Chapter 10

Making Pet Foods at Home

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"Teach thy tongue to say 'I don't know' and thou shall progress."
Anonymous

CLINICAL IMPORTANCE

Clients are increasingly interested in their own nutrition and that of their pets. Feeding commercially prepared pet foods offers several advantages over feeding homemade foods, including convenience, cost, consistency and better nutritional balance. Nevertheless, a growing number of pet owners prefer to prepare homemade foods. In doing so, they have less guilt, and feel like they are preparing a "real meal" that is "more natural" and "more traditional" (Wolter, 1988).

According to pet owners, veterinarians are the best source of pet health care (Practice Health, 1993); advice about good nutrition is a reasonable extension of this role. Therefore, veterinarians and their health care teams should be able to provide sound and practical advice about home-cooked pet foods. The first part of this chapter gives practitioners more insight into why some pet owners prefer homemade foods, and covers some pet owner concerns about commercially prepared foods because it is possible to provide a balanced homemade food. Veterinarians should not routinely discourage owners who wish to feed such foods. The second part gives practical recommendations for assessing homemade foods. The tables and boxes describe ingredients and methods for formulating homemade foods and resources to correct imbalanced foods.

Nearly all dogs and cats in the United States consume table food at some time in their lives (PFI, 1997). Many dogs fed commercial foods "exclusively" have learned about the availability of table scraps after a meal, garbage on trash day and food from children and generous neighbors. The vast majority of dogs and cats in the United States, however, receive 90% or more of their nutrition from complete and balanced commercially prepared foods (Lund et al, 1996). In one survey, 20% of pet owners answered that they feed their pet candy or table foods every day (AAHA, 1995). The occasional feeding of table foods should not be of concern for healthy pets unless the food composes more than 10% of the daily dry matter intake (Lewis et al, 1987). However, for various reasons, some clients prefer to feed their pets a homemade food exclusively. In the United States, these clients are probably more prevalent in urban areas. Some veterinarians who practice holistic medicine strongly recommend that their clients feed only a home-prepared food. The number of websites offering nutritional consultations about homemade foods by veterinary nutritionists is increasing.

In the United Kingdom and northern European countries, pet owners provide a high proportion of their pets' diets in the form of commercial pet foods. In countries with a longstanding tradition of gourmet cooking, such as France, Italy, Spain and Belgium, many pets receive a portion of the family meal as the cultural norm. In 1987, about 13% of the dog and cat owners in France fed table foods exclusively to their dogs and cats, and another 15% purchased traditional food for home cooking (Pibot, 1989). In 1987, 62% of French dog owners and 79% of cat owners professed to feed commercial pet foods regularly (Bonnavaud, 1989). However, this does not mean pet owners

Table 10-1. Common Reasons Pet Owners and Veterinarians Want to Use a Homemade Food.

They want to use ingredients that are fresh, wild-grown, organic or natural.
They want to avoid additives that are present in some commercial pet foods.
They want to avoid contaminants thought to be present in prepared foods.
They are concerned that the ingredient list is an indecipherable list of chemicals.
They fear an ingredient in a commercial food such as a "by-product."
They wish to maintain adequate food intake in a finicky pet through exceptional palatability.
They desire to personally cook for the pet.
The pet is addicted to table foods or a single grocery item.
They wish to feed major quantities of an ingredient not found in commercial pet foods.
They hope to construct a nutritional profile for dietary management of a disease for which no commercial food is available.
They hope to restrict the allergens/causative substances during an elimination trial or for long-term feeding of animals with adverse reactions to food.
They wish to support a sick or terminally ill animal through home cooking and hand feeding.
They wish to provide food variety as a defense against malnutrition, or because of the popular idea that pets need variety.
They wish to lower feeding costs by using significant quantities of table food and leftovers.
They wish to feed a pet according to human nutritional guidelines (e.g., low fat, low cholesterol, etc.).

feed commercial pet foods "exclusively." One survey estimated that commercial dog foods only provided 27% of the dogs' nutrient needs (Bonnavaud, 1989). In the same period, pet owners spent about one-third of their pet food budget for commercial pet foods and two-thirds for homemade foods (Kieffer, 1989).

In Europe, moist pet foods often are considered a meat source (protein source), rather than a complete pet food. Consequently, some pet food companies have developed a concept that is intermediate between homemade and commercially prepared foods: moist foods, high in protein and fat. To balance the diet, the food's feeding guide recommends supplementing with a specific amount of rice or pasta. A cereal-based mixer is often sold as an alternative to rice and pasta. These latter modules contain carbohydrate and fiber ingredients that are often fortified with calcium, vitamins and trace minerals. When proper ratios are used, the meal provides adequate mineral balance and appropriate protein-to-energy ratios. This may not be the case, however, when the mixer is combined with fresh meat instead of the complementary moist food. Combining, mixing, cooking and serving the modular components fulfills the owner's expectation of "proper" feeding.

RATIONALE FOR CHOOSING HOMEMADE FOODS

When a client wants to prepare pet foods at home, it is important for veterinarians to understand the client's reasons and motivation (**Table 10-1**). In many cases it is possible to address their concerns and to recommend an appropriate commercial food. In one survey, at least 25% of pet owners said they would be influenced to purchase a specific brand of pet food based on a recommendation by their veterinarian (AAHA, 1995). However, when owners strongly prefer to cook for their pet, it is better to provide them with a well-designed homemade recipe, rather than allow them to prepare food according to their own or other well-intentioned pet owner's recipes that may have deficiencies and excesses (Donoghue and Kronfeld, 1994).

Appeal of "Natural" and "Organic" Foods

Independent health food stores in the United States sold $25 million of pet foods marketed as "organic" or "natural" pet foods in 1990, which increased to $29.4 million in 2001. Sales of natural pet food in 2005 reached $520 million, and estimated sales for 2010 are $1.042 billion, with the organic segment approaching $100 million (Kvamme, 2007). These sales figures may well represent the value some pet owners place on natural or organic labeled foods. The United States Department of Agriculture (USDA) has developed national standards for organically produced agricultural products to assure consumers that products marketed as organic meet consistent uniform standards (Jones, 2006). In general, all natural (non-synthetic) substances are allowed in organic production and all synthetic substances are prohibited. Under current definitions, it is not possible to formulate a complete and balanced organic pet food because it is not possible to meet the nutritionally complete and balanced claim without adding inorganic trace minerals and vitamins (Dzanis, 2007). Likewise, it is not possible to formulate a complete and balanced homemade food without using inorganic supplements; therefore, it is only possible to offer a homemade food "made with" organic ingredients. It is important to understand that the definition of organic relates only to how a food product is made and does not relate to the quality or safety of the product.

Appeal of Vegetarian and Vegan Foods

Pet owners who want to feed a vegetarian food to their dog or cat may assume they must prepare the food at home. Commercially prepared vegetarian foods exist for dogs, and can be well-balanced using egg and milk products. Vegan foods (no animal products) should be carefully checked because they may be deficient in arginine, lysine, methionine, tryptophan, taurine, iron, calcium, zinc, vitamin A and some B vitamins (Dwyer, 1991; McDonald et al, 1995). People should be discouraged from preparing vegetarian or vegan foods at home for cats, because cats are strict carnivores. Without adequate supplementation using synthetic ingredients, cats fed vegetarian and vegan diets are at high risk for taurine, arginine, tryptophan, lysine and vitamin A deficiencies.

Concerns about Additives, Preservatives and Contaminants

Additives

In one survey that studied consumer understanding of the word "natural," most respondents mentioned freedom from various

types of additives (Miller, 1991). In surveys, additives are always high on the list of food items that consumers feel may damage their health, or are a sufficient reason not to buy a food (Miller, 1991). However, when ranking the known risks of food hazards in people, the relative risk of food-borne disease (microbial contamination) is highest, about 100,000 times the risk associated with additives (Miller, 1991).

Because food technology and additives are a difficult and confusing matter for non-experts, additives often evoke emotional responses from the misinformed (Potter, 1986). For example, minerals and vitamins added to a pet food to complete the nutritional balance are considered additives. In addition, the issue is not always presented correctly; consumer associations and some so-called experts often accuse additives of causing all kinds of disorders in pets. Advertising occasionally abuses the negative image of synthetic additives to promote "natural" or "additive-free" products. However, evidence linking a particular food or food constituent with a particular disease is often circumstantial and great care must be exercised in assessing its significance (Aruoma et al, 1991). Veterinarians do not always have the answers when owners are alarmed by nutrition gossip, but should become more knowledgeable about pet food additives so they can accurately address client concerns.

Additives (e.g., flavorings, colorings, binders and emulsifiers) in pet foods are the same or very similar to those approved for use in human foods. In the United States, no additive may be legally used in foods unless the Food and Drug Administration (FDA) recognizes that the additive is safe at the intended level of use in the intended food. The FDA usually requires at least two-year feeding tests in two species of animals to reveal short- and long-term effects. Additives currently used in human and pet foods are generally regarded as safe (GRAS; 21 CFR 582) and must be removed from human and/or pet foods if there is an indication of harmful effects (Roudebush, 1993). For example, propylene glycol has been removed from the GRAS list for cats.

Clients who want to avoid "additives" as a generic group are often poorly informed about pet food additives and the possible negative consequences of not adding these compounds to foods. Veterinarians should be able to explain the positive aspects of additives to give clients a sufficient comfort level to feed a commercial product instead of a homemade food (Chapter 8).

In general, additives provide three benefits: 1) organoleptic-to provide structure, texture and color, 2) technologic-to serve as binding and gelling agents and 3) nutritional-to serve as vitamins and antioxidants. Clients interested in additive-free products must first specifically identify which additive (intentional vs. unintentional) they wish to avoid. Some commercially available products do not contain artificial colors, flavors and synthetic preservatives. After a pet owner's specific concerns have been identified and discussed, it is likely that an acceptable commercially prepared complete and balanced product can be located.

Preservatives

Consumer research has identified several factors that pet owners associate with natural pet food including freedom from artificial preservatives (Potter, 1986). Veterinarians and their health care teams should become knowledgeable about pet food preservatives so they can accurately address client concerns. A preservative may be defined as "any substance that is capable of inhibiting or retarding the growth of microorganisms or of masking the evidence of such deterioration" (Aruoma et al, 1991). Protection against microbial attack may be achieved by several methods: chemical treatment (semi-moist and some dry foods), dehydration (dry foods), heat (moist and dry foods), irradiation or storage at a low temperature. Preservatives are very important to prevent molding or bacterial deterioration of semi-moist foods. Many preservatives are organic acids and their salts, such as sorbates, and are the same as those used in many human foods and dressings.

ANTIOXIDANTS

Antioxidants function to stabilize fats and fat-soluble vitamins against oxidation. There are two types of antioxidants: natural and synthetic (Hilton, 1989).

Natural Antioxidants

Commonly used natural antioxidants include tocopherols, ascorbic acid (vitamin C) and rosemary. Tocopherols are often referred to as vitamin E. Although vitamin E (alpha-tocopherol) is the biologically active form in the body, it does not effectively stabilize fats in food. The gamma- and delta-tocopherols exert the best antioxidant activity in food, but have very low vitamin E activity. Thus, the term "Preserved with vitamin E" is technically inaccurate, but it is commonly used to assuage client concerns. Instead, the label should indicate whether gamma- or delta-tocopherol was added.

Ascorbic acid and its salts and esters are most effective when combined with other antioxidants. Salts (L-calcium ascorbate) and esters (ascorbyl-5,6-diacetate) of ascorbic acid are synthesized compounds, but may be perceived as acceptable natural alternatives to a "more chemical sounding" antioxidant.

Rosemary has been investigated for use in pet foods. Although always considered a natural antioxidant, rosemary is not used in its original form, but as a refined extract to avoid influence on taste and odor (Löliger, 1991).

Synthetic Antioxidants

The more commonly used synthetic antioxidants are butylated hydroxytoluene (BHT), butylated hydroxyanisole (BHA) and ethoxyquin. BHT and BHA have been used in human foods since 1954 and are most effective when combined. Ethoxyquin has been approved for use in animal feeds and pet foods in the United States for more than 30 years. All three antioxidants are considered safe at their recommended levels in the United States and Europe (AAFCO, 2007; Dzanis, 1991; Council Directive 70/524/EEC, 1970; Council Directive 91/248/EEC, 1991).

Synthetic antioxidants are more effective than natural antioxidants and better withstand the heat, pressure and moisture during food processing. In doing so, they also preserve the fat-soluble vitamins A, D and E for activity in the body. Clients

Box 10-1. AAFCO Definitions for Meat Ingredients Commonly Used in Commercial Pet Foods.

MEAT
Meat is the clean flesh derived from slaughtered mammals and is limited to that part of the striate muscle which is skeletal or that which is found in the tongue, in the diaphragm, in the heart, or in the esophagus; with or without the accompanying and overlying fat and the portions of the skin, sinew, nerve and blood vessels which normally accompany the flesh. It shall be suitable for use in animal foods (IFN 5-00-394).

MEAT BY-PRODUCTS
Meat by-products are the non-rendered, clean parts, other than meat, derived from slaughtered mammals. It includes, but is not limited to lungs, spleen, kidneys, brain, livers, blood, bone, partially defatted low temperature fatty tissue and stomachs and intestines freed of their contents. It does not include hair, horns, teeth and hooves. It shall be suitable for use in animal food (IFN 5-00-395).

MEAT MEAL
Meat meal is the rendered product from mammalian tissues, exclusive of any added blood, hair, hoof, horn, hide trimmings, manure, stomach and rumen contents except in such amounts as may occur unavoidably in good processing practices. It shall not contain added extraneous materials not provided for by this definition. The calcium level shall not exceed the actual phosphorus level by more than 2.2 times. It shall not contain more than 12% pepsin indigestible residue, and not more than 9% of the crude protein in the product shall be pepsin indigestible (IFN 5-00-385).

MEAT AND BONE MEAL
Meat and bone meal is the rendered product from mammal tissues, including bone, exclusive of any added blood, hair, hoof, horn, hide trimmings, manure, stomach and rumen contents except in such amounts as may occur unavoidably in good processing practices. It shall not contain added extraneous materials not provided for by this definition. It shall contain a minimum of 4.0% phosphorus, and the calcium level shall not be more than 2.2 times the actual phosphorus level. It shall not contain more than 12% pepsin indigestible residue, and not more than 9% of the crude protein in the product shall be pepsin indigestible (IFN 5-00-388).

should be aware that most canned foods do not contain antioxidants, and that many commercially prepared dry pet foods use vitamin antioxidants. Awareness of these facts may help clients choose a more appropriate commercially prepared food.

Contaminants

Some clients are concerned about compounds that may be present unintentionally or accidentally in pet foods (pesticides, drug residues and heavy metals) (Chapter 11). Analyses have shown that contamination of pet foods with pesticides, polychlorinated biphenyls (PCBs) and heavy metals is insignificant (Mumma et al, 1986). In the late 1990s, the FDA Center for Veterinary Medicine (CVM) developed and used a sophisticated process to detect and quantify minute amounts of pentobarbital in dog food (2002). Upon finding pentobarbital residues in some samples of dry dog food, CVM scientists conducted further tests that led them to conclude that dogs eating dry dog food are unlikely to have any adverse health effects from the low levels of pentobarbital found in the dog food samples tested. CVM scientists also developed a test to detect dog and cat DNA in the protein of dog food. Because pentobarbital is used to euthanize dogs and cats at animal shelters, finding pentobarbital could suggest that pets were rendered and used in pet food. Test results indicated a complete absence of protein derived from euthanized dogs or cats (Bren, 2002). As a result, CVM scientists assumed the source of pentobarbital in dog food was euthanized farm livestock.

Clients may elect to feed a homemade food to avoid all types of contaminants. However, ingredients in homemade foods may also contain contaminants. Therefore, making a food at home does not ensure against unintentional contaminants. For example, mercury may be found in fish-based pet foods, but the same concern is real for pets fed fresh fish (Mumma et al, 1986; Ferrando, 1989).

Inability to Understand Pet Food Labels

The ingredient list on a pet food label often uses language unfamiliar to most pet owners; however, each term has a specific definition. Pet owners can easily be confused by terms such as meat, meat meal, meat and bone meal and meat by-products (**Box 10-1**).

Furthermore, pet owners may be alarmed about what they read in the popular press and on the Internet about ingredients commonly used in commercial pet foods (Stein, 1993; Pitcairn and Pitcairn, 1995; Martin, 1997, 2002, 2007), which are often undocumented material presented as "investigative research." Consequently, pet owners often assume the worst possible composition of pet food ingredients (Phillips, 1990; Remillard, 1994). Veterinarians should encourage pet owners to identify ingredient terms of concern and provide more accurate information about the composition of these ingredients. Regulatory agency descriptions exist for all ingredients commonly used in commercial pet foods; one source is the Official Publication of the Association of American Feed Control Officials (AAFCO). For example, a pet owner who has read that meat by-products include hair and fecal material (Stein, 1993; Pitcairn and Pitcairn, 2005; Martin, 1997, 2002, 2007), should be informed that it is illegal for meat by-products to contain such materials (AAFCO, 2007).

Some pet owners may still find meat by-products objection-

able after learning the AAFCO definition. However, they may be comfortable with the definition of meat as an ingredient and feed a commercially prepared product containing meat instead of a homemade food.

Some pet owners consider the last half of the ingredient list to be nothing more than a list of chemicals and cannot identify the nutrients provided by synthetic sources. Veterinarians should ask pet owners to identify bothersome ingredient terms and then explain to them which essential nutrients are provided by those ingredients. As examples, calcium carbonate provides calcium, zinc oxide provides zinc and sodium selenite provides sodium and selenium. Some vitamin examples are: thiamin mononitrate provides vitamin B_1, calcium pantothenate provides pantothenic acid and D-activated animal sterol provides vitamin D_3. Pet owners may have fewer objections to feeding commercially made products after biochemical names have been translated into more commonly recognized vitamins and minerals.

Other points of concern include whether the ingredients are available to the pet (i.e., whether the animal is able to digest and absorb the nutrients they contain). In the United States, the pet owner's attention should be directed to the AAFCO statement required on every product that claims to be complete and balanced (Chapter 9). The AAFCO statement provides valuable information (i.e., the testing procedures used and the lifestage for which the food has been substantiated). If the complete and balanced claim was not substantiated by feeding tests for the specific lifestage of the pet (i.e., growth, maintenance, reproduction), another more appropriate product should be recommended.

"My dog eats what I eat" is an expression often heard from people who prefer to cook for their pet. Preparing elaborate meals at home gives the owner the feeling of "being involved" and can be an integral part of the human-animal bond. This may be particularly important for elderly, solitary persons who benefit from feeling responsible for somebody and are motivated to remain active. Other people choose to cook simply because they feel guilty, as if they don't care enough. The latter circumstance is a minor concern in the United States, but is more important in countries such as France (AAHA, 1995; Pibot, 1989).

Quite often, the pet that receives home-cooked meals is a geriatric animal with a diminishing appetite, body weight and condition due to a slowly progressive disease (e.g., chronic renal failure, hepatic disease, cancer). Meal preparation and hand-feeding allow the owner to participate in the pet's supportive care. Formulating a simple homemade recipe that is approximately balanced for the animal with a chronic, progressive fatal disease is a reasonable, compassionate gesture on the part of veterinarians.

Table Foods Have Become a Bad Habit

Pet owners may begin feeding a young or sick dog or cat from the table only to realize that later the pet will not eat commercially prepared food. Therefore, table food is 100% of the animal's daily intake. There are several methods of weaning pets off one particular food and onto another. However, if the animal is persistent, the owner reluctant to make a change or both, formulating a diet from table foods commonly used in the household may be the only way to ensure the pet receives balanced nutrition. In addition, these animals may have very selective eating habits. In such cases, the veterinarian should inform the owner to thoroughly mix all ingredients of the homemade food to ensure balanced nutrient intake.

Table 10-2. Balanced reduced-protein/low-phosphorus homemade formulas for adult dogs and cats with kidney disease.*/**/***

Daily food formulation for an 18-kg (40-lb) dog (as fed)

Ingredients	Grams	Nutrient content (% dry matter)†††	
Rice, white, cooked†	237	Dry matter	41.0
Beef, regular, cooked††	78	*Protein*	21.1
Egg, large, boiled	20	Fat	13.7
Bread, white	50	Linoleic acid	1.8
Oil, vegetable	3	Crude fiber	1.4
Calcium carbonate	1.5	Calcium	0.43
Salt, iodized	0.5	*Phosphorus*	0.22
Total	390	*Potassium*	0.26
		Sodium	0.33
		Magnesium	0.09
		Energy (kcal/100 g)	445

Daily food formulation for a 4.5-kg (10-lb) cat (as fed)

Ingredients	Grams	Nutrient content (% dry matter)†††	
Liver, chicken, cooked	21	Dry matter	37.8
Rice, white, cooked†	98	*Protein*	24.4
Chicken, white, cooked	21	Fat	17.5
Oil, vegetable	7	Linoleic acid	7.9
Calcium carbonate	0.7	Crude fiber	0.85
Salt, iodized	0.5	Calcium	0.54
Salt, substitute (KCl)	0.5	*Phosphorus*	0.29
Total	149	*Potassium*	0.66
		Sodium	0.42
		Magnesium	0.09
		Energy (kcal/100 g)	458

*Also feed one human adult vitamin-mineral tablet (1 g) daily to dogs and 0.5 g tablet to cats to ensure all vitamins and trace minerals are included. Cats should be given one-half to one taurine tablet (500 mg/tablet) daily.
**ESHA Research. Diet Analysis Software. Food Processor Plus, version 5.03, 1990 Salem, OR. Agricultural Software Consultants, Inc. Mixit 2+, version 3.0, 1991, Kingsville, TX.
***Disclaimer for all homemade food recipes: These are computer-formulated homemade foods that meet current recommended nutrient minimums without exceeding the known maximums for dogs and cats. These foods have never been analyzed for actual nutrient content, nor have they been tested in animals (e.g., AAFCO feeding trial) as are some approved, commercially prepared, pet foods. Likewise, the urinary pH produced by these recipes is unknown, but should be adjusted using appropriate oral medications when indicated in certain medical conditions.
†May substitute rice baby cereal and flavor either selection with meat broth during cooking.
††Retain the fat.
†††Nutrients of concern are italicized.

A Veterinary Therapeutic Food is Unavailable or Unacceptable

Specific types or forms of nutritional management required by the pet are not always available commercially, or one pet food

Table 10-3. Balanced low-fat homemade formulas for overweight adult dogs and cats.*/**/***

Daily food formulation for an 18-kg (40-lb) dog (as fed)

Ingredients	Grams	Nutrient content (% dry matter)††	
Chicken, white meat	65	Dry matter	36.5
Egg, large, boiled	81	Protein	22.6
Rice, white, cooked†	325	*Fat*	8.0
Cereal, All Bran	26	Linoleic acid	1.1
Calcium carbonate	2	*Fiber*	5.8
Salt, iodized	1	Calcium	0.50
Salt substitute (KCl)	1	Phosphorus	0.37
Total	501	Potassium	0.63
		Sodium	0.45
		Magnesium	0.14
		Energy (kcal/100 g)	398

Daily food formulation for a 4.5-kg (10-lb) cat (as fed)

Ingredients	Grams	Nutrient content (% dry matter)††	
Liver, chicken, cooked	125	Dry matter (%)	33.8
Rice, white, cooked†	46	Protein	52.7
Cereal, All Bran	8	*Fat*	11.4
Calcium carbonate	1.2	Linoleic acid	1.2
Salt, iodized	0.3	*Fiber*	5.2
Salt, substitute (KCl)	0.3	Calcium	0.85
Total	180	Phosphorus	0.77
		Potassium	0.67
		Sodium	0.44
		Magnesium	0.11
		Energy (kcal/100 g)	420

*Also feed one human adult vitamin-mineral tablet (1 g) daily to dogs and 0.5 g tablet to cats to ensure all vitamins and trace minerals are included. Cats should be given one-half to one taurine tablet (500 mg/tablet) daily.
**ESHA Research. Diet Analysis Software. Food Processor Plus, version 5.03, 1990 Salem, OR. Agricultural Software Consultants, Inc. Mixit 2+, version 3.0, 1991, Kingsville, TX.
***Disclaimer for all homemade food recipes: These are computer-formulated homemade foods that meet current recommended nutrient minimums without exceeding the known maximums for dogs and cats. These foods have never been analyzed for actual nutrient content, nor have they been tested in animals (e.g., AAFCO feeding trial) as are some approved, commercially prepared, pet foods. Likewise, the urinary pH produced by these recipes is unknown, but should be adjusted using appropriate oral medications when indicated in certain medical conditions.
†May substitute rice baby cereal and flavor either selection with meat broth during cooking.
††Nutrients of concern are italicized.

may not address a patient's multiple medical problems. Some patients' medical problems may require apparently contradictory dietary management. For example, a patient with little or no pancreatic tissue may require: 1) a highly digestible food because of a deficiency in digestive enzymes but also 2) a food with moderate fiber levels to help manage diabetes mellitus.

A veterinary therapeutic food may be commercially available for a patient with a particular medical problem, but the product may be unacceptable to the patient or owner. Although some veterinary therapeutic foods are even more palatable than many specialty and grocery brands, most commercial veterinary therapeutic foods are not available in a variety of flavors, and the ingredient formulation is usually fixed. If a pet is finicky, the one flavor or formulation may be unacceptable and, the patient may not consume adequate quantities of the food to support body weight and condition.

However, it should be noted that in general, homemade formulas won't be as effective as commercially prepared veterinary therapeutic foods. Also, not all veterinary therapeutic foods can be formulated at home (**Tables 10-2** through **10-6**).

Dietary Elimination Trials

The prevalence of adverse reactions to food (including food intolerances and food allergies) has been roughly estimated at 1% of all hospital cases, or 10 to 20% of cases with allergic dermatoses presented to specialists (Brown et al, 1995; Carlotti et al, 1990). Although adverse reactions to food are a small segment of practice, there is strong evidence that they do occur in pets. Homemade foods may be fed to companion animals as a diagnostic or therapeutic measure in cases in which adverse food reactions are suspected. Veterinarians should investigate possible food reactions in cases in which gastrointestinal or dermatologic signs do not fully resolve with standard therapy (Chapter 31).

A dietary history is required to identify ingredients that must be eliminated from the patient's food; however, examining pet food labels rarely ensures that a particular protein is not in the product. For example, the words meat and liver do not specify the species of origin (i.e., cattle, swine, sheep or goats). In Europe, most pet food labels do not list individual ingredients, which makes the dietary history even less accurate. Thus, some sources of protein (and species) cannot be adequately identified from the ingredient list, and so cannot be effectively eliminated from the food. Veterinarians should not hesitate to contact pet food manufacturers for more detailed information.

The recommended protocol for demonstrating a food allergy requires feeding a food composed of protein ingredients not previously fed to the pet or a pet food product containing hydrolyzed protein sources. All protein and carbohydrate sources in a novel food must be changed (i.e., the meat and grain sources). Game meats (venison, bison, elk), rabbit, ostrich and duck are relatively novel meat sources, whereas potato, barley and pea are novel carbohydrate sources in North America. All other possible dietary sources of protein and carbohydrate should be discontinued including treats, snacks, table foods, vitamin-mineral supplements and chewable medications. Patients not successfully managed with a commercially prepared novel food or a food containing protein hydrolysates are often fed a homemade food for four to 12 weeks. Homemade foods may have an advantage because they can be better tailored to the patient's specific needs, but many have been shown to be deficient in essential nutrients (Roudebush and Cowell, 1992).

Homemade foods used in dietary elimination trials can easily be supplemented with calcium, vitamins and microminerals. Most veterinary and children's vitamin-mineral supplements and chewable/flavored medications contain proteins not derived from novel sources. Adult vitamin-mineral supplements without additives are available from health food stores

and pharmacies. Supplements are also available that contain no proteins but complete the nutritional balance for dogs and cats with a variety of concurrent medical conditions (www.balanceit.com).[a] These products are a line of all-in-one patent pending supplements specifically designed to make the preparation of foods for healthy and sick dogs and cats easier and less expensive. Any supplement should be added individually to the homemade food on a trial basis (i.e., one per week) because it may contain an item to which the pet is allergic or intolerant.

COMMON PROBLEMS WITH HOMEMADE FOODS

It is possible to achieve the same nutrient balance with a homemade food as with a commercially prepared food. However, this largely depends on the accuracy and competence of the veterinarian or animal nutritionist formulating the food, and on the compliance and discipline of the owner. Unfortunately, some homemade recipes are flawed even when followed exactly and consistently. In one survey, 90% of the homemade elimination foods prescribed by 116 veterinarians in North America were not nutritionally adequate for adult canine or feline maintenance (Roudebush and Cowell, 1992). Unlike most commercial foods, many published homemade recipes are not complete or balanced to fulfill animal requirements (Roudebush and Cowell, 1992; Kallfez, 1996; Donoghue et al, 1987). Few of the numerous published homemade food recipes for dogs and cats have been tested to document performance over sustained periods (Donoghue and Kronfeld, 1994; Kelly and Willis, 1996). Additionally, making homemade foods requires knowledge, motivation, additional financial resources and careful, consistent attention to recipe detail to ensure a consistent, balanced intake of nutrients.

Very few pet food products sold in the United States are designed to be mixed with another food at home. Some prepared meatless products are available, but the manufacturer clearly instructs the pet owner to feed the food for a limited time or to add a protein source when feeding the product long-term. In North America, homemade foods are more likely to be made "from scratch" than from modules, as in Europe.

Formulations for homemade foods should not be assumed to be complete or balanced for any canine or feline lifestage until sufficiently tested (feeding tests, nutrient analysis, etc.). Most recipes have been crudely balanced using the average nutrient content of specific foods and computer assimilation. The palatability, digestibility and safety of these recipes have not been adequately or scientifically tested (Donoghue and Kronfeld, 1994; Stein, 1993; Pitcairn and Pitcairn, 2005; Martin, 1997, 2002, 2007). Even formulations that are initially complete and balanced put pets at risk when pet owners make their own food substitutions, omit ingredients because of personal preferences or convenience or make preparation errors. Therefore, veterinarians and their health care teams should encourage regular dietary histories and patient monitoring for pets fed homemade foods.

Table 10-4. Balanced low-sodium and low-mineral homemade formulas for adult dogs and cats with heart disease.*/**/***

Daily food formulation for an 18-kg (40-lb) dog (as fed)

Ingredients	Grams	Nutrient content (% dry matter)†††	
Beef, regular cooked†	94	Dry matter	38.7
Rice, white, cooked††	330	Protein	20.8
Cereal, All Bran	9.0	Fat	12.4
Oil, vegetable	2.0	Linoleic acid	1.0
Calcium carbonate	2.0	Fiber	2.9
Salt, substitute (KCl)	1.0	*Calcium*	0.49
Total	438	Phosphorus	0.26
		Potassium	0.59
		Sodium	0.12
		Magnesium	0.11
		Energy (kcal/100 g)	431

Daily food formulation for a 4.5-kg (10-lb) cat (as fed)

Ingredients	Grams	Nutrient content (% dry matter)†††	
Beef, lean, cooked†	67	Dry matter	37.9
Rice, white, cooked††	67	Protein	36.4
Calcium carbonate	0.7	Fat	21.5
Salt, iodized	0.1	Linoleic acid	0.73
Salt, substitute (KCl)	0.1	Fiber	0.65
Total	135	*Calcium*	0.55
		Phosphorus	0.28
		Potassium	0.54
		Sodium	0.17
		Magnesium	0.07
		Energy (kcal/100 g)	500

*Also feed one human adult vitamin-mineral tablet (1 g) daily to dogs and 0.5 g tablet daily to cats to ensure all vitamins and trace minerals are included. Cats should be given one-half to one taurine tablet (500 mg/tablet) daily.
**ESHA Research. Diet Analysis Software. Food Processor Plus, version 5.03, 1990 Salem, OR. Agricultural Software Consultants, Inc. Mixit 2+, version 3.0, 1991, Kingsville, TX.
***Disclaimer for all homemade food recipes: These are computer-formulated homemade foods that meet current recommended nutrient minimums without exceeding the known maximums for dogs and cats. These foods have never been analyzed for actual nutrient content, nor have they been tested in animals (e.g., AAFCO feeding trial) as are some approved, commercially prepared, pet foods. Likewise, the urinary pH produced by these recipes is unknown, but should be adjusted using appropriate oral medications when indicated in certain medical conditions.
†Retain the fat.
††May substitute rice baby cereal and flavor either selection with meat broth during cooking.
†††Nutrients of concern are italicized.

Common Nutrient Problems in Homemade Foods

It is difficult to characterize homemade foods designed by owners because each food and patient is unique. However, many formulations contain excessive protein, but are deficient in calories, calcium, vitamins and microminerals. Commonly used meat and carbohydrate sources contain more phosphorus than calcium; therefore, homemade foods may have inverse calcium to phosphorus ratios as high as 1:10. Most homemade foods for dogs contain excessive quantities of meat, often providing excessive phosphorus and far exceeding the animal's protein requirements.

Table 10-5. Balanced low-protein/low-purine homemade formula for adult dogs with urate urinary calculi (daily food formulation for an 18-kg (40-lb) dog, as fed).*/**/***

Ingredients	Grams	Nutrient content (% dry matter)†	
Rice, white, cooked	431	Dry matter	29.5
Egg, large, boiled	49	*Protein*	9.8
Oil, vegetable	27	Fat	21.8
Calcium carbonate	1.2	Fiber	2.2
Salt, substitute (KCl)	1.2	Calcium	0.38
Total	509	*Phosphorus*	0.10
		Energy (kcal/100 g)	483

*Also feed one human adult vitamin-mineral tablet (1 g) daily.
**ESHA Research. Diet Analysis Software. Food Processor Plus, version 5.03, 1990 Salem, OR. Agricultural Software Consultants, Inc. Mixit 2+, version 3.0, 1991, Kingsville, TX.
***Disclaimer for all homemade food recipes: These are computer-formulated homemade foods that meet current recommended nutrient minimums without exceeding the known maximums for dogs and cats. These foods have never been analyzed for actual nutrient content, nor have they been tested in animals (e.g., AAFCO feeding trial) as are some approved, commercially prepared, pet foods. Likewise, the urinary pH produced by these recipes is unknown, but should be adjusted using appropriate oral medications when indicated in certain medical conditions.
†Nutrients of concern are italicized.

Table 10-6. A balanced low-residue homemade formula for adult dogs with gastrointestinal disease (daily food formulation for an 18-kg (40-lb) dog, as fed).*/**/***

Ingredients	Grams	Nutrient content (% dry matter)†	
Rice, white, cooked	232	Dry matter	27.7
Cottage cheese	232	Protein	30.4
Egg, large, boiled	116	Fat	15.6
Oil, vegetable	2.0	*Fiber*	0.71
Salt, substitute (KCl)	1.0	Calcium	0.42
Calcium carbonate	1.0	Phosphorus	0.39
Total	585	Energy (kcal/100 g)	450

*Also feed one human adult vitamin-mineral tablet (1 g) daily to dogs to ensure all vitamins and trace minerals are included.
**ESHA Research. Diet Analysis Software. Food Processor Plus, version 5.03, 1990 Salem, OR. Agricultural Software Consultants, Inc. Mixit 2+, version 3.0, 1991, Kingsville, TX.
***Disclaimer for all homemade food recipes: These are computer-formulated homemade foods that meet current recommended nutrient minimums without exceeding the known maximums for dogs and cats. These foods have never been analyzed for actual nutrient content, nor have they been tested in animals (e.g., AAFCO feeding trial) as are some approved, commercially prepared, pet foods. Likewise, the urinary pH produced by these recipes is unknown, but should be adjusted using appropriate oral medications when indicated in certain medical conditions.
†Nutrients of concern are italicized.

Feline foods designed by clients are commonly deficient in fat and energy density or contain an unpalatable fat source (vegetable oil). Homemade foods are rarely balanced for microminerals and vitamins because over-the-counter veterinary vitamin-mineral supplements are neither complete nor are the nutrients well-balanced within the product. In the United States, there is an all-in-one vitamin-mineral supplement specifically designed to balance homemade foods;[a] this supplement is available to pet owners through veterinarians and nutritionists.

Common Ingredient Problems in Homemade Foods

People are taught that eating a variety of foods is nutritionally sound. Clients often extend this principle to their pet's nutrition. As an example, owners who purchase commercial pet foods may not be brand loyal and often change brands "just in case" one brand is really not complete and balanced. Other pet owners will feed both moist and dry versions of complete and balanced products (of the same or different brands) "just in case there's something in one that's not in the other." Pet owners perceive that feeding a variety of foods is their best defense against malnutrition. Many times pet owners feed a variety of foods because they perceive the pet enjoys the frequent dietary changes.

Likewise, some owners feel a homemade food better meets their pet's nutritional requirements because they use a variety of ingredients. Nutritionally, this may or may not be accurate depending on ingredient substitutions. Inappropriate substitutions are a common error made by owners who design homemade pet foods.

Some owners choose the meat and carbohydrate ingredients for the pet's food based on their own preferences, product availability or affordability. Other pets are fed a variety of "leftover" ingredients such as fat trimmings, bones, vegetable skins, crusts and condiments. Pet food composed of table "leftovers" rarely represents the owner's food and is not complete and balanced for the pet.

On the other hand, some owners mistakenly feed their pet according to current and popular human nutritional guidelines such as avoiding fat, cholesterol and sodium. Such practices do not lead to consumption of a complete and balanced food for the pet. Many owners, who make their pet's food according to published canine or feline recipes, over time, make their own ingredient substitutions that may or may not be correct. Foods made at home, therefore, are typically designed from a variety of table foods, and generally have no consistent ingredient composition. Inconsistency is the rule.

The second most common error made by pet owners who cook for their pets is to eliminate the vitamin-mineral supplement because of its inconvenience, expense or a failure to understand its importance. Foods made from recipes that were once crudely balanced become grossly unbalanced when owners eliminate supplements. Regular veterinary checkups are necessary to monitor the patient's progress and response to the food and to monitor the owner's level of compliance.

Some owners and breeders encourage the use of uncooked meat, liver and eggs in their homemade pet food recipes. This practice can be dangerous because uncooked animal ingredients can harbor pathogenic bacteria that normally would be killed during cooking (Chapter 11).

RECOMMENDING HOMEMADE FOODS

Veterinarians should be willing to: 1) assess an existing recipe, 2) offer nutritionally adequate recipes for healthy pets, if the

client insists on cooking for the pet (**Tables 10-7** and **10-8**) or 3) if necessary, make appropriate formula substitutions for the client when the pet is diagnosed with a medical problem (**Tables 10-2** through **10-6**).

Assessing Recipes

Veterinarians encounter a wide variety of pet food recipes from breeders, chat rooms and the popular press. Improving the ingredients in such recipes is not a simple task. It requires knowledge and good formulation skills, and an up-to-date database of locally available ingredients. The ingredients should be selected on the basis of nutrient content, tolerance, availability and cost. Information about the nutrient composition of commonly available homemade ingredients can be obtained from readily available sources; however, the information is usually presented in an obscure format such as amounts of "nutrient per serving" on an as fed basis (Watt and Merrill, 1975; Carper, 1975; Pennington, 1994; Pitcairn and Pitcairn, 2005). Information in human food tables is not readily converted to common forms used to compare pet food formulations (e.g., percent as fed or dry matter basis). A simpler method to correct an inadequate homemade formulation is to adjust the proportions or change the ingredients in the recipe. Homemade formulations can be checked for nutritional adequacy and adjusted using the "quick check" guidelines below.

1. Do Five Food Groups Appear in the Recipe?

- A carbohydrate/fiber source from a cooked cereal grain.
- A protein source, preferably of animal origin, or if more than one protein source is used, one source should be of animal origin.
- A fat source.
- A source of minerals, particularly calcium.
- A multivitamin and trace mineral source.

2. Is the Carbohydrate Source a Cooked Cereal and Present in a Higher or Equal Quantity than the Meat Source?

The carbohydrate source to protein source ratio should be at least 1:1 to 2:1 for cat foods and 2:1 to 3:1 for dog foods. Carbohydrate sources for dog and cat foods are used for energy and are usually a cereal such as cooked corn, rice, wheat, potato or barley. These carbohydrate sources have similar caloric contributions, but some carbohydrate sources also contribute a significant amount of protein, fiber and fat (**Table 10-9**). A specific carbohydrate may be chosen based on specific changes in the patient's protein, fat and fiber requirements. For example, soybean may be substituted for corn if more protein is needed, or peas may be substituted if more fiber is needed.

3. What is the Type and Quantity of the Primary Protein Source?

The overall protein quality in a homemade food can be improved by substituting an animal-source protein for a vegetable-source protein. Skeletal muscle protein from different animal species has very similar amino acid profiles. The protein content of various mammalian and avian skeletal muscle tissues is generally equivalent on a water-free basis. Thus, there is no great advantage to feeding one meat source over another. Any cooked animal protein source should provide the majority of a dog's or cat's essential amino acids.

The final food should contain 25 to 30% cooked meat for dogs, (one part meat to two or three parts carbohydrate, respectively) and 35 to 50% cooked meat for cats (one part meat to one to two parts carbohydrate).

Providing some liver in the meat portion is recommended once a week or no more than half of the meat portion regularly. Liver corrects most potential amino acid deficiencies in homemade foods for dogs and cats. Liver not only improves the amino acid profile over that provided by vegetable and skeletal meat sources, but also contributes essential fatty acids, choles-

Table 10-7. Balanced generic homemade daily formulation for a healthy 18-kg (40-lb) adult dog that meets AAFCO allowances.*

Ingredients	Grams	Percent
Carbohydrate, cooked**	240	58
Meat, cooked***	120	29
Fat†	10	2
Fiber††	30	7
Bone meal†††	4.0	-
Potassium chloride∫	1.0	-

***Disclaimer for all homemade food recipes:** These are computer-formulated homemade foods that meet current recommended nutrient minimums without exceeding the known maximums for dogs and cats. These foods have never been analyzed for actual nutrient content, nor have they been tested in animals (e.g., AAFCO feeding trial) as are some approved, commercially prepared, pet foods. Likewise, the urinary pH produced by these recipes is unknown, but should be adjusted using appropriate oral medications when indicated in certain medical conditions.
**Examples include rice, cornmeal, oatmeal, potato, pasta and various infant cereals.
***Examples include all typical meats, poultry, fish and liver.
†Chicken fat, beef fat, vegetable oil or fish oil.
††Prepared high-fiber cereals (All Bran, Fiber One) or vegetables (raw or cooked).
†††Dicalcium phosphate can be used instead of bone meal.
∫Readily available as a salt substitute in grocery stores.
Human adult vitamin-mineral tablet (1 g/tablet, give 1 tablet/day)

Nutrient content (% dry matter)	
Protein	21
Fat	20
Crude fiber	6.5
Calcium	0.66
Phosphorus	0.59
Magnesium	0.1
Sodium	0.2
Potassium	0.6
kcal (as fed)	820

Directions: Bake or microwave meat component and cook starch component separately. Grind or finely chop meat if necessary. Pulverize the bone meal or dicalcium phosphate. Mix with other components except the vitamin-mineral supplement. Mix well and serve immediately or cover and refrigerate. Feed the vitamin-mineral supplement with the meal; give as a pill or pulverize and thoroughly mix in food before feeding.

Table 10-8. Balanced generic homemade daily formulation for a healthy 4.5-kg (10-lb) adult cat that meets AAFCO allowances.*

Ingredients	Grams	Percent
Carbohydrate, cooked**	60	50
Meat, cooked***	40	34
Fat†	10	8
Bone meal††	1.2	-
Salts (NaCl/KCl)†††	1.0	-
Taurine	0.5	-

***Disclaimer for all homemade food recipes:** These are computer-formulated homemade foods that meet current recommended nutrient minimums without exceeding the known maximums for dogs and cats. These foods have never been analyzed for actual nutrient content, nor have they been tested in animals (e.g., AAFCO feeding trial) as are some approved, commercially prepared, pet foods. Likewise, the urinary pH produced by these recipes is unknown, but should be adjusted using appropriate oral medications when indicated in certain medical conditions.
**Examples include rice, cornmeal, oatmeal, potato, pasta and various infant cereals.
***Examples include all typical meats, poultry, fish and liver.
†Chicken fat, beef fat, vegetable oil or fish oil.
††Dicalcium phosphate can be used in place of bone meal.
†††Readily available as a lite salt in grocery stores.
Human adult vitamin-mineral tablet (1 g/tablet, give 0.5 tablet/day).

Nutrient content (% dry matter)	
Protein	31
Fat	28
Crude fiber	2.0
Calcium	0.69
Phosphorus	0.58
Magnesium	0.1
Sodium	0.4
Potassium	0.75
kcal (as fed)	250

Directions: Bake or microwave meat component and cook starch component separately. Grind or finely chop meat if necessary. Pulverize the bone meal or dicalcium phosphate. Mix with other components except the vitamin-mineral supplement. Mix well and serve immediately or cover and refrigerate. Feed the vitamin-mineral supplement with the meal; give as a pill or pulverize and thoroughly mix in food before feeding.

terol, energy, vitamins and microminerals. If a pet owner requests an ovo-lacto vegetarian food, eggs are the best ingredient. If a vegan food is requested, soybeans provide the next best, but incomplete, amino acid profile.

4. Is the Primary Protein Source Lean or Fatty?

The fat content of different cuts of meat varies. When the specified protein source is "lean," an additional animal, vegetable or fish fat source should compose at least 2% of the formula weight for dogs, and 5% of the formula for cats to ensure adequate energy density and essential fatty acids. If a homemade food lacks sufficient caloric density (fat), the addition of cooked beef or chicken fat, poultry skins, vegetable or fish oils (tuna, mackerel, sardine) can increase the caloric density without adding other nutrients. Changing the cut of meat can also markedly increase the fat content of a food (**Box 10-2**).

5. Is a Source of Calcium and Other Minerals Provided?

A homemade food is almost never spontaneously balanced in minerals; an absolute calcium deficiency is common. Unfortunately, pet owners erroneously assume cottage cheese, cheese or milk added in small quantities to homemade pet foods provides adequate calcium. Most foods require a specific calcium supplement. When the protein fraction equals or is greater than the carbohydrate fraction, usually only calcium carbonate is added to the food (0.5 g/4.5-kg cat/day and at least 2.0 g/15-kg dog/day). Calcium carbonate, containing 40% calcium and less than 1% phosphorus, is available in various size tablets from most pharmacies, health food and grocery stores.

Calcium and phosphorus supplementation may be necessary when the protein fraction is less than the carbohydrate fraction. Steamed bone meal, dicalcium phosphate and certain proprietary mineral supplements contain approximately 27% calcium and 16% phosphorus (about 2:1) and microminerals. These supplements, fed at the same dose as calcium carbonate, usually correct the calcium and phosphorus content.

6. Is a Source of Vitamins and Other Nutrients Provided?

Supplements providing vitamins, microminerals, fatty acids and specific nutrients of concern for cats and dogs can be obtained, but they may be cumbersome to feed and greatly increase the cost of the food. An adult over-the-counter vitamin-mineral tablet that contains no more than 200% of the recommended daily allowances for people works well for both dogs and cats at one-half to one tablet per day. One tablet per day of a human adult product will not oversupplement pets with calcium, phosphorus, magnesium, vitamins A, D and E, iron, copper, zinc, iodine and selenium, according to AAFCO maximum allowances for canine and feline foods (2007). In general, veterinary supplements contribute between 0 and 300% of the vitamin-mineral requirements of dogs and cats.

Specific nutrients of concern for cats-such as arginine, arachidonic acid, L-carnitine and choline-can be purchased as individual nutrient products. However, levels in homemade cat foods are usually adequate when a combination of animal proteins is used. Cats fed a homemade formula exclusively should receive 200 to 500 mg taurine daily, depending on the calculated taurine content of the food. Iodized salt should be used whenever salt is added to the food. It is difficult to meet the iodine requirement without using the iodized form (400 µg of iodine/6 g [1 tsp] sodium chloride). The alternative is to prescribe the canine or feline supplement designed for homemade foods.[a]

Making Ingredient Substitutions

When formulating a homemade recipe, proportions of carbohydrate, protein, fat and fiber must be maintained. **Table 10-10** suggests starch, meat, fat and fiber ingredient substitutions and their relative nutrient values. When substituting one ingredient for another, determine the relative nutrient value of the old ingredient and that of the replacement ingredient. If the old

Table 10-9. Nutrient profiles of cooked grains and vegetables for homemade foods.

Cereal	Calories*	Total carbohydrate**	Sugar**/***	Protein**	Dietary fiber**	Fat**
Corn	352	81	12.2	9.0	6.1	4.3
Chickpeas	412	68	3.0	22.0	12.3	6.5
Barley	388	85	2.0	10.6	20	3.2
Peas	383	72	19.5	24.6	25.9	2.0
Potato	374	87	2.0	7.4	6.5	<1.0
Rice, brown	411	85	1.5	9.6	6.3	3.3
Rice, white	406	87	<1.0	8.4	1.6	<1.0
Rice, instant	408	88	1.4	8.6	3.3	<1.0
Soybean	467	27	8.1	44.9	17.0	24.3
Wheat (pasta)	422	80	<1.0	16.7	6.5	3.2

*Expressed on a kcal/100 g dry matter.
**Expressed on a percent dry matter basis.
***Readily available sugars (e.g., mono- and disaccharides).

recipe recommended 75 g of rice, and the owner would like to use pumpkin instead of rice, 200 g of pumpkin will be needed to supply the same amount (15 g) of carbohydrate as 75 g of rice (**Table 10-10**). As fed weights of foods can be found at the USDA National Nutrient Database (www.nal.usda.gov/fnic/foodcomp/search).

Several methods can be used to formulate homemade foods. Veterinary nutritionists in North America commonly use nutrition software programs such as those listed in Chapter 1. Most practicing veterinarians in North America either contact a veterinary nutritionist directly or use one of these software programs. A third method is to hand calculate the formulation using these steps: 1) determine the ingredients to be used from each food category (**Table 10-10**) and 2) determine the appropriate amount of each ingredient that will supply the needed amount of nutrient for the dog or cat. Each ingredient supplies more than just one nutrient (e.g., rice supplies carbohydrates and some protein). However, this simplified method of formulating a homemade food minimizes nutrient deficiencies by providing overlapping sources of nutrients.

Nutritionally Adequate Recipes

Tables 10-7 and **10-8** are homemade food recipes for healthy adult dogs and cats, respectively. These recipes should be considered all-purpose foods. It should be noted that all-purpose foods do not provide the ideal nutrient profile for most dogs and cats. All-purpose foods, however, provide excess nutrients to adult and older cats and dogs (Chapters 13, 14, 20 and 21).

There are also homemade food recipes for clinical patients. **Table 10-2** contains recipes for reduced protein/low-phosphorus foods for dogs and cats with kidney disease. **Table 10-3** contains recipes for low-fat/high-fiber foods for overweight dogs and cats. **Table 10-4** contains recipes for low-sodium/low-mineral foods for dogs and cats with heart disease. **Table 10-5** is a recipe for a low-protein/low-purine food for dogs with urinary calculi. **Table 10-6** is a recipe for a low-residue food for dogs with gastrointestinal disease.

Because these foods are for clinical patients, it is imperative that clients follow these recipes meticulously. Well-intentioned but ill-informed substitutions or other modifications could result in ineffective, or even counterproductive, nutritional therapy. Furthermore, it is unlikely that these recipes will be as effective as commercial foods in managing clinical patients, even when followed closely.

Box 10-2. Effect of Meat Substitutions on Fat and Energy Levels in Homemade Recipes.

The fat content of the animal protein source in homemade pet food recipes can greatly affect the energy density of the food. In general, animal protein sources such as fish, beef, turkey, chicken and mutton or lamb have similar protein and amino acid contents (**Table 1**). As a result, they can usually be substituted for one another on an as fed basis in most typical homemade food recipes. On the other hand, the fat content and therefore the energy density can increase greatly depending on whether the cut of meat is regular (typical), lean or extra lean (**Table 2**). See **Table 10-10** for more information about ingredient substitutions.

Table 1. Protein and energy content of interchangeable protein sources for a homemade cat food recipe (as fed).

Protein/energy	Lean beef	Chicken	Tuna
Protein	28	28	29
kcal ME/g	4.5	4.4	4.4
kJ ME/g	18.7	18.5	18.2

Table 2. Protein, fat and energy density of ground beef (30 g) with varying fat levels (as fed).

Protein/ fat/energy	Extra lean (>90%)	Lean (>80%)	Regular (<80%)
Protein (g)	7	7	7
Fat (g)	3	5	8
Energy (kcal)	55	73	100
Energy (kJ)	230	305	418

The Bibliography for **Box 10-2** can be found at www.markmorris.org.

Table 10-10. Cooked ingredient substitution lists.

Ingredients	Major nutrient	18-kg (40-lb) dog	4.5-kg (10-lb) cat
Starch, cooked	Carbohydrate	60 g	12 g
Meat, cooked	Protein	28 g	9 g
Fat	Fat	10 g	10 g
Fiber	Dietary fiber	10 g (max)	5 g (max)

Starch: These foods in these amounts yield 15 g carbohydrate with 3 g protein, trace fat and 80 kcal

Bread	25 g	Breadsticks, raisin, rye, whole wheat, white
	30 g	Bagel, English muffins, buns, rolls, pita, tortilla
Cereal	20 g	Ready to eat cereals
	25 g	Bran cereals, shredded wheat
	30 g	Bran flakes, Chex
	100 g	Cooked cereals and grits
Grains	20 g	Cornmeal, flour, cornstarch, popcorn, tapioca
	75 g	Rice
	100 g	Barley, pasta
Vegetables	50 g	Baked beans, sweet potato
	75 g	Beans, peas, lentils, plantain
	80 g	Corn
	100 g	Corn on the cob, lima beans, green peas, potato, yam
	150 g	Squash, parsnips
	200 g	Pumpkin

Protein: Should be weighed after cooking and after bone, skin and excess fat have been removed
Low fat: These foods in these amounts yield 7 g protein with 3 g fat and 55 kcal

Beef	30 g	Baby beef, chipped beef, flank tenderloin, plate ribs, round (bottom, top), all rump cuts, lean spareribs, tripe, ground beef (>90% lean) and USDA good and choice
Dairy	30 g	Cottage cheese
	45 g	Cheeses (low fat 3 g or less/oz.)
Fish	30 g	Any fresh or frozen, tuna or mackerel canned in water
Mixed meats	30 g	Low-fat luncheon meats with 3 g fat or less /oz., >90% lean
Pork	30 g	Leg, tenderloin, ham, Canadian bacon
Poultry	30 g	Chicken or turkey meat without skin
	90 g	Egg whites
Seafood	30 g	Clams, crab, lobster
	50 g	Scallops
	60 g	Shrimp
	90 g	Oysters
Veal	30 g	Leg, loin, rib, shank, shoulder
Wild game	30 g	Venison, rabbit, squirrel, pheasant, goose without skin

Medium fat: These foods in these amounts yield 7 g protein with 5 g fat and 73 kcal

Beef	30 g	Ground beef (>80% lean), corned beef, ribeye
Dairy	30 g	Cheese: mozzarella, ricotta, farmer
Fish	30 g	Tuna, salmon canned in oil, drained
Lamb	30 g	Leg, rib, sirloin, loin, shank, shoulder
Mixed meats	30 g	Low-fat luncheon meats with 3-5 g fat/oz., 85-90% lean
Organ meats	30 g	Liver, kidney, heart, sweetbreads
Pork	30 g	Loin, shoulder arm and blade, butt
Poultry	30 g	Chicken or turkey meat with skin, duck and goose well-drained of fat
	50 g	Egg whole
Veal	30 g	Cutlet
Vegetable	120 g	Tofu

High fat: These foods in these amounts yield 7 g protein with 8 g fat and 100 kcal

Beef	30 g	Ground beef (<80% lean), brisket, chuck, ribs, USDA prime
Dairy	30 g	Cheese spreads, all regular American, blue, cheddar, Monterey, Swiss
Lamb	30 g	Breast, ground
Mixed meats	30 g	Cold cuts, sausages
	45 g	Frankfurter
Pork	30 g	Spareribs, back ribs, ground, country style and deviled ham, sausage
Veal	30 g	Breast
Vegetable	30 g	Peanut butter

Fats: These foods in these amounts yield 5 g fat with 45 kcal

Monounsaturated	5 g	Margarine with soybean, cottonseed, partially hydrogenated oils, peanut oil, olive oil
Polyunsaturated	5 g	Soft tub margarine, oil (safflower, corn, sunflower, cottonseed, sesame)
	15 g	Diet margarine with safflower, corn, sun–flower oil
Saturated	5 g	Chicken fat, beef fat, bacon fat, lard, butter, shortening
	15 g	Heavy cream, cream cheese
	30 g	Sour cream, nondairy substitutes, gravy
	45 g	Light cream, half & half

Fiber: Grams of dietary fiber per 100 g of these foods

Low (0-2 g)	Asparagus, cucumber, lettuce, zucchini, alfalfa sprouts, eggplant, mushrooms, celery, green pepper, tomatoes
Medium (2-4 g)	Bamboo shoots, carrots, peas, string beans, bean sprouts, chickpea, pinto beans, summer squash, broccoli, cauliflower, pumpkin, turnips, cabbage, kidney beans, spinach, watercress
High (5 g or more)	Beans (white, red, lima, black, broad, soy)

Additional Instructions

Specific instructions for preparing, storing and feeding of homemade foods should be given to pet owners. Explaining the importance of a balanced food and providing practical recommendations about how to mix and cook the food will increase compliance. Some owners may even prefer a commercially prepared food when they realize what is involved in preparing a balanced homemade recipe.

Some owners and breeders encourage the use of uncooked meat and eggs in their homemade pet food recipes. Pet owners should be informed that uncooked meat and eggs can harbor pathogenic bacteria that are normally killed during cooking (Chapter 11). Animal ingredients (meat and eggs) should be cooked for at least 10 minutes at 82°C (180°F). Vegetable ingredients should be washed or rinsed and cooked if increased digestibility is desired. Owners can make homemade foods that lack preservatives and antioxidants in three- to seven-day batches but must refrigerate the food in airtight containers between meals (0 to 4°C [32 to 40°F]). Larger quantities of food can be frozen (-20°C [<0°F]). Because homemade foods

are relatively high in moisture and lack a preservative system, they are highly susceptible to bacterial and fungal growth when left at room temperatures for more than a few hours. Pet owners who feed homemade foods must also check the food daily for color and odor changes that may indicate spoilage or deterioration. Clients should be advised of these food safety issues when feeding homemade foods (Chapter 11).

Pet owners should be encouraged to use a dietary gram scale to weigh ingredients. Later, they can convert weights to volumes for easier compounding. Ingredient compositions are published in different ways. For example, some recipes specify cooked rice, whereas others specify rice to be weighed as purchased. Formulation must take this variability into account, and the owner should be informed about it.

Cooking is necessary to improve the digestibility of starch in carbohydrate sources (Walker et al, 1994; Wolter, 1982). Cooking also destroys anti-nutrient factors that may be present (e.g., anti-trypsin in soybeans, thiaminase in some fish). However, carbohydrate and animal protein sources should be cooked separately. Carbohydrate sources need a longer cooking time to increase digestibility, due to swelling and gelatinizing of starch granules. Meat and liver, on the other hand, should not be overcooked to avoid protein denaturation. Cooking vegetables may increase starch digestibility, but does not decrease the value of vegetables as a source of fiber. Longer cooking times, however, may increase vitamin losses (Meyer, 1990).

After cooking, all ingredients should be thoroughly mixed in a blender to prevent the animal from picking out single food items. An unbalanced intake of nutrients may occur if ingredients of a nutritionally balanced homemade food are allowed to separate and the animal does not consume the entire mixture. Be sure the owner understands the dietary formulation only approximates the recommended nutrient intake of the pet at a given weight for a certain number of days.

Owners should be warned that although vitamins and minerals are present in only small quantities, they are very important and are not optional. Vitamin-mineral supplements should not be cooked or heated or stored with the food. Vitamins may be destroyed by heat or oxidation. The vitamin-mineral supplement should be kept separate from the food, and administered just before, during or after a meal to ensure proper dosing. Overall digestibility and availability of vitamin-mineral supplements are improved when using USP labeled products and when these nutrients are present in the small intestine with a meal composed of proteins, fats and carbohydrates.

The food should be warmed to just below body temperature before feeding. Clients should be advised to carefully check for "hot spots" that could burn a pet's mouth after food has been rewarmed in a microwave oven. Wetting the food may improve palatability. Moisture content of homemade foods is approximately 70%, which is more similar to that of moist than dry commercial foods. Animals that favor dry forms of commercial foods may reject homemade foods.

When stored too long, the food mixture may separate and dry out, becoming less palatable. Therefore, it is best not to prepare large amounts of food that cannot be eaten in a few days. Mixing the food before warming will improve palatability.

When choosing the ingredients for specific foods, keep in mind that some ingredients are acceptable for one species, but may markedly decrease the palatability for another. For example, dogs like sugar but cats do not. When formulating a food for patients with diabetes mellitus or colitis, for example, beans and peas may be a suitable carbohydrate and protein source for dogs, but increasing the amount of these ingredients may make a food unacceptable to cats.

Vegetable and meat sources may be substituted for similar ingredients in a recipe (**Table 10-10**). Owners who feed a variety of foods decrease the risk that a particular nutrient might be below requirement long enough to cause clinical signs of deficiency. Clients should receive a list of possible substitutes, and be informed that inappropriate substitutions may jeopardize nutritional balance.

If the patient has a history of food rejection or gastrointestinal upset with food changes, advise the client to feed the homemade food without supplements for a week or so, and then add the supplements one at a time (one per week) to avoid the problem or better identify the source of the problem.

In practices where homemade foods are regularly recommended, the staff should have experience preparing the recipes to become familiar with the preparation of homemade foods. Furthermore, it is worthwhile and probably cost effective to send the most commonly recommended formulas to a food analytical laboratory to confirm the calculated analysis. In the United States, AAFCO provides valuable guidelines for minimum and maximum nutrient allowances within which a food for healthy dogs and cats should be formulated if no feeding tests are done. These guidelines may be a useful target for formulating homemade foods as well.

PATIENT ASSESSMENT/MONITORING

Patients that eat homemade foods should be brought in for regular veterinary examinations (two to three visits per year). Because the nutritional profile of homemade foods is quite variable, a nutritional review is recommended at least twice a year. If a dog or cat eats a homemade food exclusively for more than six months, the veterinarian should ask the client to record and submit a three- to five-day food history so that the nutrient profile and ingredient substitutions can be reevaluated.

The effectiveness of a food can be grossly evaluated by noting the patient's body weight, body condition and activity level. Laboratory data such as albumin level, red blood cell number and size and hemoglobin concentration are gross estimations of the animal's nutritional status and can be used with other clinical observations to evaluate homemade foods.

More specifically, the skin and hair should be examined closely and an ophthalmic examination, including evaluation of the lens and retina, should be performed. These tissues are more sensitive than others to nutritional status (Remillard et al, 1993; Glaze and Blanchard, 1983; Sousa et al, 1988; Harvey, 1994). Stool quality should also be assessed.

Veterinarians should always: 1) offer to have a homemade recipe evaluated by a nutritionist and 2) recommend the feeding of a consistent complete and balanced commercial product as often as possible. This is especially true if the pet has a medical condition for which dietary management depends on the highest level of diet consistency and quality assurance.

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ENDNOTE

a. Balance IT Supplements, DVM Consulting Prof. Corp., Davis, CA, USA.

REFERENCES

The references for **Chapter 10** can be found at www.markmorris.org.

CASE 10-1

Lethargy and Vomiting in Three Cats

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Patient Assessment

Three cats were examined for lethargy and occasional vomiting. Two cats were at their optimal body weight and condition (weight = 4.5 kg, body condition score = 3/5); one cat weighed 5.5 kg and had a body condition score of 4/5. All three cats were icteric, had elevated hepatic enzyme levels and were diagnosed as having hepatic lipidosis.

Assess the Food and Feeding Method

The owners read about pet food manufacturing in a popular cat publication and decided they no longer wanted to feed a commercially produced food to their three cats. They discarded all pet food products in the house, chose a recipe suggested in the text that suited them and began feeding the homemade food exclusively for two weeks. Two cats reluctantly ate a little food almost every day, whereas one cat refused food completely.

Questions

1. How should the veterinarian advise these clients about making food changes in the future?
2. These owners did not want to feed a commercially produced cat food because they were convinced the ingredients used were making their cats subclinically but progressively ill. What food recommendations should be made for these cats?

Answers and Discussion

1. When making food changes for cats, a gradual transition schedule that decreases the old food and increases the proportion of new food is highly recommended (Chapter 1). Generally, cats should eat daily and should not go more than three days without eating a sufficient quantity of food to meet their resting energy requirement. Hepatic lipidosis can occur in normal and overweight cats. The condition occurs more commonly when cats are completely anorectic, but can also occur in cats that have been partially anorectic for weeks to months.
2. Because the owners are convinced they should feed a homemade food, they should be offered a nutritionally adequate generic recipe or should be referred to a nutritionist who could formulate a recipe that takes into consideration their particular concerns.

Progress Notes

The three cats were fed a complete and balanced liquid feline formula for three days (30 ml every three hours) by nasogastric tube. Moist kitten food was offered free choice. Two cats began eating on Days 4 and 5 and were discharged. The third cat progressively deteriorated and was euthanatized on Day 5.

CASE 10-2

Weight Loss in an Older Cat

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Patient Assessment

The owner of a 17-year-old, neutered female domestic shorthair cat with chronic renal failure requested a recipe so she could cook for her cat at home. The owner thought the cat's poor appetite would improve if the cat were fed a food that contained chicken, the cat's favorite ingredient. She asked the veterinarian to review a homemade recipe she obtained from a cat breeder. The cat weighed 3.2 kg (7 lb) and had a body condition score of 2/5.

Assess the Food and Feeding Method

The recipe's nutrient content follows:

Ingredient	(g)	(%)
Meat (chicken, white)	25	25
Rice or pasta	55	55
Vitamin-mineral supplement	13	13
Brewer's yeast	5	5
Spirulina (blue green algae)	2	2

Question

Using the quick check guidelines for homemade foods (See chapter text.), what suggestions should be made about nutrients, ingredient levels and food preparation?

Answer and Discussion

The meat source should constitute at least 30% of the as fed homemade food and contain more fat. The recipe as presented contains virtually no fat. This cat is underweight and has a less than optimal body condition score; it needs a more energy dense food. If the cat prefers white meat then approximately 10 to 20 g of fat is necessary. Chicken skin, beef fat or vegetable or fish oils may be used to constitute at least 10% of the as fed weight of the food.

The food needs a calcium source, such as 0.3 g of calcium carbonate per day. Review the vitamin-mineral supplement label to ensure the supplement contains trace minerals (copper, zinc, manganese, iron, iodine and selenium), B vitamins, vitamin A and taurine. Encourage the owner to use a dietary gram scale to weigh and blend all ingredients to prevent the cat from picking out the chicken, but administer the vitamin-mineral supplement with the meal. The revised recipe follows:

Ingredient	(g)	(%)
Meat (chicken, white)	35	31
Rice or pasta	60	52
Fat (chicken skin)	15	13
Vitamin-mineral supplement	4	3
Calcium carbonate	0.3	0.25

The client was advised to feed chicken liver once a week in place of the chicken meat. The vitamin-mineral supplement recommended was one-half of an adult vitamin-mineral tablet. Brewer's yeast adds magnesium, B vitamins, microminerals and fiber; however, nutritional yeast is fortified and has a better nutritional profile of B vitamins and microminerals. The *Spirulina* is of questionable nutritional value, but probably causes no harm.

CASE 10-3

Understanding Pet Food Labels

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Patient Assessment

A dog owner recently went to a local kennel club meeting and heard that synthetic preservatives in pet foods should be avoided. She was especially concerned about a preservative with a long name that begins with an "e." Because she didn't know which pet foods in the grocery store contained the compound, she preferred to make her dog's food at home. She asked her veterinarian to review the ingredient list and specifically asked if the ingredient called "ethylenediamine dihydroiodide" is the preservative she should avoid.

Questions

1. What is ethylenediamine dihydroiodide?
2. Where or how can this information be found?
3. What should be the recommendation to the dog owner?

Answers and Discussion

1. Ethylenediamine dihydroiodide is a source of iodine in pet foods in the United States. It is not the preservative ethoxyquin.
2. The Association of American Feed Control Officials (AAFCO) manual provides this information. Alternatively, the pet food company could be contacted directly.
3. The owner need not be concerned about feeding ethoxyquin; however, if she wishes to avoid this preservative, she could choose a commercial pet food product preserved with other antioxidants (e.g., a natural preservative). A commercially prepared complete and balanced pet food is preferable to a homemade food.

CASE 10-4

Back Pain and Weakness in a Springer Spaniel

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Patient Assessment

A 13-month-old female English springer spaniel was examined for chronic small bowel diarrhea of seven months' duration. The dog weighed 5.5 kg and had a body condition score of 2/5.

Assess the Food and Feeding Method

The owner was unwilling to feed any commercially produced dog food because "he had tried them all and none of them ever worked." According to the client, the dog does well and had normal stools when fed a homemade food containing only one part boiled white chicken and two parts instant rice. The pet owner would like for the veterinarian to balance this food.

The veterinarian gave the client the following recipe:

Ingredient	(g)	(%)
Chicken, dark meat with skin	80	24
White rice, cooked	250	74
Calcium carbonate	0.6	0.2
Vitamin-mineral supplement	8	2
Salt (NaCl), iodized	0.4	0.1

The owner was also given a printed complete set of instructions and cautions.

Reassessment

Six months later the dog presented with severe back pain, rear leg weakness, inappetence, depression and lethargy. The dog ate the homemade food exclusively for six months and had few episodes of diarrhea. The dog's serum calcium concentration was 8.9 mg/dl (reference range = 9 to 11 mg/dl). The dog's serum albumin concentration was normal.

Questions

1. What additional information would be important to obtain about feeding the homemade food?
2. What is the most likely food-related problem given the clinical signs of generalized muscle weakness and lethargy?
3. What common omission do clients who feed a homemade food often make?

Answers and Discussion

1. The recipe should be checked item by item to ascertain whether the owner is following the recipe and then the instructions for mixing and feeding the food should be reviewed with the client.
2. Long-term feeding of a calcium-deficient food can result in marked muscle weakness, lethargy and osteoporosis.
3. Omitting the vitamin-mineral supplement is a common error made by owners who feed a homemade food.

Progress Notes

After reviewing the food formulation with the owner, he admitted that he had not been giving calcium carbonate supplementation because it was inconvenient to give the dog one (0.5 g calcium carbonate) tablet per day. Ten percent calcium gluconate solution was administered intravenously at 15 mg/kg slowly over one hour. Within hours the dog's attitude improved and the dog was able to stand. The dog was apparently difficult to medicate, so liquid or powdered supplements mixed in the food were suggested.