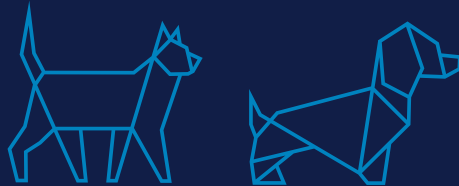


ROLES OF NUTRIENTS IN CAT & DOG DIETS



PREMIER
NUTRITION

ROLES OF NUTRIENTS IN CAT & DOG DIETS

This document is intended to give an overview of the key nutrients supplied in premixes to supplement cat and dog diets. It is not exhaustive, and does not cover major minerals and other nutrients less commonly used in premixes.

Vitamins

Vitamins are organic compounds which help to regulate a wide range of metabolic functions. Generally, these are not synthesised from precursors in the diet (or the rate of synthesis is suboptimal), and so can therefore be classed as essential.

Vitamins are either fat soluble (such as vitamins A, D, E and K), or water soluble (for example, vitamin C and the B vitamins). The fat-soluble vitamins have functions within the fat matrix of the body e.g. cell membranes. The B-complex vitamins have their functions in the aqueous phase, mostly as enzyme co-factors. As such the enzymes involved in metabolism of fat, protein and carbohydrate rely upon these vitamins.

Excesses of fat soluble vitamins can be stored in the body, whereas excesses of water soluble vitamins are excreted. Therefore tissue levels of water soluble vitamins deplete faster in times of deficiency (over 1-2 weeks) so dietary supply is required on a daily basis. As such, generally, clinical signs associated with dietary deficiencies of water soluble vitamins would be noticed sooner than in cases of dietary deficiencies of fat soluble vitamins. Whilst animals can usually cope with a marginal supply of a vitamin for a short period of time, adequate quantities should be supplemented on a long term basis to avoid deficiencies.

When formulating a pet food and premix, consideration should be made to the background supply of vitamins from the recipe ingredients. For some vitamins these levels may be quite high in diets with high meat and fish contents (for example vitamin D in recipes high in ingredients from only fish). However, it would normally be necessary to supplement vitamins to ensure that a finished pet food is complete and balanced as background levels would not be sufficient to meet the requirements of all pets in all physiological states. It is also important to understand that there will be differences in background levels between different sources of materials (for example, chicken livers, chicken carcasses, etc.), the geographical territory from where they originate, and the season.



Along with consideration of background supply of vitamins, we also have to recognise that there will be losses during processing and throughout storage. For published industry standard data on vitamin retention during processing and storage of extruded pet foods see Petfood Technology, edited by Kvamme and Phillips (2003) and NRC (2006). Similar published data is not available for wet pet foods due to the likely greater variability in this format between recipes, packaging and processing. Processing will affect native vitamins and supplemented vitamins differently, with losses during processing of native vitamins being greater than for supplemented vitamins, which tend to be added in protected and stabilised forms.

An important factor to consider in vitamin supply and retention is the product shelf life; the finished product should contain adequate vitamins at the end of shelf life to meet animal requirements.

The best way to understand vitamin levels in finished pet food diets is by way of analysis on a regular basis. This will allow an estimation of background levels after calculations have been made considering supplemented levels and processing and storage losses.

Taurine

Whilst neither a vitamin nor a trace element, taurine has been included in this nutrient summary as it is essential for cats as they are unable to synthesise it in adequate quantities and is normally supplemented via premixes. It is also important for some breeds of dog, particularly larger breeds.

Table 1 below gives a summary of the key roles of vitamins and taurine, whether they are water soluble or fat soluble, the main feed materials that contribute to background supply of these vitamins, and a generalised guide to expected levels in finished pet foods (Premium and Super Premium) containing typical levels of meat and fish proteins.

The estimated background levels of nutrients in typical finished premium and super premium cat and dog diets should not be taken to mean that 'good' levels are adequate to meet animal allowances, but rather as a guide to understand nutrient background levels that should be considered (alongside supplementary levels) when evaluating total nutrient supply from the diet.



TABLE 1

Summary of key roles of vitamins, the main feed materials that contribute to background supply of these vitamins, and a generalised guide to expected levels in finished pet foods (Premium and Super Premium) containing typical levels of meat and fish proteins.

	ROLE	WATER OR FAT SOLUBLE	LOSSES DURING PROCESSING/ STORAGE**	PUBLISHED ALLOWANCE IN DOGS & CATS*	FEED MATERIAL SOURCES	TYPICAL BACKGROUND LEVELS***
Vitamin A	Required for general health & immunity, growth, bone formation, hair & skin condition and specifically for the sight apparatus of the eye.	Fat	Yes	Cats Dogs	Animal & fish fats/oils Liver Egg yolk Some vegetables supply beta carotene (typically those of yellow/orange/red colour) which can be utilised by dogs but not cats.	Varying depending on diet formulation & the materials used. Products with a high liver content generally have good levels.
Vitamin D ₃	Required as a precursor of the hormone 1,25 dihydroxy-cholecalciferol, which controls calcium and phosphorus in the body. It is needed for normal growth, especially of bone & teeth. Deficiency leads to bone deformities, especially in growing dogs.	Fat	Yes	Cats Dogs	Fish oils Some animal fats Egg yolk	Generally good to high levels in high fish & fish oil content diets. Varying in meat-based diets, depending on the formulation & materials used.



	ROLE	WATER OR FAT SOLUBLE	LOSSES DURING PROCESSING/ STORAGE**	PUBLISHED ALLOWANCE IN DOGS & CATS*	FEED MATERIAL SOURCES	TYPICAL BACKGROUND LEVELS***
Vitamin E	In the body, vitamin E has a role in preventing the oxidation of fats by quenching free radicals, which could otherwise lead to the destruction of key cellular apparatus, eg. DNA. Vitamin E has recently been recognised to help reduce the impact of stress from disease, excess exercise & other events, which produce free radicals. Vitamin E helps to maintain healthy organs, which are susceptible to free radical damage, such as the heart, the liver, the skin, the sex organs & the blood.	Fat	Yes	Cats Dogs	Plant seeds Vegetable oils Green plants	Low to medium
Vitamin K	Several forms of complex molecules have vitamin K activity. It is also endogenously synthesised by a healthy gut flora. It is required for blood clotting, skeletal proteins, and has some antioxidant properties. Supplementation may be required when there is a gut disturbance, eg. disease or antibiotic use.	Fat	Yes	Cats Dogs (NRC only)	Liver Eggs	Generally adequate from intestinal microbial synthesis



	ROLE	WATER OR FAT SOLUBLE	LOSSES DURING PROCESSING/ STORAGE**	PUBLISHED ALLOWANCE IN DOGS & CATS*	FEED MATERIAL SOURCES	TYPICAL BACKGROUND LEVELS***
Vitamin B ₁ (Thiamine)	Required for a healthy metabolism, growth & fertility. Deficiency leads to inappetence and general weakness.	Water	Yes Significant losses in retortion of wet pet foods	Yes Cat allowances higher than dog allowances	Liver Kidneys Legumes Yeast Eggs Whole grain cereals (high levels in the germinal portion of the grain)	Generally good in dry pet foods Low in wet pet foods Some raw fish-based diets for cats may need more attention as thiaminases can destroy thiamine
Vitamin B ₂ (Riboflavin)	Required for healthy metabolism, growth & fertility. Deficiency leads to inappetence and general weakness. A deficiency in B ₂ can impact other vitamins (folic, B ⁶ , K, D & niacin) because flavin coenzymes are involved in their metabolism.	Water	Yes	Yes	Meat meals Yeasts Oil seed meals Rice	Generally good
Vitamin B ₆ (Pyridoxine)	Required for healthy metabolism, growth & fertility. Deficiency leads to inappetence and general weakness with nervous disorders, diarrhoea & roughened skin. Kidney lesions can also occur in cats.	Water	Yes	Yes	Fish meal Poultry meal Yeast Wholegrain cereals Potatoes Oil seed meals Rice bran Eggs	Generally good



	ROLE	WATER OR FAT SOLUBLE	LOSSES DURING PROCESSING/ STORAGE**	PUBLISHED ALLOWANCE IN DOGS & CATS*	FEED MATERIAL SOURCES	TYPICAL BACKGROUND LEVELS***
Vitamin B ₁₂ (Cyanocobalamine)	Required for a healthy metabolism, growth & fertility. Deficiency leads to anaemia, inappetence & general weakness. Diarrhoea/ intestinal problems and a reduction in coat condition can also be seen.	Water	Yes	Yes Genetic abnormality in some dog breeds leads to malabsorption of cobalamin	Meat meals Fishmeal Eggs Liver Kidneys	Generally good
Niacin (Nicotinamide/ Nicotinic acid)	Required for healthy metabolism, growth & fertility. Deficiency leads to inappetence and general weakness with inflammation of the mouth, which is referred to as black tongue in dogs. The skin becomes coarse, a condition known as pellagra & animals appear unkempt. Dogs are able to synthesis niacin from tryptophan, whereas cats do not produce measurable quantities.	Water	Yes	Yes	Meat meals Fishmeal Liver Yeast Legumes Wholegrain cereals	Generally good
Pantothenate	A key component of Coenzyme A. Required for healthy metabolism, growth & fertility. Deficiencies are rare but can lead to inappetence & general weakness and gastrointestinal problems & vomiting.	Water	Yes	Yes	Organ meats (liver, heart, kidneys) Yeast Egg yolks Potatoes Wholegrain cereals	Generally good



	ROLE	WATER OR FAT SOLUBLE	LOSSES DURING PROCESSING/ STORAGE**	PUBLISHED ALLOWANCE IN DOGS & CATS*	FEED MATERIAL SOURCES	TYPICAL BACKGROUND LEVELS***
Folic acid	Required for a healthy metabolism, growth & fertility. Deficiency leads to anaemia, inappetence & general weakness, inflammation of the tongue, reduced antibody response, diarrhoea & potential birth deformities.	Water	Yes	Yes	Meat meals Liver Yeast Legumes Rice bran Green vegetables	Generally good
Biotin	Required for healthy metabolism, growth & fertility. Deficiency is rare, partly because of microbial synthesis in the gut & a good distribution in feedstuffs. If deficiency does occur, it can lead to inappetence & general weakness, and poor skin & coat condition.	Water	Yes	Cats only	Liver Yeast Oilseed meals Maize gluten feed Alfalfa	Generally good
Carnitine	Has a role in many body functions and is a vital coenzyme. Generally more than adequate amounts are synthesised in the liver by dogs and cats, however some breeds of dog have a defect in the synthetic pathway. Deficiency symptoms can include poor appetite & exercise intolerance.	Water	Yes	No	Meat meals Fishmeal Yeast	Synthesised by dogs & cats



	ROLE	WATER OR FAT SOLUBLE	LOSSES DURING PROCESSING/ STORAGE**	PUBLISHED ALLOWANCE IN DOGS & CATS*	FEED MATERIAL SOURCES	TYPICAL BACKGROUND LEVELS***
Vitamin C	Dogs & cats are able to synthesise the ascorbic acid required for normal metabolism. Ascorbic acid acts as an antioxidant in many biological reactions, and is involved in the synthesis & activation of several hormones	Water	Yes (sodium calcium ascorbyl phosphate is more stable than ascorbic acid)	Yes	Green vegetables Potatoes Fruit	Synthesised by dogs & cats
Choline	Sometimes considered as a B-complex vitamin, but required in larger amounts in the diet for healthy metabolism, growth & fertility. It acts as a methyl group donor for the synthesis of important metabolic compounds such as acetyl choline, lecithin & ceramides. Deficiency leads to poor growth, inappetence, fat metabolism problems, especially in the liver, and can lead to birth deficiencies.	Water	Yes (but very low losses)	Yes	Meat meals Fishmeal Yeast Egg yolks Legumes Oilseed meals	Generally good



	ROLE	WATER OR FAT SOLUBLE	LOSSES DURING PROCESSING/ STORAGE**	PUBLISHED ALLOWANCE IN DOGS & CATS*	FEED MATERIAL SOURCES	TYPICAL BACKGROUND LEVELS***
Taurine	Taurine is synthesized in the liver from the sulphur-containing amino acids methionine & cystine. Dogs have a greater capacity for synthesis, so taurine is not essential for dogs, whereas it is for cats. However, some large breeds of dogs may benefit from supplementation as may lamb and high fibre diets. Deficiency can result in poor fertility, congenital defects, dilated cardiomyopathy & heart failure, and retinal degeneration and blindness.	n/a	No	Yes, only for cats (but some large breeds of dog can benefit from supplementation) Requirement in canned foods higher than dry foods	Meat meals Fish meals	Generally good, but cats require supplementation

* NRC Nutrient Requirements of Dogs & Cats 2006 and FEDIAF Nutritional Guidelines for Complete & Complementary Pet Food for Cats & Dogs.

** See Petfood Technology, edited by Kvamme and Phillips (2003) and NRC (2006) for average retention figures in extruded pet foods.

*** The estimated background levels of nutrients in typical finished premium and super premium cat and dog diets should not be taken to mean that 'good' levels are adequate to meet animal allowances, but rather as a guide to understand nutrient background levels that should be considered (alongside supplementary levels) when evaluating total nutrient supply from the diet and whether these will be satisfactory to meet animal requirements at the end of shelf life.



Trace Elements

Trace elements, or micro minerals, are nutrients such as copper, zinc, iron, manganese, iodine and selenium. These nutrients usually have roles in the active sites of key proteins such as hormones, enzymes, and energy and oxygen transmission proteins. Trace elements are not considered to suffer degradation during processing or storage. However, there can be complex interactions between different minerals in terms of absorption and transport in the body.

Whilst animals can usually cope with a marginal supply of a trace element for a short period of time as there can be significant pools in the body, adequate quantities should be supplemented on a long term basis to avoid deficiencies. Excessive intakes of trace elements are toxic and can lead to the manifestation of a number of clinical signs if supplied in excess for long periods. For this reason, there are maximum permitted levels in pet foods.

When formulating a pet food and premix, consideration should be made to the background supply of trace elements from the recipe ingredients. For some trace elements these levels may be quite high in diets with high meat and fish contents (for example selenium). However, it would normally be necessary to supplement trace elements to ensure that a finished pet food is complete and balanced as background levels would not be sufficient to meet the requirements of all pets in all physiological states. It is also important to understand that there will be differences in background levels between different sources of materials, (for example, chicken livers, chicken carcasses, etc.), the geographical territory from where they originate, and the season.

The best way to understand trace element levels in finished pet food diets is by way of analysis on a regular basis. This will allow an estimation of background levels after calculations have been made considering supplemented levels.

Table 2 gives a summary of the key roles of trace elements, the main feed materials that contribute to background supply of these nutrients, and a generalised guide to expected levels in finished pet foods (Premium and Super Premium) containing typical levels of meat and fish proteins.

The estimated background levels of nutrients in typical finished premium and super premium cat and dog diets should not be taken to mean that 'good' levels are adequate to meet animal allowances, but rather as a guide to understand nutrient background levels that should be considered (alongside supplementary levels) when evaluating total nutrient supply from the diet.

In general, wet pet foods tend to have higher trace element contents (on a DM basis) compared to dry pet foods. In some cases, certain trace element supplementation may not be required (e.g. iron and manganese). However, zinc supplementation is usually required, and potentially other trace elements e.g. copper. As mentioned above the best way to understand trace element levels in finished pet food diets is by way of analysis on a regular basis.



TABLE 2

Summary of key roles of trace elements, the main feed materials that contribute to background supply of these nutrients, and a generalised guide to expected levels in finished pet foods (Premium and Super Premium) containing typical levels of meat and fish proteins.

	ROLE	LOSSES DURING PROCESSING/ STORAGE**	PUBLISHED ALLOWANCE IN DOGS & CATS*	NATURAL SOURCES	TYPICAL BACKGROUND LEVELS***
Copper	Required for healthy metabolism, growth & fertility. Copper is a component of, or essential in the activity of, many enzymes within the body, allowing fat, protein and carbohydrate to be utilised efficiently. Deficiency leads to anaemia & poor coat condition. Certain breeds have an issue with excess copper (eg. Bedlington Terrier).	No	Yes	Meat meals Fishmeal	Generally good
Manganese	Required for healthy metabolism, growth & fertility. Manganese is required as a co-factor for some of the principal enzyme cofactors of the body, which allow fat, protein and carbohydrate to be utilised efficiently.	No	Yes	Meat meals Fishmeal Cereals	Generally good Wet pet foods may not require additional supplementation but depending on the diet, some addition may be required.
Zinc	Required for healthy metabolism, growth & fertility. Zinc is a component of, or essential in the activity of, many enzymes within the body, which allow fat, protein & carbohydrate to be utilised efficiently. Deficiency leads to poor skin & coat condition (including lesions), and greater susceptibility to disease. Certain breeds have inherent deficiency (eg. Siberian Huskies, Doberman).	No	Yes	Meat meals Fishmeal Whole grain cereals Legumes Insect meals	Generally good



	ROLE	LOSSES DURING PROCESSING/ STORAGE**	PUBLISHED ALLOWANCE IN DOGS & CATS*	NATURAL SOURCES	TYPICAL BACKGROUND LEVELS***
Iron	Required for blood formation, healthy metabolism, growth & fertility. Iron is key for the formation of haemoglobin, the protein which carries oxygen in the blood. Extra is required during pregnancy and lactation and at times of growth. Iron is also required in energy transmission in cells because it is a component of proteins involved in the oxidation-reduction reactions controlling carbohydrate, fat & protein metabolism. Deficiency leads to anaemia, poor growth, lethargy & weakness and diarrhoea.	No	Yes	Meat meals Fishmeal Legumes Sweet potatoes	Generally good
Iodine	Required for healthy metabolism, growth & fertility. Iodine is required for thyroid hormone function, which is important for cell differentiation, growth & development in growing animals, and for the regulation of metabolic rate in adults. Deficiency leads to greater risks of disease and poor temperature control. In severe cases, goitres can form.	No	Yes	Seaweed Fishmeal	Low-medium Tends to be higher in high fish content diets.



	ROLE	LOSSES DURING PROCESSING/ STORAGE**	PUBLISHED ALLOWANCE IN DOGS & CATS*	NATURAL SOURCES	TYPICAL BACKGROUND LEVELS***
Selenium	Required for healthy metabolism, growth & fertility. Selenium has a major role in the enzyme glutathione peroxidase, which is an important antioxidant, protecting the body from free radical and other oxidative damage. It is also required for thyroid hormone function, which controls the metabolic rate. Deficiency is similar to vitamin E deficiency, where muscle and fertility problems are observed with a greater susceptibility to infectious diseases.	No	Yes	Fish meals Meat meals	Medium-good in high meat content diets. Good-high in high fish content diets.

* NRC Nutrient Requirements of Dogs & Cats 2006 and FEDIAF Nutritional Guidelines for Complete & Complementary Pet Food for Cats & Dogs.

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