

COMMERCIAL VS HOMEMADE CAT DIETS

What you need to know



Cecilia Villaverde and Marge Chandler

Introduction

Good nutrition is critical for the health of cats in all life stages, and for the management of nutrient-sensitive diseases. Selecting a diet should begin with a nutritional assessment of the cat to consider any factors affecting nutritional requirements, such as age, life stage and health status.¹ Many diseases, such as urolithiasis and chronic kidney disease (CKD), as well as adverse reactions to food, are managed by adjunct nutritional therapy or diet as the major treatment option.

While cats are not unique insofar as diseases may be caused by dietary deficiencies, excesses or imbalances, the nutritional requirements of cats are very different to those of humans or dogs.² Errors in feeding may have serious consequences for health. A poorly balanced diet may cause problems such as dilated cardiomyopathy, neurological disorders or an increased risk of diseases such as diabetes mellitus, and may shorten the life of the cat.

To achieve a complete and balanced diet, pet food manufacturers blend a mixture of ingredients such as meat, fish, cereals, vegetables, vitamins and minerals to meet cats' nutritional requirements. Advances in feline nutrition and food technology have transformed the industry over the years. Cats are living longer, healthier lives as a result of improved care, including nutrition.

While commercial cat food is more commonly fed to healthy cats and for management of nutrient-sensitive diseases, some owners prefer homemade diets. Trends in human nutrition, including veganism, as well as veterinary dietary trends, such as grain-free diets, appeal to some owners. Some cats may have conditions for which no commercial diet is suitable.



Practical relevance: A feeding plan recommendation for cats, both healthy and with disease, should include diet choice, amounts to feed and the feeding method. Diet choice can be complex owing to the abundance of products, sometimes with conflicting marketing messages, and the prevalence of information with no scientific basis. It is important to be aware of the specific challenges of both commercial and homemade diets. Moreover, a nutritional assessment is a prerequisite when recommending a diet to ensure that it is safe, appropriate for the cat's life stage and nutritious for long-term feeding.

Commercial vs homemade diets: There are a variety of commercial diets available, allowing considerable customisation. These products are regulated and can be tested to determine nutritional adequacy and safety, although as the industry is partly self-regulated, choice of manufacturer is important. Properly formulated homemade diets can be customised to the patient and are a good option when no commercial product that meets the patient's needs exists. Homemade diets can be an owner preference. A serious limitation is the lack of testing, potentially affecting safety and also resulting in a reliance on database information to determine nutritional adequacy. Generic homemade diet recipes (eg, sourced from the internet) have additional risks of deficiencies and imbalances, and are not recommended. Homemade diets should be devised by a veterinary nutrition specialist with consideration of both patient and owner factors.

Clinical challenges: Dietary misinformation, which is all too readily available on the internet, may result in owners making questionable feeding choices for their pets. A homemade diet may be requested by owners based on the perception that there are poor ingredients in commercial foods. The veterinary healthcare team needs to have good evidence-based information to present to owners about diet choice.

Evidence base: Several decades of research on feline nutrition forms the basis for nutritional requirements and dietary recommendations. There are varying degrees of evidence regarding requirements for each nutrient, and a lack of data on the effects of different types of processing on nutrient needs.

Keywords: Commercial cat food; homemade diets; nutrition; cat food regulations; nutritional deficiencies; cat food ingredients

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Cecilia Villaverde

BVSc, PhD, Diplomate ECVN (EBVS European Specialist in Veterinary and Comparative Nutrition), DACVIM (Nutrition)
Expert Pet Nutrition, Fermoy, County Cork, Ireland

Marge Chandler

DVM, MS, MANZCVS, DACVIM (SAIM, Nutrition), MRCVS*
VetsNow Referrals, Glasgow G3 7DA, UK

*Corresponding author:
marge.chandler@vets-now.com



Figure 1 Advert for ‘Spratt’s’ patent cat food, which appeared in *The Cat* magazine in 1934. Courtesy of *Cats Protection*

Commercial diets

Commercially manufactured diets have been popular with pet owners for many years. A British version of commercial cat food was advertised as ‘Spratt’s’ patent cat food as early as the late 1800s (Figure 1).³

In a 2008 survey in the USA and Australia, commercial foods made up at least half of the diet of 98.8% of cats⁴ and in a separate study of US and Australian cat owners published the same year, 95.5% were described as commercial feeders, with only 2.7% being non-commercial feeders.⁵ A more recent survey looking at how pet feeding practices changed between 2008 and 2018, reported that 90% of cats were fed commercial food, although 46% were also offered some homemade foods.⁶

Types of commercial cat foods

Complete vs complementary cat foods

Complete cat foods are formulated with a combination of ingredients to be sufficient to feed alone as a daily ration and should provide all the cat’s nutritional needs (Table 1) when fed for the entire life stage; for example, a food appropriate for growth being fed

It is important to be aware of the specific challenges of both commercial and homemade diets to ensure that the diet chosen is safe and nutritious throughout the cat’s life.



during kittenhood. Nutritional life stages are growth, reproduction and adult maintenance. A food labelled as ‘complete for all life stages’ is generally formulated for growth and reproduction, as those are the most nutritionally demanding life stages. There are no delineated requirements for senior or geriatric cats as the nutritional requirements for older cats vary more greatly among individuals than those of other nutritional life stages.

Complementary foods, labelled in the USA as ‘intermittent feeding only’, are not complete and are intended for use as a treat, for short-term or occasional feeding. Some therapeutic diets are also indicated for short-term feeding (eg, some struvite dissolution diets), and should only be used as prescribed by veterinarians. Other therapeutic diets that are labelled for intermittent feeding (eg, diets for renal disease), may provide balanced nutrition when fed as appropriately prescribed by a veterinarian. Other complementary foods are sufficient as a daily ration only if combined with other foods. Complementary foods include some soups and pastes used to increase palatability. Some over-the-counter wet food products can appear to be complete on their packaging, but are labelled as complementary or for intermittent feeding only.

Physical form

Dry cat foods have a moisture (water) content of between 3% and 11%. They are generally more economical to feed than other food forms. They can be fed free choice for cats that are able to self-regulate food intake to maintain a healthy body condition. One survey suggested that dry diets are the most popular choice for UK, US and Australian domestic cats.^{4,7}

Wet foods contain between 60% and 87% moisture. They have a lower calorie density (on an as fed basis) than dry foods owing to the water content. Many cats find wet foods more palatable (Figure 2), although this is an individual choice and some prefer dry foods.

Semi-moist cat foods (containing 15–35% moisture) are less common although certain dry food products contain a proportion of semi-moist components or they may be sold as treats.

Raw foods obviously contain uncooked ingredients, including meats/poultry. There are commercial raw products that may be refrigerated, frozen or freeze-dried. (Homemade diets may also contain raw foods, as discussed later.)

Ingredients used in commercial pet foods By-products

‘By-product’ is the term for an ingredient produced in parallel to another one. Meat by-products are the parts of a slaughtered animal that are either not used for human food owing to cultural preferences or that are produced in

Table 1 Required nutrients for cats*	
Macronutrients	Protein, fat
Essential fatty acids (omega 6)	Linoleic acid, arachidonic acid
Essential fatty acids (omega 3)	Alpha-linolenic acid, eicosapentaenoic acid (EPA), docosahexaenoic acid (DHA)
Amino acids	Arginine, lysine, histidine, leucine, isoleucine, valine, threonine, tryptophan, methionine, phenylalanine, taurine
Minerals	Macrominerals: calcium, phosphorus, magnesium, sodium, potassium, chloride; and trace elements: copper, iron, iodine, manganese, selenium, zinc
Vitamins, fat soluble	A, D, E, K
Vitamins, water soluble	Thiamine, riboflavin, niacin, pantothenic acid, B6 (pyridoxine), biotin, folic acid, B12 (cobalamin)
Vitamin-like substances	Choline

*Nutrient Research Council (2006)²



Figure 2 Many cats find wet foods more palatable than dry foods

amounts in excess to human requirements or desires; for example, kidneys vs steaks. The Association of American Feed Control Officials (AAFCO) definition of meat by-products includes ingredients such as lungs, spleen, kidneys, brain, liver, blood and bone, but specifically excludes hair, horns, teeth and hooves.⁸

In Europe, meats must come from animals slaughtered under veterinary supervision. Animal-based ingredients not permitted in pet food in the European Union (EU) include those from an animal that has not passed veterinary inspections as being fit for human consumption at slaughter, waste products, roadkill or meat from diseased animals.

These label terms are prescribed by law in the EU. In Europe, meat by-products may be listed by category as meat and animal derivatives, or as named ingredients; for example, beef, liver or duck.⁹ Being a by-product is not an indication of an ingredient's quality or nutritional value.¹⁰

In Europe, other protein sources that may be included in commercial pet food include hunted animals (eg, deer) after veterinary inspection, fish and seafood from sources regulated by the European Food Safety Authority (Figure 3), inspected dairy products and eggs, and vegetable protein from soybeans and other legumes. Meals are animal by-products that have been heat treated and dried, removing most of the moisture and fat; therefore, they provide a concentrated protein source.⁹ Cereals



Figure 3 A protein source that may be included in commercial pet food is fish and seafood; in Europe, this comes under the regulation of the European Food Safety Authority

and root vegetables can provide part of the protein as well as energy and other nutrients.

By-products can also include non-meat ingredients; for example, wheat bran is a by-product of flour production and corn meal is a by-product of corn oil production. By-products of vegetable production may be listed on European labels as derivatives of vegetable origin.

Grains and other carbohydrate sources

Cats are strict carnivores and have evolved on a high protein diet, containing moderate amounts of fat and little carbohydrate. Cats, like most mammals, do not have an absolute requirement for carbohydrates. Like all animals, they need glucose but are able to synthesise it from amino acids as well as from carbohydrate sources. Cats have pancreatic amylase, and while the amylase activity is lower than in some other species, cats can digest and utilise diets with varying amounts of properly processed carbohydrates. In studies on carbohydrate digestion, cats fed diets containing 35% starch had an apparent total tract carbohydrate digestibility of between 94% and 100%.^{11,12}

Digestible carbohydrates provide an easy-to-use source of energy, and their inclusion allows for production of lower fat diets. This can help with formulation of low calorie diets for weight management. It also helps spare the use of animal protein, which is a limited resource in pet (and human) nutrition and is associated with an increased carbon footprint.


Common carbohydrate sources, such as grains, as well as providing essential nutrients like protein, vitamins, minerals and fatty

By-products (meat derivatives) should not include hair, horns, teeth, hooves, roadkill or meat from diseased animals, and must come from animals slaughtered under veterinary supervision. Being a by-product is not a reflection of an ingredient's quality or nutritional value.

Guidance on interpreting food labels

Figures 4 and 5 provide details on how to interpret pet food labels in North America and the European Union, respectively. These resources are available as part of the World Small Animal Veterinary Association's (WSAVA) Global Nutrition Toolkit, which

is designed to help owners to determine what is an appropriate and high quality diet for their pet. The toolkit is available at: wsava.org/wp-content/uploads/2021/04/WSAVA-Global-Nutrition-Toolkit-English.pdf



Interpreting Food Labels, North America

Net weight or net volume (for wet food) in both metric and avoirdupois

All ingredients (raw materials and additives) must be declared in descending order of weight (fresh matter, as formulated). If a claim is made, the ingredient inclusion % must be included. Ingredients must be safe and approved and must be referred to by the correct nomenclature

Feeding directions: must state, minimum, the amount of product required per weight of dog/cat. Feeding frequency must be included. Can also include instructions for transition. (this section is not required for treats)

Name, address of the manufacturer/distributor. If the manufacturer is different from the distributor, this should be noted ("manufactured for" or "distributed by") in front of the address

[Turkey Food Formula]

Cat Food

400 g / 14 ounces

Ingredients: Turkey (26%), brewers rice, corn gluten meal, chicken meal, dried egg product, soy protein isolate, animal fat preserved with mixed-tocopherols (form of Vitamin E), fish meal, powdered cellulose, wheat flour, animal liver flavor, soybean hulls, inulin, gelatin, potassium chloride, phosphoric acid, salt, choline chloride, Vitamin E supplement, calcium carbonate, taurine, zinc sulfate, ferrous sulfate, L-ascorbyl-2-polyphosphate (source of Vitamin C), manganese sulfate, niacin, L-Lysine monohydrochloride, Vitamin A supplement, copper sulfate, calcium pantothenate, thiamine mononitrate, riboflavin supplement, Vitamin B-12 supplement, pyridoxine hydrochloride, folic acid, Vitamin D-3 supplement, calcium iodate, biotin, menadione sodium bisulfite complex (source of Vitamin K activity), and sodium selenite,

weight (kg)	serving / day (g)	Guaranteed analysis	
2	35	Crude protein (max)	40%
3	50	Crude fat (min)	15.5%
4	62	Crude fiber (max)	4.8%
5	74	Moisture (max)	12%

Feed throughout the day

ABC [company responsible of labelling/packaging], address/phone #

Calorie content (calculated):
4037 kcal/kg; 1835 kcal/lg; 445 kcal/cup


Product name (& brand, if any)

The pet food label must specify target species prominently

The guaranteed analysis must report crude protein (minimum), crude fat (minimum), crude fiber (maximum) and moisture (maximum) as percentages (grams per 100 grams of pet food) in fresh matter ("as is"). Ash (maximum) is not mandatory. Other nutrients may be included here voluntarily or to support any claim

The calorie content statement is mandatory. It must be expressed at least as both kcal per kg and kcal per familiar household measure (e.g. cup, can, treat). If this has been determined experimentally, the heading of this section is **calorie content (fed), whereas, if this value is estimated, the heading reads **calorie content (calculated)**. The calculation assumes that protein, fat and ELN provide 3.5, 8.5, and 3.5 kcal/g respectively. This calculation is done with average values, rather than the guarantees reported on the label**

Figure 4 Food labelling in North America. Global Nutrition Committee Toolkit, provided courtesy of the World Small Animal Veterinary Association



Interpreting Food Labels, EU

Ingredients (raw materials) are listed under "composition"

**-In descending order of weight (fresh matter)
-The names can be specific or can also be named by their legal category (see example)**

Label must include those nutritional additives (vitamins and minerals) with legal inclusion maximums. The amounts are those added (therefore, the overall amount of nutrient might be different depending on raw material provision and effect of processing. Other additives (like preservatives, dyes, or flavouring agents) do not have to be reported by their specific name, but the company responsible for labelling should provide this information if contacted.

Name, address and contact information of the company responsible for labelling must be included. Label does not have to include country of production. If it applies, companies can use "made in the EU"

Label should include traceability information such as batch number and plant approval number. Best before date must be included in month and year (plus day if short shelf life)

[Product name]

Complete pet food for adult cats

400 g

Composition: Meat and animal derivatives (4% chicken), vegetable protein extract, derivatives of vegetable origin, cereals, minerals, various sugars

Additives (per kg):
Nutritional additives:
Vitamin D3 xx UI, E1
(iron) xx mg [...].
Preservatives:
antioxidants

weight (kg)	serving / day (g)
2	35
3	50
4	62
5	74

Store in a cool dry place

Analytical constituents: Crude protein XX %, Crude oils and fats XX %, Crude ash XX %, Crude fibres XX %, Moisture XX%

ABC [company responsible of labelling/packaging], address/phone #

BATCH 1234567890
plant ABCD
Best before date MM/YYYY

24h

Net weight must be reported

The pet food label must:
- Specify target species and lifecycle
- Specify if the food is "complete" (provides all necessary nutrients and energy for the species and lifecycle, and can be used as sole source of nutrition) or "complementary" (does not provide all nutrients and mainly refers to treats)

Feeding instructions can be more or less detailed. Many labels state that these are only recommendations and might vary depending on age, breed, activity and health

Label should include storage instructions (canned food might also include storage instructions after opening)

Dry pet food must recommend that the pet must have fresh water available at all times

Analytical constituents are declared as percentages (grams per 100 g of pet food) in fresh matter. The ones that are mandatory are crude protein, crude oils and fats, crude ash, and crude fibres. Moisture is only mandatory if >14%. The energy density (kilocalories per kg, cup or can) is not mandatory and is often absent from labels.

Figure 5 Food labelling in the European Union. Global Nutrition Committee Toolkit, provided courtesy of the World Small Animal Veterinary Association

acids, are also a source of dietary fibre. While dietary fibre is not an essential nutrient, it has multiple benefits, such as promotion of a healthy intestinal microbiota and adequate intestinal transit, and production of short chain fatty acids which provide fuel for colonocytes. Grain-free diets do not have any proven benefits over grain-containing diets for healthy cats.¹³

Advantages of commercial diets

Convenience and cost

Feeding a complete commercial diet is more convenient than preparing a homemade diet. A recent cost comparison study of diets for dogs showed that homemade dog foods were more expensive than dry maintenance diets and dry therapeutics diets, although commercial wet diets were the most expensive overall.¹⁴ While no equivalent feline study has been performed, the higher protein requirement of cats compared with dogs may make homemade diets more costly than commercial wet diets.

Regulation

Regulation of commercial diets exists to promote their safety and nutritional value (see box). Countries differ in how they regulate pet food and the industry in many is partly self-regulated; a product must meet legal requirements established by the country or region in which it is sold.¹⁵ Pet food in many countries is regulated at every stage from sourcing of the ingredients, the production process and through to marketing. The pet food industry within a country can be self-regulated through industry codes or guidelines that provide rules for implementation of legislation or establish rules in areas not regulated by law.

Within the EU, the European Commission proposes legislation and together the European Parliament and European Council of the EU adopt the legislation. The EU Member States are responsible for the implementation

As described by the Global Alliance of Pet Food Associations (GAPFA): 'The objectives of legislation and self-regulation are to ensure that pet food products fulfil the nutritional need of pets, are safe for both animals and people, and that the information to consumers is accurate and truthful.'¹⁵

Regulation of commercial diets promotes their safety and nutritional value. They may also undergo testing to ensure adequacy.



of the legislation.¹⁵ In the USA, the Federal Food, Drug and Cosmetic Act (FFDCA) requires that all animal foods, like human foods, be safe to eat, produced under sanitary conditions, contain no harmful substances and be truthfully labelled.¹⁶ Feed regulations are enforced by both state and federal regulatory officials.

Testing diets formulated for healthy cats for nutritional adequacy

To be labelled a complete food, cat foods must be formulated to meet the cat's nutritional requirements for its nutritional life stage. Commercial diets formulated for healthy cats should ideally undergo testing to ensure they are nutritionally adequate. The nutrient requirements of commercial cat foods are usually defined by AAFCO and the Fédération Européenne de l'Industrie des Aliments pour Animaux Familiers (FEDIAF, or the European Pet Food Industry Federation) in the USA and Europe, respectively. These nutrient requirements are based on the National Research Council (NRC) 2006 nutrient recommendations for dogs and cats,² but may also be informed by more recent research publications. These recommendations are adapted for commercial foods using a safety margin to prevent deficiencies owing to individual animal variation and nutrient interactions.^{2,17,18} Many nutrients also have a safe upper limit in the requirements.

Before a cat food is marketed, it should have been tested for adequacy; ongoing analysis by nutritionists is recommended to ensure the food continues to meet nutritional standards (Table 1). In Europe, approved methods of sampling and nutrient analysis of feeds are found in the European Commission regulations.¹⁹ AAFCO has published quality assurance/quality control guidelines for feed laboratory accreditation with ISO 17025 to ensure accurate laboratory analyses,²⁰ and provides feed testing laboratories with performance monitoring procedures for quality control.

In addition to formulation and chemical analysis, commercial cat foods may also be tested by feeding trial. AAFCO describes feeding trial protocols for maintenance of adult cats, for growth and for reproduction (gestation and lactation). The protocols specify the length of the trial, number of cats, feeding procedures and diagnostic tests required. Feeding trials help to determine nutrient



Most commercial processed cat foods are safe, especially if produced under strict quality control measures and adequately tested. However, incidents of contamination and nutrient imbalances do occur and can lead to nutrient deficiencies, excesses and illness, resulting in pet food recalls.

Vegetarian and vegan diets

Vegan and vegetarian cat foods are difficult to formulate owing to the cat's nature as an obligate carnivore and may be deficient in total protein, arginine, lysine, methionine, tryptophan, taurine, iron, calcium, zinc, vitamin A and some B vitamins. While a survey study of US and Canadian cat owners, published in 2021, showed that owners who fed plant-based diets did not perceive health issues in their cats,²³ due to the biases and limitations of such a study this cannot be

Vegan and vegetarian cat foods are difficult to formulate and may be deficient in total protein, essential amino acids, minerals, vitamin A and some B vitamins.

considered evidence of long-term safety. Another recent study identified potential deficiencies and excesses in four vegan diets (three for dogs, one for cats),²⁴ and a second study identified low concentrations of specific amino acids in 6/24 vegetarian diets for dogs and cats.²⁵ An older study, published in 2004, found that two US vegan cat diets did not meet the minimum requirements of the AAFCO cat food nutrient profiles.²⁶

bioavailability and interaction, although the protocols may not be long enough for some long-term effects to be detected. Many companies run much longer feeding trials, with additional testing. For example, AAFCO feeding trials for adult maintenance are 6 months long, whereas some companies may feed a diet for trials lasting years.

In the USA, the label can specify how the diet was determined to be nutritionally adequate; that is, by meeting the recommended nutrient profiles and/or by undergoing feeding trials. This is not part of EU law and the label in foods produced in EU Member States does not specify how the manufacturer has determined the product's nutritional adequacy.

Therapeutic diets

Some commercial pet food companies have developed foods to help the management of a range of nutrient-sensitive disorders, including CKD, urolithiasis, diabetes mellitus, adverse reactions to food, obesity, gastrointestinal disorders and osteoarthritis. Their research has provided the knowledge underpinning nutritional support of these disorders, resulting in improved quality of life and prolonged survival time. These products have variable efficacy and require clinical trials to determine their optimal therapeutic use. These trials are distinct from AAFCO life stage feeding trials.

Therapeutic diets are restricted or modified in nutrients (eg, diets used for renal disease), and should always be used under veterinary supervision. In Europe, these are termed 'foods intended for particular nutritional purposes' (PARNUTS) and are covered by European Commission regulations.²¹ In the USA, the Food and Drug Administration (FDA) has oversight on the labelling and marketing of such products.¹⁶ If they do not meet AAFCO requirements for healthy cats owing to the modifications indicated for the disease, they may be labelled 'for intermittent feeding only' and should be used only under veterinary guidance.

Potential problems of commercial diets

Most commercial processed cat foods are safe, especially if produced under strict quality control measures and adequately tested. However, incidents of contamination and nutrient imbalances do occur and can lead to nutrient deficiencies, excesses and illness resulting in pet food recalls.²²

Nutrient imbalances

❖ **Vitamin deficiency and excess** Thiamine concentrations below the AAFCO minimum were identified in 12/90 US canned cat foods, especially patés.²⁷ Foods from smaller companies had significantly lower thiamine concentrations compared with those from larger companies, but neither flavour nor manufacturer's country were associated with thiamine concentration.²⁷ Thiamine deficiency has also been reported linked to a dry cat food in Taiwan²⁸ and in a food preserved with sulfur dioxide in Australia.²⁹

There have been recalls of commercial pet food associated with vitamin D excess, although recent recalls in the USA were due to a premix in dog foods rather than cat foods.³⁰ Hypercalcaemia owing to excess dietary vitamin D has been described in kittens fed a natural, complementary, canned kitten food as part of their diet.³¹

❖ Food restriction and nutrient restriction

When the amount fed is being restricted below label recommendations, deficiencies of nutrients are possible.³² Deficiency is less likely if a therapeutic diet for weight loss is fed as directed on the label as these diets are nutrient enriched while being lower in calories. Cats differ greatly in their energy requirements, so a cat

The potential for ration imbalance stresses the importance of quality control and regular nutritional analysis of pet food. An inherent disadvantage of homemade diets is that there is no quality control involved in their preparation (see later).

What to do if a diet-related problem is suspected

If you suspect a diet-related problem in a cat, instruct the owner to stop feeding that food immediately and collect as much information on the diet history as possible. Standard dietary history forms are produced by the World Small Animal Veterinary Association (WSAVA)³⁸ and American College of Veterinary Nutrition (ACVN),³⁹ and are available on their websites (see references for full URL details). In addition to this information, obtain the manufacturer's or distributor's name and address, the product and variety names, the type of product (eg, dry kibble), the lot or date codes and batch number from the label. Saving or photographing the bar code from the bag can help substantiate any claims. If possible, find out the place (or website) and date where the food was purchased. Saving the bag (or a sample) of the

suspected diet is also advisable, in case analysis is required. Switch the cat to a different diet in the meantime. It is prudent to collect blood and urine samples and store them before the switch.

Initially contact the pet food company and then the national regulatory body.

- ❖ In the USA, it is recommended to contact the FDA when a diet-related disorder is suspected.⁴⁰
- ❖ In Australia, veterinarians can contact PetFAST, a system to track health problems in dogs and cats that are suspected of being associated with pet food, treats and pet meat. PetFAST is a joint initiative of the Australian Veterinary Association (AVA) and the Pet Food Industry Association of Australia (PFIAA), and aims to identify possible patterns that might point to a cause.⁴¹

with lower requirements is at greater risk of nutrient deficiencies as they will be fed less food.

❖ **Other nutrient imbalances** Other nutrient imbalances have also been described in the past, such as taurine deficiency leading to dilated cardiomyopathy.³³ Fortunately, taurine deficiency is now considered uncommon in properly formulated foods.

Contamination with pathogens

While dry foods can become contaminated, it is uncommon as they are processed at temperatures that are lethal to pathogens (Figure 6). However, an outbreak of *Salmonella enterica* serotype *Infantis* infection in humans was linked to an unopened bag of dry dog food in the USA and Canada.³⁴ Contamination is even more unlikely in unopened canned foods as they are sterilised in the can. Cross contamination can also occur during food storage.



Figure 6 Due to being processed at high temperatures that are lethal to pathogens, it is uncommon for dry foods to become contaminated

Microbiological contamination is more likely in raw foods; freezing or freeze drying does not kill most pathogenic bacteria.



Microbiological contamination is more common in raw foods. Commercial raw frozen or freeze-dried cat foods were shown to be contaminated with a variety of zoonotic bacterial and parasitic pathogens in studies in Europe³⁵ and the USA.³⁶ In a recent UK study, tuberculosis, likely caused by *Mycobacterium bovis* in a commercial frozen raw cat food, was suspected or diagnosed in 47 cats.³⁷ While commercial raw foods should have better quality control than homemade ones, risks are present, as shown by these studies.

The recommended course of action if a food-related imbalance or contamination is suspected, is set out in the box above.

Do commercial dry cat foods increase the risk of disease?

Obesity

While some studies have identified feeding dry diets as a potential risk factor for feline obesity, other risk factors include the amount of food fed, eating a high fat, high calorie food, being given treats, being a 'greedy' eater, and being a neutered, indoor male cat with less opportunity for exercise.^{7,42,43} One study assessing risk factors for cats to be obese at 2 years of age also found feeding ≥ 250 g of wet food daily between 2 and 6 months of age to be a risk factor, along with feeding a diet comprising over 50% dry food.⁴⁴ These epidemiological studies have not accounted for the number of calories being fed to the cats in dry foods compared with wet foods.

For cats at risk of becoming overweight, increased dietary water content may be beneficial. Cats had a significant decrease in body weight while eating a canned food compared with the same diet freeze-dried to remove the moisture; this was the result of a lower energy intake even though the cats ate more volume of the canned diet (as fed basis).⁴⁵ Canned foods' higher water content, resulting in lower energy density, may help promote weight loss.⁴⁵ As well as being more calorie dense on an as-fed



Figure 7 While many retrospective studies have been performed to examine dry foods and dietary carbohydrates as risk factors for feline type 2 diabetes mellitus, no clear association has been found

basis, dry foods are fed free choice more often than wet foods. It may be that the increased risk of obesity relates more to the increased calorie intake and fat content than the form of food.⁴⁶

Diabetes mellitus

Many retrospective studies have been conducted examining the role of dry foods and dietary carbohydrates as risk factors for feline type 2 diabetes mellitus (Figure 7). These studies have not found a clear association between feeding dry food (potentially higher in carbohydrates than wet food) and diabetes risk.⁴⁷ In one study, control cats had eaten a higher proportion of dry food compared with diabetic cats (median 79% vs 44% of dry matter intake/day, respectively), suggesting a potentially lower risk with dry food.⁴⁸ Another study found that dry diets were associated with a higher risk of diabetes in lean but not overweight cats, but the reason for this association was not explained.⁴⁹ An important limitation of this latter study was that owners assessed the cat's body condition, and owners are often inaccurate in this assessment.^{42,44,50} The risk of diabetes mellitus appears to be more related to obesity than the food's nutritional composition or form.^{47,48,51}

While epidemiological studies have not shown a specific effect of dry diets on the risk of diabetes, the carbohydrate content of a diet can affect glucose metabolism. A high carbohydrate, low protein diet (carbohydrate 48%, protein 26%, fat 26% of calories) was associated with 20–32% higher peak postprandial glucose concentrations compared with a moderate carbohydrate, high protein diet (carbohydrate 27%, protein 47%, fat 26% of calories) in healthy cats fed one meal per day;⁵² however, blood glucose was within the physiological range. The carbohydrate source may also

Neither carbohydrate content nor dry cat foods have been definitively associated with an increased risk of obesity, diabetes mellitus, lower urinary tract disease or chronic kidney disease.



influence the glycaemic response. Some carbohydrates, such as white rice, result in a larger postprandial glucose and insulin increase than others, such as sorghum or corn.⁵²

For cats diagnosed with type 2 diabetes mellitus, the use of high protein and/or low carbohydrate diets along with insulin therapy is often recommended,^{53,54} although not all studies have found a benefit to this dietary approach over others.⁵⁵

Lower urinary tract disease

Decreased fluid intake and the subsequent formation of a more concentrated urine (ie, one potentially more saturated with urolith precursors) is a risk factor for urolith formation in cats predisposed to urolithiasis.⁵⁶ The moisture content of the diet affects the urine concentration in cats as they do not completely compensate by adjusting their water intake.⁵⁷

Studies have found an association between dry diets and cats with lower urinary tract disease (LUTD),^{58,59} but the relationship is not always clear-cut^{60,61} and might be affected by other characteristics of the diet, patient and environment. From these studies, it appears that for cats at risk for, or having been diagnosed with, calcium oxalate and other uroliths, a wet diet is preferable, but there does not seem to be a risk for LUTD in all cats overall due to being fed a dry diet. For cats with feline interstitial cystitis, increasing fluid intake, including feeding a wet diet, can also be beneficial.^{62,63}

Chronic kidney disease

Wet diets are often recommended for cats with CKD to help maintain hydration in the face of increased water loss. As noted above, most cats will not have an equivalent fluid intake on wet and dry diets.⁵⁷

Dry foods have not been implicated as a risk factor for the development of CKD. On the contrary, one study showed that commercial dry cat food, along with filtered water and an indoor lifestyle, was associated with a significantly decreased risk of developing CKD.⁶⁴



A homemade diet tailor-made to make it more appetising can be particularly helpful in thin cats that are picky eaters or have a waxing and waning appetite.

Homemade diets

Homemade diets can be a useful tool in the nutritional management of feline diseases and can also be used to feed healthy cats as long as they are nutritionally adequate and safe. The practice of feeding exclusively homemade diets in countries such as the USA and Australia appears more prevalent in dogs than in cats.^{4,6} Reasons given by owners for feeding homemade diets to cats included mistrust of commercial pet food and food processing, and a perception of homemade food as being more healthful.⁵

Potential benefits of homemade diets

Palatability

In the authors' experience, palatability is a common reason provided by owners to feed homemade diets. A homemade diet can be more appetising, especially if tailor-made to the patient's preferences. This can be helpful in thin cats that are picky eaters or that have a waxing and waning appetite, which can be associated with some diseases (Figure 8). However, the palatability of homemade diets, like commercial products, is variable between individuals and will differ depending on the ingredients used. Cats used to commercial food might prefer its texture and using a homemade diet in these cases can be a challenge, especially if the diet has to be low in protein.

Digestibility

It has also been proposed that homemade diets can be more digestible than commercially available dry and wet diets,^{65,66} although there is a lack of studies in this area. This could be due to the type of ingredients used, amount of fibre and different heat processing of homemade diets compared with commercial diets. One study in cats fed a standard dry diet, a raw diet and the same raw diet but cooked (similar to how a homemade diet would be processed) showed higher apparent faecal digestibility of the raw and homemade compared with the dry food.⁶⁵ Another study comparing faecal digestibility of two raw diets and a dry commercial cooked diet in kittens reported higher digestibility of organic matter, protein and energy for the raw products, resulting in smaller faeces, with no difference in faecal score.⁶⁶

However, these studies are simply product comparisons, and it is hard to generalise these results, considering

The ability to formulate a homemade diet specifically for a cat's nutritional needs can be especially useful in patients with comorbidities where no suitable commercial diets exist.



both commercial and home-prepared diets can be made with a variety of ingredients and processing methods and, therefore, have a large variation in digestibility. For example, a study comparing the digestibility of one dry, one wet and two raw diets (one a whole 1- to 3-day-old chick, the other minced chicken) saw higher overall digestibility of the raw minced chicken diet, while the digestibility of the whole chick diet was lower than all others.⁶⁷ This may be related to the presence of undigestible material in the whole chick, such as tendons and feathers. Despite the perception that cats in the wild eat highly digestible diets, because the fibre content in animal prey is non-existent, there may be a role for, and significance of, undigestible material of animal origin as a source of 'fibre-like' activity in the gut, but this is still unknown.⁶⁸

If digestibility is sufficiently high to provide adequate nutrition, increased digestibility is not necessarily beneficial for all cats. Overweight cats needing lower calorie density or those requiring more fibre in their diet for intestinal health may benefit from diets with lower digestibility. High digestibility, on the other hand, can benefit some patients with intestinal disease such as short bowel syndrome or malassimilation. It is also important to note that faecal apparent digestibility, used in the cited studies,⁶⁵⁻⁶⁸ has several limitations and does not necessarily correlate with nutrient bioavailability.

Customisation

The availability of many types of commercial foods allows tailoring of diet choice to some degree, according to the nutritional assessment findings, to the cat and life stage, but also lifestyle, food sensitivities (eg, hairballs or 'sensitive' skin) and even feeding philosophies (such as grain-free or high protein). However, a homemade diet can be formulated more specifically for a cat with respect to their nutritional needs, preferences and any modifications

required for disease management. This ability can be especially useful in those cats with comorbidities where there are no commercial diets that meet all their needs. There are no published reports in cats, but one canine study reported the efficacy of low potassium homemade diets in dogs with CKD and hyperkalaemia,⁶⁹ and another documented the efficacy of homemade diets ultra-low in fat (lower than any commercial option) in the management of canine intestinal lymphangiectasia.⁷⁰



Figure 8 A homemade diet can be more appetising, especially if tailor-made to the patient's preferences

Recommendations if feeding a homemade diet

Given the issues of generic recipes reported in multiple studies (see text), the authors' recommendation is to consult with a board-certified veterinary specialist (such as diplomates of the ACVIM [Nutrition] or European College of Veterinary and Comparative Nutrition [ECVCN]) to obtain a recipe taking into account the medical record, dietary history and food preferences of the cat,

as well as the owner's resources. Such a recipe should include detailed follow-up information that the veterinary team can use to monitor the patient. These cats should receive a complete nutritional assessment twice a year at their primary veterinary clinic to identify and address any problems, as well as to assure compliance with the prescribed recipe.

Potential problems of homemade diets

Feeding homemade diets is not risk-free and several problems have been described even for diets properly formulated by experts.

Cost and time investment

As mentioned earlier, complete canine homemade diets are usually more expensive than dry food but can be cheaper than some canned diets,¹⁴ and this is likely also true for cats. In the authors' experience, homemade diets for the management of adverse food reactions (where the ingredient might be more costly and hard to find, such as venison or ostrich) and those high in protein, with no carbohydrate source, can incur significant additional costs. Home cooking also requires more time investment and sufficient storage space.

Nutritional adequacy

In terms of nutritional adequacy, there are several limitations of homemade diets.

✦ **Lack of testing** Lack of testing is the main limitation of homemade diets and can influence not only the nutritional adequacy of the diet but also its safety. Commercial cat food can undergo assessment in different ways to ensure the diet is nutritionally adequate and safe. This level of testing, in vitro or in vivo, is not possible with homemade diets, where there is instead heavy reliance on database information, which can be of variable quality (see below). Chemical testing of a homemade diet is possible, but at high expense, and is impractical.

Lack of testing applies equally to homemade diets for patients with disease. Clinical trials are usually performed with commercial therapeutic diets, and while homemade diets can mimic the strategies, there is a lack of evidence regarding their efficacy.

✦ **Database quality** Databases provide the formulator of the homemade diet with average nutritional composition of ingredients. In one study, 15 canine recipes from the internet

'Diet drift', with owners changing amounts or substituting ingredients, can compromise the nutritional adequacy of homemade diets.



and books were analysed with computer software and via laboratory testing.⁷¹ The analysis was not complete; that is, it did not include all the essential nutrients, but did include the macronutrients, fibre, crude energy, and some vitamins (D and E) and minerals (calcium, copper, iron, magnesium, manganese, phosphorus, potassium, selenium, sodium and zinc). In the study, computer analysis was highly predictive of deficiencies and excesses identified via laboratory analysis, but there were some differences in the actual nutrient values. The study supports the usefulness of computer software and databases in assessing recipes, but it is important that the formulator is aware of, and compensates for, any database-associated errors. Databases used for assessing homemade diet formulations were developed for people and so might also lack information on ingredients used in feline homemade diets (eg, chicken necks) or information on nutrients essential for cats but not for people (eg, taurine or choline).

✦ **Lack of compliance** Nutritional adequacy can also be compromised in homemade diets due to compliance issues, referred to as 'diet drift'. Survey studies in the USA⁷² and Brazil⁷³ have documented that pet owners given a complete recipe will modify it by changing amounts or adding, omitting or substituting ingredients, all of which can alter the nutritional composition of the original formulated diet. This is particularly concerning when the diet has modifications for disease states.

✦ **Inadequate formulation** Several studies analysing recipes obtained from books and the internet using computer software (usually comparing them with the NRC nutrient requirements²) have identified multiple nutritional issues. These have involved recipes for healthy adult cats,⁷⁴ healthy dogs and cats,⁷⁵ and dogs and cats with CKD.⁷⁶ These publications also describe several issues associated with generic recipes from books and the

Potential problems of homemade diets include

increased cost and nutritional inadequacy; the latter due to lack of testing, database quality, poor owner compliance and inadequate formulation if there is not involvement of a qualified veterinary nutritionist.

internet, including vagueness of instructions, which required assumptions in most cases (type and dose of supplements, cooking methods, specific cuts of meat, etc), and lack of guidance on feeding amounts, which can result in unwanted weight changes. Some of these generic recipes also use potentially toxic ingredients (eg, garlic) and some recipes are quite old and might use outdated nutrition recommendations. Moreover, it is important to note that these recipes are not customised to the patient, and it is not possible to consult with the formulator to accommodate for any changes or to troubleshoot any issues.

Feeding these diets can result in nutritional pathology. Unfortunately, there are no studies following up patients fed unbalanced diets long term, and some nutrient deficiencies can be very subtle or manifest only after years of marginal intakes. One study reported pansteatitis in cats fed unbalanced homemade diets⁷⁷ and there are reports in kittens^{78,79} and a tiger⁸⁰ of skeletal disease associated with feeding unbalanced homemade diets (cooked and raw) due to calcium and/or vitamin D deficiencies.

Other concerns

In addition to the above concerns, homemade diets may also use raw meat-based products and bones. Raw meat-based diets, both home prepared and commercial, are a health risk for cats due to potential pathogen contamination, as discussed earlier.

All of these potential problems stress the importance of quality control and regular nutritional analysis of pet food, and the inherent disadvantage of homemade diets in this respect.

Despite the perception of homemade diets being more natural than commercial products, there is no evidence that feeding them results in a longer or healthier life for cats.



Conflict of interest

Cecilia Villaverde has carried out consultancy work for a variety of pet food companies. She has participated as an investigator in clinical trials sponsored by pet food companies. She develops educational materials for Mark Morris Institute. She is part of the Scientific Advisory Board of FEDIAF and a Co-Chair of the Global Nutrition Committee of the WSAVA. She participates as a speaker or attendee in continuing education events sponsored or organised by pet food companies.

Marge Chandler has received honoraria from pet food companies and previous research funding from pet food companies. She develops educational materials for the Mark Morris Institute. She is Chair of the Scientific Advisory Board of FEDIAF, Co-Chair of the Global Nutrition Committee of the WSAVA and a member of an advisory group for the Purina Institute.

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Ethical approval

This work did not involve the use of animals and therefore ethical approval was not specifically required for publication in *JFMS*.

Informed consent

This work did not involve the use of animals (including cadavers) and therefore informed consent was not required. No animals or people are identifiable within this publication, and therefore additional informed consent for publication was not required.

KEY POINTS

- ❖ The veterinary team should perform a nutritional assessment on each cat to be able to recommend an adequate diet, be it commercial or homemade.
- ❖ There are a variety of commercial diets available to meet the nutritional requirements of most healthy cats and those with health disorders. These products have the advantage of generally being safe, especially if produced under strict quality control measures and being adequately tested. There have been reports of nutrient imbalances and contamination, but these problems are less likely than for homemade food, where problems are often not recognised or reported.
- ❖ Pet food labels should note if a food is complete (ie, contains all the required nutrients in appropriate amounts), which should provide assurance to the owner that the diet is likely to meet their cat's needs.
- ❖ There is no convincing evidence that feeding commercial diets in appropriate amounts increases the risk of any feline disorders. There are also many well-researched commercial therapeutic diets available for a variety of feline health problems.
- ❖ Despite the perception of homemade diets being more natural and more healthful than commercial products, there is no evidence that using them results in a longer or healthier life for cats. In addition, their use has some intrinsic risks that require closer monitoring of cats fed this way; specifically, lack of quality control and regular nutritional analysis is an inherent disadvantage of homemade diets.
- ❖ Some cats might benefit from a customised homemade diet, especially if there are no reliable commercial products that address the diseases present or if commercial diets are not palatable to the patient.



Case notes

Amy, a 5-month-old female spayed domestic shorthair cat, was presented with a 3-week history of abnormal gait and unwillingness to walk, with no associated traumatic episode.

Assessment Amy was fully vaccinated and dewormed. Abnormalities detected on physical examination included small size for age (1.8 kg), low body condition score (4/9), mild muscle atrophy noted bilaterally affecting the thigh and back muscles, and pain on palpation of both hindlimbs. Serum chemistry and complete blood count results were unremarkable. Radiographs showed generalised osteopenia (see right) and femoral fractures in both hindlimbs.

Differential diagnoses included neuropathy, myopathy, metabolic disorder, electrolyte imbalance or a nutritional imbalance.

Dietary history Given the patient's age and clinical signs, it was important to rule out dietary deficiency through a complete dietary history before performing more, potentially invasive, diagnostics. Notably, nutritional secondary hyperparathyroidism is a potential sequela of calcium deficiency, diets with an inverse calcium:phosphorus ratio and rickets (vitamin D deficiency). Examples of diet history forms can be found on the WSAVA³⁸ and ACVN³⁹ websites.



Radiograph showing generalised osteopenia

Assessment of the diet The clients reported that Amy had been fed a variety of meats, including chicken breast, chicken thigh, ground beef, beef steak and pork loin, with occasional offal, occasionally raw but mainly cooked, for about 8 weeks (since weaning). When they offered a variety of commercial foods, these were refused. They were unable to specify the amounts of foods fed.

Unfortunately, the daily variation and lack of amounts made it impossible to determine the calories and nutritional profile of the diet to compare with the cat's requirements; however, a diet rich in skeletal muscle with no supplementation will be deficient in calcium (and potentially vitamin D) and have an inverse calcium:phosphorus ratio.

Presumed diagnosis Nutritional secondary hyperparathyroidism and possible vitamin D deficiency (rickets).

Additional diagnostics A vitamin D panel (ionised calcium, parathyroid hormone and 25-hydroxycholecalciferol) can confirm a diagnosis of nutritional secondary hyperparathyroidism. Unfortunately, this was not carried out due to budget limitations, but suspicion for this disease was high enough that treatment was implemented.

Treatment Cage rest and change to a complete kitten diet were recommended. Amy continued refusing all complete commercial kitten foods, despite trying different brands, textures and styles. A consultation with a board-certified veterinary nutritionist was pursued to formulate a complete and balanced homemade kitten diet. The diet was based on chicken thigh as a source of protein and essential omega-6 fatty acids, and fish oil to provide essential omega-3 fatty acids, and was supplemented with essential vitamins and minerals (eg, calcium, salt, choline and vitamin B12).

Follow-up Amy accepted the diet and a recheck after 8 weeks (at 7 months of age) showed marked improvement in gait and bone density and 0.2 kg weight gain. At a recheck 4 months later Amy presented clinically well, but was smaller and weighed less (2.8 kg) than expected for a cat of 11 months of age.

✦ **What this case demonstrates:** Amy's case illustrates the importance of a dietary history to identify any pathology caused by diet. A homemade diet, especially if not formulated by an expert, needs to be considered a risk factor for malnutrition. Such a diet, particularly during growth, can have lifelong consequences. In this case, a homemade diet was causing a likely nutritional secondary hyperparathyroidism, and the treatment involved feeding a complete and balanced homemade diet formulated by a veterinary nutritionist due to the kitten's refusal to eat commercial options.

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