FEEDING DOGS FOR AGILITY

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Dog agility is one of several activities involving pet dogs which are gaining popularity. Agility trials involve dogs completing an obstacle course as quickly as possible under the direction of a handler. Courses increase in complexity with the level of competition but commonly include 13-18 different obstacles over a course that is 120-200 yards in length. The assigned course time in which dogs are expected to complete the course assumes a speed of approximately 2 yds/s for the simpler courses and 1.5 yds/s in the more complex courses (UKC regulations). Thus, dogs run at approximately 7 km/h over a very short distance but are required to jump, climb, start and stop and change direction rapidly.

Most nutritional studies involving exercising dogs have been performed either on dogs undertaking sprint exercise such as Greyhounds or dogs undertaking endurance exercise such as Beagles on treadmills or sled dogs in teams pulling loads. Greyhounds sprint for 17-57 seconds over a distance of 300-900 meters at an average speed of approximately 60 km/h (37 mph), whereas racing sled dogs run for up to hundreds of kilometers daily in long distance races of 10-1800 km trotting at 16 km/h (which results in an average speed of 7 km/h over several days when allowing for rest stops). Greyhounds undertake what is called 'supra-maximal' exercise because the rate of oxygen uptake necessary to sustain this rate of sprinting exceeds the maximum rate at which oxygen can be taken up by the body. The extra energy for very rapid sprinting is generated without oxygen. This produces lactic acid which then builds up in the blood. In contrast, long distance running involves 'sub-maximal' exercise. The oxygen required to maintain this type of exercise does not exceed the maximum rate of uptake and concentrations of lactic acid do not increase in the blood. I am unaware of any nutritional studies that have been performed on agility dogs but the type of activity they perform has some characteristics of both these extreme types of exercise and some of the principles derived from studies in other athletic dogs may be applied to agility dogs.

Nutrition should not be treated as a substitute for training, however. Most dogs sleep for more than two-thirds of each day and these dogs cannot be expected to perform optimally at the weekend if they have been lying on the couch for the rest of the week. Training (frequently repeated exercise) increases bone mass, red blood cell turnover, heart size, maximal oxygen consumption, use of fat for energy and stamina. Training reduces heart rate, lactic acid production and oxidative free radical formation and probably reduces the risk of injury. The benefits of training far outweigh any potential benefit that might be achieved by modifying the diet. Owners of agility dogs should, therefore, exercise their dogs more regularly rather than seek nutritional solutions to improve their dog's

performance. This training may involve sprinting, endurance or resistive exercise or interval training in which aerobic and anaerobic exercise are alternated but the ideal type of training remains unknown. It is possible, for example, that sprinting, resistive or interval training may increase muscle hypertrophy and improve the performance of agility dogs more than endurance exercise.

As a reference for the studies that support the statements in this presentation, the reader should turn to the 2004 National Research Council publication on the Nutrient Requirements of Dogs and Cats. It is available in a prepublication form at present and should soon be published in its final form.

ENERGY REQUIREMENTS

The energy required by a dog is composed of energy for maintaining normal body systems when the animal is at rest and not eating (the basal metabolic rate or BMR) plus energy used in consumption of food (dietary thermogenesis) plus energy for keeping itself warm in a cold environment (cold-induced thermogenesis) plus energy for exercise. The energy requirement of a dog, therefore, consists of the energy required in the absence of exercise plus the energy required for exercise.

The energy required for running is proportional to the distance traveled irrespective of the speed (approximately 1 kcal/kg body weight (BW) for each horizontal km traveled). Thus, Greyhounds require little energy because they travel only short distances, whereas sled dogs require massive amounts of energy. Acceleration requires additional energy (approximately 3 kcal/kg BW for each horizontal meter traveled and there is an additional cost of climbing or jumping (0.007 kcal/kg BW for each vertical meter) but dogs recover much of the energy used going up hill when they come down again. Agility dogs travel only 200 m and, therefore, would require little energy ($\approx$ 4 kcal for an average 20 kg BW dog) to complete a trial if that trial involved trotting in a straight line. Agility dogs have to accelerate and turn corners, however. A generous assumption would be that half each trial will involve acceleration or turning corners. This would approximately double the energy requirement (equivalent to an additional 4 kcal/trial for an average 20 kg BW dog). To this must be added an additional cost of climbing or jumping (an additional 0.6 kcal for an average 20 kg dog to climb 4 meters during a trial). This is in addition to the cost of standing which is about half as much again as basal metabolic rate, i.e. 0.2 kcal for standing in addition to BMR of 0.5 kcal for a 60 s trial for an average 20 kg BW dog). Overall, therefore, this generous estimate of the energy required for each agility trial is very small (no more than 8.6 kcal for an average 20 kg BW dog or 0.4 kcal/kg BW above BMR) when compared to the total daily energy requirement of a dog (720 kcal daily for BMR or 1200 kcal daily for maintenance for an average 20 kg BW dog in kennels).

It can be concluded, therefore, that an active agility dog probably requires only slightly more energy each day than an active dog in kennels, i.e., an agility dog is likely to require 120-160 kcal ME/kg $BW^{0.75}$ daily, which is equivalent to 1100-1500 kcal daily for a 20 kg BW dog. This recommendation has a wide range because energy requirements are

greatly affected by individual variation between animals and breeds, by age, neutering, ambient temperature and coat length. Energy requirements will also vary with the distance dogs travel during training. Rather than use a calculation to estimate how much an agility dog should be fed, therefore, it is best to adjust the amount fed to ensure that each dog maintains a lean body condition score (4-5 for most dogs or 3-3.5 for sight-hounds on a 9 point scale). A lean body condition is probably ideal because it will reduce the momentum that must be overcome when turning corners and will probably improve performance. It will also reduce pressure on joints and may extend the active life of those breeds of agility dogs which are prone to arthritis.

PROTEIN

Dogs use protein for making glucose for energy only after they have been running for about 30 minutes. As agility dogs run for less than a minute, they probably do not require increased protein for optimal performance. Only dogs undertaking endurance training would require more protein. Most commercial dry diets should contain enough protein but low protein therapeutic, 'lite' and 'senior' diets may not contain enough protein.

SOURCES OF ENERGY: CARBOHYDRATE VERSUS FAT

The energy for muscle contraction comes from (1) the high energy phosphate bonds in adenine triphosphate (ATP) and creatine phosphate stored in muscle, (2) from the metabolism of glycogen stored in muscle to glucose and then to lactic acid and pyruvate, or (3) from the oxidation of glucose and fat to carbon dioxide and water. The production of lactic acid from glucose does not require oxygen and is termed 'anaerobic glycolysis'. The oxidation of glucose and fat does require oxygen and, therefore, involves 'aerobic' metabolism.

High energy phosphate from ATP and creatine supports the highest rate of activity and provides much of the energy for acceleration but these substances are only present in small amounts and become rapidly exhausted. Anaerobic glycolysis supports the next highest rate of activity but build up of lactic acid in the blood limits the energy available from this source. Anaerobic glycolysis provides some of the energy required for fast sprints by Greyhounds but agility dogs do not run as fast. Anaerobic glycolysis is probably less important in agility dogs and it is unlikely that lactic acid should build up during an agility trial. Aerobic oxidation of glucose supports the next highest level of activity and provides some of the energy during long distance running. High speeds supported by glucose oxidation are only possible, however, while supplies of glucose from glycogen stored in muscle last. When supplies of glycogen are exhausted, only lower speeds supported by fat oxidation are supported and athletes are unable to accelerate. The amount of glycogen in muscle can, therefore, affect stamina.

Unlike the other sources of energy, fat provides an almost inexhaustible source of energy. Dogs, in particular, are adapted to using the oxidation of fat as an energy source. All canine muscle fibers are able to use aerobic as well as anaerobic sources of energy and canine muscle, unlike human and cat muscle, does not contain type IIb fast twitch fibers

that rely primarily on anaerobic sources of energy. Thus, glucose oxidation increases when dogs walk and run at low speeds but fat oxidation increases even more and provides most of the energy for sub-maximal aerobic exercise. Only when lactic acid builds up in dogs running very fast, such as Greyhounds, or in untrained dogs at lesser speeds, is fat oxidation less important. Aerobic metabolism of fat is likely, therefore, to provide most of the energy for agility dogs. Carbohydrate oxidation will, however, aid in supporting a higher rate of energy expenditure and a higher running speed than fat oxidation while glycogen stores last. The duration of an agility trial is so short that glycogen stores are unlikely to be depleted but should glycogen become depleted during several trials, fat oxidation would become the only available source of energy. Dogs may not be able then to turn, jump and accelerate as well as when glycogen was available.

WHAT TO FEED?

Dogs appear to run faster and have better stamina when fed a higher fat diet. Nevertheless, the ideal amount of fat that should be fed to agility dogs has yet to be determined. Very high fat diets have been reported to slow racing Greyhounds but increase the stamina of long distance running dogs. Low fat diets slow racing Greyhounds and decrease the stamina of long distance dogs. Intermediate (moderate to high) amounts of fat are, therefore, recommended for agility dogs. Inexpensive dry extruded dog foods are comparatively low in fat. These probably do not contain enough fat for agility dogs. More expensive dry dog foods tend to be higher in fat because fat is sprayed on to the kibble after it emerges from the extruder. These higher fat dry commercial diets probably provide enough fat for agility dogs. Alternatively, canned dog food can be added to the less expensive dry foods to increase the fat content of the diet. Training is important, however, to enable dogs to utilize the increased fat in their diet.

WHEN TO FEED

Dogs do not need to be fed immediately before intense exercise. They show better stamina when they have not been fed. Dogs should therefore be fed after exercise has finished for the day. Ideally, dogs should not undertake intense exercise less than 8 hrs after a small meal or less than 16 h after a large meal to allow for the meal to pass through the intestinal tract.

WATER

Water is more important than food to exercising dogs and should always be made available for drinking free choice. Water is essential for dogs to maintain normal body temperature in high ambient temperatures and when exercising. Dogs keep cool by panting which increases their water requirements. Heat is generated during exercise and unless heat is lost to the environment, rectal body temperature tends to rise. This exercise-induced hyperthermia limits how long dogs can exercise. Body temperature increases more during exercise in dehydrated dogs, whereas free access to water minimizes exercise-induced hyperthermia and markedly improves stamina. Body temperature can increase explosively even in sedentary animals in a warm environment

when they become more than 10% dehydrated and the problem is exacerbated during exercise. Dogs should, therefore, be offered free access to water before, between and after agility exercise to reduce the risk of hyperthermia and to improve performance. It should be emphasized, however, that dogs are at even greater risk of hyperthermia when they exercise in high humidity. Even well hydrated dogs cannot control their body temperature if the humidity is high because water will not then evaporate to allow cooling. Under these circumstances, dogs should be cooled with cold water or ice or kept in an air conditioned environment before and after exercise to maximize performance.

The amount of water required by an agility dog will be affected more by ambient temperature than the amount of exercise. The water requirement can more than double in a warm environment. The water requirement during exercise, however, increases with the amount of energy expended by approximately 1 mL/kcal. An agility dog needs very little energy to complete each trial so it should require very little additional water for each trial (≈0.4 mL/kg BW for each 200 m trial). This increase in water intake is trivial compared to daily water requirements (≈50 mL/kg BW daily).

GLUCOSE

Glucose (0.2 to 5 g/kg BW) given before, during or after exercise helps to maintain blood glucose during exercise, promotes more rapid repletion of muscle glycogen after exercise and reduces the increase in body temperature that occurs during exercise. It does not improve endurance performance but could improve recovery between bouts of exercise. Any benefits are likely to be small in agility dogs, however, because glycogen is probably not greatly depleted during exercise in these dogs. It is not recommended to add any other nutrient to drinking water as some have been shown to reduce performance or to have detrimental effects when added to the drinking water.

CALCIUM AND PHOSPHORUS

There is no evidence that the dietary requirements for calcium and phosphorus are any higher in dogs that exercise than in sedentary dogs or dogs undertaking normal amounts of exercise. The bones of exercising dogs are 10% heavier than those of confined dogs but this increase develops over a long time and extra calcium should not be fed to exercising dogs. Excess calcium supplementation increases the risk of osteochondritis dissecans in growing large breed and in exercising dogs. Supplements are not necessary, therefore, when dogs are fed a balanced diet containing approximately 3 g/mcal calcium and phosphurus.

Calcium may need to be added to unbalanced diets, such as home-made diets containing lots of meat, however. Feeding foods without adequate calcium supplementation, such as meat can result in poor bone mineralization and increased risk of fractures in dogs.

SALT

Loss of salt in sweat does not occur in dogs as it does in humans during exercise. Sodium and potassium losses in saliva and urine are comparatively small. Most commercial diets contain adequate amounts of sodium, chloride and potassium (≈ 1g/Mcal ME) but very low sodium diets are not recommended.

Addition of salt to the drinking water is unnecessary and is not recommended. The osmolality (water absorbing tendency) of the blood increases in dogs when they become dehydrated. Dogs drink to correct this hyper-osmolality. Adding salt increases the osmolality of the drinking water and prevents correction of this hyper-osmolality. Dogs will, therefore, continue to crave and drink water when given salt-containing water, whereas dogs satisfy their deficit with one episode of drinking when given water to drink without any salt added.

TRACE MINERALS AND VITAMINS

There have been no studies of the effect of exercise on vitamin and trace mineral requirements in dogs. Vitamin B1 and B6 requirements probably increase in proportion to energy and protein consumption, respectively, but agility dogs require little extra energy or protein. Balanced commercial diets designed for dogs undertaking only moderate amounts of exercise contain plenty of vitamins and minerals and additional supplementation is almost certainly not required when agility dogs are fed such diets. Unbalanced home cooked diets may, however, require supplementation.

Antioxidants

Oxidation reactions are an essential part of normal physiological processes but reactive oxygen containing substances and free radicals have the potential to cause oxidative damage to the fat in cell walls, to proteins and to DNA. The production of reactive oxygen containing substances and free radicals increases and the concentration of antioxidants in blood decreases during exercise. This may represent an oxidative stress. Nevertheless, this oxidative stress has not as yet been shown to cause any pathology in trained dogs during exercise. Furthermore, supplementation of antioxidant nutrients such as vitamins E, C or retinoids, have mostly failed to show any benefit in exercising dogs, whereas very high daily doses of vitamin E (35 IU vitamin E/kg body weight) and vitamin C (35 mg/kg body weight) slowed racing Greyhounds. Currently, therefore, there is no evidence that the requirement for antioxidant nutrients is greater in exercising dogs than in sedentary dogs and supplementation of agility dogs is probably not necessary if they are fed a balanced commercial diet. Nevertheless, the production of reactive oxygen species during exercise is increased during exercise in untrained dogs and there have been no studies examining the effect of antioxidant supplementation in untrained dogs. It is possible, therefore, that there may be more benefit from antioxidant supplementation of the diet in untrained dogs that exercise only at weekends.

OTHER ‘ERGOGENIC’ NUTRIENTS

Arginine, tryptophan, aspartate, L-carnitine, creatine, dimethyl glycine, pangamic acid (vitamin B_{15}), inosine, co-enzyme Q, bee pollen, methylsulfonylmethane, caffeine, alcohol and vinegar have all been suggested to improve the performance of exercising dogs. To date, there is no evidence to support the addition of any of these substances to the diet of agility dogs or dogs undertaking any other form of exercise. Arginine, tryptophan and aspartate are all amino acids and there is no data to suggest that requirements for these amino acids increase more than the requirement for protein in exercising dogs. L-carnitine and creatine are synthesized by dogs and there is no evidence that this synthetic capacity is inadequate in exercising dogs. Addition of creatine to the diet, for example, does not appear to increase creatine concentrations in the muscle of exercising dogs as it does in some humans. The improvement in performance of racing Greyhounds given dimethylglycine and diisopropylammonium dichloroacetic acid can probably be attributed to dichloroacetic acid. Dicholoroacetic acid is a potent drug which markedly curtails lactic acid production but dichloroacetic acid also has many toxic side-effects and a safe dose has not been established. Glucosamine, green lipped mussel, or chondroitin sulfate supplementation may be beneficial, however, in dogs with degenerative joint disease and dental chews may help to reduce the build up of dental tartar.