Fat Content in ZIWI Recipe

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Why Fat is the Preferred Energy Source for Carnivores (rather than carbs)

At first glance, it might look like ZIWI Peak recipes contain a high level of fat. This is especially so if people are used to feeding kibble.

The high level of crude fat percentage in ZIWI Peak recipes is due to the lack of carbohydrates in the recipes. As per AAFCO and NRC guidelines (*see below for explanation), carbohydrates are not considered an essential dietary nutrient for dogs and cats. Dogs and cats source glucose and energy from fat and protein.

The fat in ZIWI Peak recipes is the fat which naturally occurs in the meat of the source animal species. On examining the nutritional analysis, the fat percentage may look high because of the low moisture in air-dried ZIWI Peak - the air-dried recipes contain less than 14% moisture. The fat in ZIWI Peak recipes is similar to what you would find in raw or cooked meat, it just has the moisture removed.

(* The National Research Council (NRC) and AAFCO publish nutrient profiles for dogs and cats for various life stages. They aim to list minimum nutrient requirements and maximum nutrient requirements for nutrients with potential toxicity. To read more about AAFCO, click here.)

Is a diet high in crude fat % healthy for dogs and cats?

Dogs and cats are classified as “high density lipoprotein mammals” and express atherogenic resistance (NRC, 2006). High-density lipoprotein, or “good” cholesterol, absorbs cholesterol and carries it back to the liver. Thus, dogs and cats can tolerate high dietary fat (lipid) concentrations. Even if obese, dogs do not develop fasting hyperglycaemia, atherogenic hyperlipidaemia, or type 2 diabetes (see Verkest, 2014). For dogs and cats, dietary fats are an essential nutrient. Indeed, essential fatty acids must be contained in the diet as these are unable to be synthesised by the body.

Lipids provide a carrier for fat-soluble vitamins; they are essential for the absorption of the vitamins A, D, E, and K. When there is insufficient fat in the diet, these vitamins cannot be absorbed efficiently, and deficiencies can arise as a result. Dietary fats generally improve the palatability of food and add an acceptable texture to foods. Palatability tests generally show that dogs and cats find ZIWI Peak to an extremely palatable food.

The digestibility of fat is higher than that of carbohydrates and proteins, and fat contains approximately three times the energy. Fat accounts for approximately 2.25 times the metabolisable energy (ME) of either protein or carbohydrates (NRC, 2006). Even though fat may be only a small percentage of the diet, it can provide most of the kilocalories.

The main use of fat in the body is energy storage. Animals have an unlimited capacity to store excess energy as fat, whereas they have a limited capacity to store carbohydrates as glycogen. Glycogen is made up of many connected glucose molecules and is the stored form of glucose (NRC, 2006). Glucose is the main metabolite of carbohydrate digestion in humans. In dogs and cats, where there is an absence of dietary glucose, through the process of gluconeogenesis glucose will be synthesised from amino acids and glycerol (NRC, 2006).

The dog is capable of meeting its metabolic requirement for glucose from gluconeogenic pathways throughout growth and adult maintenance, provided that sufficient fat and protein are included in the diet.

Cats are in a constant state of gluconeogenesis, and do not appear to utilise carbohydrates as rapidly as do dogs. Cats have lower rates of glucose utilisation; they have lower levels of glucokinase activity, a hepatic enzyme that in other species adjusts to diet and blood glucose levels (NRC, 2006). Additionally, cats have comparatively longer blood glucose elimination times. Even though cats can readily absorb dietary carbohydrates, the utilisation for the resulting glucose is not efficient (NRC, 2006).

When given the option to choose what to eat, research shows that dogs will choose to consume a diet high in energy from fat and protein and will consistently choose a diet low in carbohydrates.

In a study by Roberts et al. (2018), 15 adult dogs were given access to three wet diets over a 10 day period. All diets were nutritionally complete, and formulated using the same four ingredients in different proportions to supply high levels of protein (58% ME), fat (86% ME) or carbohydrate (54% ME).[1]

It was found that dogs initially prioritised a diet high in energy dense over protein initially, and then over the course of the study transitioned to a diet with a more balanced protein: fat ratio. Dogs consistently chose a diet low in carbohydrates, at 3% throughout the study.

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What about pancreatitis?

Fat does not actually cause pancreatitis!

Most cases of pancreatitis in pets are idiopathic. Many veterinarians are A common view amongst veterinarians is that a high fat diet is detrimental to the health of dogs. In particular, a commonly expressed viewpoint is that a high fat diet will increase the risk of developing pancreatitis. It is known that most cases of pancreatitis in pets are idiopathic, yet the idea is perpetuated that fat consumption is a cause of pancreatitis in dogs. Why is that – is there any evidence?

Actually, there is very little scientific evidence, and no direct experimental evidence, that fat increases the risk of pancreatitis. Indeed, this viewpoint contrasts with the diet of the domesticated dog's ancestors, prior to the industrial revolution and the development of a pet food industry and kibble, and the diet choice of dogs when self-selecting nutrients.

In a 2009 study, using 10 healthy adult dogs, it was found that dietary fat content had no effect on serum cTLI, cPLI, or gastrin concentrations (James et al., 2009). In this study, dogs were fed one of four diets. Diets A and B contained 16% and 5% crude fat, respectively; diet C was composed of diet A with pancreatic enzymes; diet D was composed of diet B with pancreatic enzymes and MCTs. It was found that serum cTLI, cPLI, or gastrin concentrations in the dogs did not differ among the different diets fed, among dogs, or over time.

This topic was also examined by Dr Mark Roberts in his PhD thesis. In this study, 10 dogs were fed a high fat diet for 8 weeks, and the other half were fed a high carbohydrate diet. On conclusion, all dogs were fed a high fat meal. Triglycerides were measured during the study. It was found that dogs fed a carbohydrate based diet had higher plasma triglycerides than dogs fed the high fat diet. Dr Roberts concluded that this finding brings into doubt that fat plays a role in the development of pancreatitis.

Dr Roberts points out that this result is consistent with data from human studies. The phenomenon, referred to as carbohydrate-induced hypertriglyceridemia (HPTG), consists of a rise in plasma triglycerides being directly linked to dietary carbohydrate intake.

A relevant factor for pancreatitis in dogs is certainly dietary indiscretion (i.e., consuming things that aren't proper food, like garbage). A study in 2008 identified that ingesting unusual food items, table scraps and getting into the trash were found to increase the odds of pancreatitis (Lem et al, 2008).

This is likely to be a relevant factor because QUALITY of fat is also as relevant as quantity of fat consumed.

References:

Zoran, DL 2002, 'The carnivore connection to nutrition in cats', Journal of the American Veterinary Medical Association, vol. 221, no. 11, pp. 1559-67.
See also Dr Richard Malik 2007, "Feeding cats for health and longevity – an idiosyncratic perspective", Australian College of Veterinary Scientists – Science Week 2007 – Small Animal Medicine Chapter meeting
Roberts MT, Bermingham EN, Cave NJ, Young W, McKenzie CM & Thomas DG 2018, 'Macronutrient intake of dogs, self-selecting diets varying in composition offered ad libitum', Journal of Animal Physiology & Animal Nutrition (Berlin), vol. 102, no. 2, pp. 568-575. doi: 10.1111/jpn.12794.

Good Fats and Bad Fats

Traditionally, when the term "bad fats" has been used, it was generally referring to saturated fats. In the late 20th century, saturated fats (meat, dairy, coconut oil) received a lot of bad press in human health based on a scientific study which linked consumption of saturated fat with increased risk of heart disease, stroke etc. However this research has been debunked.

In 2010, a meta-analysis of prospective epidemiologic studies showed that there is no significant evidence for concluding that dietary saturated fat is associated with an increased risk of coronary heart disease, stroke, and cardiovascular disease (Siri-Tarino et al., 2010).

What needs to be considered in evaluating pet food is the quality of the fat.

The majority of fat used in most dry, extruded dog food is rendered fat. The fat source can be of either animal or vegetable origin or often a mixture of both. Labeling is often vague, such as just 'animal fat'. For dry, extruded pet food made in the US, AAFCO even permits the inclusion of diseased meat, animals treated with medication (e.g. antibiotics), euthanised animals, and oil or grease from restaurants (fat which is repeatedly heated to a high temperature). In the EU there are stricter regulations.

To make extruded dry food, rendered ingredients are cooked under a high heat and pressure. Rendered fat is sprayed on the extruded product comprising the dry food (kibble), which improves palatability.

This creates two issues (at least!):
- oxygenation
- heating.

Oxygenation is what happens when fats are exposed to the air.

Good fats like marine fats are high in omega 3 polyunsaturated fatty acids (PUFAs). Omega 3s are highly prone to oxidation due to their large number of double bonds and their position within the fatty acid chain. They rapidly oxidize during storage to a complex chemical soup of lipid peroxides, secondary oxidation products, and diminishing concentrations of unoxidised fatty acids. For a detailed explanation of the oxidation process see Albert et al., 2013). The rate of lipid peroxidation is influenced by light, heat, and oxygen concentration even at normal room conditions.

All fats can oxidise and become rancid, creating free radicals. To contain and neutralise free radicals, the body must use antioxidants such as vitamin A, C, D and E. If the amount of free radicals in the body overwhelm the body's capacity to regulate them, this leads to oxidative stress, which leads to disease.

In order to stop oxygenation and prevent inevitable fat breakdown, kibble is sprayed with synthetic chemicals. Of concern, is the use of buylated hydroxyanisole (BHA) and buylated hydroxytoluene (NHT) – although they are powerful in their antioxidant effect, their links to carcinogenicity are concerning (see Brady, 2021).

Numerous studies confirm that the heating of fat reduces the quality of fat.

In a 2010 study examining the effect of rendering on the fat and protein content on raw animal by-product when it is made into meat meal (contained in dry pet food). It was found that rendering:

- Caused an increase in the saturated to unsaturated fatty acid ratio – that is, a decrease in both linoleic and linolenic acids content and the increase in palmitic and stearic acids content.
- Caused a decrease in amino acid content, because of a significant decrease in lysine, methionine, threonine, leucine, valine, phenylalanine, cystine, serine and aspartic acid. (Perez Calvo et al., 2010)

When Atlantic salmon oil is heated, EPA and DHA were significantly degraded, even at 50 °C (Hădărugă et al., 2016).

What does ZIWI use as a preservative?

ZIWI Peak air-dried food is a shelf stable product. It uses a combination of low moisture, citric acid, mixed tocopherols, and lecithin to ensure this stability. Citric acid's main purpose in pet food is as a fat preservative. This is particularly important for pet food that has high levels of crude fat, such as ZIWI Peak. The amount used in pet food is very, very small, and is a naturally sourced preservative. Mixed tocopherols (vitamin E) inhibit the oxidation of fats in the product, while also providing additional antioxidant supplementary benefits, particularly regarding polyunsaturated fatty acids. Lecithin is used as an emulsifier to prevent the fat from separating in the product, which can visually result in a "fat bloom". When consumed in the diet, lecithin is converted into acetylcholine, a substance that transmits nerve impulses. Studies in human trials show that lecithin can modify the cholesterol homeostasis in the liver, which then increases the activity of HMG-CoA reductase and cholesterol 7-alpha-hydroxylase, in turn decreasing the microsomal ACAT activity (LeBlanc et. al., 2003). It can reduce the excess of LDL cholesterol and promotes the synthesis of HDL in the liver (Nicolosi et. al., 2001).

Good Fats: Getting the fat balance right

Over recent years, there has been extensive research in both human and pet nutrition exploring the role of polyunsaturated fatty acids (PUFAs) in immune response and health. In particular, the focus has been on the importance of omega 3s, which are known to have an effect on mediating the inflammatory and immune system responses in the body.

There are two distinct PUFA families, omega-6 and omega-3:
- Linoleic acid (LA) is the head of the omega-6 family. The important omega-6 derivatives of LA are gamma-linolenic acid (GLA) and arachidonic acid (AA).
- Alpha-linolenic acid (ALA) is the head of the omega-3 family. The important derivatives of ALA are eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA). When mammals eat oils or foods that contain LA or ALA, it is theoretically possible for enzymes in their bodies to convert these fatty acids to longer-chain fats with more double bonds — that is, long chain PUFAs (LC-PUFAs). But in reality, full conversion to LC-PUFAs is an inefficient process.

This has enormous bearing on which fats are essential for dogs and cats. Logically, canine PUFA metabolism reflects their carnivore-omnivore status. Canines convert LA to AA more readily than humans do (Lloyd, 1990). Therefore, dogs do not benefit from large quantities of vegetable oils rich in LA; in fact, this may exacerbate allergic and inflammatory conditions. Vegetable oils are not prevalent in the natural canine diet (Hayek & Reinhart, 1998).

Feline PUFA metabolism is strictly carnivorous. Cats lack some of the enzymes that enable humans and dogs to convert LA to LC-PUFAs. Because cats cannot synthesize AA, their daily requirement for AA is so high that it must be provided in the diet (Bauer, 1997). DHA is critical for cats, because they cannot make it from LNA, for the same reasons they cannot convert LA to LC-PUFAs (Logas & Kunkle, 1993).

What is the ideal omega-6/ omega-3 ratio for dogs? AAFCO is not particularly helpful, recommending that the ratio should be less than 30:1. Research in humans, and into the Mediterranean diet, suggest that a ratio of 5:1 and 4:1 has beneficial impact on inflammatory disease and prevents cardiovascular disease (see Brady, 2021; Martínez-González et al., 2021).

We can look to the nutrient content of typical wild prey animals for guidance. Paulsen et al (2014) investigated the fatty acid composition of a range of prey animals. It was found that the omega-6/omega-3 ratios were lower for wild animals (from 2:1 to 8:1), and higher for domesticated animals (11:1 to 13:1).

Good sources of Omega-3 and Omega-6 fatty acids can be found in wild-caught fish and seafood and free-range grass-fed, grass-finished meat protein. Animals that are grass-fed and grass-finished retain twice the level of Omega-3 and Omega-6 fatty acids, compared to grain-fed animals.

All meat used in ZIWI Peak recipes comes from New Zealand grass-fed and finished, free-range animals, sustainably sourced and ethically managed. Furthermore, all ZIWI Peak recipes contain 3% whole New Zealand Green Mussel which is a rich natural source of Omega fatty acids. ZIWI also offers recipes containing Blue Mackerel. These recipes naturally contain higher levels of Omega-3 and Omega-6 fatty acids. All of ZIWI's recipes meet or exceed the suggested essential fatty acids requirements of AAFCO and the NRC.

Dogs fed with kibble should be supplemented with omega-3, as dry food is often high in omega-6 and low in omega-3.

Study 1: fatty acids contained in commercial dry dog food vary greatly (from some to none at all!)

Norwegian School of Veterinary Science

Aim: to measure the omega-6 and omega-3 levels of 12 different brands of commercially available dry dog food sold in Norway (large breed puppy in particular).
- Included Eukanuba (large breed puppy); Proplan (puppy), Hill's (large breed puppy); Pedigree (puppy); Friskies (puppy); Royal Canine (large breed puppy)

Method:
- Analysed for total contents of fat and fatty acid composition.

Results:
- Analysis of the foods showed a wide range of both types of fatty acids.
- Some foods were almost completely devoid of marine oils (thus low in EPA and DHA)
- The brands containing "omega-3 fatty acids" were primarily in the form of alpha-linolenic acid (ALA) from plant oils.
- This is an important finding because often only omega-3 content is reported on the pet food label. If the omega-3 fatty acids are supplied primarily as alpha-linolenic acid, for example from flax, the health benefits that come from EPA and DHA will not be provided by that food (Case, 2020).
- All brands had sufficient amounts of omega-6 fatty acids (according to NRC recommended levels).

Ref: *Alhstrom O, Krogdahl A, Vhile SG, Skrede A 2004, "Fatty acid composition in commercial dog foods", Journal of Nutrition, vol. 134: 2145S-2147S.*

Study 2: nutritional labels on dog food are not always truthful re omega 3

University of Maringa, Brazil

Aim: to compare the fat content reported on the labels of 10 dry extruded dog foods with laboratory-measured profiles of omega-3 fatty acids, DHA and EPA from the foods

Results:
- All 10 foods reported total omega-6 and total omega-3 fatty acid levels.
- In all 10 foods, chicken fat appeared to be the predominant fat source.
- Only 5 foods included EPA and DHA content on their product label.
- BUT NONE actually contained ingredients containing DHA or EPA, and the lipid profiles did not fit with typical oily fish ingredients.Instead ALA (plant based omega-3 fatty acid) was found to constitute the omega 3 content.

Why?
The researchers speculate that the EPA and DHA in the samples could have been destroyed by oxidation of the long-chain unsaturated fatty acids during the heat processing of extrusion. Alternatively, it is possible that the manufacturers of the foods had not included DHA and EPA in the first place.

Ref: *Silveria R, dos Santos PDS, Pizzo JS, et al, 2020, "Evaluation of dog food authenticity through lipid profile using GC-FID and ESK-MS", Journal of Brazilian Chemical Society, vol. 31, No. 12, 2511-2517*

Study 3: "Skin and health" dry dog food labels can be misleading

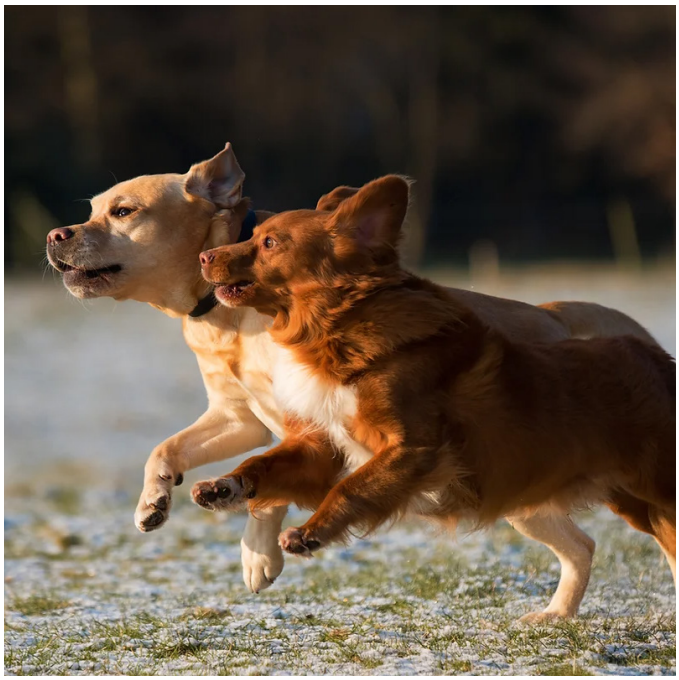
Tufts University's Cummings School of Veterinary Medicine, USA

Aim: to examine the nutrient profiles and ingredients list of 24 brands of dog food that all were marketed for skin and coat health – using terms such as "sensitive", "skin sensitivities", "digestive sensitivity", "digestive health", and "limited/unique ingredients". They looked at 15 dry (extruded) foods and 9 canned foods, representing 11 different brand names.

Results:
- Protein source varied widely and included chicken, fish, egg, venison, beef, pork, duck, lamb, soy, peas, and turkey.
- Thus not appropriate for an elimination diet
- Carbohydrate sources varied widely and included rice, potato, wheat, oats,barley,millet, corn, quinoa and tapioca.
- There were 22 diets that promoted inclusion of omega-6 or omega-3 fatty acids or that promoted inclusion of omega fatty acids used vague terms such as "omega fatty acids" or "omega oils", rather than specifying which fatty acid was contained.When EPA and DHA were listed, the amounts included were similar to that found in dry food not labelled for skin/coat health.

Conclusions
The researchers concluded that the wide variety of ingredients and large range in nutritional value of products marketed for skin and coat health make product selection for owners who are interested in these foods confusing.

Ref: *Johnson LN, Heintze CR, Linder DE & Freeman LM 2015, "Evaluation of marketing claims, ingredients, and nutrient profiles of over-the-counter diets marketed for skin and coat health of dogs", Journal of the American Veterinary Medical Association, vol. 246, pp 1334-1338.*



Article: Fat content in ZIWI recipes
Research on fat tolerance in dogs

What do ketogenic diets tell us about fat tolerance in dogs?

In the last few decades ketogenic diets have been studied as an adjuvant to cancer therapy in both animal studies and human case reports (Allen et al., 2014). The majority of animal studies have yielded evidence for an anti-tumour effect of the ketogenic diet, either through slower tumour growth or through longer overall survival times in the treated animals (Klement, 2017).

A ketogenic diet is typically composed of at least 75% fat, with a maximum 10% of energy from carbohydrate sources. The diet typically adheres to a ketogenic ratio of about 2:1. The ketogenic ratio is defined as the weight percentage of fat in the diet divided by the combined weight percentage of protein and carbohydrate (Klement, 2017).

An interesting project was conducted in the US which recruited dogs that had been diagnosed with cancer (prior to the study commencement). Human doctors and some veterinarians formed a flagship program called KetoPet in 2014 in order to test the effect of ketogenic diets on canine cancer patients. The researchers recruited dogs from kill shelters in Texas that were diagnosed with naturally occurring cancer(s) (Mettapets, 2018).

Dietary treatment for these dogs included a raw food ketogenic diet, at a 2:1 – 4:1 ratio titrated to keep the dog at lean but healthy weight. The diet consisted of 30% protein – either raw beef or chicken breast, with 70% fat which comprised of either MCT powder (medium chain triglyceride supplement), cream, butter, coconut cream or other fats cycled for variety. The diet included vegetables added for fibre, probiotics, vitamins and minerals. Glucose and ketones were monitored daily, ultrasound was conducted at 30 and 60 days, and overall condition, appearance and blood work was monitored. Overall, the results were promising, as 50 percent of dogs that completed the program showed no evidence of disease many months longer than they were prognosed to survive.

Of relevance to this discussion, none of the dogs involved in the KetoPet study developed pancreatitis. Some dogs in the study did develop changes on ultrasound consistent with fatty liver during the 120 days they were fed the high fat diet, however no dog developed clinical signs associated with liver disease. After the dogs were transitioned to the maintenance phase these ultrasound changes resolved. Thus, it is not clear whether the fat deposition in the liver were clinically relevant.

The fat percentage of the KetoPet diet was VERY high, as a fresh diet – much higher than any ZIWI recipe. As stated – the fat content of ZIWI Peak recipes are below the NRC safe upper limit.

Benefits of a high fat diet for active dogs

Active dogs in particular can benefit from high protein, high fat diets. Breeds that are used for work or endurance sports have high levels of activity and therefore have an increased daily caloric requirement. Using a calorie dense food in these cases is helpful, as dogs do not need to consume vast amounts of food to achieve these caloric goals, which can be four to five times greater than a dog with average activity levels (Loftus et. al., 2014). A high calorie, high protein, and high fat diet like ZIWI Peak is an ideal source of fuel for these dogs.

The source of this energy for high-performance active dogs is just as important as the caloric requirement. Many studies recommend that the composition of the diet should be low carbohydrate, high in bioavailable protein, and high in fat. Kronfeld demonstrated that endurance athlete dogs receiving greater than approximately 30–40 % of their metabolisable energy (ME) as a carbohydrate source can develop signs of 'tying up', coprophagy and hypoglycaemia during periods of intense endurance exercise (Kronfeld, 1973). These issues were observed to resolve when the carbohydrate percentage of the diet was reduced. It has therefore been recommended that the diet for canine athletes should limit carbohydrate content to 0-22% of ME energy (Hinchcliff et. al. 1997). Kronfeld and colleagues therefore suggest that dietary carbohydrates are not necessary in the composition of a high-performance endurance dogs' diet (Kronfeld, 1977).

Additionally, high fat and high protein diets can result in physiological changes. In one study, dogs on a high protein and high fat diet maintained higher serum concentrations of albumin, calcium, magnesium, and non-esterified fatty acids (NEFA) during the racing season compared to dogs fed on diets with higher proportions of carbohydrates contributing to their metabolisable energy (Kronfeld et. al., 1977). The dogs on the high fat and high protein diet showed the greatest increase in red cell count, haemoglobin concentration, and packed cell volume during training (Kronfeld et. al., 1977). The higher energy density and digestibility of the carbohydrate-free, high-fat diet was advantageous for prolonged strenuous exercise regarding metabolic responses in training. (Kronfeld et. al., 1977).

A separate study using high fat and high protein diets for endurance dogs resulted in higher serum concentrations of cholesterol, glucose, lactic acid, NEFA and ketones (Hammel et. al. 1977). Hammel deduced that an enhanced ability to utilise fat offers an advantage in a dog subjected to prolonged strenuous exercise in which fatty acid oxidation accounts for most of the oxygen consumption.

Furthermore, throughout the endurance race, the muscle glycogen in dogs will increase, which indicates that they have a compensatory mechanism that results in reduced muscle glycogen depletion after the first bout of activity (Mackenzie et. al., 2008).

The aforementioned studies have typically been performed with sled dogs, however interesting research with working dogs such as Beagles, Pointers, and Labradors used for scent work also shows improvement in performance when consuming a low carbohydrate diet (Downey et. al., 1980).

A study compared the hunting performance of working English Pointers when fed two different dog foods. Diet B was a standard adult pet food, and Diet A was a performance food that was higher in fat and protein. There was a 10% increase in metabolised energy from fat in Diet A compared to Diet B. The results were statistically significant and showed that dogs fed Diet A maintained or gained weight and body condition throughout the hunting season, while dogs fed Diet B lost body weight and body condition (Davenport et. al., 2001). Dogs fed Diet A demonstrated superior hunting performance, as dogs fed on the lower fat food had significantly less finds per hour of hunting (Davenport et. al., 2001).

Research with scent work Beagles supports the use of high fat and high protein diets, as it was shown that stamina improved for Beagles on treadmills when feeding higher fat diets with approximately 69% metabolizable energy as fat compared to diets of 27% ME fat (Downey et. al., 1980).

Many studies have suggested a link between fat intake and olfaction performance, which could be a factor in Davenport's study on Pointers achieving better finds per hour on a high fat diet. Another study on working English Pointers demonstrated that polyunsaturated fatty acids improved or maintained the efficiency of olfaction (Altom et. al., 2003). It is suggested that polyunsaturated fatty acids might positively affect olfaction by altering the olfactory bulb cellular constitution, which enhances neuronal signalling (Ober et. al., 2016).

In theory, a high fat diet is very efficient thermodynamically, as there is a reduced need for gluconeogenesis from protein as a source of energy during exercise, which is less efficient than fat or carbohydrates (Ober et. Al., 2016). As previously mentioned, fat as a source of energy is superior to carbohydrates, as a diet high in carbohydrates can result in signs of 'tying up', coprophagy and hypoglycaemia during periods of intense endurance exercise, resolving when carbohydrates were reduced (Kronfeld, 1973).

The ZIWI Peak recipes offer a source of highly bioavailable protein and fat that could appropriately support high-performance endurance dogs during intense periods of activity and also throughout their recovery.

References:

Adkins TO & Kronfeld DS 1982, “Diet of racing sled dogs affects erythrocyte depression by stress”, Canadian Veterinary Journal, vol. 23, n. 9, pp. 260-3. PMID: 17422178; PMCID: PMC1790196.

Albert BB, Cameron-Smith D, Hofman PL & Cutfield WS 2013, “Oxidation of marine omega-3 supplements and human health”, Biomed Research International, art. 464921. doi: 10.1155/2013/464921

Alhstrom O, Krogdahl A, Vhile SG, Skrede A 2004, “Fatty acid composition in commercial dog foods”, Journal of Nutrition, vol. 134: 2145S-2147S

Altom EK, Davenport GM, Myers LJ & Cummins KA 2003, “Effect of dietary fat source and exercise on odorant-detecting ability of canine athletes”, Research in Veterinary Science, vol. 75, no. 2, pp. 149-55. doi: 10.1016/s0034-5288(03)00071-7. PMID: 12893164.

Axelrod HE, Gullberg MG & Morgan AF 1951, “Carbohydrate metabolism in riboflavin-deficient dogs”, American Journal of Physiology, vol. 165, no. 3, pp. 604-19. doi: 10.1152/ajplegacy.1951.165.3.604. PMID: 14846984.

Bauer JE 1997, “Fatty acid metabolism in domestic cats (Felis catus) and cheetahs (Acinonyx jubatas)”, Proceedings of the Nutrition Society, vol. 56, pp 1013-24.

Brady, C 2021, Feeding Dogs. Dry or Raw? The Science Behind the Debate, Farrow Road Publishing, Sydney.

Davenport GM, Kelley RL, Altom EK & Lepine AJ 2001, “Effect of diet on hunting performance of English pointers”, Veterinary Therapeutics, vol. 2, no. 1, pp:10-23. PMID: 19753695.

Downey, R. L., Kronfeld, D. S., & Banta, CA 1980, “Diet of beagles affects stamina”, Journal of the American Animal Hospital Association, 16, 273–277.

Hădărugă DI, Ünlüsayin M, Gruia AT, Birău Mitroi C, Rusu G & Hădărugă NG 2016, “Thermal and oxidative stability of Atlantic salmon oil (Salmo salar L.) and complexation with β-cyclodextrin”, Beilstein Journal of Organic Chemistry, vol. 12, pp. 179-91. doi: 10.3762/bjoc.12.20.

Hammel DP, Kronfeld DS, Ganjam VK, Dunlap, Jr HL 1977, “Metabolic responses to exhaustive exercise in racing sled dogs fed diets containing medium, low, or zero carbohydrate”, The American Journal of Clinical Nutrition, vol. 30, no. 3, pp. 409–418, https://doi.org/10.1093/ajcn/30.3.409

Hayek MG & Reinhart GA 1998, “Utilization of w3 fatty acids in companion animal nutrition”, World Review of Nutrition and Dietetics; vol. 83, pp. 176-85.

Hinchcliff KW, Reinhart GA, Burr JR, Schreier CJ & Swenson RA 1997, “Metabolizable energy intake and sustained energy expenditure of Alaskan sled dogs during heavy exertion in the cold”, American Journal of Veterinary Research, vol. 58, no. 12, pp. 1457-62. PMID: 9401699.

Ivy, A.C., Schmidt, CR. & Beazell, J 1936, “Starch digestion in the dog”, North American Veterinarian, vol. 17, no. 4, pp.44-46.

James FE, Mansfield CS, Steiner JM, Williams DA & Robertson ID 2009, “Pancreatic response in healthy dogs fed diets of various fat compositions”, American Journal of Veterinary Research, vol. 70, no. 5, pp. 614-8.

Johnson LN, Heintze CR, Linder DE & Freeman LM 2015, “Evaluation of marketing claims, ingredients, and nutrient profiles of over-the-counter diets marketed for skin and coat health of dogs”, Journal of the American Veterinary Medical Association, vol. 246, pp 1334-1338

Klement, RJ et al. 2016, “Anti-Tumor Effects of Ketogenic Diets in Mice: A Meta-Analysis”, PlosONE, <https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0155050>..

Kronfeld DS, Hammel EP, Ramberg CF Jr, & Dunlap HL Jr 1977, “Hematological and metabolic responses to training in racing sled dogs fed diets containing medium, low, or zero carbohydrate”, American Journal of Clinical Nutrition, vol. 30, no. 3, pp. 419-30. doi: 10.1093/ajcn/30.3.419. PMID: 842493.

Kronfeld DS 1973, “Diet and the performance of racing sled dogs”, Journal of the American Veterinary Medical Association, vol. 162, no. 6, pp. 470-3. PMID: 4734973.

LeBlanc MJ, Brunet S, Bouchard G, Lamireau T, Yousef IM, Gavino V, Lévy E & Tuchweber B 2003, “Effects of dietary soybean lecithin on plasma lipid transport and hepatic cholesterol metabolism in rats”, Journal of Nutritional Biochemistry, vol 14, no. 1, pp. 40-8. doi: 10.1016/s0955-2863(02)00253-x. PMID: 12559476.

Lem KY, Fosgate GT, Norby B & Steiner JM 2008, “Associations between dietary factors and pancreatitis in dogs”, Journal of the American Veterinary Medical Association, vol.233, no. 9, pp. 1425-31.

Lindsay, S., Entenman, C & Chaikoff IL. 1948, “Pancreatitis accompanying hepatic disease in dogs fed a high fat, low protein diet”, Archives of Patholology & Laboratory Medicine, vol. 45, pp.635-638.

Lloyd, D, Essential fatty acids in dermatological disorders of dogs and cats. In: Horrobin D, (ed) 1990, “Omega-6 essential fatty acids: pathophysiology and roles in clinical medicine”, N.Y.: LNAn R. Liss Inc, p 113-20.

Loftus JP, Yazwinski M, Milizio JG, Wakshlag JJ 2014, “Energy requirements for racing endurance sled dogs”, Journal of Nutritional Science, vol. 30, no. 3, e34. doi: 10.1017/jns.2014.31. PMID: 26101603; PMCID: PMC4473159.

Logas D & Kunkle G 1993, “Double-blind study examining the effects of evening primrose oil on feline pruritic dermatitis”, Veterinary Dermatology, vol. 4, pp. 181-4.

Martínez-González MA, Gea A & Ruiz-Canela M 2019, “The Mediterranean Diet and Cardiovascular Health”, Circulation Research, vol. 124, no. 5, pp. 779-798.

McKenzie EC, Hinchcliff KW, Valberg SJ, Williamson KK, Payton ME & Davis MS, 2008, “Assessment of alterations in triglyceride and glycogen concentrations in muscle tissue of Alaskan sled dogs during repetitive prolonged exercise”, American Journal of Veterinary Research, vol. 69, no. 8, pp. 1097-103. doi: 10.2460/ajvr.69.8.1097. PMID: 18672977.

Metta Pets 2018, Ketogenic feeding, viewed on 31 August 2022, https://www.mettapets.info/ketogenic-diet.

National Research Council, 2006. Nutrient requirements of dogs and cats. National Academies Press.

Nicolosi RJ, Wilson TA, Lawton C & Handelman GJ 2001, “Dietary effects on cardiovascular disease risk factors: beyond saturated fatty acids and cholesterol”, Journal of American College Nutrition, vol. 20, no. 5, Suppl 421S-427S; discussion 440S-442S. doi: 10.1080/07315724.2001.10719179. PMID: 11603652.

Obelebe & Afukwa E 2019, “Nutritional Properties of Atlantic Mackerel and Salmon as Affected by Traditional Cooking Methods”, IOSR Journal of Biotechnology and Biochemistry (IOSR-JBB), vol. 5, no. 4, pp. 23-27

Ober J, Gillette RL, Angle TC, Haney P, Fletcher DJ & Wakshlag JJ 2016, “The Effects of Varying Concentrations of Dietary Protein and Fat on Blood Gas, Hematologic Serum Chemistry, and Body Temperature Before and After Exercise in Labrador Retrievers”, Frontiers of Veterinary Science, vol. 2, no. 3, pp. 59. doi: 10.3389/fvets.2016.00059. PMID: 27532039; PMCID: PMC4969627.

Perez Calvo, Estefania & Castrillo, Carlos & Baucells, M & Guada, JA 2010, “Effect of rendering on protein and fat quality of animal by-products”, Journal Of Animal Physiology And Animal Nutrition, vol. 94, e154-63. 10.1111/j.1439-0396.2010.00998.

Siri-Tarino PW, Sun Q, Hu FB & Krauss RM 2010, “Meta-analysis of prospective cohort studies evaluating the association of saturated fat with cardiovascular disease”, American Journal of Clinical Nutrition, vol. 91, vol. 3, pp. 535-46.

Silveria R, dos Santos PDS, Pizzo JS, et al, 2020, “Evaluation of dog food authenticity through lipid profile using GC-FID and ESK-MS”, Journal of Brazilian Chemical Society, vol. 31, No. 12, 2511-2517.

Verkest, KR 2014, “Is the metabolic syndrome a useful clinical concept in dogs? A review of the evidence”, The Veterinary Journal, vol. 199, no. 1, pp. 24-30. doi: 10.1016/j.tvjl.2013.09.057.