

FATS IN THE DIET OF INDOOR AND FREE-RANGING DOMESTIC CATS

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Summary. Fat plays an important role in cats diet. It is as an energy source, it also increases the palatability of food, is a source of essential fatty acids and it is a carrier of fat-soluble vitamins. Cats are unique, because they are evolutionarily adapted to digesting large amounts of saturated fat. Unlike other mammals, they could not effective convert linoleic acid to arachidonate. In this paper, the quantity and quality of lipid fraction of food consumed by indoor and free-living cats are compare. Available data of crude fat content and the fatty acid composition were compared for commercial dry and wet food, commercial whole prey items and the recommendations of Association of American Feed Control Officials and European Pet Food Industry Federation.

Key words: fat, essential fatty acids, fatty acids composition, cat diet, cats

INTRODUCTION

More and more people decide to become a cat owner. According to European Pet Food Industry Federation (FEDIAF) cats are the most popular pets in European households with a population of 74.4 million in the European Union while a dogs population is 66.4 million in 2017. Owning a cat carries with certain responsibilities, such as taking care of the animal's welfare, including providing adequate food. Nowadays, many companies offer commercial food in the form of cans or kibbles. But cat owners started to have concerns about the suitability of feeding commercial diets to cats [Buffington 2008, Freeman et al. 2013]. For years certain lots of pet food from multiple brands are recalled due to imbalance or contaminations such as aflatoxin, melamine or Salmonella strains

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[Cianciolo et al. 2008, Behravesch et al. 2010, Bischoff and Rumbleha 2012]. But it is not the only problem. Cats are strict carnivores that rely on nutrients in animal tissues to meet their specific and unique nutritional requirements. Their diet in nature are composed mainly of small prey, like rodents and birds [van Aarde 1980, Biro et al. 2005]. So, they consume food which are high in protein, moderate in fat and include only minimal carbohydrates. It is why another commonly raised issue with regard to cat foods is the suitability of using large amount of carbohydrates in dry foods. In nature cats do not consume carbohydrates, so fat play even more important role as an energy source. It also increases the palatability of food, is a source of essential fatty acids (EFA) and it is a carrier of fat-soluble vitamins [MacDonald et al. 1983, Morris 2002]. Cats have also needs for dietary nutrients that are not essential for other mammals, e.g. cats have reduced the endogenous synthesis of taurine, they are unable to use carotenoids to synthesis retinol and have a limited ability to synthesis arachidonic acid from linoleic acid, etc. [MacDonald et al. 1984, Morris 2002, Zoran 2002, Zaghini and Biagi 2005].

FUNCTIONS OF FAT

In general, saturated fats are considered to be the bad fats and polyunsaturated fats are considered to be the good fats [Gardner and Kraemer 1995, Hu et al. 2001]. Although the concept of good and bad fats is appropriate for human health, cats are able to consume both types of fats in their diets without a big risk of coronary artery diseases, heart attacks, or strokes [Bauer 2006]. Cats are evolutionarily adapted to digesting large amounts of saturated fat and are resistant to the development of hypercholesterolemia and atherosclerosis. They transform them in the β -oxidation process to a fuel to the body to provide energy for work, regulation of body temperature, growth, reproduction, etc. Fat enhances palatability, the acceptable textures of foods and promotes the absorption of fat-soluble vitamins. They are also a source of essential fatty acids (EFA). The essential fatty acids for cats are linoleic (LA), alpha-linolenic (ALA), arachidonic acids (AA) eicosapentaenoic (EPA) and docosahexaenoic acids (DHA) which are involved in skin and coat condition, kidney function, and reproduction.

Cats are unique, because they have a dietary requirement for AA. Unlike other mammals, they could not effective convert linoleic acid to arachidonate [Sinclair 1981, Rivers 1982]. Cats do not possess the necessary Δ -6 desaturase to perform this conversion. An alternative pathway to arachidonic acid synthesis in cats was proposed (the figure) and it assumes that they possess both Δ -5 and a Δ -8 desaturases. Thus cats appear to be able to synthesize arachidonic acid from linoleic acid at least to some extent. Deficiency of AA in diet causes problems with reproduction [Pawlosky and Salem 1996, Morris 2004]. Kittens appeared to grow normally, adult males can successful reproduce, but adult females give birth only to a limited number of viable litters. To ensure an adequate amount of AA in the diet, cats must eat animal tissue, because arachidonic acid is present only in fat of animal origin [Li et al. 1999, Bauer 2006].

Additionally, because of low activity of hepatic desaturase enzymes is observed poor conversion of alpha-linolenic acid to eicosapentaenoic and docosahexaenoic acids in cats [Lenox and Bauer 2013]. Acids EPA and DHA are essential nutrients for cats, especially

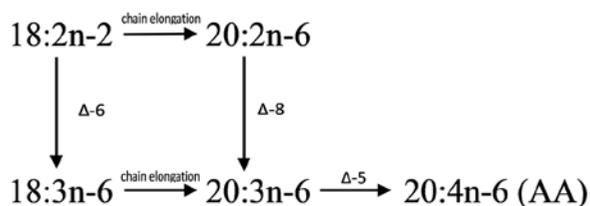


Fig. An alternative pathway to arachidonic acid synthesis in cats (not in sufficient quantity)

Rys. Alternatywny szlak syntezy kwasu arachidonowego u kotów (produkcja niewystarczającej ilości)

in certain life stages such as growth and reproduction [AAFCO 2019]. In cats, omega-3 have been shown to be beneficial in the treatment of cardiovascular disorders, inflammatory skin disorders and osteoarthritis [Bauer 2011]. Increased dietary long-chain polyunsaturated fatty acids alter serum fatty acid concentrations and lower risk of urine stone formation in cats [Hall et al. 2017]. It should be mentioned that the long-term safety of omega-3 fatty acids has not been determined in cats, nor has a safe upper limit been set by the National Research Council (NRC). Dosages > 75 mg of EPA and DHA per kg of BW^{0.67} daily should be used with caution until further evaluations are performed [Bauer 2011]. Important potential adverse effects of overdosage of omega-3 fatty acid supplementation include many disorders like altered platelet function, gastrointestinal adverse effects, detrimental effects on wound healing, etc. [Lenox and Bauer 2013]. The main dietary sources of DHA and EPA are fish and fish oil. The flaxseed oil has also great amount of omega-3, but mainly ALA which is not efficiently converted to EPA and DHA. This is also confirmed by the research it shows that fish and flaxseed oil can reduce skin inflammatory responses in cats, however, flaxseed oil appears less immunosuppressive than fish oil [Park et al. 2011]. The safety of using algal oil containing EPA and DHA has also recently been investigated in cats' diet during gestation, lactation and growth [Vourinen et al. 2020]. But, there is one thing that we should remember: in rodents the synthesis of EPA and DHA from ALA is several times more efficient than in humans and other mammals and cats in wild eat mainly small rodents and birds.

It is worth to mention that cats have special needs for vitamins A and D which are fat-soluble vitamins [Zoran 2002]. They cannot convert β -carotene (present in plants) to retinol (the active form of vitamin A), because of lack the necessary intestinal enzyme [Gershoff et al. 1957]. Cats are also unable to meet their metabolic needs for vitamin D, because they lack 7-dehydrocholesterol, which is required for synthesis [How et al. 1994]. Vitamins D and A are found in high amounts in the liver and fatty tissue of animals, so cats normally meet their needs for this vitamin via their carnivorous diet [Zoran 2002].

INTAKE OF FAT IN INDOOR AND FREE-RANGING CATS

We decide what our indoor cats eat. Usually it is dry and canned food, but raw diet and whole prey model is becoming more and more popular. Free-ranging and feral cats mostly eat small animals they hunt – rodents and birds. Commercial food and whole preys are

completely different ways of feeding. Most commercial dry food contain relatively large amount of carbohydrates, an example, from cereals, beans, peas, potatoes, corn which are added to formulas. It causes the fat and protein content to be lower in dry matter. Pet food regulatory bodies, notably the Association of American Feed Control Officials (AAFCO) in the United States and the European Pet Food Industry Federation (FEDIAF) in Europe recommend minimum 9 g of fat per 100 g DM (what is significantly lower content than cat eat in nature). Manufacturers also often add vegetable oils to their products. It has influence on the fatty acids composition. The thermal processes used in production also affects the composition of the food, an example cause faster oxidation of fats. In general, doses of EPA and DHA in commercial pet foods are relatively low [Bauer 2011]. Lower content of animal origin ingredients results also in lower content of AA. Moreover, domestic cats are fed commercial food containing lipids from captive domestic animals and thus consume a different fatty acid composition compared with feral cats. Fatty acid composition, especially the polyunsaturated fatty acids content and the n-6 : n-3 ratios, differ between wild (6 : 1 to 19 : 1) and feedlot animals (2 : 1) [Plantinga 2011].

The composition of cats prey items was checked in the literature. Plantinga et al. [2011] estimated the dietary profile of free-roaming feral cats based on percentage of weight for each consumed dietary item and data on the nutrient composition of the consumed preys living in the wild. The fat content (based on dry matter) varied between preys from 9 to 31%. The crude fat data for preys was: rats 30.5%, mice 24.5%, voles 17.2%, other rodents 22.1%, insectivores 19.0%, rabbits 22.3%, other mammals 31.0%, birds 15.9%, reptiles/ /amphibians 9%, fish 24.1% and invertebrates 20.0%. Unfortunately, because of the lack in the literature, data for wild rats was replaced by data for captive rats. Data for wild rats can be found later in Kremen et al. [2014] and fat content is only 8.8%. This low level of fat can be caused by several factors. The fluctuations in composition of the preys depend on latitude, sex, age, season, genetics, diet composition, activity level etc. [Fleaharty et al. 1973, Blem 1976, Stewart and Barnett 1983, Webster 1986]. The nutrient profile by Plantinga shows that mean fat content in the diet of cats is 22.8% in the dry matter.

It is also beneficial to compare the fatty acid composition of commercial food, commercial whole prey items and the recommendations of AAFCO and FEDIAF (the table). Five dry foods and one wet food, which analyzes were available, were selected for comparison. Unfortunately, there is no data for wild preys, but data for commercially available frozen whole prey we can find in the literature [Kerr et al. 2014]. The concentrations of total fatty acids as well as LA, ALA and EPA+DHA for all samples were above minimal recommendations for all life stages. AA content for all samples, excluding dry-2 (0.19 g·kg⁻¹ DM), was above the minimal recommendations for all life stages. It is worth to notice that the mean content of fat in dry matter for commercial whole prey items (24.4%) is similar to this which was evaluated by Plantinga (22.8%), while for commercial food is significantly lower. The LA content is highly variable, but it can be noticed that ALA content is considerably lower in whole prey items than in commercial food. The AA content in whole prey items is higher than in commercial food what is a result of quantity, quality of meat and lack of manufactural processings. The low EPA+DHA content in whole prey items is probably connected with their diet during farming period. This content in the wild preys is supposed to be higher because of differences in their diet.

Table. Concentrations of crude fat and EFA in the dry food, wet food, commercial whole prey items and Association of American Feed Control Officials and European Pet Food Industry Federation recommendations

Tabela. Zawartość tłuszczu i NNKT w karmie suchej, mokrej, *whole prey* oraz rekomendacje Association of American Feed Control Officials i European Pet Food Industry Federation

Specification Wyszczególnienie	Commercial food Karma komercyjna							Whole prey items** Produkty <i>whole prey</i>				Recommendations Rekomendacje		
	dry-1†	dry-2†	dry-3†	dry-4†	wet-1†	dry-0‡	mouse	rat	rabbit	quail	adult	GR*	adult	GR*
Fat [% DM]	17.10	18.19	13.49	15.34	10.20	10	29.92	26.35	22.05	19.24	9	9	9	9
LA [g·kg ⁻¹ DM]	35.11	33.43	34.51	26.27	25.68	26.30	27.03	33.47	10.28	18.76	6	6	5	5.5
ALA [g·kg ⁻¹ DM]	4.31	3.33	3.12	4.79	2.56	2.90	0.46	1.13	0.47	0.71	-	0.2	-	0.2
AA [g·kg ⁻¹ DM]	1.11	0.19	1.77	0.35	0.35	0.10	2.18	6.86	0.34	2.75	0.2	0.2	0.06	0.2
EPA [g·kg ⁻¹ DM]	0.15	0.10	0.11	0.07	0.08	0.60	0.02	0.22	0.01	0.04	-	-	-	-
DHA [g·kg ⁻¹ DM]	1.85	0.35	1.03	0.44	0.54	0.80	0.79	2.28	0.03	0.72	-	-	-	-
EPA+DHA [g·kg ⁻¹ DM]	1.99	0.45	1.14	0.51	0.62	1.40	0.81	2.5	0.04	0.76	-	0.12	-	0.1

*Growth and reproduction period; **according to Kerr et al. [2014]; † unpublished data; ‡ according to van den Ingh et al. [2019].

*Okres wzrostu i reprodukcji; **według Kerr i in. [2014]; † niepublikowane dane; ‡ według van den Ingha i in. [2019].

CONCLUSIONS

Cats are obligate carnivores and they depend solely on animal flesh for their nutrient requirements. It is the reason why we should carefully plan their diet. Fat is the one of the macronutrients and it plays an important role in cats' diet as an energy source, it contains EFA and fat-soluble vitamins. Food consumed in the wild differs significantly in composition from commercial diets. Mean content of fat in dry matter for analyzed commercial whole prey items (24.4%) is similar to this which was evaluated by Plantinga (22.8%) for preys live in wild, while for commercial food is significantly lower. In turn, meat content and its quality as well as manufactural processings affect composition of fatty acids, especially the most important among them essential fatty acids, an example the AA content in whole prey items is higher than in commercial food. These differences could potentially have a significant impact on the health and condition of cats.

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TŁUSZCZE W DIECIE KOTÓW NIEWYCHODZĄCYCH I WOLNOŻYJĄCYCH

Streszczenie. U kotów tłuszcz odgrywa główną rolę jako źródło energii. Poprawia on również smakowość pożywienia i jest źródłem niezbędnych nienasyconych kwasów tłuszczowych, a także dostarcza witamin rozpuszczalnych w tłuszczach. Koty są wyjątkowe, ponieważ ewolucyjnie są przystosowane do trawienia dużej ilości nasyconych tłuszczów i w przeciwieństwie do innych ssaków nie potrafią efektywnie przekształcać kwasu linolowego w arachidonowy. W tej pracy porównano ilościowo i jakościowo frakcję lipidową pożywienia konsumowanego przez koty niewychodzące i wolnożyjące. Zestawiono dostępne dane zawartości tłuszczu i składu kwasów tłuszczowych suchych i mokrych karm komercyjnych, hodowlanych drobnych zwierząt padających często ofiarą kotów oraz rekomendacji Association of American Feed Control Officials i European Pet Food Industry Federation.

Słowa kluczowe: tłuszcz, niezbędne nienasycone kwasy tłuszczowe, skład kwasów tłuszczowych, dieta kotów, koty