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Nutritional Peculiarities and Diet Palatability in the Cat

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ABSTRACT

Cats have become the most popular companion animal in Western Europe. Unlike other domestic animals, cats are strict carnivores and this influences both their nutritional requirements and food preferences. Cats have very high protein requirements and their diet must contain some nutrients, such as arginine, taurine, niacin, vitamin A and arachidonic acid. Besides its nutritional value, a diet for cats must also be highly palatable. This paper offers a quick overview of feline nutritional peculiarities and the factors that influence food palatability in cats.

Keywords: cat, eating behaviour, feed palatability, nutritional peculiarities

INTRODUCTION

Today, the number of domestic cats (*Felis silvestris catus*) in the Western European countries is estimated to have reached 47 million, while there are 41 million dogs (FEDIAF data cited by Zentek, 2004) and, while the number of dogs is stable or even decreasing, the number of cats is increasing. Cats adapt better than dogs to the lifestyles of many owners, especially those who live in a city, and many people own more than one cat. Unlike dogs and other domestic animals, cats are strict carnivores. Because of the inefficiency of some metabolic pathways, cats develop severe nutritional deficiencies if they are fed a diet containing high amounts of plant products and little or no ingredients of animal origin. In the feeding of cats, not only the composition but also the palatability of the diet is very important. It is well known that cats can refuse to eat a diet and starve until they develop clinical consequences. A better understanding of the factors that influence food palatability in cats may be helpful in the treatment of feline anorexia and also in the oral delivery of medications by the pet owner.

NUTRITIONAL PECULIARITIES OF CATS

Protein and amino acids

Feline nutritional peculiarities have been exhaustively reviewed by MacDonald and Rogers (1984), and Morris (2002).

Cats have higher protein requirements than other domestic animals, but the reason for this difference is not yet completely understood. Furthermore, cats seem to have high requirements for food nitrogen, rather than for essential amino acids. One possible reason for the high protein requirements may be the activity of the hepatic enzymes that are involved in amino acid catabolism (MacDonald and Rogers, 1984). While most animals reduce the activity of these enzymes if they are fed diets low in protein, cats do not seem to be able to adapt protein catabolism and activity of the urea cycle to protein-deficient diets (Rogers *et al.*, 1977; Russell *et al.*, 2000, 2003).

Taurine is an amino acid that is not incorporated into large proteins and is not oxidised but is only found in animal tissues as a free amino acid. In most mammals, taurine is synthesized from methionine and cysteine and is not essential. In cats, the activity of the two enzymes involved in the synthesis of taurine is very low so that only minimal amounts are produced (Park *et al.*, 1991). While most mammals can use either glycine or taurine for bile acid conjugation, cats (and dogs) are only able to bind taurine to bile acids (Rabin *et al.*, 1976). As a consequence, if their diet does not contain adequate levels of taurine, cats develop a dietary deficiency that can lead to reproductive failure, dilated cardiomyopathy and central degeneration of the retina. Cooking reduces the amount of taurine in animal ingredients used for home-made diets (Spitze *et al.*, 2003). Taurine depletion in cats has also been associated with diets with low protein digestibility that may favour a more proteolytic microflora which degrades taurine, and to diets with a high fibre content (Stratton-Phelps *et al.*, 2002) or indigestible Maillard products (Anantharaman-Barr *et al.*, 1994). Canned food generally requires a higher taurine supplementation than dry food. Morris (2002) has speculated that cats eating prey do not need an endogenous synthesis of taurine and that conversion of cysteine to taurine would only result in an energy loss since taurine cannot be oxidised and is excreted with urine.

Moreover, unlike most other animals, cats are not able to synthesize arginine from glutamate and glutamine (Morris, 1985).

Vitamins

While most animals are able to synthesize vitamin A from some precursors, of which beta-carotene is the most important, cats lack the dioxygenase enzyme that starts the conversion of carotenoids to retinal and need a dietary source of pre-formed vitamin A (Schweigert *et al.*, 2002). Since the body of prey contains adequate amounts of vitamin A and only traces of carotenoids, the maintenance of the enzymes for the conversion of carotenoids into vitamin A would represent in cats only an energetic cost.

In the case of niacin and vitamin D, high activities of enzymes result in degradation of the precursors for their synthesis (Morris, 2002).

Fatty acids

Linoleic acid ($\omega = 6$; LA) and α-linolenic acid ($\omega = 3$) are essential in all animals. In most animals, these fatty acids are converted through the action of elongase and desaturase enzymatic systems respectively to arachidonic acid ($\omega = 6$; AA) and EPA and DHA ($\omega = 3$), that can be found only in food of animal origin. Cats show only little $\delta = 6$ desaturase activity and require foods of animal origin as a source of AA, EPA and DHA (Sinclair *et al.*, 1979). Cats fed diets containing adequate LA but lacking AA show reproductive failure and impaired platelet aggregation (MacDonald *et al.*, 1984a,b). Interestingly, male cats fed LA-adequate AA-deficient diets show normal reproductive functions. This finding suggests that some conversion of LA into AA may take place (Pawlosky *et al.*, 1994). Thompson (2004) pointed out that more research is needed to establish the minimal requirements of essential fatty acids in cats.

In her review of the nutritional differences between dogs and cats, Legrand-Defretin (1994) underlined the fact that cats are less able than dogs to handle high-carbohydrate diets.

PALATABILITY OF FOOD IN CATS

Eating behaviour and development of food preferences of cats

Cats are strictly carnivorous animals and this is reflected by their anatomical and nutritional characteristics. The feeding behaviour of cats is still influenced by the eating habits of wild cats (Case *et al.*, 2000). Wild cats hunt only small prey and require several prey each day to meet their energy requirements. Domestic cats have from 7 to 20 small meals a day if they have free access to food (Mugford, 1977) and this behaviour is not influenced by the age of the animal (Peachey and Harper, 2002). The food preferences for cats are influenced by the diet of the mother during pregnancy and lactation, and particularly the flavours that the kitten experiences from the fourth week until the sixth month of age (Stasiak, 2001, 2002).

Sensorial factors influencing food preferences

Smell plays an important role in determining cat dietary preferences (Bradshaw, 1991). The sense of smell can be reduced by different factors, such as aging, adverse weather conditions, and drugs. Taste plays a pivotal role in determining cat food preferences and it is strictly combined with olfaction (Hullar *et al.*, 2001). Furthermore, the taste of food stimulates salivary, gastric and intestinal secretion, and gives the cat the opportunity to reject a potentially toxic food (Levesque, 1999). Boudreau (1989) classified the neuron units able to respond to flavour. The most abundant units are those that respond to amino acids. Cats show a preference for the amino acids described as “sweet” in man (such as proline, cysteine, ornithine, lysine, histidine, and alanine) that stimulate these units and reject the “bitter” amino acids (such as arginine, isoleucine, phenylalanine and tryptophan) that inhibit them (Bradshaw *et al.*, 1996). Cats also reject the monophosphate nucleotides that accumulate in mammalian tissues after death, and this may be partly responsible for the cat’s dislike of carrion (Bradshaw, 1991). Despite their preference for “sweet amino acids”, amino acid units are not stimulated by sugars in cats (Boudreau, 1989). The second most abundant group of taste receptors are the acid units, which are stimulated by phosphoric and carboxylic acids, nucleotide triphosphates, histidine and other metabolites (Boudreau *et al.*, 1985). Another group of units is less well characterized and is stimulated by a diversity of substances, including quinine, alkaloids, and tannic, malic and phytic acids that are perceived by the cat as bitter and can be refused (Levesque, 1999). Size, shape and texture of kibbles also influence food palatability. Cats will reject dry food if the kibbles are sharp-edged and hurt the mouth and stomach (Trivedi and Benning, 1999). The temperature at which food is served is also important, since cats reject food with a temperature lower than 15°C or higher than 50°C (Sohail, 1983).

Factors influencing food palatability

Palatability is one of the most important criteria in diet formulation for cats, and pet food manufacturers spend a significant proportion of their research budget on palatability testing. The pet owners' perception of diet is another important factor in determining the re-purchasing of a diet (Hendriks and Moughan, 2000). Cats usually prefer moist food with a water content similar to that of meat (70–85%); nevertheless, semi-moist and dry food are also well accepted. Food palatability is positively correlated to the amount of protein, especially if ingredients of animal origin are used. Among the ingredients, liver, red meat and blood are highly palatable (Crane *et al.*, 2000). Fish can be preferred to red meat by some cats but can also be rejected by others (Bradshaw and Thorne, 1992). Fats applied to the outside of the dried kibble are an excellent flavour enhancer and a good source of energy. Fat is believed to positively influence food texture, rather than flavour, and cats seem to like both animal and vegetal sources of fat. Nevertheless, adding medium-chain fatty acids, but not those with short chains, to a diet strongly reduces food acceptance (MacDonald *et al.*, 1985). Food processing techniques also influence food acceptance. The formation of Maillard products during heating improves palatability, while lipid oxidation strongly reduces it (Voragen *et al.*, 1995). Extrusion of food may therefore improve food palatability, especially if the food is rich in vegetal ingredients such as soy-bean and corn meal (Hullar *et al.*, 1998). Food palatability can also be increased by using hydrolysates of animal proteins (usually referred to as "digest"), or, secondarily, artificial flavouring agents and flavour enhancers, such as sodium glutamate and sodium inosinate (Trivedi and Benning, 1999).

CONCLUSIONS

The nutritional peculiarities of cats are strictly related to their carnivorous nature. Their specific needs for nutrients that can be found only in food of animal origin cannot be ignored, otherwise the cats will face severe nutritional deficiencies. Furthermore, the use of ingredients of animal origin is essential to improve food acceptance. Although the high palatability of some diets may be one of the causes of the increasing incidence of obesity in the feline population, feeding such a diet may reduce the risk of anorexia in clinical situations that are characterized by loss of appetite.

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