Discrepancy between the composition of some commercial cat foods and their package labelling and suitability for meeting nutritional requirements

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Objective To investigate if the label information and nutrient composition of commercial cat foods are accurate and compliant with the Australian Standard (AS 5812–2011) and if they meet the nutritional requirements of an adult cat.

Methods A chemical analysis of 10 wet and 10 dry commercial cat foods labelled as ‘nutritionally complete’ for the adult cat was performed. The results were compared with the package composition values, the Australian Standard and the unique dietary requirements of the cat. In addition, the results of the chemical analysis were compared with the nutrient requirements published by the Association of the American Feed Control Officials and the National Research Council.

Results When compared with the Australian Standard, 9 of the 20 cat foods did not adhere to their ‘guaranteed analysis’ and 8 did not adhere to the standards for nutrient composition. Also, various deficiencies and excesses of crude protein, crude fat, fatty acid and amino acid were observed in the majority of the cat foods.

Conclusions The results of this study highlight a need for an improved method of ensuring that label information and nutrient composition are accurate and comply with the Australian Standard (AS 5812–2011) to ensure the adult cat’s unique dietary requirements are being met by commercial adult cat food.

Keywords amino acids; cats; diet; fatty acids; nutritional geometry; pet nutrition

Abbreviations AA, arachidonic acid; AAFCO, Association of the American Feed Control Officials; AOAC, Association of Official Analytical Chemists; CP, crude protein; DHA, docosahexaenoic acid; DM, dry matter; DMI, dry matter index; EFA, essential fatty acid; EPA, eicosapentaenoic acid; LA, linoleic acid; MUFA, monounsaturated fatty acid; NRC, National Research Council; PUFA, polyunsaturated fatty acid; RDI, recommended daily intake; RNC, recommended nutrient concentration; SFA, saturated fatty acids; SUL, safe upper level; EPA, eicosapentaenoic acid; WSC, water-soluble carbohydrates


Cats have remained strict carnivores throughout their evolution and must consume animal tissues to meet their unique dietary requirements for high protein levels, taurine and arachidonic acid.1 The strict requirement for animal tissue is a concern in regards to the commercial cat food industry, because pet foods contain considerable amounts of starch,2 which is not found in significant concentrations in most animal tissues. It has been demonstrated that cats possess a small capacity for starch digestion by their own enzymes,2 which cannot be enhanced by adaptation to starch in the diet, and that digestive disorders have often occurred in response to starch and sugar intake.2,3 It is therefore imperative that commercial cat foods are formulated to ensure the cat’s unique dietary requirements are met.

The Official Publication of the Association of the American Feed Control Officials (AAFCO),4 the National Research Council (NRC) recommendations5 and the Australian Standard for the manufacturing and marketing of pet food (AS 5812–2011)6 have been integral in the development of standards for commercial cat food and their recommendations are based on peer-reviewed scientific data and information from experts in the field.4,5 The recommendations published by NRC5 are the required amounts of each nutrient to be included in a diet that is formulated to support adult maintenance and includes a safety factor for nutrients with uncertain bioavailability.

In Australia, pet food companies are required to conform to the Australian Standard,4 which mandates companies to provide on the packaging of pet food a ‘statement of guarantee’, expressing the chemical analysis as a minimum percentage, or a ‘typical’ composition, expressing the chemical analysis as an average percentage. The safe upper level (SUL) is defined by the NRC5 as the maximal concentration of a nutrient that has not been associated with any adverse health effects.

Cat foods labelled as ‘nutritionally complete’ for adult cats in maintenance must conform to the AAFCO Official Publication4 in regards to nutrient content. A company may achieve nutritional adequacy according to the AAFCO Official Publication4 either by formulating the food so that the nutrient composition satisfies the established ‘AAFCO Cat Food Nutrient Profile’4 or through feeding trials following AAFCO protocols.

The aim of the current study was to compare chemical analysis of 20 cat foods with the ‘guaranteed’ or ‘typical’ composition on the packaging package values and to establish if they complied to the Australian Standard.6 A further aim was to determine the extent to which each food met the nutritional requirements recommended by AAFCO4 and NRC5 for an adult cat in maintenance, if provided in the daily amounts recommended on the packaging.
Materials and methods

Chemical analysis

A chemical analysis of 10 dry and 10 wet commercial adult cat foods (labelled 1–10d and 1–10w) was conducted. Each cat food purchased for the current study specified on the packaging that it was ‘nutritionally complete’ for adult cats in maintenance. For each of the 20 cat foods, two different production batches were purchased from the supermarket or pet shop. A sample was taken from each batch, ground to 1 mm and analysed in duplicate. An average of the two production batches was taken as the result for each nutrient.

Using AOAC methods, the foods were analysed to determine the concentrations of dry matter (DM; method no. 967.03), ash (no. 942.05) and ether extract (no. 920.29). Crude protein (CP; nitrogen × 6.25) content was determined using a nitrogen and protein analyser (Model FP628, LECO, St Joseph, MI, USA). Water-soluble carbohydrate (WSC) concentrations were determined as previously described.

A fatty acid methyl ester and amino acid analysis was conducted by Animal Health Laboratories, Perth, WA, using Zorbac Eclipse-AAA columns and the Agilent 1100 HPLC analysis, respectively. Total analysed essential amino acids were calculated.

Calculations

The projected daily intakes of fat, fatty acids, CP and amino acids for each food were calculated using the nutrient concentration determined in this study and the recommended daily DM intake (DMI), which was determined by the feeding guide specified on the packaging of each food. The total daily intake of each nutrient was calculated as: daily intake (g) = nutrient concentration (in g/kg) × DMI (kg).

The daily intakes were then compared to the recommended daily intakes (RDI; in g) and SUL (in g) for a 4-kg adult cat and the recommended nutrient concentrations (RNC; in g/kg).

The equation ((recommended allowance × daily metabolisable energy (ME) requirement)/1000) was used to calculate the RDIs recommended by the NRC for each nutrient. The daily ME requirement for a lean 4-kg adult cat was calculated as: 418.68 kJ × (4 kg0.67). Therefore, a 4-kg lean adult cat has an approximate daily ME requirement of 1060 kJ. Cats that have a body condition score ≤5 on a 9-point scale are considered as ‘lean’.

The SUL values published by the NRC were corrected for a 4-kg lean adult cat: (SUL × daily ME requirement)/1000.

The AAFCO recommendations presume an energy density of 16,747 kJ of ME/kg DM and any rations greater than 18,841 kJ of ME/kg are required to be corrected for energy density. All the studied cat foods had energy densities less than 18,841 kJ of ME/kg, except for wet foods 4w, 6w, and 7w; consequently, these foods required adjustment: (RNC/18,841 kJ) × ME of the diet printed on the packaging.

Statistical analysis

Measure of deviation of actual nutrition composition of feeds from package values. A mean bias index was used to compare measured values of DM, CP, crude fat and ash with the package values. The mean bias indicates the average error of the predicted values across the entire data set, indicating over or under predicted values of DM, CP, crude fat or ash printed on the packaging compared with the actual values obtained from the chemical analyses values.

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\text{Mean bias} = \frac{\sum (\text{predicted} - \text{actual})}{\text{number of observations}}
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The univariate procedure in SAS was used to test for normal distribution of the nutritional composition data.

Right-angled mixture triangles were used to explore the relationships among the proportional content of macronutrients of the foods. The nutritional composition of the foods were examined in terms of CP (X axis), crude fat (Y axis) and carbohydrate (Z axis) content and also as a breakdown of the total saturated fatty acids (SFA), polyunsaturated fatty acids (PUFA) and monounsaturated fatty acids (MUFA) of the total fatty acid composition of each food.

Comparison of measured and package chemical analyses

All cat foods had package values for CP and fat, but only five wet and six dry foods had values for DM. Four wet and five dry foods had values for ash and none declared a WSC, PUFA, MUFA or SFA concentration (Table S1). For the five wet (3w–7w) and seven dry (3d–7d, 9d and 10d) foods that provided a ‘guaranteed’ analysis on the packaging, two wet (4w and 7w) and all seven dry foods measured lower than the package value for CP and the remaining three wet foods measured higher. All seven dry foods measured lower than the package value for fat and all five of the wet foods measured higher.

For the five wet (1w, 2w, 8w, 9w and 10w) and three dry (1d, 2d and 8d) foods that provided a ‘typical’ analysis on the packaging, two wet foods (1w and 9w) measured higher CP and fat than the package values, and three wet foods (2w, 8w and 10w) and all three dry foods measured lower (Table S1).

Figure 1 shows a comparison of the dry weight concentrations of CP and fat in the dry and wet foods. Wet foods had a high variability in both macronutrients compared with dry foods, which clustered within a smaller region of the composition space (Figure 1). Wet foods had higher maximum percentages of CP and fat than the dry foods. The majority of the foods analysed exceeded the minimum recommendations of the NRC (Figure 1). Exceptions were the dry foods, which had lower CP and fat than recommended, and one dry and three wet foods that exceeded the minimum recommended CP but not the minimum recommended fat.

Essential fatty acid and amino acid composition

The essential fatty acid composition for the 10 wet and 10 dry foods was statistically different (P < 0.05) (Table S2). The total PUFA content ranged from 5.1% to 47.1% for the wet foods and from 12.3% to 34.0% for the dry foods.
The average total analysed SFA, MUFA and PUFA were similar: 36.7%, 42.0% and 21.3% for the wet foods and 36.7%, 41.0% and 22.3% for the dry foods, respectively. A right-angle mixture triangle plot showed higher variability in the percentage of PUFA in comparison with SFA and MUFA between the dry and wet foods (Figure 2).

Each analysed essential amino acid showed a higher average concentration in the wet foods than in the dry foods (Table S3).

**Daily crude fat and essential fatty acid intakes**

The crude fat and essential fatty acid (EFA), RDI and percentage of the recommendations for each cat food are presented in Table S2.

Foods 1w, 10w, 1d, 4d and 10d contained less than the RDI for crude fat, with 94%, 77%, 83%, 91% and 80% of the RDI, respectively. The remaining foods exceeded the recommendation by a range of 149–448% (2w–9w) and 114–219% (2d, 3d and 5d–9d). One wet food (7w) exceeded the SUL for crude fat by 122%. No dry food exceeded the SUL for crude fat.

One wet (10w) and two dry (1d and 10d) foods did not provide an adequate concentration of crude fat according to the RNC (70%, 82% and 70% of the RNC, respectively). The remaining foods exceeded the RNC by a range of 132–314% (1w–9w) and 106–193% (2d–9d).

Foods 1w, 4w and 10w contained less than the RDI of linoleic acid (LA) (81%, 76% and 64% of the RDI, respectively). The remaining 7 wet and 10 dry foods exceeded the recommendation by a range of 205–687% and 223–647%, respectively. Foods 4w and 10w contained less than the RNC of LA (69% and 65% of the RNC, respectively). The remaining foods exceeded the RNC by a range of 134–762% (wet) and 273–783% (dry).

All foods exceeded the RDI for the essential fatty acid arachidonic acid (AA). The mean percentage of SUL was 99% for all wet foods and 66% for all dry foods, and was exceeded in foods 2w, 6w and 7w by 343%, 1495 and 243%, respectively.

All 10 of the wet and 9 of the dry foods exceeded the RDI for docosahexaenoic acid (DHA) (range 215–12,196%) and eicosapentaenoic acid (EPA) (range 128–1464%). One dry food (6d) contained the recommended RDI.

**Daily CP and essential amino acid intakes**

The CP and amino acid daily intakes and percentage of recommendations for each cat food are presented in Table S3. All foods exceeded the RDI for CP (range 134–398% for wet foods and 138–211% for dry foods). Foods 4w and 10d did not provide an adequate concentration of CP according to the RNC (88% and 93%, respectively). All remaining foods exceeded the recommendation by a range of 107–234% (wet) and 109–153% (dry).

All foods greatly exceeded the RDI and RNC (Table S3) for analysed essential amino acids. The concentration of methionine exceeded the maximum recommendation of the AAFCO in five wet foods.
(1w, 2w, 5w, 7w and 10w) by a range of 102–166%. The remaining 5 wet and 10 dry foods did not exceed the maximum.

Discussion

Package versus measured values

The comparison between package and measured values demonstrated that two of five wet and all seven dry foods that provided a ‘guaranteed analysis’ on the packaging did not comply with the Australian Standard,6 as these foods measured less CP or fat than the package value.

There were inadequate daily amounts of crude fat for maintenance of the adult cat in two of the wet and three of the dry foods. Even though studies determining the requirement for crude fat have not yet been conducted specifically in cats, the recommendations established by the NRC5 and AAFCO4 recognise that fat is essential as a source of EFAs and as a carrier of fat-soluble vitamins, as well as increasing the palatability of the food and supplying adequate caloric density. Cats consuming diets 1w, 10w, 1d, 4d and 10d may develop a deficiency in EFAs, fat-soluble vitamins or energy and a possible decrease in overall nutrient intake. However, a requirement for fat above the need for EFA intake has not yet been demonstrated.7

It is important to also assess the EFA content of the cat foods as well, including LA, AA, DHA and EPA. Adult cats require a dietary source of LA for proper membrane structure, growth, lipid transport, normal skin and coat condition and maintenance of the epidermal permeability barrier.14,15 Feeding trials with kittens have shown that linoleate deficiency resulted in reduced feed efficiency, high rates of transepidermal water loss, poor skin and coat condition and fatty liver.15 Of the foods that we analysed, three wet foods did not supply adequate daily amounts of LA for the adult cat in maintenance and adult cats consuming these foods may be at risk of developing the adverse effects described above. Adult cats consuming the foods that did not supply adequate daily amounts of both crude fat and LA foods would be at greatest risk of developing adverse health effects.

An adequate supply of the essential n-6 long-chain PUFA, AA, may help reduce the development of an LA deficiency in the adult cat. Most mammals are able to synthesise an adequate supply of AA from dietary sources of LA, but this process is limited in the adult cat because of a deficiency in the synthesis of AA at the Δ6-desaturase conversion step.16,17 One study identified 20:3ω9 in the tissues of cats fed an EFA-deficient diet for 6 months, suggesting that this may have been largely synthesised using a Δ8-desaturase and a Δ5-desaturase pathway, which is known to be present in the cat.18 Those reports indicate that cats do have some ability to synthesise long-chain PUFA from C18 dietary EFA.16,18 Another study has shown that high amounts of LA, without a dietary source of AA, did not maintain the adult cat in good health.15 The excess daily intake of AA in foods 1w, 4w and 10w may help reduce possible adverse health effects from an LA deficiency.

Other foods in the current study provided excess amounts of crude fat, LA, AA, DHA and EPA. Excess fat and fatty acids can be detrimental to the health of the adult cat, as providing more fat than the gastrointestinal tract can effectively digest and absorb may result in fatty stools and diarrhoea.19 Over a long period of time it may also contribute to weight gain and obesity because of the high palatability and energy density of the diet. The relationship between obesity and the development of disease has not been extensively researched in the cat, but studies have revealed that an increased risk of diabetes mellitus, lameness and skin disease are associated with obesity in the adult.20,21 Increasing the caloric density of the food may require the adjustment of other nutrients such as essential amino acids, vitamins and minerals. As animals tend to eat to meet their energy needs, they will tend to consume lower amounts of high-macronutrient food daily,22,23 which would then lead to a net decrease of protein, vitamin and mineral intake over time.5

In relation to protein, one wet (4w) and one dry food (10d) did not supply adequate concentrations of CP. A dietary source of protein is required by the adult cat to supply essential amino acids and nitrogen. Because each wet and dry food exceeded the recommendations for all analysed essential amino acids according to both the NRC5 and AAFCO4, cats consuming foods 4w and 10d would not be at risk of developing an amino acid deficiency, but rather, a nitrogen deficiency. Nitrogen is required for the synthesis of non-essential amino acids and other compounds such as nucleic acids, purines, pyrimidines and neurotransmitters.23 Cats have a much higher nitrogen requirement than other species, such as the dog and rat, and show, at best, limited adaptation to low-protein foods.24 When cats are fed low-protein foods, they tend to excrete a high amount of nitrogen and develop a negative nitrogen balance.25,26 In contrast, rats will downregulate nitrogen catabolic enzymes in order to adapt to low-protein foods, which is the key to maintaining nitrogen balance when fed a low-protein diet.27 A study by Silva and Mercer28 has demonstrated that the cat does have some ability to regulate the rate of catabolism of amino acids in response to low protein intake.28 In a similar study,29 they also demonstrated that a mixture of essential amino acids caused the largest decrease in the degradation rate; however, the magnitudes of the effects were less than what is evident in the rat. That same study indicated that amino acids in the liver are substrates for opposing pathways of oxidation and protein synthesis and cannot be utilised with an efficiency of 100% for protein synthesis. It was suggested that the amino acid requirements for protein synthesis in the cat must be met by a high dietary intake of protein. In relation to the current study, cats consuming foods 4w and 10d may be at risk of loss of nitrogen reserves and the development of a negative nitrogen balance, which over time may result in a reduced ability for the animal to replace bodily tissue through protein synthesis.19 Severe illness or injury may result over an extended period of time.

In comparison, all of the remaining foods provided an excess of CP (Figure 1). Studies have shown that cats do efficiently adapt to medium or high protein diets.30,31 Cats appear to adapt through increased liver mass, increased delivery of substrate to urea cycle enzymes and the regulation of enzyme activities.19 Although cats can adapt well, the consumption of excess protein and amino acids over time may contribute to weight gain and the onset of obesity from the high calorie intake.5 The overconsumption of protein would be a particular concern for cats that are also consuming foods high in crude fat, as fat provides more than twice the calories of protein.19 Five wet (2w, 3w, 5w, 7w and 9w) and five dry (2d, 3d, 6d, 7d and 9d) foods provided a daily excess of both protein and fat. Therefore,
cats consuming these foods would have high risk of weight gain and, over time, obesity-related diseases, such as diabetes mellitus, lameness and skin disease.20,21

Research on the adverse effects of excess consumption of essential amino acids in the cat is limited. A small number of studies have been performed in cats and kittens in an attempt to determine the SUL for each essential amino acid. However, there have been no reports of acute or chronic toxicity related to feeding certain large quantities of free lysine, phenylalanine or taurine in the kitten.33–35 or free isoleucine, leucine, threonine, valine or histidine in the cat.33,34 It should be noted, however, that a number of wet foods exceeded the concentration of individual amino acids that were used in those SUL studies. The concentrations of isoleucine (in one wet food), leucine (in one wet food) and histidine (in three wet foods) were greater than the concentrations investigated by Hargrove et al.34 and Taylor et al.35 Possible consequences of such high concentrations of certain amino acids in these commercial cat foods are currently unknown.

With regard to the essential amino acid methionine, a study by Fau et al.36 demonstrated a SUL for dietary methionine in the growing kitten. It was discovered that high doses of L-methionine (20, 30 and 40 g/kg of food containing 16,747 kJ of ME/kg DM) caused a decrease in both food intake and weight gain. Consequently, the NRC3 established a SUL for the growing kitten, which is similar to the methionine content of an all-meat diet.5 Additionally, a study by Maede et al.36 demonstrated that adult cats given 1.0 g/kg DL-methionine for each kilogram of bodyweight per day developed severe haemolytic anaemia and an increase in methaemoglobin with Heinz body formation by 6 days. Because of the adverse effects observed from high doses of L-methionine in growing kittens and from high doses of DL-methionine in adult cats, the AAFCO4 established a maximum concentration of 1.5% for methionine (presuming the energy density of the food is 16,747 kJ of ME/kg DM) for adult cats. After adjustment for energy density,4 five wet (1w, 2w, 5w, 7w and 10w) and one dry (2d) food in the present study exceeded the SUL, by 128%, 135%, 166%, 102% and 160%, respectively. Although the adverse effects of a dietary excess of methionine in the adult cat are not yet well understood, it is a concern that such high concentrations were present in 6 of the 20 commercial cat foods analysed.

Furthermore, the three foods that showed a deficiency in CP, fat or LA and the five foods that exceeded the SUL for methionine, according to the recommendations of the AAFCO,4 did not comply with the Australian Standard6 in regards to nutrient content for an adult cat in maintenance. This is contrary to the statement printed on the packaging, which specifies that the products had been formulated to meet the nutritional levels established by the AAFCO.4

A total of 9 of 20 commercial cat foods did not adhere to the Australian Standard (AS 5812–2011)9 in regards to the ‘guaranteed’ analysis, and 8 foods did not adhere to the Standard in regards to nutrient content for the adult cat in maintenance. An overall discrepancy was also demonstrated between the nutrient composition described on the label and the chemical analysis determined in the laboratory. To improve the nutritional health and wellbeing of the Australian cat population, the government and pet food companies should work together to explore an improved method of ensuring label information and nutrient composition are accurate and that they adhere to the Australian Standard.6

Furthermore, all of the commercial cat foods varied in their satisfaction of the nutritional requirements of a 4-kg adult cat in maintenance as recommended by the AAFCO4 and NRC.3 The various nutrient deficiencies and excesses observed in a majority of the foods in this study highlight a serious issue in the nutritional composition of commercial cat foods in Australia. Both the nutrient composition and feeding guidelines require extensive review to ensure the adult cat’s unique dietary requirements are being met.

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References