NUTRITION OF COMPANION ANIMALS : RECENT ADVANCES

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SUMMARY

The nutritional needs of our companion dogs and cats have, and continue to be, studied and defined. Research over the past twenty years or so has revealed a number of unique feline nutritional requirements. The delivery of nutritionally complete foods has a vital role in the maintenance and health of our pets. This paper examines the current status of the nutritonal requirements of dogs and cats.

More recently research has centred on the practical requirements of feeding our pet animals and also the application of dietary restriction in the management of certain clinical illnesses. Recent advances are too numerous to review here, however the nature of the research underway is discussed by way of examples.

INTRODUCTION

Pet ownership is a bond shared by millions of Australians, with this country having one of the highest pet populations, per capita, in the world. It is estimated that 33% of all Australian households own a pet cat, whilst 38% of households own a dog. These ownership levels equate to a cat population of 2.8 million cats and a dog population of 3.1 million dogs. The prepared pet food industry in Australia commenced in earnest in the mid-1960's and has grown to provide approximately 50% of the calories fed to our pet dogs and 66% of the calories fed to our cats. In 1992 retail sales of prepared pet food were estimated to be valued at $635 million per annum.

The role of pets in our lives is a more complex interaction than often recognised and the bond we form with our pets is important to our own health and well being The food we feed our companion animals will have an important impact on their health and longevity.

Interestingly there are significant differences in the nutritional requirements of the two species and the special needs of the cat, in particular, are still being elucidated with significant new learning in the past twenty years. Research into the nutritional requirements of companion animals is directed at the maintenance of health (somewhat similarly to human nutrition). This paper will present the nutritional requirements of dogs and cats as they are currently known and discuss the direction in which companion animal nutritional research is progressing by way of current examples.

NUTRITIONAL REQUIREMENTS OF THE DOG AND CAT

Canine nutrient requirements may have changed little since dogs were first domesticated. However, knowledge and understanding of nutrient requirements and their applications have changed dramatically. Also, an examination of the nutritional requirements of the cat, as compared to other domesticated and laboratory animals, shows some striking differences and supports the view that several aspects of metabolism in the cat have evolved from the cat's adherence to a strict carnivorous diet (MacDonald et al. 1984).

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Commercially prepared foods are usually designed as “complete”. The American Association of Feed Control Officials defines a complete food as “a nutritionally adequate feed for animals other than man; by specific formula is compounded to be fed as the sole ration and is capable of maintaining life and/or for promoting production without any additional substance being consumed except water"(A.A.F.C.O. 1993). There are two general procedures that are used in determining the adequacy of a specific formula: analysis followed by comparison with known nutrient requirements and feeding trials according to recognised protocols.

For the purpose of analytical comparison the National Research Councils, publications “Nutrient Requirements of Cats” (1986) and “Nutrient Requirements of Dogs” (1985) are generally recognised as the basis for all comparisons. These two documents represent a review of nutritional research undertaken, however the stated requirements represent diets formulated principally from semi-purified diets and hence of relatively high biological value. Ingredients used to formulate practical diets rarely have such a high biological value and hence allowances must be made. The Association of American Feed Control Officials, in conjunction with industry’s representatives under the auspices of the American Petfood Institute, has recently published its own tables of nutrient requirements (A.A.F.C.O. 1993) and these endeavour to make appropriate allowances for digestibility and bioavailability of nutrients. Table 1 compares the National Research Council Requirements with those of A.A.F.C.O. Note that the A.A.F.C.O. guidelines have established maxima for certain nutrients where nutritional excess has been shown to be toxic. Compared with the requirements of the adult dog or cat, there are additional needs for the more demanding life stages of the life cycle such as growth, gestation and lactation. It has been possible to obtain more precise values for these life stages in the dog and cat than has been possible in the study of the nutritional requirements of man.

As mentioned earlier, it has been demonstrated that the cat has a number of nutritional peculiarities when compared with most other animals. These peculiarities are principally, but not exclusively, due to the lack of certain metabolic enzymes.

Vitamin A metabolism

Ahmad (1931) first discovered that the cat lacks the ability to convert the precursor,-carotene to Vitamin A and must therefore be supplied a dietary source of the preformed vitamin. The practical consequence of this peculiarity is that the cat must be supplied a diet containing at least some animal derived material.

Niacin and tryptophan metabolism

The niacin requirement of many animal species can be satisfied by synthesis of the vitamin from the amino acid, tryptophan. The cat liver, whilst having all the necessary enzymes, is incapable of producing significant amounts of niacin. It has been found that the rate of removal of an intermediate compound, -amino--carboxymuconic--semialdehyde, is so rapid via an alternative pathway that virtually no niacin is produced (Suhadolnick et al. 1957).

TABLE 1 Nutrient requirements of dogs and cats - adult maintenance

ient	Units DM basis	NRC DOGS (1985)	AAFCO (1993) DOGS Min	Max	NRC CATS[1] (1986)	AAFCO (1993) CATS Min	Max
tein	%		18.0		24.0	26.0	
Arginine	%	0.50	0.51		1.0	1.04	
Histidine	%	0.18	0.18		0.3	0.31	
Isoleucine	%	0.36	0.37		0.5	0.52	
Leucine	%	0.58	0.59		1.2	1.25	
Lysine	%	0.51	0.63		0.8	0.83	
Methionine	%				0.4	0.62	1.5
Methionine-cystine	%	0.39	0.43		0.75	1.10	
Phenylalanine-tyrosine	%	0.72	0.73		0.85	0.88	
Taurine	%				0.04	0.20[2]	
Threonine	%	0.47	0.48		0.7	0.73	
Tryptophan	%	0.15	0.16		0.15	0.16	
Valine	%	0.39	0.39		0.6	0.62	
Dispensable amino acids	%	6.26					
at	%	5.0	5.0			9.0	
Linoleic Acid	%	1.0	1.0		0.5	0.5	
Arachidonic Acid	%				0.02	0.02	
Minerals							
Calcium	%	0.59	0.6	2.5	0.8	0.6	
Phosphorus	%	0.44	0.5	1.6	0.6	0.5	
Ca:P ratio	%		1:1	2:1			
Potassium	%	0.44	0.6		0.4	0.6	
Sodium	%	0.06	0.06		0.05	0.2	
Chloride	%	0.09	0.09		0.19	0.3	
Magnesium	%	0.04	0.04	0.3	0.04	0.04	
Iron	mg/kg	31.9	80	3000	80	80	
Copper	mg/kg	2.9	7.3	250	5.0	5.0	
Manganese	mg/kg	5.1	5.0		5.0	7.5	2000
Zinc	mg/kg	35.6	120	1000	50	75	
Iodine	mg/kg	0.59	1.5	50	0.35	0.35	
Selenium	mg/kg	0.11	0.11	2	0.1	0.1	
Vitamins							
Vitamin A	IU/kg	3710	5000	50000	3333	5000	750000
Vitamin D	IU/kg	404	500	5000	500	500	10000
Vitamin E	IU/kg	22	50	1000	30	30	
Vitamin K	mg/kg				0.1	0.1	
Thiamin	mg/kg	1.0	1.0		5.0	5.0	
Riboflavin	mg/kg	2.5	2.2		4.0	4.0	
Pantothenic Acid	mg/kg	9.9	10		5.0	4.0	
Niacin	mg/kg	11.0	11.4		40	60	
Pyridoxine	mg/kg	1.1	1.0		4.0	5.0	
Folic Acid	mg/kg	0.2	0.18		0.8	0.8	
Vitamin B12	mg/kg	0.026	0.022		0.020	0.02	
Choline	mg/kg	1250	1200		2400	2400	

[1] NRC for cats is actually a statement of the nutritional requirements of growing kittens

[2] Taurine requirement inextruded products is 0.1% dm.

Choline requirement

Whilst not fully understood, it has been shown that the cat has a high requirement for the vitamin, choline (Schaeffer et al. 1982). A deficiency of choline results in poor growth rate in kittens and fatty infiltration of the liver. As choline is broadly distributed in both animal and plant material this nutritional peculiarity is of little practical consequence in the formulation of commercial pet foods.

Essential fatty acid metabolism

The dog, like most mammals, has the ability to synthesise the 20-carbon essential fatty acid, arachidonic acid, from the parent essential fatty acids, linoleic and -linolenic acids. It has been demonstrated that the cat has only limited ability to perform this conversion (Rivers 1982). This failure has been presumed to be due to a lack of -6-desaturase, involved in the conversion of linoleic acid to -linolenic acid, and -5-desaturase involved in the subsequent conversion of -linolenic acid to arachidonic acid.

Arginine metabolism

Arginine has been demonstrated to be an essential nutrient for the cat (Morris and Rogers 1978). Arginine deficiency in the cat rapidly results in severe adverse effects because of an inability to metabolise nitrogen compounds via the urea cycle, resulting in hyperammonaemia. The accumulation of ammonia in the blood stream may result in death within several hours. This unique nutritional requirement appears to be due to the cat's inability to synthesise the amino acid, ornithine, as the latter has been shown to protect the cat against the adverse effects of arginine depletion.

High protein reauirement

The higher demand for protein by the cat has been recognised for some time however, to date, the exact requirement is yet to be elucidated. The Waltham Centre for Pet Nutrition has been investigating the protein requirements of the adult cat. The higher protein requirement of the cat does not appear to be due to an increased requirement for essential amino acids, but rather a need for more total protein. This appears to be due to the cat's inability to adjust amino acid breakdown, even when receiving a low protein diet. It seems that the cat's hepatic enzymes are constantly set for a moderate to high level of dietary protein.

Taurine Taurine is an amino-sulphonic acid, which is not part of the polypeptide chain of proteins It is an end product of sulphur amino acid metabolism and is normally produced from methionine and cystine. The importance of taurine in cat nutrition was only uncovered as recently as 1975. It has been demonstrated that a deficiency was associated with central retinal degeneration (Hayes et al. 1975; Hayes et al. 1975). More recently there has been evidence that taurine deficiency may also be associated with cardiomyopathy-in the cat.

CURRENT RESEARCH ON COMPANION ANIMALS

Nutritional research activities within the pet food industry have tended to move toward investigation of some very practical considerations of the needs of our pets. The following discussion outlines some important studies currently under way. This is not an exhaustive list but serves to demonstrate the nature of the research being undertaken by way of example.

Management of obesity in dogs and cats

Obesity can be defined as "a pathological condition characterised by an accumulation of fat much in excess of that necessary for optimal body function". Built into this definition is the concept that obesity leads to some degree of physiological dysfunction and a deterioration of health.

Various studies in Europe have assessed the incidence of obesity in dogs attending veterinary practices, and figures range from 24 to 44%. The most complete study involved over 8,000 dogs (Edney and Smith 1986). Comparatively less work has been carried out with the cat; the cited incidence is about 9% in the United Kingdom. The incidence appears to be higher in the United States and this may be attributable to a common feeding practice of providing high energy density dry foods on an ad libitum basis

Most surveys conclude that the incidence of obesity increases with age; as the dog gets older, its lean body mass decreases, activity decreases (with concurrent cardiovascular problems, arthritis, ocular dysfunction) and the dog, therefore, requires less energy. It is estimated that an older dog's calorie requirement may be approximately 20% less than when it was a young, more active dog. Obesity is more common in females than males and is twice as common in neutered dogs and bitches. Certain breeds have also been shown to be more prone to obesity.

Total body water estimation has been used as a method of assessment in dogs. Water is not present in stored triglyceride and by using an isotope (deuterium and tritium) dilution technique the volume of body water has been quantified. More recently, in collaboration with the Waltham Centre for Pet Nutrition, workers at the University of Glasgow Veterinary School have used ultrasound as an objective and non-invasive means of measuring subcutaneous fat. The equipment used was an A-mode ultrasound, a technique originally developed for the determination of subcutaneous fat depth in human patients prior to skin grafting. To date correlations with total body fat have been poor and research is now continuing using C-mode ultrasound. Other techniques which have been developed for use in total body composition determination in man and that are now being assessed for their suitability in the determination of body fat in dogs include near infra-red interactance or bioelectric impedance. Despite these current endeavours the most practical method of assessing obesity is by simple observation and palpation of tissue over the ribs.

The majority of cases of obesity are related to simple over-feeding, often coupled with a lack of exercise. The remaining cases may be associated with endocrine disturbances, such as diabetes mellitus, hypothyroidism or Cushing's Disease.

The medical implications of obesity in the cat are not as well defined as in the dog, but it is thought that obesity predisposes to certain conditions, such as hepatic lipidosis, diabetes mellitus and feline urological syndrome.

Commercial weight reducing diets are formulated in one of two ways. The calories are diluted with either insoluble fibre, or water in the form of gelling agents. High fibre diets are said to cause satiety by expanding the stomach. High fibre diets reduce

digestibility and bioavailability of the food. This can lead to mineral and vitamin deficiencies. Figure 1 shows the reduction in body weight that can be achieved in dogs on a low calorie diet for 12 weeks. In this example a target of 15% weight loss was set and the dogs were fed at 40% of the calculated maintenance requirements at the target weight. The diet used was WALTHAMS® Canine Low Calorie Diet and the graph represents data from 33 dogs.

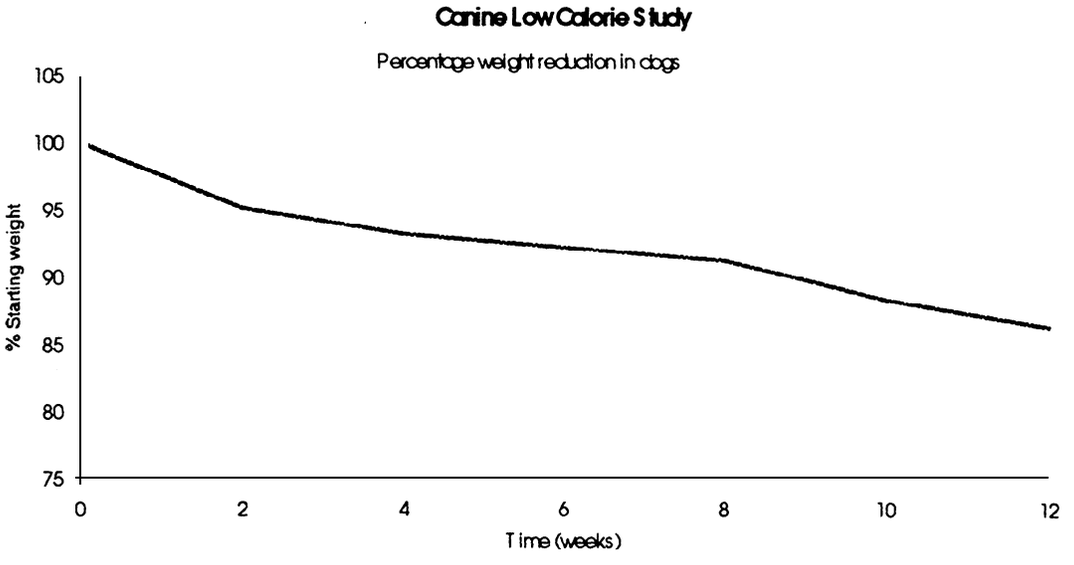

Figure 1 Average weight reduction achieved in a group of 33 dogs fed a low calorie diet for 12 weeks

Similar weight reduction can be achieved in cats. In this instance it would be most common to target a 15% weight reduction over 18 weeks and the food supplied would be targeted to deliver 60% of the calorie requirement at that target weight.

Management of chronic renal failure

Chronic renal failure is a common syndrome in both cats and dogs. It represents the end stage of many progressive renal diseases, and occurs when some 75% of renal mass has been destroyed (Bovee 1977). As renal mass is progressively destroyed, glomerular filtration and tubular transport are decreased. The major principle of dietary management of chronic renal failure is therefore the minimisation of build-up of protein catabolites by restricting dietary protein intake.

Clinical trials are undertaken to demonstrate the efficacy of diets developed for the management of disease. One such study was undertaken at the University of Vienna in 1991. This study examined the use of WALTHAM Canine Medium Protein Diet in the management of chronic renal failure in dogs. In the first part of this study 1600 dogs over 5 years of age were screened for early chronic renal failure. This screening was based on raised serum urea and creatinine levels and clinical signs; 22% of these dogs had serum urea levels > 6.67 mmol / L and serum creatinine levels > 88.4 µmol L, hence indicating early renal disease.

In the second part of the same study, 60 dogs with renal disease were randomised into two groups. Group 1 was fed WALTHAM Canine Medium Protein Diet, a diet restricted in protein and phosphorus, group 2 was fed a home-made diet low in protein

d phosphorus. In both groups serum urea, creatinine and phosphorus were lowered gnificantly within four weeks.

CONCLUSION

These are just two small examples of a very large pool of research underway at the resent time, examining the efficacy of diets designed for the management of clinical ntities. The Waltham Centre for Pet Nutrition alone has 41 studies underway in 14 ountries. The studies include the management of feline urinary tract diseases and the aurine requirement of the adult cat and a large number of studies focussing on particular spects of lifestage nutritonal requirements Pets play an important role in many of our ives. The social benefits of pet ownership are also being more clearly understood. Insuring the health of our pets is maintained through feeding a sound diet is an mportant aspect of pet ownership. The nutritional design of most reputable commercial Foods is based in sound research and verfication of design through analysis and feeding studies. The nutritional requirements of healthy adult dogs and cats are more fully understood than most species and research has now extended into the areas of dietary modification in clinical cases and further elucidation of the changing requirements in various physiological states throughout life.

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