± 2.0%) than it was for foods analyzed in Rhode Island (−0.6 ± 0.3%; P < 0.001), and there was an interaction between intended species and manufacturer (P = 0.002). Differences in nutrient analyses of liquid foods, soft-moist and soft-dry foods, supplemental foods, and foods in pouches were within the same ranges as those of canned, dry, and treat foods.

A complete proximate analysis involving measurement of crude protein, crude fat, crude fiber, ash, and moisture was performed on only 1 food. Thus, MED could only be calculated for that 1 food, and mean differences in calculated MED among foods could not be reported. Nevertheless, mathematic calculation suggests that failing to account for these differences when making an estimate of MED by use of modified Atwater factors would result in a clinically important underestimation of the MED of the food. Thus, if the MED value is in kilocalories per gram as fed; CP, CF, ash, moisture, and NFE represent the percentage as-fed crude protein, crude fat, crude fiber, ash, moisture, and nitrogen-free extract in the food, respectively; the subscript g denotes the value obtained from the guaranteed analysis without modification; and the subscript a denotes the estimated value of the actual value after correction, then the error in the MED can be calculated as follows:

\[
NFE_a = 100 - CP_a - CF_a - ash_a = moisture_a \\
MEDI_a = \left( [3.5 \times CP_a] + [8.5 \times CF_a] + [3.5 \times NFE_a] \right)/100 \\
NFE_a = 100 - (CP_a + 1.5) - (CF_a + 0.7) - (ash_a + 0.5) - (moisture_a - 4) = 100 - CP_a - CF_a - ash_a - moisture_a = 1.5 + 0.7 + 0.5 + 4 = NFE_a + 2.7 \\
MEDI_a = \left( [3.5 \times CP_a] + [8.5 \times CF_a] + [3.5 \times NFE_a] \right)/100 \\
= \frac{([3.5 \times CP_a] + [8.5 \times CF_a] + [3.5 \times NFE_a] + 5.25 + 8.5 + 9.45)/100 = ([3.5 \times CP_a] + [8.5 \times CF_a] + [3.5 \times NFE_a]/100) + (23.2)/100 = MEDI_a + 0.23}
\]

The difference between the guaranteed and actual analysis for crude fat, crude fiber, and moisture differed among dry and canned foods and treats. Thus, for dry and canned foods and treats, it is possible to make different adjustments on the basis of the mean differences for each type of food: for example, addition of 1.2% and

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**Table 1**—Differences between guaranteed and measured percentage as-fed analyses for 2,208 pet foods manufactured by 204 companies as determined from annual inspection reports of pet food analyses from 5 states. Negative values indicate a measured analysis that was less than the guaranteed crude protein or crude fat minimum value or less than the crude fiber, moisture, or ash maximum value.

<table>
<thead>
<tr>
<th>Component</th>
<th>No. of foods evaluated</th>
<th>Mean ± SD</th>
<th>Median</th>
<th>5% quantile</th>
<th>95% quantile</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crude protein</td>
<td>2,280</td>
<td>1.5 ± 2.0</td>
<td>1.4</td>
<td>−0.7</td>
<td>4.1</td>
<td>−13.9</td>
<td>34.4</td>
</tr>
<tr>
<td>Crude fat</td>
<td>1,431</td>
<td>1.0 ± 2.1</td>
<td>0.8</td>
<td>−1.1</td>
<td>3.7</td>
<td>−8.2</td>
<td>18.8</td>
</tr>
<tr>
<td>Crude fiber</td>
<td>695</td>
<td>−0.7 ± 1.3</td>
<td>−0.4</td>
<td>−3.0</td>
<td>−0.1</td>
<td>−11.0</td>
<td>8.9</td>
</tr>
<tr>
<td>Moisture</td>
<td>573</td>
<td>−4.0 ± 3.3</td>
<td>−3.9</td>
<td>−8.8</td>
<td>0.4</td>
<td>−22.2</td>
<td>10.2</td>
</tr>
<tr>
<td>Ash</td>
<td>39</td>
<td>−0.5 ± 1.0</td>
<td>−0.5</td>
<td>−2.2</td>
<td>0.8</td>
<td>−4.7</td>
<td>1.4</td>
</tr>
</tbody>
</table>

**Table 2**—Measured percentage as-fed nutrient composition and differences between guaranteed and measured percentage as-fed analyses for canned, dry, and treat pet foods as determined from annual inspection reports of pet food analyses from 5 states. Data are presented as mean ± SD; the number of foods evaluated is given in parentheses. Negative values indicate a measured analysis that was less than the guaranteed crude protein or crude fat minimum value or less than the crude fiber, moisture, or ash maximum value.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Food type</th>
<th>Crude protein</th>
<th>Crude fat</th>
<th>Crude fiber</th>
<th>Moisture</th>
<th>Ash</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measured percentage</td>
<td>Canned</td>
<td>10.4 ± 2.1 (1,156)</td>
<td>6.1 ± 2.5 (601)</td>
<td>1.0 ± 0.5 (448)</td>
<td>74.5 ± 6.5 (328)</td>
<td>2.2 ± 0.6 (223)</td>
</tr>
<tr>
<td>as-fed nutrient composition</td>
<td>Dry</td>
<td>29.3 ± 9.7 (739)</td>
<td>12.6 ± 4.2 (646)</td>
<td>2.7 ± 1.7 (139)</td>
<td>6.7 ± 3.6 (150)</td>
<td>5.9 ± 0.9 (12)</td>
</tr>
<tr>
<td></td>
<td>Treat</td>
<td>22.1 ± 13.8 (253)</td>
<td>8.5 ± 3.0 (152)</td>
<td>2.0 ± 1.3 (86)</td>
<td>13.5 ± 11.7 (91)</td>
<td>5.2 ± 1.8 (5)</td>
</tr>
<tr>
<td>Difference between</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Canned</td>
<td>1.3 ± 1.2 (1,156)</td>
<td>1.2 ± 1.5 (601)</td>
<td>−0.3 ± 0.6 (448)</td>
<td>−3.5 ± 3.4 (328)</td>
<td>−0.4 ± 0.7 (22)</td>
<td></td>
</tr>
<tr>
<td>Dry</td>
<td>1.8 ± 2.0 (139)</td>
<td>0.7 ± 1.8 (646)</td>
<td>−1.5 ± 1.8 (139)</td>
<td>−4.6 ± 2.4 (150)</td>
<td>−0.3 ± 0.9 (12)</td>
<td></td>
</tr>
<tr>
<td>Treat</td>
<td>2.4 ± 3.8 (253)</td>
<td>1.6 ± 1.8 (152)</td>
<td>−1.1 ± 1.4 (86)</td>
<td>−4.9 ± 3.7 (91)</td>
<td>−1.6 ± 2.2 (4)</td>
<td></td>
</tr>
</tbody>
</table>

*Inside a column, means with different superscript letters are significantly (P < 0.05) different.†Inside a column, means with different symbols are significantly (P < 0.05) different.
0.7% to the guaranteed analysis for crude fat in canned and dry diets, respectively, and subtraction of 3.5% and 4.5% from the guaranteed analysis for crude moisture in canned and dry foods, respectively (Table 2). Such adjustments would result in a difference between MEDn and MED, of 0.21 kcal of ME/g for canned foods and differences as much as 0.27 and 0.35 kcal of ME/g for dry foods and treats, respectively.

**Discussion**

Results of the present study indicated that the measured proximate analysis of commercial pet foods is slightly different from the guaranteed analysis and that a more accurate estimate of the major nutrient composition of commercial pet foods can be obtained following addition of 1.5% and 1%, respectively, to the guaranteed minima for crude protein and crude fat and subtraction of 0.7%, 4%, and 0.5%, respectively, from the guaranteed maxima for crude fiber, moisture, and ash. However, the difference between the guaranteed and measured analyses indicated some variation about these mean values; thus, the recommended adjustments should improve the accuracy of the estimate of diet composition of most foods, but may reduce the accuracy of the estimated analysis of individual foods for which the actual composition and the guaranteed analysis are similar. Furthermore, within all types of food, there were some instances in which actual food analyses diverged markedly from the guaranteed analysis. For such foods, the adjusted estimate of composition would remain wildly inaccurate. Therefore, it is more useful to ascertain the actual composition of a food from the manufacturer or via analysis of several batches of food rather than to rely on the guaranteed analysis as a measure of the actual analysis, even after adjustment.

Few foods failed to conform to the guaranteed analysis. This is not surprising considering the regulatory requirement to conform to the guaranteed analysis. Furthermore, some foods may appear to contain less of a given nutrient than stated in the guaranteed analysis because of AV. To aid in determining whether the discrepancy with the guaranteed analysis is sufficient to warrant further testing or enforcement action, AAFCO provides guidelines as to the AV that should be expected for standard analytic methods used for the analysis of pet foods. 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, in an actual analysis of a single sample, as much as 11.2% of moisture could be explained by AV. Although such a result is potentially worthy of further testing by the state feed control official, it generally would not constitute a basis for enforcement action. On the other hand, a single measurement > 11.2% or multiple analyses of samples that reveal a pattern of failing to meet a 10% maximum guarantee (even if all samples are within the AV) may represent grounds for enforcement action. Other AAFCO guideline AVs for major nutrients are also small. The AV guideline for measuring crude protein is (20x) + 2)% of the guaranteed percentage (x) of crude protein (0.8% less than a guaranteed minimum of 30% protein). The AV guideline for measuring crude fat is 10% of the guaranteed percentage of fat (1% less than a guaranteed minimum of 10% fat). The AV guideline for measuring crude fiber is ((30x) + 6)% of the guaranteed percentage (x) of crude fiber (0.54% greater than a guaranteed maximum of 4% crude fiber). The AV guideline for measuring ash is ((45x) + 3)% of the guaranteed percentage (x) of ash (0.63% greater than a guaranteed maximum of 6% ash). Most foods evaluated in the present study met AAFCO guidelines; therefore, only a few foods would have been subject to additional testing or enforcement action.

In the present study, mean differences in nutrient composition were small but resulted in a clinically important underestimation of the calculated MED of a diet by 0.23 kcal of ME/g as fed. Thus, a canned diet with an MED of 1 kcal/g would have an MED of 1.23 kcal/g (ie, an error of 23%), whereas a dry diet with an MED of 4 kcal/g would have an MED of 4.23 kcal/g (ie, an error of 6%). This in turn would result in an overestimation of the amount of food that should be fed to a pet to maintain body weight and could result in development of obesity were the owner to rigorously follow a recommendation based on MEDn. For example, the recommendation for a 15-kg (33-lb) dog that is estimated to require 1,000 kcal of ME daily would be to feed 250 g daily of a dry diet with an MED of 4 kcal of ME/g. Because that 250 g of food would actually provide 4.23 kcal of ME/g or 1,058 kcal of ME daily, the extra 58 kcal of ME consumed daily would be stored as new tissue. In dogs, the ME of new tissue containing protein and fat is approximately 7.2 kcal/g, and the efficiency of utilization of ME above maintenance energy requirements is 70%. Thus, an additional 58 kcal of ME would result in the addition of 5.7 g of new tissue daily or 170 g monthly of new tissue. Underestimation of the MED by 6% would result, therefore, in an increase in body weight of >1% each month until the change in body condition was detected. Following the same logic, underestimation of the MED of a canned diet by 23% would result in an increase in weight of >4% monthly.

The number of analyses evaluated in the present study was large (>500) for crude protein, crude fat, crude fiber, and moisture but low (39) for ash. The number of analyses for ash was low because a maximum guarantee for ash is not required in the guaranteed analysis and because only the reports from the South Dakota laboratory included measurements of ash. Therefore, the mean difference between the guaranteed and measured analyses for ash is a less reliable estimate than the estimate for other nutrients, but an accurate estimate of the difference from a guaranteed analysis is of limited value because a guaranteed analysis 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 the MED of many foods because the carbohydrate content of the food can only be estimated by difference (as nitrogen-free extract) after the ash content has been estimated. The mean ash content was 6% and 2% in dry and canned foods, respectively. Thus, these values can be used directly, without adjustment, for calculation of the nutrient and ME densities of pet foods for which the ash content is unknown.

A further potential limitation of the present study was the method of sampling. The state laboratories included in the study were a sample of convenience. The choice of foods was decided by the state laboratories; foods were selected for reasons such as new registration of a product for
distribution within the state. It is possible, therefore, that the foods chosen may not be representative of all foods sold in the United States, and data obtained randomly might provide slightly different results. This is especially true for ash because a guaranteed analysis of ash is probably mostly provided for foods for which the manufacturer wishes to emphasize the lack of ash in the diet. Thus, evaluation of a more representative sample might reveal that the mean ash content of pet foods is higher than that determined in the present study. Nevertheless, the values for other nutrients determined in the present study are likely to be representative because guaranteed analyses of crude protein, crude fat, crude fiber, and moisture are always required and foods from a large number of manufacturers were tested.

The results of the present study indicated that actual analyses of pet foods differ from the manufacturers’ guaranteed analyses. Therefore, an adjustment should be made to the guaranteed analysis to obtain a more accurate estimate of the nutrient and ME densities of a food when only the guaranteed analysis of a diet is known. However, variation in the difference between the actual analysis and the guaranteed analysis among individual foods suggests that there is no substitute for ascertaining the actual composition of a food and that providing a mean analysis on the label would represent the composition of a pet food more accurately than a guaranteed analysis. These data also lend support for the recommendation by the American College of Veterinary Nutrition, supported by the AVMA, that a calorie content statement should be required on pet food labels.

References

Selected abstract for JAVMA readers from the American Journal of Veterinary Research

Indices of urine N-acetyl-β-D-glucosaminidase and γ-glutamyl transpeptidase activities in clinically normal adult dogs

Jill D. Brunker et al

Objective—To establish reference ranges for indices of urine N-acetyl-β-D-glucosaminidase (NAG) and γ-glutamyl transpeptidase (GGT) activities in clinically normal adult dogs.

Animals—38 dogs.

Procedures—Each dog underwent a physical examination, CBC, serum biochemical analysis, urinalysis, and serologic testing for heartworm antigen and antibodies against Ehrlichia canis and Borrelia burgdorfer.

Activities of NAG and GGT in urine were evaluated, and values of the respective indices were determined as urine NAG or GGT activity (U/L) divided by urine creatinine concentration (g/L).

Results—All dogs were considered clinically normal. A 90% prediction interval based on the 5th and 95th percentiles for GGT and NAG index values from both sexes was used to establish the reference ranges for dogs: 1.93 to 28.57 U/g and 0.02 to 3.63 U/g, respectively. Between males and females, urine NAG index differed significantly, whereas urine GGT index did not. When accounting for sex differences, reference ranges for the urine NAG index in males and females were 0.02 to 3.85 U/g and 0.02 to 2.31 U/g, respectively. Changes in urine pH significantly affected the urine GGT index but not the urine NAG index. Neither index changed significantly with changes in body surface area.

Conclusions and Clinical Relevance—Data suggest that increases in urine NAG and GGT indices allow for earlier detection of renal tubular damage in dogs. Such early detection would enable adjustment of the clinical management of affected dogs to decrease morbidity and death rates associated with acute tubular injury and acute tubular necrosis. (Am J Vet Res 2009;70:297–301)