Macronutrients in Feline Health

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KEYWORDS

• Feline • Protein • Fat • Carbohydrates • Nutrition

KEY POINTS

- The ideal dietary macronutrient composition to optimize health in cats is still undetermined.
- Studies on feral cat prey and colony cats' preferences suggest that high-protein, high-fat, and very-low-carbohydrate diets are preferentially selected.
- High-protein diets (>40% protein calories) are beneficial for the management of weight loss in cats, and high-protein diets may also help geriatric cats maintain muscle mass.
- Ad libitum consumption of high-fat, and not high-carbohydrate diets, is associated with weight gain.
- Macronutrient modification in feline diets is helpful to manage a variety of diseases, such as obesity, diabetes mellitus (DM), liver disease, lower urinary tract disease, and renal disease, among others; however, the evidence for a particular macronutrient distribution beyond providing minimal requirements for the prevention of most of these diseases is lacking.

INTRODUCTION

Currently there is tremendous interest in identifying the ideal macronutrient profile to maximize health and longevity in cats. Current nutritional recommendations[1,2] are based on minimal intake data rather than optimal intake. Minimal requirements are established with easily measured outcomes, such as growth or adequate reproductive performance. Optimal intake is harder to measure, because defining and measuring health and longevity outcomes is not an easy task.

Some investigators have suggested that the carbohydrate content of commercial, dry cat foods is too high and, simultaneously, the protein content too low for a strict carnivore, such as cats, and they have hypothesized that several chronic diseases in this species, in particular obesity and DM,[3,4] could be related to feeding dry foods. There is no clear evidence, however, supporting this statement.

Disclosures: C. Villaverde and A.J. Fascetti consult for various pet food companies.

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Vet Clin Small Anim 44 (2014) 699–717

http://dx.doi.org/10.1016/j.cvsm.2014.03.007 **vetsmall.theclinics.com**

0195-5616/14/$ – see front matter

MACRONUTRIENT REQUIREMENTS FOR CATS: MINIMUMS AND MAXIMUMS

The 3 macronutrients in foods are protein, fat, and carbohydrates. These are called macronutrients because they are present in high amounts in the diet (compared with vitamins and minerals, the micronutrients) and provide energy.[1] Fat provides more than twice the metabolizable energy (ME) of protein and carbohydrates (**Table 1**). In the United States, the guaranteed analysis on cat food labels provides the minimum value on an as-fed basis for crude protein and crude fat, but carbohydrates are not required to be reported. The carbohydrate content of a diet can be estimated by a calculated difference (100 − [crude protein + crude fat + moisture + ash + crude fiber]), but this value is an estimate at best.

Protein Requirements

Protein, in addition to providing energy, is a source of nitrogen and essential amino acids. The current minimal protein requirement for adult cat foods is reported to be 50 to 65 g/1000 kcal ME (**Table 2**).[1,2] This is assumed to provide 2.3 to 5.2 g protein/kg body weight. The Association of American Feed Control Officials' (AAFCO) recommendations are higher than the National Research Council's (NRC) to account for individual variation and assumed differences in bioavailability and digestibility between commercial and experimental diets. Dry commercial feline diets generally have a crude protein content of 30% to 40% on an ME basis, whereas canned and raw foods are generally higher in protein.

In addition to meeting nitrogen requirements, feline diets also have to provide essential amino acids above their respective minimal requirements. Cats require 11 essential amino acids: methionine, lysine, threonine, tryptophan, histidine, leucine, isoleucine, valine, arginine, phenylalanine, and taurine.[1] Taurine is a β-sulfonic amino acid that is not incorporated into proteins.[5] If essential amino acid requirements are not met, the diet is inadequate, irrespective of the total amount of protein.

Protein requirements in cats are considerably higher than in dogs. This has been attributed to the fact that protein catabolic enzymes are not down-regulated in this carnivorous species.[6,7] Recent research has shown that cats can adapt protein oxidation to their protein intake[8,9] but only if this intake is above their minimal requirement.[9] Cats' inability to down-regulate their hepatic catabolic capacity at low protein intakes may only partially explain this carnivore's high nitrogen requirement. A second, emerging argument suggests that cats have evolved a high capacity for gluconeogenesis from amino acids to solve the dilemma of how to survive on a high-protein, prey-based diet as a small mammal with a large brain,[10] given the reliance of brain tissue on glucose for energy. Although arguably this overarching model[10] requires more direct

Table 1
Estimated crude and metabolizable energy content (based on modified Atwater factors) of protein, fat, and carbohydrates in commercial cat food

Macronutrient	Crude Energy (kcal/g)	Metabolizable Energy (kcal/g)[a]
Protein	5.7	3.5
Fat	9.4	8.5
Carbohydrates (nitrogen-free extract)	4.1	3.5

[a] Modified Atwater factors assume fixed macronutrient digestibilities and thus are useful only to provide a ballpark approximation to the energy density of a diet.

Data from National Research Council. Nutrient requirements of dogs and cats. Washington, DC: The National Academies Press; 2006.