

# Why Sports Drinks Are Going to the Dogs:

A Research White Paper on the Beneficial Impacts of Blended Carbohydrate/Amino Acid Supplementation on Canine Physical Performance and Overall Health

The Varsity Pets Canine Fitness Research Panel<sup>1</sup>

## Abstract

Scientific research conducted over the past three decades has conclusively demonstrated that ingestion of carbohydrate/amino-acid nutritional supplements before, during, and after strenuous exercise improves muscular recovery and overall physical performance in humans. These research findings have given rise to a

wide range of extremely popular and useful products, including so-called “sports drinks,” such as PepsiCo’s Gatorade.

In recent years, many of these research findings have been replicated in studies of domestic dogs. Thus, as dog owners – both those who compete in canine

athletics and those simply concerned with managing their pets' health and quality of life – become increasingly aware of the importance of exercise to canine health and well-being, the authors of this paper forecast that canine sports drinks will grow to become just as popular as analogous human-use products.

In 2012, a research team from Varsity Pets developed a patent-pending formula to be put to immediate use in the most advanced canine sports drink supplement ever invented, a product that would come to be called ***Drool Fuel™***. Each serving of Drool Fuel™ provides active dogs with a muscle-building blend of canine essential amino acids and easily-digestible carbohydrates, as well as antioxidants and electrolytes – everything an active

dog needs to recovery efficiently from strenuous exercise.

***“The authors of this paper forecast that canine sports drinks will grow to become just as popular as analogous human-use products.”***

Moreover, Drool Fuel's highly-palatable beef flavoring facilitates “pre-hydration” by encouraging drinking by dogs even before the sensation of thirst and its easy-to-use single-serving packets enable owners and handlers to easily feed Drool Fuel™ in the field, on the trail, or in the competition ring.

Drool Fuel™ is the first canine sports drink in history to incorporate all of these functional elements into a single product. This highly advanced formula and its early adoption by numerous world-class canine athletes suggests that Drool Fuel™ is poised to lead the development of an exciting new market.

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<sup>1</sup> Varsity Pets, LLC (“Varsity Pets”) is an American limited liability company that develops products and services under the guiding mission of helping busy pet owners raise fit, happy, and healthy companions. The Varsity Pets Canine Fitness Research Panel is a team of canine fitness professionals whose research and expertise help to guide the development of Varsity Pets products. For more information about Varsity Pets, please visit [www.varsitypetsonline.com](http://www.varsitypetsonline.com) or contact us via e-mail at [contact@varsitypetsonline.com](mailto:contact@varsitypetsonline.com).

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# I. “Sports Drinks,” “Exercise Recovery Drinks,” and the Beneficial Effects of Carbohydrate/Amino Acid Supplementation on Human Metabolic Function, Muscular Recovery, and Overall Physical Performance

The beneficial effects of carbohydrate supplementation on human exercise performance have been studied extensively. Studies indisputably show that ingestion of simple carbohydrates during exercise delays the onset of metabolic fatigue and improves overall physical performance in both prolonged, endurance-style exercise<sup>2</sup> and high-intensity

exercise of shorter duration.<sup>3</sup> Ingestion of easily-digestible carbohydrate supplements during exercise allows the body to maintain a high rate of carbohydrate oxidation while preserving its limited stores of the metabolic “fuel” glycogen. When an exercising body depletes its glycogen stores, it

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<sup>2</sup> See, e.g., O. Bjorkman, K. Sahlin, L. Hagenfeldt, and J. Wahren, *Influence of Glucose and Fructose Ingestion on the Capacity for Long Term Exercise in Well Trained Men*, Clin. Physiol. 4:483-494 (1984); E.F. Coyle, J. M. Hagberg, B. F. Hurley, W. H. Martin, A. A. Ehsani, and J. O. Holloszy, *Carbohydrate Feeding During Prolonged Strenuous Exercise*, J. Appl. Physiol. 55(1),230-235 (1983); M. Hargreaves, D. L. Costill, A. Coggan, W. J. Fink, and I. Nishibata, *Effect of Carbohydrate Feedings on Muscle Glycogen Utilisation and Exercise Performance*, Med. Sci. Sports Exerc. 16(3):219-222 (1984); J.L. Ivy, W. Miller, V. Dover, L. G. Goodyear, W. M. Sherman, S. Farrell, and H. Williams, *Endurance Improved by Ingestion of a Glucose Polymer Supplement*, Med. Sci. Sports Exerc. 15(6):466-471 (1983); R. Murray, J. G. Seifert, D. E. Eddy, G. L. Paul, and G. A. Halaby, *Carbohydrate Feeding and Exercise: Effect of Beverage Carbohydrate Content*, Eur J. Appl. Physiol. 59:152-158 (1989).

<sup>3</sup> See, e.g., R. Anantaraman, A. A. Carmines, G. A. Gaesser, and A. Weltman, *Effects of Carbohydrate Supplementation on Performance During 1 H of High-Intensity Exercise*, Int. J. Sports Med. 16(7):461-465 (1995); P.R. Below, R. Mora-Rodriguez, J. Gonzales Alonso, and E. F. Coyle, *Fluid and Carbohydrate Ingestion Independently Improve Performance During 1 H of Intense Exercise*, Med. Sci. Sports Exerc. 27(2):200-210 (1995); J. Carter, A. E. Jeukendrup, T. Mundel, and D. A. Jones, *Carbohydrate Supplementation Improves Moderate and High-Intensity Exercise in the Heat*, Pflugers Arch. 446(2):211-219 (2003).

is forced to turn to less efficient energy pathways to continue powering it through strenuous activity. Thus, by increasing the availability of metabolic fuel, simple carbohydrate supplements delay the onset of fatigue and improve overall exercise performance.<sup>5</sup>

Ingestion of simple carbohydrates immediately after exercise has also been shown to deliver performance benefits in the form of accelerated replenishment of exercise-depleted muscle glycogen

stores.<sup>6</sup> Glycogen, the primary source of metabolic fuel for high-intensity exercises lasting more than a minute, is stored in the skeletal muscles and depleted quickly during high-intensity exercise efforts.<sup>7</sup> Ingestion of simple carbohydrate supplements immediately following exercise accelerates the resynthesis of muscle glycogen, shortening recovery time and improving performance in subsequent physical activities.<sup>8</sup>

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<sup>4</sup> See, e.g., Bjorkman, et al. at 483 (“Intermittent glucose ingestion ... during prolonged, heavy bicycle exercise postpones exhaustion and exerts a glycogen-conserving effect in the working muscles.”); see also O-K Tsintzas, C. Williams, L. Boobis, P. Greenhaff, *Carbohydrate Ingestion and Glycogen Utilization in Different Muscle Fibre Types in Man*, *Jour. of Phys.* 489.1:243-250 (1995).

<sup>5</sup> See, e.g., id. at 243-50; Borkman, et al. at 483.

<sup>6</sup> See, e.g., A. Casey, R. Mann, K. Banister, J. Fox, P.G. Morris, I.A. Macdonald, P. Greenhaff, *Effect of Carbohydrate Ingestion on Glycogen Resynthesis in Human Liver and Skeletal Muscle, Measured by 13(C) MRS*, *Am. J. Physiol. Endocrinol. Metab.* 278(1): E65-75 (2000); A.M. Wootton, T. Ng, M.J. Watt, J.A. Hawley, *High Rates of Muscle Glycogen Resynthesis After Exhaustive Exercise When Carbohydrate is Coingested With Caffeine*, *J. Appl. Physiol.* 105(a):7-13 (2008); D.L. Costill, W.M. Sherman, W.J. Fink, C. Maresh, M. Witten, J.M. Miller, *The Role of Dietary Carbohydrates in Muscle Glycogen Resynthesis After Strenuous Running*, *Am. J. Clin. Nutr.* 34(9):1831-1836 (1981); G. Cox, S.A. Clark, A. Cox, S. Halston, M. Hargreaves, J. Hawley, N. Jeacocke, R. Snow, W.K. Yeo, L. Burke, *Daily Training With High Carbohydrate Availability Increases Exogenous Carbohydrate Oxidation During Endurance Cycling*, *J. Appl. Physiol.* 109(1):126-134 (2010).

<sup>7</sup> See, e.g., J.L. Ivy, *Regulation of Muscle Glycogen Repletion, Muscle Protein Synthesis and Repair Following Exercise*, *J. Sports Sci. and Med.* 3, 131-138 (2004) (“The major source of fuel used by the skeletal muscles during prolonged aerobic exercise of a strenuous nature is muscle glycogen. The importance of muscle glycogen as a fuel

In summary, it is no exaggeration to say that the benefits of physical exercise cannot be fully realized without proper nutritional supplementation with simple carbohydrates.

The performance benefits of carbohydrate supplementation are so well recognized that ingestion of simple carbohydrate drinks (as opposed to water) during athletic competitions has become a near-universal practice among both professional and recreational human athletes. Such supplements, in the form of *sports drinks*, deliver simple carbohydrates along with electrolytes such as potassium, chloride, and sodium, all of which are lost during human exercise. Sports drinks are ubiquitous in the marketplace, with brands such as Coca Cola Co.'s Powerade and PepsiCo's Gatorade competing for shares of a

multi-billion dollar global market.

Further scientific advancements in the field of sports nutrition have been made in the decades since products like Gatorade were first introduced into the marketplace. One of the most important breakthroughs relating to nutritional performance-enhancement concerns the significance of supplementation with simple carbohydrates blended with *whole proteins and essential amino acids*.<sup>9</sup>

***“In summary, it is no exaggeration to say that the benefits of physical exercise cannot be fully realized without proper nutritional supplementation with simple carbohydrates.”***

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source cannot be overstated. In general, it has been demonstrated that aerobic endurance is directly related to the initial muscle glycogen stores, that strenuous exercise cannot be maintained once those stores are depleted, and that perception of fatigue during prolonged intense exercise parallels the decline in muscle glycogen.”).

<sup>8</sup> See, e.g., Casey, et al., at E65-75; Pedersen, et al., at 7-13; Costill, et al., at 1831-36.

<sup>9</sup> Amino acids are often referred to as the “building blocks of protein.” See, e.g., R.B. Kreider, *Effects of Protein and Amino-Acid Supplementation on Athletic Performance*, *Sportscience* 3(1) (1999) (“Amino acids are the building blocks of protein in the body; as such they are essential for the synthesis of structural proteins, enzymes, and some hormones and neurotransmitters.”). They play a variety of critical roles in the body and generally come in two varieties, “essential” and “non-essential.” Non-essential amino acids can be synthesized by the body on its own. But essential amino acids cannot. Accordingly, all essential amino acids must be ingested as part of the diet. See P. Trumbo, S. Schlicker, et al., *Food and Nutrition Board of the Institute of the National Academies. Dietary Reference Intakes for Energy, Carbohydrate, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids*, *J. Am. Diet Assoc.* 102(11): 1621-1630 (2002).



Studies on human athletes have recently shown that consuming simple carbohydrates combined with whole proteins or essential amino acids tends to increase the rate of postexercise muscle glycogen resynthesis *beyond that which occurs with carbohydrate alone*.<sup>10</sup>

These papers show that post-workout supplementation with carbohydrate/ amino-acid blends tends to elevate *blood insulin* levels and plasma amino acid availability, both of which tend to increase post-exercise glycogen synthesis rates beyond those achieved with carbohydrate supplementation alone. In other words, combining simple carbohydrates with amino acids provides a

synergistic recovery benefit that cannot be achieved by either constituent alone.

Moreover, post-workout amino acid supplementation alone (even without carbohydrate blending) has been shown to accelerate new muscle protein synthesis,<sup>12</sup> as has pre-workout ingestion of carbohydrate/amino acid blends.<sup>13</sup> Thus, in summary, there is significant evidence suggesting that ingestion of carbohydrate/amino acid blends both prior to and immediately after exercise increases glycogen resynthesis rates and optimizes muscular recovery, thereby improving physical performance even more than carbohydrate supplementation alone.<sup>14</sup>

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<sup>10</sup> J.L. Ivy, H.W. Goforth Jr., B.M. Damon, T.R. McCauley, E.C. Parsons, T.B. Price, *Early Postexercise Muscle Glycogen Recovery is Enhanced With a Carbohydrate-Protein Supplement*, J. Appl. Physiol., 93(4):1337-44 (2002); L.J. van Loon, M. Kruijshoop, H. Verhagen, W.H. Saris, A.J. Wagenmakers, *Maximizing Postexercise Muscle Glycogen Synthesis: Carbohydrate Supplementation and the Application of Amino Acid or Protein Hydrolysate*, Am. J. Clin. Nutr. 72:106-11 (2000); M.A. Tarnopolsky, M. Bosman, J.R. Macdonald, D. Vandeputte, J. Martin, B.D. Roy, *Postexercise Protein-Carbohydrate and Carbohydrate Supplements Increase Muscle Glycogen in Men and Women*, J. Appl. Physiol., 83(6):1877-83 (1997); B.D. Roy and M.A. Tamopolsky, *Influence of Differing Macronutrient Intakes on Muscle Glycogen Resynthesis After Resistance Exercise*, J. Appl. Physiol., 84(3):890-96 (1998); K.M. Zawadzki, B.B.D. Yaspelkis, J.L. Ivy, *Carbohydrate-Protein Complex Increases the Rate of Muscle Glycogen Storage After Exercise*, J. Appl. Physiol. 72:1854-59 (1992).

<sup>11</sup> L.J. van Loon, M. Kruijshoop, H. Verhagen, W.H. Saris, A.J. Wagenmakers, *Ingestion of Protein Hydrolysate and Amino Acid-Carbohydrate Mixtures Increases Postexercise Plasma Insulin Responses in Men*, J. Nutr. 130(10): 2508-2513 (2000); L.J. van Loon, M. Kruijshoop, H. Verhagen, W.H. Saris, A.J. Wagenmakers, *Plasma Insulin Responses After Ingestion of Different Amino Acid or Protein Mixtures with Carbohydrate*, Am. J. Clin. Nutr. 72:96-105 (2000) ("Conclusions: Insulin responses are positively correlated

Just as growing recognition by the scientific community of the benefits of carbohydrate supplementation contributed to the rise in popularity of carbohydrate-rich sports drinks, recognition of the benefits of carbohydrate/amino acid blends has also manifested in the marketplace. The result has been a veritable paradigm shift in the world of nutritional supplementation, as producers strive to address the public's increasing awareness of cutting-edge research findings. Thus, over recent years, the use of carbohydrate-amino acid blends

in the form of *exercise recovery drinks*, such as PacificHealth Labs' Endurox R4, GU Energy Labs' ROCTANE, and Gatorade's G-Series Recover, has become wildly popular among professional athletes and others seeking a performance edge in physical competitions. This includes recreational athletes engaged in competitive hobbies like running, triathlon, and Crossfit, as the rise in popularity of such activities, along with their relative rigors, has fueled the explosive growth of the exercise recovery drink market over the past ten years.

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with plasma leucine, phenylalanine, and tyrosine concentrations. A mixture of whey protein hydrolysate, free leucine, phenylalanine, and carbohydrate can be applied as a nutritional supplement to strongly elevate insulin concentrations.”).

<sup>12</sup> R.R. Wolfe, *Branched-Chain Amino Acids in Exercise: Skeletal Muscle Protein Metabolism and Resistance Exercise*, J. Nutr. 136:525S-528S (2006); E. Volpi, B. Mittendorfer, B.B. Rasumussen, R.R. Wolfe, *The Response of Muscle Protein Anabolism to Combined Hyperaminoacidemia and Glucose-Induced Hyperinsulinemia is Impaired in the Elderly*, J. Clin. Endocrinol. Metab. 85:4481-90 (2000); R.R. Wolfe, *Regulation of Muscle Protein by Amino Acids*, J. Nutr. 132:3219S-3224S (2002).

<sup>13</sup> See, e.g., E. Borsheim, K.D. Tipton, S.E. Wolfe, R.R. Wolfe, *Essential Amino Acids and Muscle Protein Recovery From Resistance Exercise*, Am. J. Physiol. Endocrinol. Metab. 283:E648-E657 (2002); Wolfe, at 527S.

<sup>14</sup> J.L. Ivy, P.T. Res, R.C. Sprague, M.O. Widzer, *Effect of a Carbohydrate-Protein Supplement on Endurance Performance During Exercise of Varying Intensity*, Intl. J. Sports Nutr. Exerc. Metab., 13:382-95 (2003); M.J. Saunders, M.D. Kane, K.M. Todd, *Effects of a Carbohydrate-Protein Beverage on Cycling Endurance and Muscle Damage*, Med. Sci. Sports Exerc., 36:1233-38 (2004); D.K. Levenhagen, et al., *Postexercise Protein Intake Enhances Whole-Body and Leg Protein Accretion in Humans*, Med. Sci. Sports Exerc. 24:828-37 (2002); E. Blomstrand, J. Eliasson, H.K.

Karlsson, R. Kohnke, *Branched-Chain Amino Acids Activate Key Enzymes in Protein Synthesis After Physical Exercise*, J. Nutr. 136:269-73 (2006); M.B. Williams, P.B. Raven, D.L. Fogt, J.L. Ivy, *Effects of Recovery Beverages on Glycogen Restoration and Endurance Exercise Performance*, J. Strength Cond. Res., 17:12-19 (2003).



## II. Canine Sports, Working Dogs, Obesity, and the Increasing Importance of Canine Physical Performance

Over the past decade the physical demands placed upon domestic dogs have grown dramatically. These rising expectations stem primarily from three distinct phenomena:

- (1) The increasing reliance upon working dogs by public service organizations such as law enforcement agencies, military divisions, and search and rescue units;
- (2) The recent popularity boom enjoyed by canine athletic competitions, including agility, rally obedience, dock-diving, flyball, flying disc, lure coursing, and herding; and
- (3) The increasing awareness of pet owners of the health dangers associated with canine obesity and the attendant rise in popularity of recreational exercise as a weight-management strategy, as well as a means of enhancing the well-being of beloved household pets.

Optimization of canine physical performance plays an important role in each of these arenas.

Professional working dogs regularly train for and perform feats of explosive speed (such as pursuing and apprehending criminal suspects) as well as phenomenal endurance (such as long-distance

tracking and recovery). With matters of life and death on the line, both handlers and the public-at-large rely upon working dogs to perform these activities at their physical peak, day-in and day-out. Their value as working professionals is bound tightly to the quality of their physical performances.

For their part, competitive canine athletes, like their human counterparts, are actively judged based upon the quality of their physical performances. They compete in events designed to test their agility, explosiveness, strength, speed, and endurance. For these athletes and their handlers, marginal improvements in physical performance often represent the differences between success and failure.

Even household pets must perform at consistently high physical levels in order to meaningfully execute the exercises that help them to stave off the deadly effects of obesity. As with humans, obesity is a major concern in the population of dogs kept as companion animals. Three recently-published studies suggest that 29-34% of pet dogs are overweight and that the overall rate of obesity among companion dogs is increasing.<sup>15</sup> Modern scientific research has also revealed the myriad dangers posed by canine obesity. Most famously, a widely-cited

study published in the *Journal of the American Veterinary Medical Association* documented a 12-year analysis of dozens of dogs and concluded that obesity tended to significantly shorten the lifespans of the moderately overweight animals.<sup>16</sup> Other studies have shown that canine obesity contributes to the development of dangerous health conditions such as osteoarthritis, diabetes, and heart disease.<sup>17</sup>

While the canine obesity epidemic remains underappreciated, committed efforts by veterinarians and other advocates have raised public awareness about its deadly effects in recent years. Today, perhaps more than ever before, dog owners understand the dangers of obesity and the importance of keeping their canine companions physically fit via a consistent exercise regimen and a sensible nutritional program.

***“A widely-cited study published in the *Journal of the American Veterinary Medical Association* documented a 12-year analysis of dozens of dogs and concluded that obesity tended to significantly shorten the lifespans of the moderately overweight animals.”***

Regular exercise plays a critical role in preventing and managing canine obesity.<sup>18</sup> But in order to achieve meaningful physiological gains, such as increased muscle mass and decreased body fat, many exercises must be performed at a high intensity

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<sup>15</sup> A.J. German, et al., *Obesity, its Associated Disorders and the Role of Inflammatory Adipokines in Companion Animals*, *Vet. J.*, 185:4-9 (2010); E.M. Lund, P.J. Armstrong, C.A. Kirk, J.S. Klausner, *Prevalence and Risk Factors for Obesity in Adult Dogs From Private US Veterinary Practices*, *Intl. J. Res. Vet. Med.*, 3:88-95(2006).

<sup>16</sup> R.D. Kealy, D.F. Lawler, et al., *Effects of Diet Restriction on Life Span and Age-Related Changes in Dogs*, *J. Am. Vet. Med. Assoc.*, 220:1315-1320 (2002); see also B.P. Yu, *Food Restriction Research: Past and Present Status*, *Rev. Biol. Res. Aging* 4:349-371 (1990); E.J. Masoro, *Diet Restriction and Aging*, *J. Am. Geriatr. Soc.* 41:994-99 (1993).

<sup>17</sup> A.J. German, et al., *Obesity, its Associated Disorders and the Role of Inflammatory Adipokines in Companion Animals*, *Vet. J.*, 185:4-9 (2010); P.G. Kopelman, *Obesity as a Medical Problem*, *Nature* 404:635-43 (2000); R.D. Kealy, S-E Olsson, et al., *Effects of Limited Food Consumption on the Incidence of Hip Dysplasia in Growing Dogs*, *J. Am. Vet. Med. Assoc.* 201:857-63 (1992); R.D. Kealy, D.F. Lawler, J.M. Ballam, et al., *Five-*

and frequency.<sup>19</sup> Accordingly, continual pursuit of improved metabolic fitness and consistently high-quality physical performances are necessary prerequisites to the achievement of optimally-healthy canine bodies.

Thus, as the physical demands placed upon modern-day dogs increase, the importance of ensuring peak physical performance by these athletic animals

increases contemporaneously. It should come as no surprise then that, just as in the human domain, sports science researchers have also sought to identify the most effective nutritional interventions for optimizing canine metabolic function, muscular recovery, and overall physical performance.

Their findings are shaping the future of canine sports science.

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*Year Longitudinal Study on Limited Food Consumption and Development of Osteoarthritis in Coxofemoral Joints in Dogs*, J. Am. Vet. Med. Assoc. 210:222-25 (1997); R.D. Kealy, D.F. Lawler, J.M. Ballam, et al., *Evaluation of the Effect of Limited Food Consumption on Radiographic Evidence of Osteoarthritis in Dogs*, J. Am. Vet. Med. Assoc. 217:1678-80 (2000).

<sup>18</sup> See, e.g., E.A. Courcier, R.M. Thomson, D.J. Mellor, P.S. Yam, *An Epidemiological Study of Environmental Factors Associated With Canine Obesity*, J. Small An. Prac., 51(7):362-67 (2010).

<sup>19</sup> See, e.g., J.L. Talanian, G.J. Heigenhauser, A. Bonen, L.L. Spriet, *Two Weeks of High-Intensity Aerobic Interval Training Increases the Capacity for Fat Oxidation During Exercise in Women*, J. Appl. Physiol. 102(4):1439-47 (2007); I. Tabata, et al., *Effects of Moderate-Intensity Endurance and High-Intensity Intermittent Training on Anaerobic Capacity and VO<sub>2</sub>max*, Med. Sci. Sports Exerc., 28(10):1327-30 (1996).

### III. The Beneficial Effects of Carbohydrate/Amino Acid Supplementation on Canine Metabolic Function, Muscular Recovery, and Physical Performance

As an area of research specialization canine sport science remains in its infancy. Nevertheless, even in the early years of this blossoming field, researchers have already replicated in the canine domain many of the key findings concerning the benefits to human athletes of carbohydrate and carbohydrate/amino-acid supplements. These findings strongly suggest that properly-formulated canine sports drinks and canine exercise recovery drinks hold much of the same promise for active dogs as their human analogues once did for human athletes. Indeed, the benefits may even outweigh those achieved with humans, due to the unique metabolic physiology of the domestic dog.<sup>20</sup>

Just like in the human domain, sports science researchers evaluating canine subjects have documented links between post-exercise carbohydrate supplementation and improved muscu-

lar recovery as well as overall physical performance.<sup>21</sup> Not surprisingly, performance enhancement in active dogs stems from the same physiological bases as in their human counterparts – enhanced insulin response and increased skeletal muscle glycogen concentrations during the post-workout recovery period.<sup>22</sup>

***“These findings strongly suggest that properly-formulated canine sports drinks and canine exercise recovery drinks hold much of the same promise for active dogs as their human analogues once did for human athletes.”***

Moreover, studies of dogs have also demonstrated the *additional* physiological benefits of post-exercise supplementation with carbohydrate/amino-acid

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<sup>20</sup> See, e.g., R.C. Hill, *The Nutritional Requirements of Exercising Dogs*, J. Nutr. 128:2686S-2690S (1998) (“Canine metabolism is unique. Mammalian muscle fibers have been classified into types I, IIa and IIb based on their metabolism. Type I fibers contain less ATPase activity compared with type II fibers. Types I and IIa are characterized by oxidative metabolism, whereas type IIb fibers are characterized by anaerobic glycolytic metabolism. Canine muscle contains mainly oxidative fibers. Guy and Snow (1981) describe some low oxidative muscle fibers in dogs but acknowledge that the activity of the oxidative enzyme succinate dehydrogenase in the low oxidative fibers was still greater than that in type IIb fibers from other species. Relative to metabolic body size, dogs also metabolize free fatty acids at twice the rate observed in humans.”).

blends – beyond those achieved with carbohydrate supplementation alone. Most notably, in a paper published in the journal *Metabolism* in 1999, researchers from the Saga Research Institute in Osaka, Japan, documented their findings from a set of experiments designed to determine the effects of carbohydrate/ amino-acid supplementation on post-exercise muscle protein degradation in dogs.<sup>23</sup> Not surprisingly, just as studies on humans would suggest, they found that post-exercise supplementation with amino acids and the simple carbohydrate glucose tended to increase plasma insulin levels as well as the overall rate of net protein synthesis during exercise in dogs.<sup>24</sup> The Osaka team was particularly impressed with the impact of amino acids on overall muscular recovery and they highlighted the importance of this phenomenon for the development of fu-

ture canine sports supplement products, stating that “[t]hese findings suggest that amino acids may thus be necessary to achieve net skeletal muscle protein synthesis during exercise.”<sup>25</sup>

These breakthrough studies have opened the door to much additional canine sports science research. But they also form a clear and unequivocal scientific basis for the development of canine sports drink and exercise recovery drink products that will meaningfully improve canine muscular recovery and overall physical performance. Somewhat surprisingly, however, as of 2012, few researchers had sought to tackle the challenging project of translating those research findings into a cutting-edge canine exercise recovery formula.

But all that changed in November 2012.

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<sup>21</sup> A.J. Reynolds, D.P. Carey, G.A. Reinhart, et al., *Effects of Post-Exercise Carbohydrate Supplementation on Muscle Glycogen Repletion in Trained Sled Dogs*, *Am. J. Vet. Res.* 58(11):1252-56 (1997); R.C. Hill, *The Nutritional Requirements of Exercising Dogs*, *J. Nutr.* 128(12):2686S-2690S (1998); A.J. Reynolds, L. Fuhrer, H.L. Dunlap, et al., *Effect of Diet and Training on Muscle Glycogen Storage and Utilization in Sled Dogs*, *J. Appl. Physiol.* 79(5):1601-07 (1995) (“For dogs running in multiple heats on a single day or over several consecutive days, immediate postexercise carbohydrate supplementation may promote more rapid and complete recovery between bouts of exercise.”); J.L. Wakshlag, K.A. Snedden, et al., *Effects of Post-Exercise Supplements on Glycogen Repletion in Skeletal Muscle*, *Vet. Therapeutics*, 3(3):226-234 (2002).

<sup>22</sup> See, e.g., Wakshlag, Snedden, et al., at 233 (“In conclusion, there is a profound increase in skeletal muscle glycogen concentration with the use of post-exercise carbohydrate supplementation...”); Reynolds, Fuhrer, Dunlap, et al., at 1252 (“Immediate postexercise carbohydrate supplementation in sled dogs leads to increased glucose concentration, which in turn promotes more rapid rate of [muscle glucose] repletion in the first 4 hours of recovery than is observed in dogs not given supplements.”).

<sup>23</sup> K. Hamada, K. Matsumoto, K. Okamura, et al., *Effect of Amino Acids and Glucose on Exercise-Induced Gut and Skeletal Muscle Proteolysis in Dogs*, *Metabolism*, 48(2):161-

## IV. Varsity Pets™ Announces the Release of Drool Fuel™, a Canine Exercise Recovery Drink Formulated Specifically to Meet the Nutritional Demands of Active Dogs

In early 2012 a team of researchers funded by American canine fitness innovator Varsity Pets™ set out with a straightforward but challenging goal: develop the most scientifically-advanced canine sports drink supplement ever invented. After months of dedicated collaboration with handlers for world-class canine athletes and professional working dogs, as well as industry-leading sports science chemists, work culminated in November 2012 with the filing of United States Patent Application No. 61750712.

The core aspect of the formula described in the patent application is a proprietary blend of carbohydrates and canine essential amino acids proven by the published, peer-reviewed scientific

***“Drool Fuel™ translates all of the core elements of effective human sports drinks and post-workout recovery supplements into a single sports drink product designed just for active dogs.”***

studies discussed throughout this whitepaper to improve physical performance and post-exercise muscular recovery in active dogs. After combining this proprietary carbohydrate/amino-acid blend

with powerful antioxidants and electrolytes, the formula was distilled into a micronized powder that mixes easily with water, combined with a beef flavoring to encourage drinking, and packaged in single-serving packets for easy on-the-go mixing. The result was a highly-palatable “beverage” mixture that not only supplies optimal nutritional content but encourages drinking and thereby facilitates hydration before, during, and after exercise, not unlike a human-use sports drink.

The final product was brought to market in early 2013 under its unofficial research project codename – ***Drool Fuel™***.

Drool Fuel™ translates all of the core elements of effective human sports drinks and post-workout recovery supplements into a single sports drink product designed just for active dogs:

(1) As explained above, the proprietary blend of simple carbohydrates and canine essential amino-acids in Drool Fuel™ elevates postexercise blood insulin levels, halts protein degradation, and kickstarts glycogen resynthesis, just like the sports supplements relied upon every day by human athletes around the world. This unique combination of ingredients helps active dogs build fat-



burning muscle and avoid much of the muscular pain and fatigue that is otherwise brought about by physical exercise.

(2) Unlike repackaged human supplements sold as canine-use products, the free amino acid content in Drool Fuel™ was crafted just for a dog’s unique physiology. Specifically, Drool Fuel™ combines energy-rich carbohydrates with *all ten (10) canine essential amino acids*. Studies show that so-called “essential” amino acids (those amino acids that bodies cannot synthesize on their own and must be ingested as part of the diet) are primarily responsible for the muscle-building effects of amino acids.

<sup>26</sup> Accordingly, while protein sources that contain all essential amino acids are considered “complete,” those that do not contain all of the essential amino acids are deemed to be “incomplete.”<sup>27</sup> Researchers have therefore concluded that complete proteins are “of a higher protein quality and are more effective at promoting protein synthesis.”<sup>28</sup> Dogs must ingest ten (10) different types of essential amino acids from outside sources – a greater number than humans, whose bodies produce a higher proportion of amino acids on their own.

Drool Fuel™ maximizes the anabolic effect of its free amino acid ingredients by including all ten (10) canine essential amino acids in every dose.

(3) Just as human sports drinks help forestall performance-induced dehydration, the beef flavoring in Drool Fuel™ helps to thwart deadly canine dehydration by encouraging dogs to drink Drool Fuel™ before, during, and after exercise. Dehydration increases canine body temperature and decreases overall cardiac output in exercising dogs,<sup>29</sup> with loss of as little as 15% of total body water potentially leading to death.<sup>30</sup> But in high-temperature environments, where dehydration occurs quickly, exercising dogs often do not become thirsty until after they are already severely dehydrated.<sup>31</sup> The beef flavoring in Drool Fuel solves this problem by encouraging drinking even before exercise occurs (“pre-hydration”). The Drool Fuel™ taste profile was tested extensively with a wide variety of active dogs and honed through months of experimentation. The result is a beverage that encourages copious drinking by most dogs even *prior* to the onset of severe thirst.

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66 (1999).

<sup>24</sup> *Id.*

<sup>25</sup> *Id.* (emphasis added).

<sup>26</sup> See E. Volpi, H. Kobayashi, et al., *Essential Amino Acids are Primarily Responsible for the Amino Acid Stimulation of Muscle Protein Anabolism in Healthy Elderly Adults*, Am.

(4) The antioxidants in Drool Fuel™ also help to combat the dangers of exercise-induced oxidative stress. Strenuous exercise can lead to the accumulation in the body of “free radicals” and other reactive oxidative species (ROS), dangerous by-products of oxidation that have been shown to damage cellular struc-

tures, leading to pain and fatigue.<sup>32</sup> But studies suggest that supplementation with antioxidants may limit the dangers of oxidative stress in both humans<sup>33</sup> and canines alike.<sup>34</sup> That’s why each serving of Drool Fuel contains a dose of free radical-annihilating antioxidants.

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J. Clin. Nutr. 78:250-258 (2003).

<sup>27</sup> C.M. Kerksick, C.J. Rasmussen, et al., *The Effects of Protein and Amino Acid Supplementation on Performance and Training Adaptations During Ten Weeks of Resistance Training*, J. Strength and Conditioning Res. 20(3): 643-653 (2006).

<sup>28</sup> *Id.*; see also E. Borsheim, K.D. Tipton, S.E. Wolf, and R.R. Wolfe, *Essential Amino Acids and Muscle Protein Recovery From Resistance Exercise*, Am. J. Physiol. Endocrinol. Metab., 283:E648-E657 (2002) (“we conclude that non-essential amino acids are not necessary for stimulation of net muscle protein balance and that there is a dose-dependent effect of essential amino acid ingestion on muscle protein synthesis”); L.R. Bucci and L.M. Unlu, *Proteins and Amino Acid Supplements in Exercise and Sport, In: Energy-Yielding Macronutrients and Energy Metabolism in Sports Nutrition*, J.A. Driskell and I. Wolinsky, eds. Boca Raton, FL: CRC Press, 1999, pp. 191-212.

<sup>29</sup> M.A. Baker, *Thermoregulatory Responses to Exercise in Dehydrated Dogs*, J. Appl. Physiol. 56(3): 635-40 (1984).

<sup>30</sup> L.D. Lewis, M.L. Morriss, M.S. Hand, *Clinical Nutrition III*, Topeka: Mark Morriss Associates (1989): 5-17.

<sup>31</sup> A.J. Reynolds, K. Sneddon, et al., *Hydration Strategies for Exercising Dogs* (available as of March 2013 at [www.hydrolyte.us/Arleigh%20Reynolds-Hydration%20Strategies.pdf](http://www.hydrolyte.us/Arleigh%20Reynolds-Hydration%20Strategies.pdf)) (“Flavouring the water to make it more palatable has long been a successful way of getting dogs to drink.”).

<sup>32</sup> See, e.g., S.K. Powers, M.J. Jackson, *Exercise-Induced Oxidative Stress: Cellular Mechanisms and Impact on Muscle Force Production*, Physiol. Rev. 88(4):1243-76 (2008) (“It is now well established that both resting and contracting skeletal muscles produce reactive oxygen species and reactive nitrogen species. Importantly, intense

By combining all of these powerful elements into a single supplement, the development of the Drool Fuel™ formula represents an unprecedented advancement in the domain of canine sports science. Moreover, Drool Fuel™ mixes easily with water and each serving is packaged into a single, on-the-go pack-

et, thus ensuring maximal ease-of-use in the field, on the trail, or in the competition ring.

As the first product in history to include all of these vital elements, Drool Fuel™ represents the most advanced canine sports drink ever invented.

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and prolonged exercise can result in oxidative damage to both protein and lipids in the contracting myocytes.”); Z. Radak, H.Y. Chung, et al., *Exercise, Oxidative Stress, and Hormesis*, *Ageing Res. Rev.* (2007)(“Exercise can increase the generation of ROS and this is especially true for single bouts of exercise. As a consequence of increased concentration of ROS, oxidative damage of lipids, proteins and DNA have been reported following single bouts of exercise.”); L.L. Ji, *Antioxidants and Oxidative Stress in Exercise*, *Exp. Biol. Med.* 222(3): 283-92 (1999) (“Reactive oxygen species pose a serious threat to the cellular antioxidant defense system, such as diminished reserve of antioxidants vitamins and glutathione, and increased tissue susceptibility to oxidative damage.”).

<sup>33</sup> See Ji at 286-87; U. Singh, S. Devaraj, et al., *Vitamin E, Oxidative Stress, and Inflammation*, *Annu. Rev. Nutr.* 25: 151-74 (2005); S. Vega-Lopez, S. Devaraj, et al., *Oxidative Stress and Antioxidant Supplementation in the Management of Diabetic Cardiovascular Disease*, *J. Investig. Med.* 52(1): 24-32 (2004).

<sup>34</sup> See, e.g., C.R. Baskin, K.W. Hinchcliff, et al., *Effects of Dietary Antioxidant Supplementation on Oxidative Damage and Resistance to Oxidative Damage During Prolonged Exercise in Sled Dogs*, *Am. J. Vet. Res.* 61(8): 886-91 (2000) (“Dietary supplementation with antioxidants resulted in increased plasma concentrations of antioxidants. Moreover, supplementation decreased DNA oxidation and increased resistance of lipoprotein particle to in vitro oxidation. Antioxidant supplementation of sled dogs may attenuate exercise-induced oxidative damage.”).

## V. The Future of Canine Sports Drinks and Exercise Recovery Drinks

As explained above, the widespread popularity of human-use sports drinks is attributable to the empirically-verified positive influence they exert on human health and performance and the high demand for such advantages among health-conscious consumers. Products like Gatorade and Powerade are popular, in other words, because they not only promise but actually deliver valuable benefits – they have been scientifically proven to improve physical performance and optimize health.

For these same reasons, scientifically-validated canine-use sports drinks appear poised to enjoy the same kind of widespread popularity as products like Gatorade and Powerade. The scientific research proving the effectiveness of these canine-use products is no less compelling than is the analogous research conducted in the human domain. And, as the meteoric growth of canine sports such as dock diving and agility demonstrates, dog owners are more aware now than ever before of the importance of exercising their canine companions.

Just as the popularity of human-use sports drinks grew dramatically in the wake of the publication of scientific studies validating their usefulness, canine-use sports drinks like Drool Fuel™ now appear poised to enjoy similarly explosive growth. The early adoption of Drool Fuel™ by numerous world-class canine athletes confirms that the market is beginning to embrace the benefits of scientifically-advanced canine sports drink products.<sup>35</sup> Dog owners, it seems, are now prepared to take care of their dogs' bodies using the same scientifically-validated strategies that they have used to optimize their own performance for decades.

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Drool Fuel™ is made 100% in the U.S.A. It contains no gluten and no trans fats. For more information about Drool Fuel, including a detailed nutritional profile and list of ingredients, please visit [www.varsitypetsonline.com](http://www.varsitypetsonline.com).

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At least three top competitors from the 2012 Dock Dogs World Championships, including a world-record holder, have already adopted Drool Fuel as their official canine sports drink.