

# ROLE OF DIETARY FATTY ACIDS IN DOGS & CATS

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- Encourage continuing education for both specialists and general practitioners
- Promote evidence-based research
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The goal of this column is to provide the latest in unbiased and evidence-based veterinary nutrition from the foremost experts irrespective of their places of employment. We, as always, welcome your feedback on the column and hope the material herein proves of value in your practice.

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Dietary fats, as well as specific fatty acids, are essential in the diet of dogs and cats, as recognized in the nutrient recommendations for pet food provided by the National Research Council (NRC) and the Association of American Feed Control Officials (AAFCO).<sup>1,2</sup> Fats and fatty acids:

- Provide energy
- Aid in fat-soluble vitamin absorption
- Modulate inflammation
- Act as a precursor to eicosanoids and prostaglandins
- Serve structural roles as a component of cell membranes
- Promote healthy growth and development
- Affect skin and coat health.<sup>1</sup>

The type of fatty acids fed to a patient, as well as the total amount of fatty acids in the diet, have the additional potential to improve or impair health. This review discusses basic properties of fatty acids; sources of essential fatty acids; therapeutic modifications of dietary fatty acids, fish oils, and other fatty acid supplements; and areas of caution in clinical practice when supplementing fatty acids.

TABLE 1.  
Essential Fatty Acids with Numeric Formula

COMMON NAME (Abbreviation)	NUMERIC FORMULA (chain length:double bonds)	LOCATION OF FIRST DOUBLE BOND (relative to omega end of chain)
Linoleic acid (LA)	18:2	Omega-6
Alpha-linolenic acid (ALA)	18:3	Omega-3
Arachidonic acid (AA)	20:4	Omega-6
Eicosapentaenoic acid (EPA)	20:5	Omega-3
Docosahexaenoic acid (DHA)	22:6	Omega-3

### BASIC PROPERTIES OF FATTY ACIDS

Fatty acids are classified as *lipids*, a larger macronutrient class that serves a structural role and provides energy, among other functions. Lipids include phospholipids and cholesterol as well as fats, oils, and fatty acids.

#### Classification of Fatty Acids

The functions of different fatty acids depend on their structure and composition. Fatty acids are classified based on:

- Length of the hydrocarbon chain
- Number of double bonds present in the chain
- Location of the first double bond relative to the methyl, or omega, end of the hydrocarbon chain (**Figure**).

Fatty acids are considered short-chain (< 8 carbons in length), medium-chain (8–12 carbons), or long-chain (> 12 carbons). The number of carbons in the chain gives the fatty acid different properties in terms of digestion, absorption, and usage.<sup>1</sup>

Fatty acids are further defined by the number of double bonds: saturated fats contain no double bonds, monounsaturated fats contain 1 double bond, and polyunsaturated fats contain 2 or more double bonds.

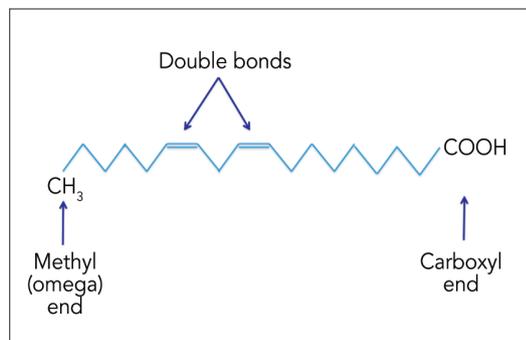


FIGURE. Chemical structure of linoleic acid (18:2, omega-6), with important features noted.

Fatty acids with double bonds are called omega-9, omega-6, or omega-3 based on the location of the first double bond from the methyl (omega) end of the hydrocarbon chain. For example, omega-6 fatty acids, often found in animal tissue and in sunflower and safflower oils, have their first

double bond between carbons 6 and 7 from the omega end, whereas omega-3 fatty acids, derived from plant and marine sources, have their first double bond between carbons 3 and 4.

#### Essential Fatty Acids

Dogs and cats require omega-6 and omega-3 fatty acids in the diet because they cannot produce these essential fatty acids on their own.<sup>1</sup> Essential fatty acids and their numeric formulas are listed in **Table 1**.

The **omega-6 essential fatty acids** are linoleic acid (LA, containing 18 carbons with 2 double bonds [18:2]) and arachidonic acid (AA, 20:4). LA is essential for both dogs and cats, whereas AA is essential only for cats. Cats require AA due to the lack of delta-6 desaturase, an enzyme required for endogenous conversion of LA to the longer and more unsaturated fatty acid AA.<sup>3</sup>

It is important to note that these omega-6 fatty acids cannot be endogenously produced in sufficient quantities. They must be provided in the diet to prevent signs of deficiency. Deficiency of omega-6 fatty acids can cause skin and coat abnormalities, reproductive problems, and failure to thrive.<sup>1</sup>

The **omega-3 essential fatty acids** are alpha-linolenic acid (ALA, 18:3), eicosapentaenoic acid (EPA, 20:5), and docosahexaenoic acid (DHA, 22:6). EPA and DHA are found primarily in marine sources, including fish oil as well as phytoplankton and other marine plants.

As a result of the poor conversion of ALA to EPA and DHA,<sup>4,7</sup> the NRC lists dietary requirements for EPA and DHA for both dogs and cats.<sup>8</sup> However, requirements vary among different life stages; for example, growing puppies and kittens require more DHA than adult dogs and cats. Omega-3 fatty acid deficiency may result in neurologic abnormalities, such as decreased visual acuity.<sup>1</sup>

TABLE 2.  
Minimum Requirements of Essential Fatty Acids in Grams/1000 kcal<sup>2,8</sup>

	DOGS (Growth)	DOGS (Adult Maintenance)	CATS (Growth)	CATS (Adult Maintenance)
<b>Total Fat</b>				
NRC RA	21.3	13.8	22.5	22.5
AAFCO	21.3	13.8	22.5	22.5
<b>Linoleic Acid</b>				
NRC RA	3.3	2.8	1.4	1.4
AAFCO	3.3	2.8	1.4	1.4
<b>Arachidonic Acid</b>				
NRC RA	0.08	ND	0.05	0.015
AAFCO	ND	ND	0.05*	0.05*
<b>Alpha-linolenic Acid</b>				
NRC RA	0.2	0.11	0.05	ND
AAFCO	0.2	ND	0.05	ND
<b>Eicosapentaenoic Acid + Docosahexaenoic Acid</b>				
NRC RA	0.13	0.11	0.025	0.025
AAFCO	0.1	ND	0.03	ND

ND = not determined; RA = recommended allowance

\* Corrected after original publication by AAFCO

## ESSENTIAL FATTY ACIDS IN THE DIET

### Dietary Requirements

It is recommended that all pet food provide essential omega-6 and omega-3 fatty acids. Minimum requirements for total fat, LA, ALA (except for adult cats), EPA + DHA, and AA are published by the NRC, and minimum requirements for the concentration of crude fat, LA, ALA, AA (cats only), and EPA+DHA in pet food are listed in the AAFCO nutrient profiles.<sup>2,8</sup> These minimum requirements are listed in **Table 2**.

### Sources of Essential Fatty Acids

Sources of LA and ALA are plant-based oils,

including corn oil, soybean oil, canola oil, and flaxseed oil. AA is found typically in animal fat, with little to no AA present in plant oils and seeds.<sup>1</sup>

As of 2016, EPA and DHA are described in AAFCO nutrient profiles for growth and reproduction, and the NRC lists these fatty acids as essential. As a result, many pet foods contain sources of EPA and DHA. Fish oil is the main dietary source of EPA and DHA.

Common oils used in pet food and their saturated and essential fatty acid content can be found in **Table 3**. More information regarding sources of essential fatty acids can be found elsewhere.<sup>9</sup>

TABLE 3.  
Common Oils Used in Pet Food and Fatty Acid Content (grams/100 g)<sup>a</sup>

	Saturated Fatty Acids (total)	LA 18:2 n-6	ALA 18:3 n-3	AA 20:4 undifferentiated	EPA 20:5 n-3	DHA 22:6 n-3
<b>Corn oil</b>	12.948	53.230	1.161	0	0	0
<b>Canola oil</b>	7.365	18.640	9.137	0	0	0
<b>Flaxseed oil</b>	8.976	14.246	53.368	0	0	0
<b>Fish oil, menhaden</b>	30.427	2.154 <sup>b</sup>	1.490 <sup>c</sup>	1.169	13.168	8.592

a. USDA Food Composition Database, [ndb.nal.usda.gov](http://ndb.nal.usda.gov)

b. 18:2 undifferentiated

c. 18:3 undifferentiated

n-3 = omega-3; n-6 = omega-6

TABLE 4.  
**Components of a Dietary History**

Information about diet, including:

- Type
- Amount
- Frequency of feeding
- Duration of feeding

Information about other foods fed, including:

- All treat types and frequency
- Table scraps/human food amounts and frequency
- Food for medication administration
- Food for training
- Dietary supplements
- Any other food or treats

Information about what other pets in the household eat

### Quality of Supplement

If supplementing a diet with fatty acids, it is important to choose a quality supplement. When choosing a fish oil supplement, take special care to select one from a reputable company with good quality control practices. Potential exists for nutrient excess (mainly vitamins A and D) and toxin exposure, including mercury exposure with fish oil supplements.<sup>10</sup> Calling a manufacturer to inquire about quality control testing and consulting an independent (third party) evaluator are 2 ways to ensure the supplement quality.

### DIETARY FATTY ACIDS: BODY CONDITION & DISEASE

Dietary fat levels can be adjusted to help manage disease. Adjusting the amount of dietary fat and specific fatty acids can also affect the energy density of a pet food.

#### For Body Condition

At 8.5 kcal/g, dietary fat is more than twice as energy dense as protein and carbohydrate (each 3.5 kcal/g).<sup>11</sup>

- **Higher fat diets** (when tolerated) can increase the energy density of a diet, aiding in weight gain without significantly increasing the volume of food needed to improve body condition.
- **Lower fat diets**, which are lower in energy density, can help with weight loss, while providing required essential fatty acids and allowing a patient to consume a larger volume of food without significantly increasing caloric intake.

#### For Disease: Fat Restriction

Not all patients can tolerate average amounts of dietary fat. Managing conditions, such as hyperlipidemia, canine pancreatitis, and lymphangiectasia, often necessitates dietary fat restriction (< 20% of total calories from fat).<sup>12-14</sup> In some patients, therefore, dietary fat restriction is used as an adjunct therapy in disease management, despite the animal's body condition and the desired energy density for its diet.

Before implementing fat restriction, however, a dietary history should be obtained (**Table 4**). This helps ensure that, when the patient's nutritional plan is adjusted, dietary fat is restricted relative to the previous diet. It is also imperative that essential fatty acid requirements be met despite fat restriction. A low fat diet can be provided that meets fatty acid requirements, with most dietary fat coming from essential fatty acids, including LA, ALA, AA, EPA, and DHA.

Overall, a nutritional assessment and plan should ensure adequate energy and nutrient intake for the patient despite fat restriction. A thorough nutritional assessment includes assessment of animal factors, dietary factors, and feeding management and environmental factors.<sup>15</sup>

#### For Disease: Supplementation

Fatty acids, especially EPA and DHA, have a number of therapeutic uses in dogs and cats that are summarized elsewhere.

TABLE 5.  
**EPA + DHA for Adult Maintenance: Intake, Allowance, Safe Upper Limit, & Doses<sup>8</sup>**

	ADEQUATE INTAKE	RECOMMENDED ALLOWANCE	SAFE UPPER LIMIT	SUGGESTED SUPPLEMENTAL DOSE*
<b>Dog</b> (body weight, 10 kg)	169 mg (0.03 × 10 <sup>0.75</sup> )	169 mg (0.03 × 10 <sup>0.75</sup> )	2080 mg (0.37 × 10 <sup>0.75</sup> )	500–750 mg (50–75 mg/kg × 10 kg)
<b>Cat</b> (body weight, 5 kg)	7.3 mg (0.0025 × 5 <sup>0.67</sup> )	7.3 mg (0.0025 × 5 <sup>0.67</sup> )	NA	150–250 mg (30–50 mg/kg × 5 kg)

NA = information not available

\* To avoid exceeding the safe upper limit and potential adverse effects, include fatty acids present in the main diet as part of the total supplemental dose.

- Supplemental fish oil is used as adjunctive therapy for inflammatory conditions, such as inflammatory skin disease and osteoarthritis, cancer, hyperlipidemia, and cardiac disease.<sup>16</sup>
- DHA is supplemented in growth diets to support optimal retinal function and neuronal development.<sup>17</sup>
- Supplementation with fatty acids, including LA and EPA/DHA, is used to treat dermatologic disease.<sup>1,18,19</sup>

If fatty acid supplementation is indicated, a full clinical assessment, including medical and dietary history and physical examination, is necessary to determine the most appropriate fatty acid supplement for the patient.

### AREAS OF CAUTION IN CLINICAL PRACTICE

Although fatty acids are essential nutrients and provide many benefits to dogs and cats, providing too much dietary fat or excessive fish oil supplementation can have detrimental effects:

- In patients in which dietary fat restriction is recommended—such as those prone to hyperlipidemia or other diseases associated with fat intolerance—supplementation of additional fatty acids could be detrimental.
- Omega-3 fatty acid supplementation can result in potential adverse effects, including gastrointestinal signs (ie, vomiting or diarrhea), decreased platelet aggregation, alterations in immune function, decreased wound healing, and nutrient–drug interactions.<sup>10</sup>

Due to the potential for detrimental effects, use caution when recommending high fat diets or fish oil supplements in certain patients.

Use **high fat** diets with caution in patients that:

- Are overweight or obese (due to high calorie content of dietary fat and fatty acid supplements)
- Have fat-intolerant conditions, such as hyperlipidemia, canine pancreatitis, or lymphangiectasia.

Use caution when recommending **fish oil supplements** in patients:

- With thrombocytopenia, large or nonhealing wounds, or gastrointestinal disease
- Receiving drugs that alter platelet function, such as aspirin.<sup>10</sup>

### FISH OIL SUPPLEMENTATION & DOSING

Fish oil is a commonly used supplement in dogs and cats and is added to many pet foods. Some manufacturers supplement with flaxseed oil, which is a rich source of ALA, instead. However, the conversion rate of ALA to EPA is very low in dogs, and production of AA and EPA from LA and ALA, respectively, is virtually zero in cats due to low activity of the enzyme delta-6 desaturase.<sup>3,4,6</sup>

Therefore, if the goal is therapeutic supplementation of specific fatty acids, such as omega-3s, those particular fatty acids likely need to be provided in the diet. For example, the most efficient way to increase EPA and DHA in a pet's diet is to provide these fatty acids in a supplemental form, such as fish oil. It can be challenging, however, to supplement EPA and DHA in the form of fish oil capsules to large dogs because EPA and DHA concentrations in standard fish oil capsules are not extremely high.

#### Dosing Calculations

Several methods can be used to calculate a dose for a fish oil supplement, and there is no consensus on the most appropriate way to dose EPA and DHA. Fish oil can be dosed as:

- Milligrams EPA + DHA (combined) per kg body weight (body weight<sup>0.75</sup>) or per kg metabolic body weight (body weight<sup>0.67</sup>)
- Grams per 100 g of food on an as fed or dry matter basis
- Grams per 1000 or 100 kcal of diet fed
- An omega-6 to omega-3 ratio.<sup>20</sup>

Although more research is needed to determine the most appropriate dose and dosing method, I typically dose fish oil at:

- **Dogs:** 50 to 75 mg EPA + DHA (combined) per kg body weight
- **Cats:** 30 to 50 mg/kg.

#### Considerations of Supplementation

When recommending fish oil supplementation for a patient whose food already contains EPA and DHA, consider reducing the dose of supplemental fish oil. Some diets, such as those designed for skin or joint disease, contain significant quantities of EPA and DHA. With these diets, additional supplementation of EPA and DHA may exceed the NRC safe upper limit for a particular patient, and could be potentially harmful.

On the other hand, not all diets or supplements that contain “omega-3 fatty acids” include EPA or DHA. Therefore, reading the ingredient list or supplement information is necessary. In many cases, it may be necessary to call a manufacturer to get the EPA, DHA, and ALA concentrations in a diet or supplement.

#### Recommended Allowances & Upper Limits

The NRC has established an adequate intake and a recommended allowance for EPA + DHA for all canine and feline life stages. In addition, a safe upper limit of 2.8 g EPA + DHA per 1000 kcal has been established for puppies, adult dogs, and reproducing dogs. No safe upper limit has been published for cats at any life stage.<sup>8</sup> Therefore, I use more caution when supplementing EPA and DHA to cats.

**Table 5** provides examples of adequate intake, recommended allowance, and safe upper limit for an adult dog weighing 10 kg and an adult cat weighing 5 kg, in addition to suggested total EPA + DHA doses for patients requiring fish oil supplementation.

**IN SUMMARY**

Although numerous studies have investigated the potential benefits of fatty acid supplementation, the appropriate type of fatty acid and dose of the supplement are dependent on the patient, history, clinical signs, and concurrent diseases. For multiple reasons, what is appropriate for one patient may not be appropriate for another.

Before supplementing a patient with either omega-6 or omega-3 fatty acids, it is important to note that supplements, including fatty acid supplements, can

have adverse effects. In addition, although certain patients may benefit from omega-3 and/or omega-6 fatty acid supplementation, most commercial diets contain these fatty acids, albeit at varying levels.

Therefore, before supplementing any patient with fatty acids, be sure to get a full diet history and conduct both a clinical and nutritional assessment to determine the best nutritional plan.

AA = arachidonic acid; AAFCO = Association of American Feed Control Officials; ALA = alpha-linolenic acid; DHA = docosahexaenoic acid; EPA = eicosapentaenoic acid; LA = linoleic acid; NRC = National Research Council

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## CE Test: Role of Dietary Fatty Acids in Dogs & Cats

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### Learning Objective

Upon completion of this article, the reader should be able to recognize the names and classifications of essential fatty acids, discuss the benefits and precautions of dietary fatty acids in small animal veterinary medicine, and give examples of when to use high fat diets or fatty acid supplements and when to avoid them.

### Article Overview

This article provides an overview of the roles of fatty acids in canine and feline medicine, including basic properties of fatty acids, sources of essential fatty acids, therapeutic modifications of dietary fat and fatty acids, and areas of caution when supplementing fatty acids.

1. Which of the following is an omega-6 fatty acid and is essential for dogs?
  - a. Arachidonic acid
  - b. Linoleic acid
  - c. Alpha-linolenic acid
  - d. Eicosapentaenoic acid
2. True or false: Vegetable oils are a good source of arachidonic acid.
  - a. True
  - b. False
3. Which of the following oils is likely to provide the highest concentrations of essential fatty acids?
  - a. Coconut oil
  - b. Corn oil
  - c. Olive oil
  - d. Beef tallow
4. Supplementation of which of the following oils has the highest concentration of alpha-linolenic acid?
  - a. Corn oil
  - b. Canola oil
  - c. Flaxseed oil
  - d. Fish oil
5. True or false: Diet selection should be based on dietary history in addition to the patient's medical conditions.
  - a. True
  - b. False
6. Which of the following nutrients is the most energy dense?
  - a. Protein
  - b. Fat
  - c. Carbohydrate
  - d. Vitamins
7. Caution should be used when supplementing fish oil in which of the following types of patients?
  - a. Thrombocytopenic patients
  - b. Patients with large non-healing wounds
  - c. Patients with gastrointestinal disorders such as vomiting or diarrhea
  - d. All of the above
8. High fat diets should be used with caution in which of the following types of patients?
  - a. Overweight patients
  - b. Patients with hyperlipidemia
  - c. Patients with pancreatitis
  - d. All of the above
9. Docosahexaenoic acid (DHA) is often supplemented specifically for which types of patients?
  - a. Puppies and kittens
  - b. Patients with cancer
  - c. Patients with dermatologic disease
  - d. Osteoarthritic patients
10. Which of the following is NOT an essential omega-3 fatty acid?
  - a. Alpha-linolenic acid
  - b. Arachidonic acid
  - c. Eicosapentaenoic acid
  - d. Docosahexaenoic acid



### Note

Questions online may differ from those here; answers are available once CE test is taken at [vetmedteam.com/tvp.aspx](http://vetmedteam.com/tvp.aspx). Tests are valid for 2 years from date of approval.