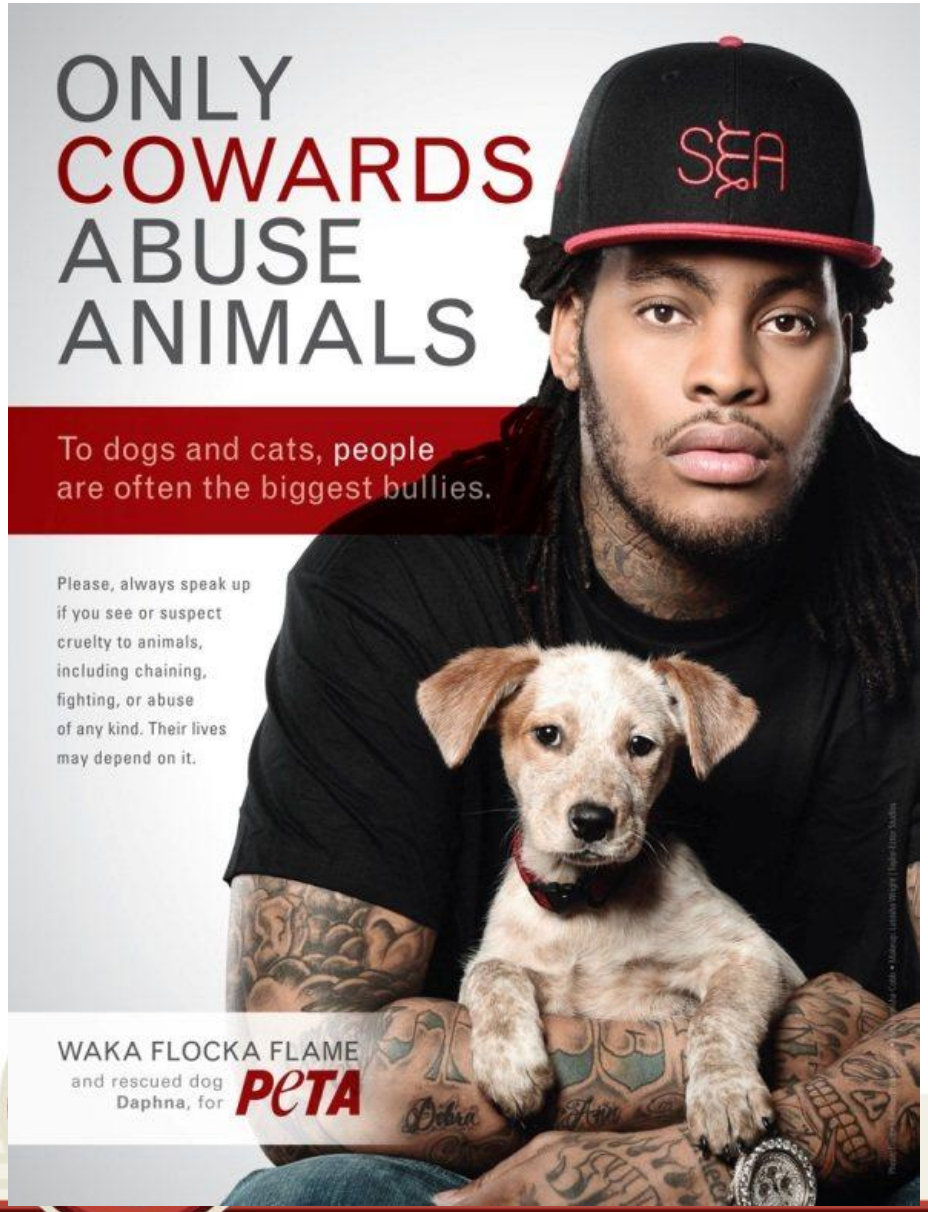
Nutrition and the Working Canine

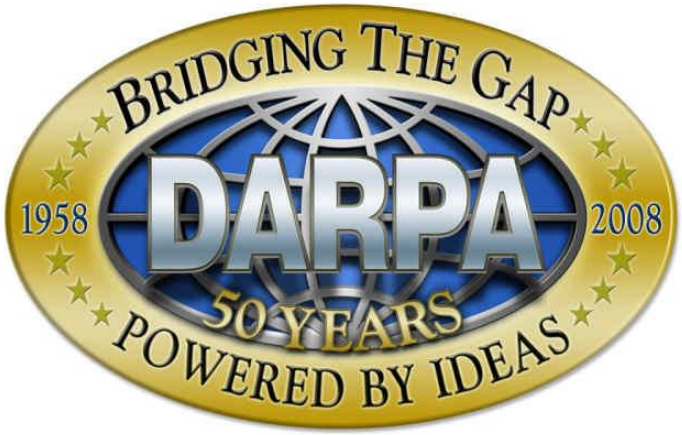
New Work: New Nutrition

Joseph J Wakshlag DVM, PhD, DACVN, DACVSMR

All Good Things Must Come to an End



Who wants to improve working dogs quality of life now?



AMERICAN KENNEL CLUB
CANINE HEALTH FOUNDATION
PREVENT TREAT & CURE®

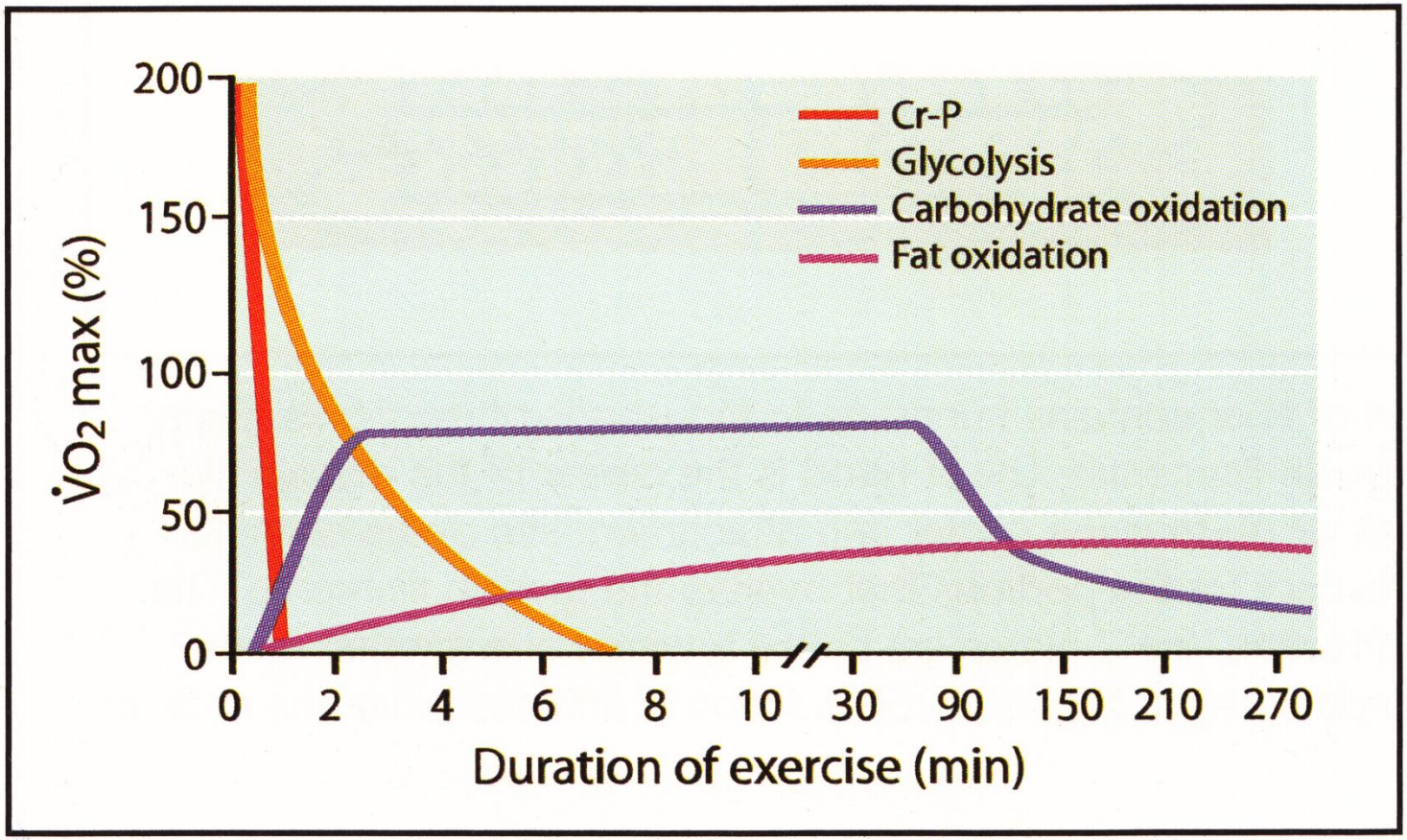
Topics to cover – Field Studies

- Metabolism/Energetics of different dogs
- Feeding strategies
  - Post exercise glycogen repletion
  - High protein diet.
- Feeding for Olfaction
  - Old and new data.
- Antioxidant supplements
  - Sled dogs
  - Greyhounds
- Where is the future?

Different Dogs

- Endurance Dogs
  - Sled dogs, tracking dogs, detection dogs, hunting dogs, herding dogs
- Intermediate Athletes
  - Sprint sled dogs, field trial dogs, hunting dogs, herding dogs.
- Sprint Athletes
  - Greyhounds, earth dogs, agility dogs, fly ball dogs, dock dogs, lure coursing dogs, dancing dogs, high jump dogs. Etc.

Energetics over time



Hand, Remillard, Novotny, Thatcher; Sm Animal Clinical Nutr; 2010

Diet and the Performance of Racing Sled Dogs

D. S. Kronfeld, M.V.Sc., Ph.D.

Composition	Diet I	Diet II	Diet III*	Diet IV*
Dry food (oz.)	13**	8†	....	....
Horsemeat (oz.)	5	18	....	....
Corn oil (oz.)	1	....	....	....
Chicken (oz.)	....	....	53*	27*
Energy (kcal.)	1,717	2,140	3,149	1,641
Energy (M‡)	1.25	1.55	2.25	1.19
Protein (energy equivalent, %§)	29	33	34	34
Fat (energy equivalent, %)	32	45	66	66
Carbohydrate (energy equivalent, %)	39	22	0	0

* ALPO Chicken and Chicken Parts, Allen Products Company, Allentown, Pa. This product was fed exclusively. ** Bench and Field Cubes, Martin's Feed Mill, Inc., New Paris, Ind. †Bench and Field Cubes for 13 days, then Canine Maintenance, Hill's Division, Riviana Foods, Inc., Topeka, Kan., for 7 days, then diet III. This calculation is for Canine Maintenance plus horsemeat. ‡ M is maintenance, e.g., for a 22.2-kg. dog, 22.2 × 62 = 1,376 kcal. dietary energy.[1] § These calculations assumed 5.5 kcal./Gm. of protein, 9.5 kcal./Gm. of fat, and 4 kcal./Gm. of soluble carbohydrate. Manufacturer's analysis was used for ALPO Chicken and Canine Maintenance; the horsemeat and Bench and Field Cubes were analyzed by Dr. H. Yacowitz and Company, Piscataway, N.J.

Metabolic responses to exhaustive exercise in racing sled dogs fed diets containing medium, low, or zero carbohydrate[1, 2]

Elaine P. Hammel,[3] V.M.D., D. S. Kronfeld,[4] Ph.D., D.Sc., M.V.Sc., V. K. Ganjam,[5] Ph.D., B.V.Sc., and Harris L. Dunlap, Jr.,[6] M.S.

Hematological and metabolic responses to training in racing sled dogs fed diets containing medium, low, or zero carbohydrate[1, 2]

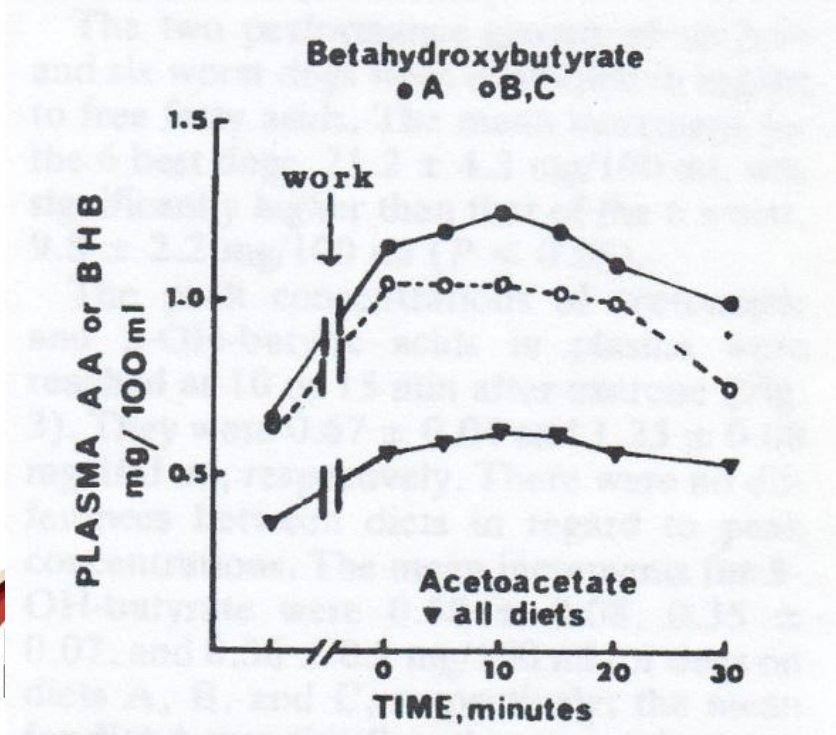
D. S. Kronfeld,[3] Ph.D., D.Sc., M.V.Sc., Elaine P. Hammel,[4] V.M.D., C. F. Ramberg, Jr., V.M.D., and Harris L. Dunlap, Jr.,[6] M.S.

Diet A: ME; 39% Protein, 61 % Fat, 0% Carb

Diet B: ME; 32% Protein, 45% Fat, 23% Carb

Diet C: ME; 28% Protein, 34% Fat, 38% Carb

Exercised intensely for 30 mins



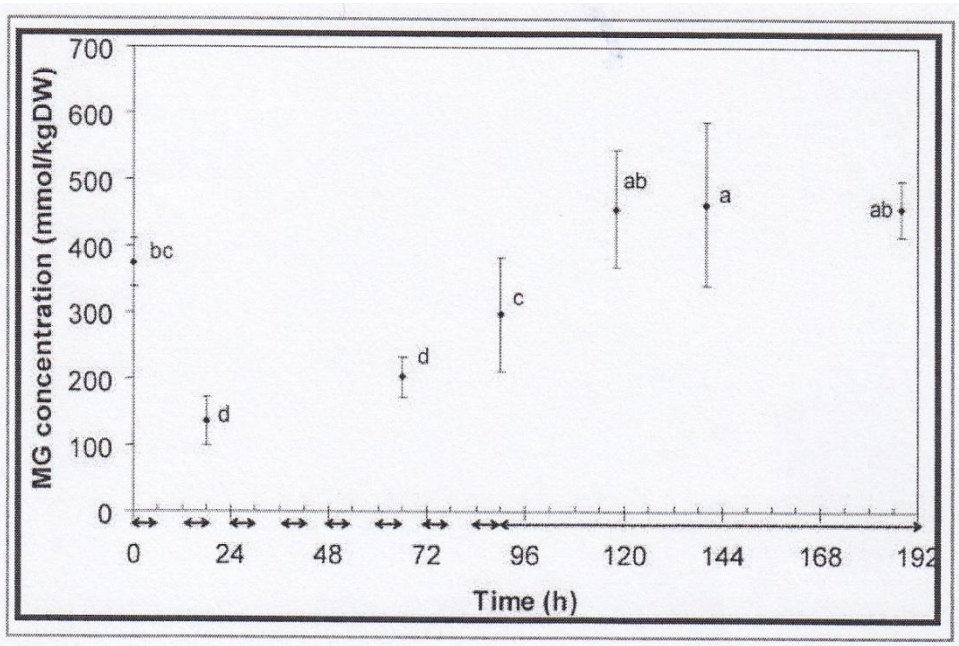
Assessment of alterations in triglyceride and glycogen concentrations in muscle tissue of Alaskan sled dogs during repetitive prolonged exercise

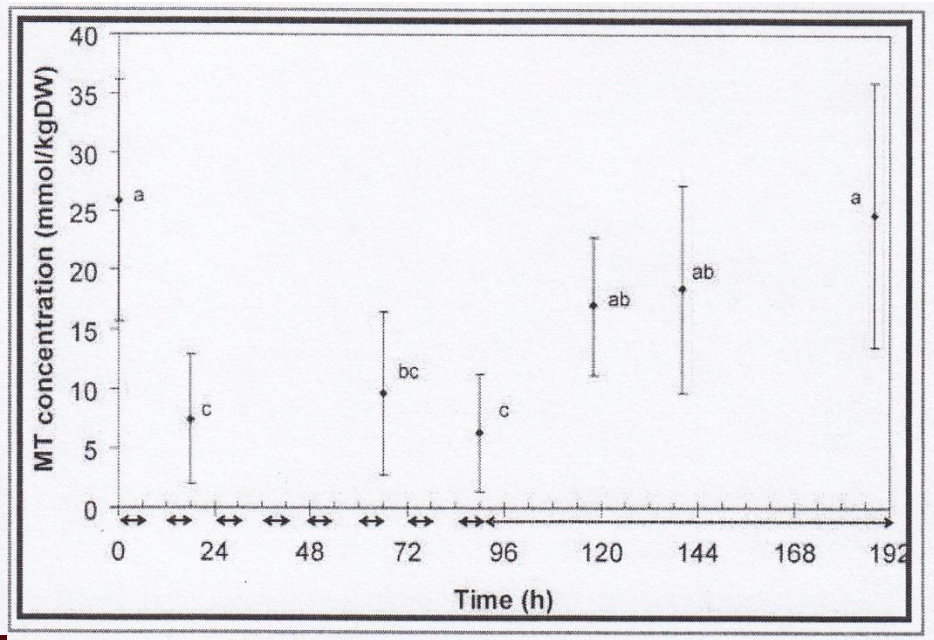
Erica C. McKenzie, BVMS, PhD; Kenneth W. Hinchcliff, BVSc, PhD; Stephanie J. Valberg, DVM, PhD; Katherine K. Williamson, DVM; Mark E. Payton, PhD; Michael S. Davis, DVM, PhD

- Previous study suggested increased muscle glycogen after 5 days of running
- 6 control dogs; 38 dogs biopsied at 140, 420, 560 km and recovery points
- Dogs only consuming 5,000 kcals a day (ME 33% Protein, 39% Fat, 33% Carbs)

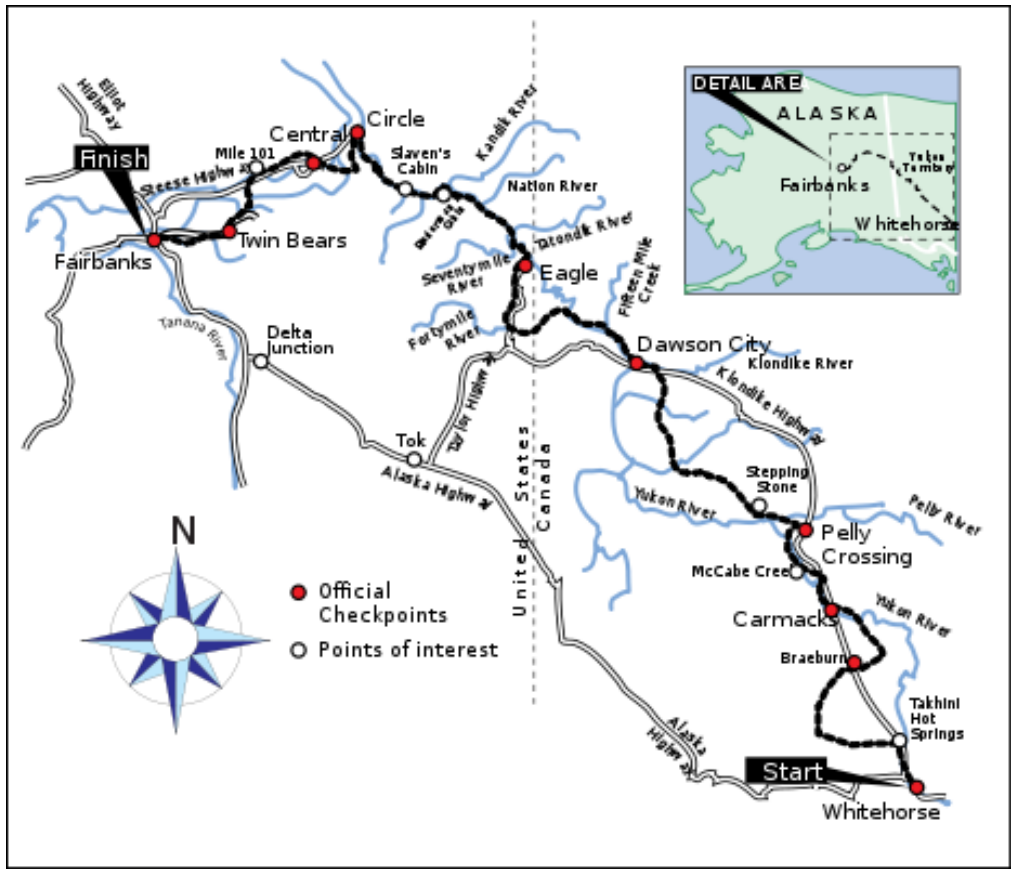
Selection of dogs for removal did not appear to be random.

- 64 % reduction in muscle glycogen in first 24 hrs

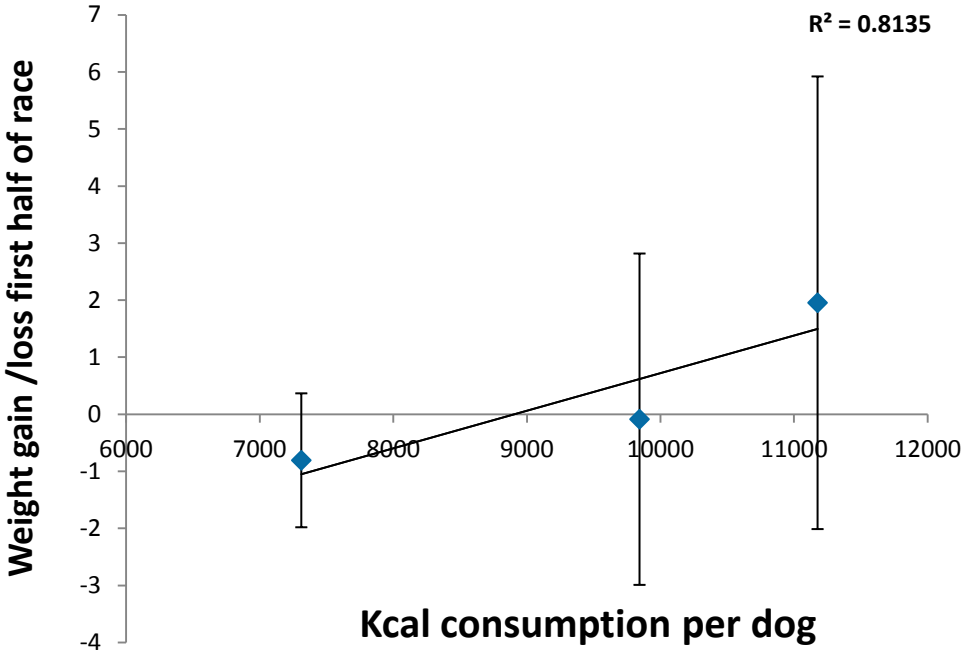




Yukon Quest 2011



- Examined 3 teams
- Mushers diaries and food composition
  - lbs of meat
  - lbs of dry dog food
  - Other supplements
  - Analysis of meats company contact regarding nutrient composition of dog food.
  - Assess total kcals consumed per day/per dog fed
  - Due to fortunate circumstances diets did not change over race trail for all three teams regardless of dogs dropped.



Whitehorse to Dawson

Rolling Hills – Flat /downhill Terrain

One peak

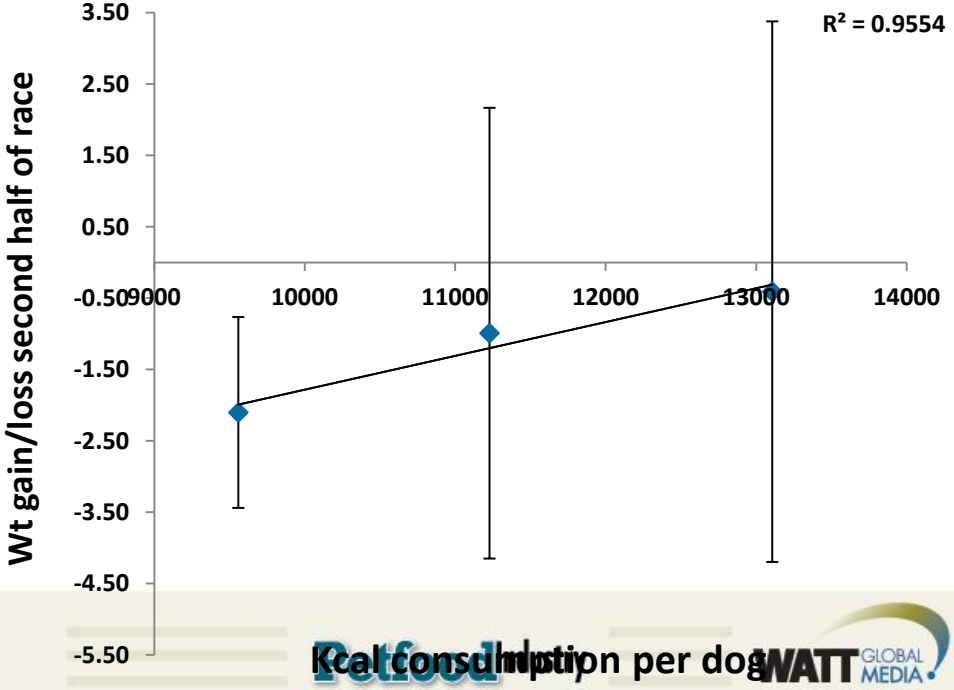
Temps = -12 to -23 °C (10 to -10 °F)

Whitehorse to Dawson

More Mountainous Terrain

Two peaks

Temps = -26 to -40 °C (-15 to -40 °F)



Energy expenditure and water turnover in hunting dogs in winter conditions

Øystein Ahlstrøm[1]*, Paula Redman[2] and John Speakman[3]

8 hunting dogs (ave 19.8 kg SD = 3.8 kg)
Utilized the "double labeled water technique"
Each dog was hunted (ptarmigan) 3hr/d for 3 days (-6°C or 21 F)
GPS data showed dogs range from 16 – 25 km traveled

Findings:
DEE increases with body weight
Mean DEE - 2,644 ± 745 kcals
Per kg $^{0.75}$ = 281 kcals/kg $^{0.75}$ or 133 kcal/kg BW
Equates to 2.1 times the MER

Maintenance energy requirements and the effect of diet on performance of racing Greyhounds

Richard C. Hill, MA, VetMB, PhD; Mark S. Bloomberg, MS, DVM;
Veronique Legrand-Defretin, DEA Doctorat; Ivan H. Burger, BSc, PhD; Sean M. Hillock, BS;
Deborah A.Sundstrom, BS; Galin L. Jones, MStat

8 Greyhounds weighing 31.2 kg – fed once daily
2 diets fed – HFHP , LFLP (two 8 week periods)
HFHP ME = 32% Fat, 25% Protein, 43% Carbs
LFLP ME = 35% Fat, 21% Protein, 54% Carbs
Feces collected for digestibility calculations
Food samples were collected for analysis

Findings:
High fat and protein diet may increase RBC /hematocrit
Possible increased performance
Lower carb diets may be preferred.
Dogs required approximately a 155 kcal/kg $^{0.75}$ =1900 kcal/d 30 kg dog

When and how is Fat used?

- To promote lipolysis.
  - Feed a high fat diet at least 8 weeks before competition, preferably 12 weeks.
  - Mitochondrial size will increase with feeding fat and promotes a larger "furnace".
  - Oxidative capacity increases and time to lipolysis will decrease.
  - Will spare glycogen reserves for "bursts" of activity.

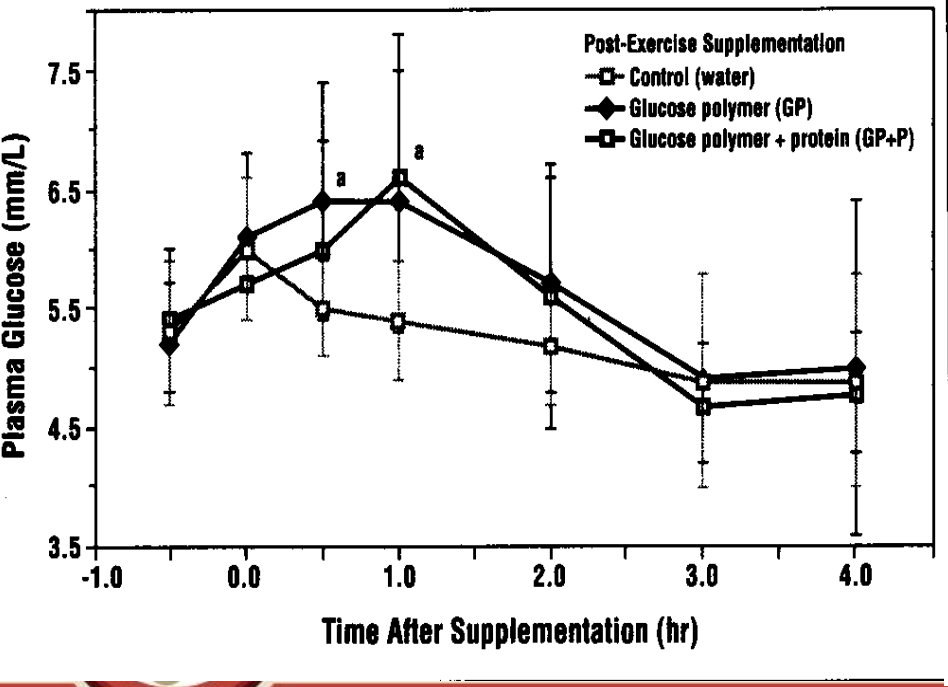
i.e. Sled dogs VO_2 Max
Low fat diet 15% =141 ml/min/kg
High fat diet 30%= 184ml/min/kg

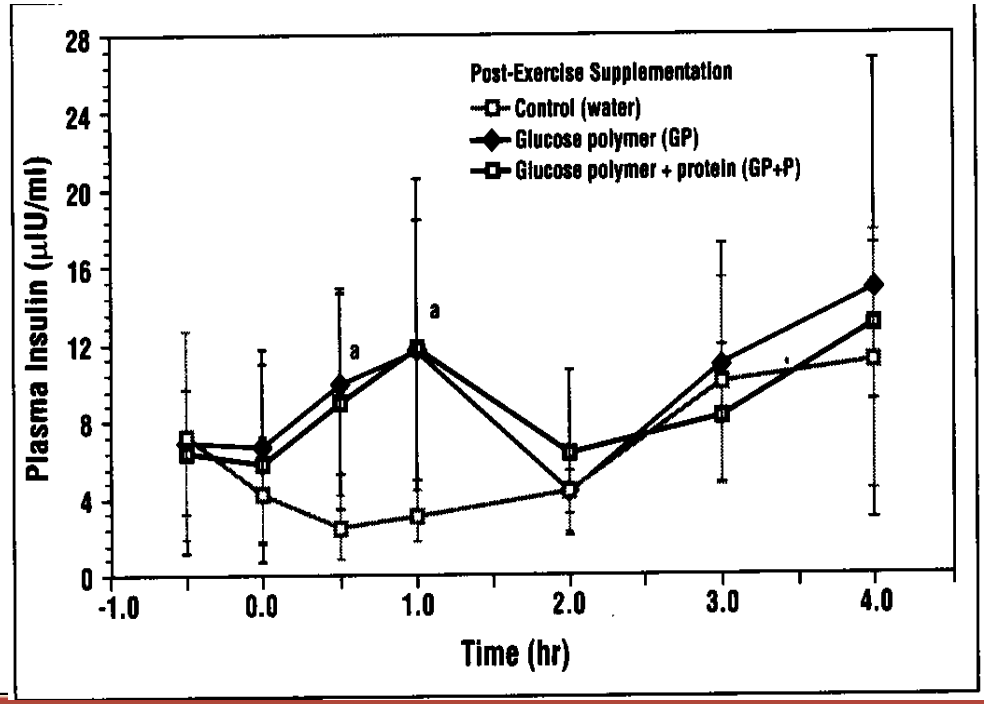
Effects of Post-Exercise Supplements on Glycogen Repletion in Skeletal Muscle*

Joseph J. Wakshlag, MS, DVM[a]
Kimberly A. Snedden, MS[a]
Annette M. Otis, MS[a]
Christopher A. Kennedy, DVM[a]
Todd P. Kennett, BS[a]
Janet M. Scarlett, DVM, PhD[b]
Francis A. Kallfelz, DVM, PhD[a]
Gary M. Davenport, PhD[b]
Arleigh J. Reynolds, DVM, PhD[a]
Gregory A. Reinhart, PhD[c]

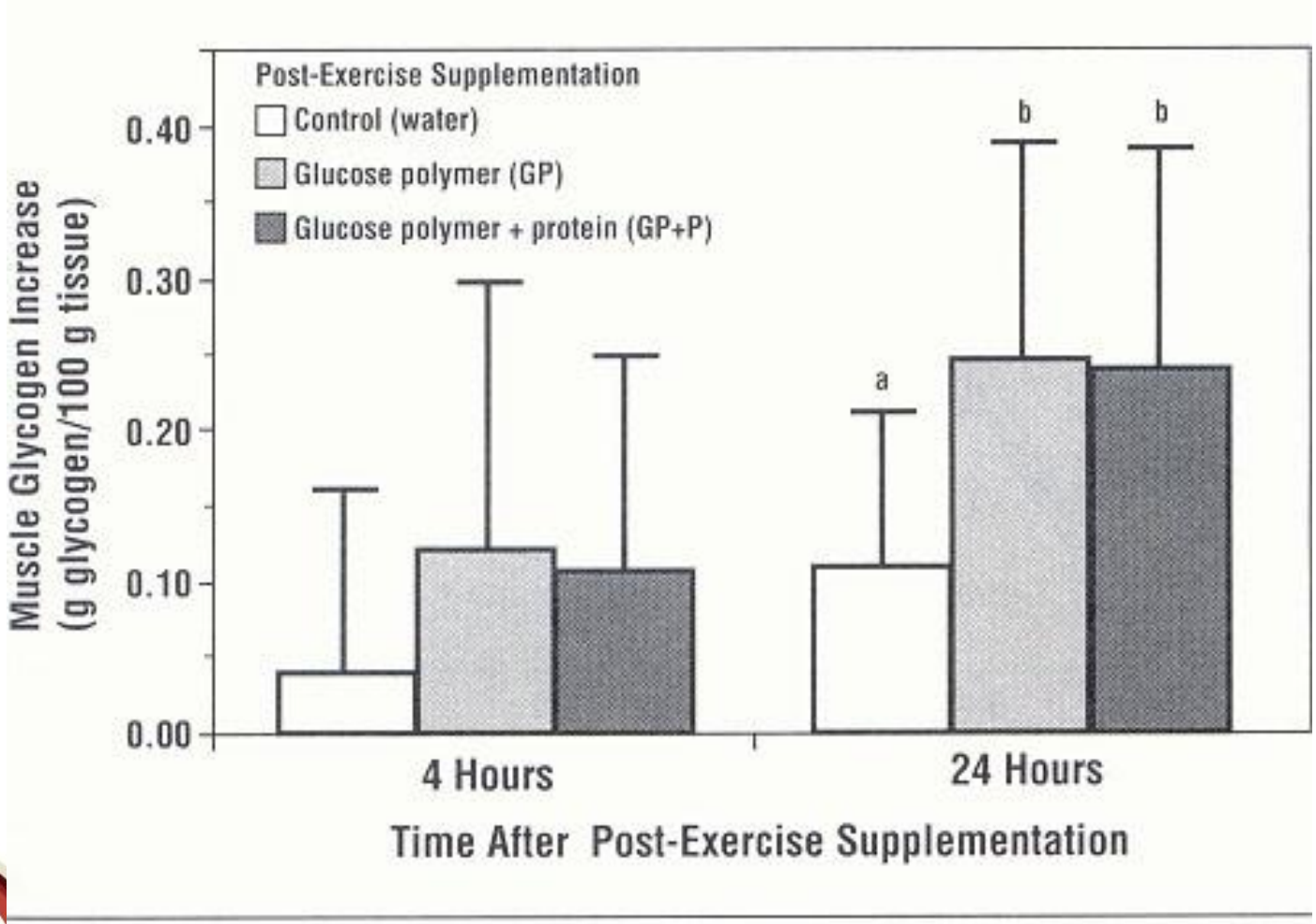
10 sled dogs in cross over design study
Dogs ran for 30 minutes at 21 km/hr at 2% incline
Achieved about 50% glycogen reduction

1) Water
2) Polycose (1.5g/kg)
3) Glycocharge (1g/kg +0.5g/kg protein)

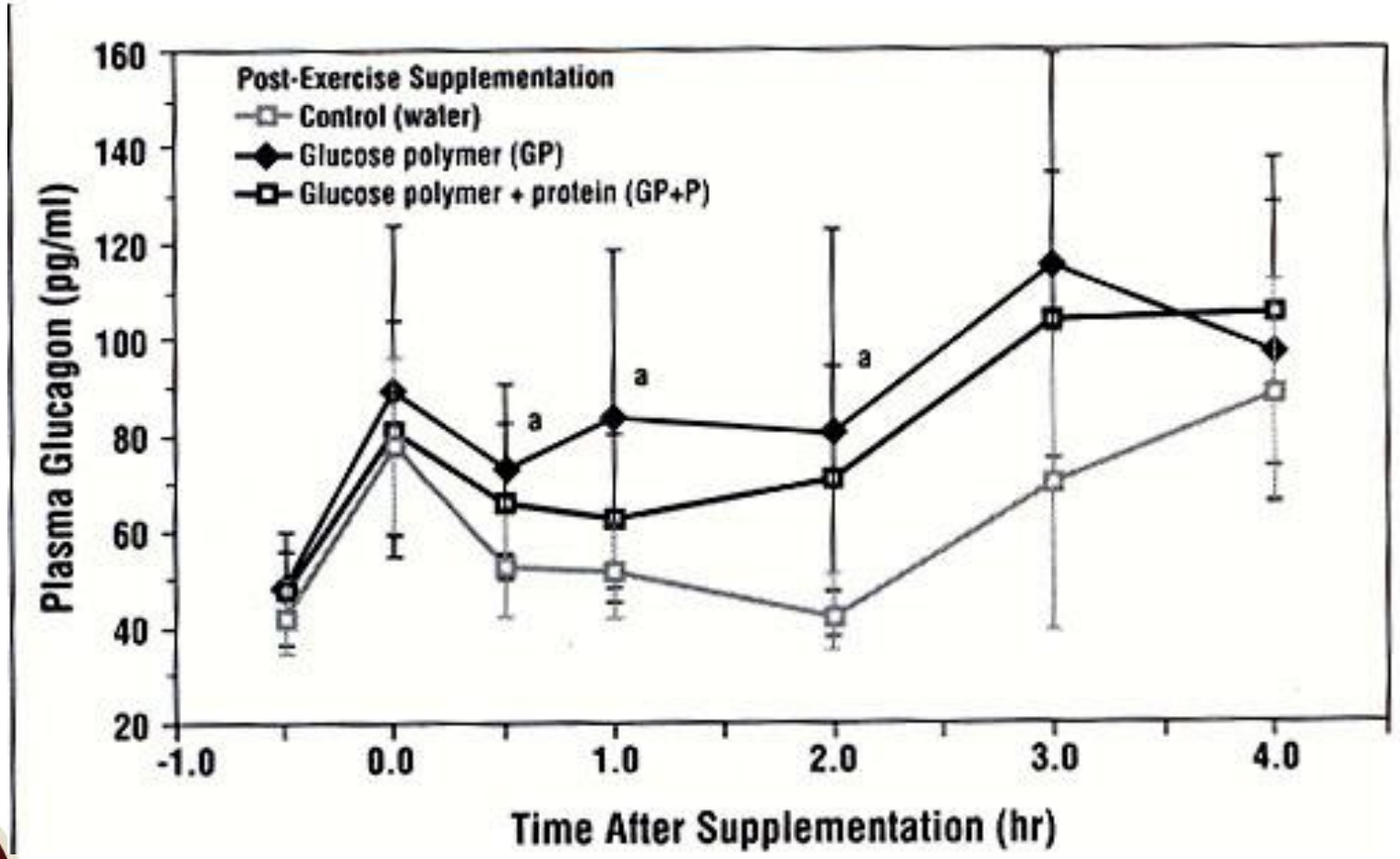




Muscle Glycogen



Serum Glucagon post exercise

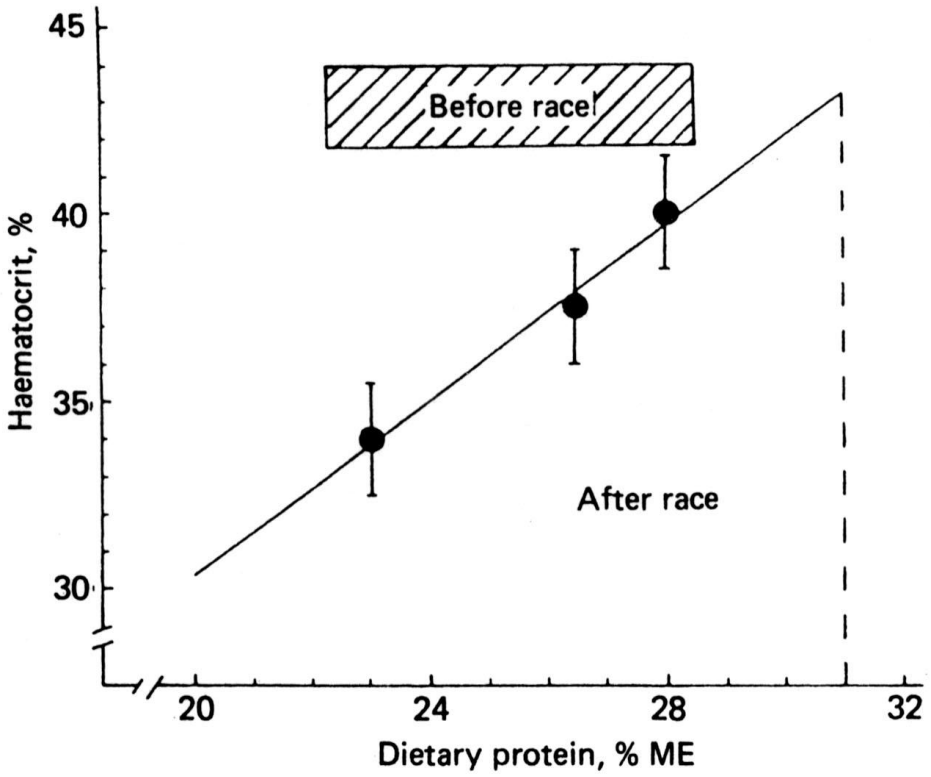


PRE/DURING/POST

- The principles apply to humans
- Can they apply to dogs?

Thoughts on protein and exercise

- **Dr. David Kronfeld and colleagues, 1986**
  - **Hct was correlated to protein intake during strenuous activity**
  - **These dogs took in excessive calories as working endurance sled dogs – but calorie balance unknown**
- **Would need to be 75g/1000 kcals**
  - **NRC = 25 g/100 kcals**



Waltham Symposium,
Nutrition of the Dog and Cat, 1986

Effect of protein intake during training on biochemical and performance variables in sled dogs

Arleigh J. Reynolds, DVM, PhD; Gregory A. Reinhart, PhD; Daniel P. Carey, DVM; Dawn A. Simmerman, DVM; David A. Frank, BS; Francis A. Kallfelz, DVM, PhD

8 Alaskan Sled Dogs in each group for 12 week dietary Trial (18-22 kg)
Protein ME ; A – 18%; B – 23% ME; C-29%; D – 35%: Ave 1600 kcals/ dog
Mild activity 8 weeks then trained intensely for 4 weeks
Findings: 35% increase in RBC parameters. More injuries in 18% group
59 g/1000 kcals appears adequate

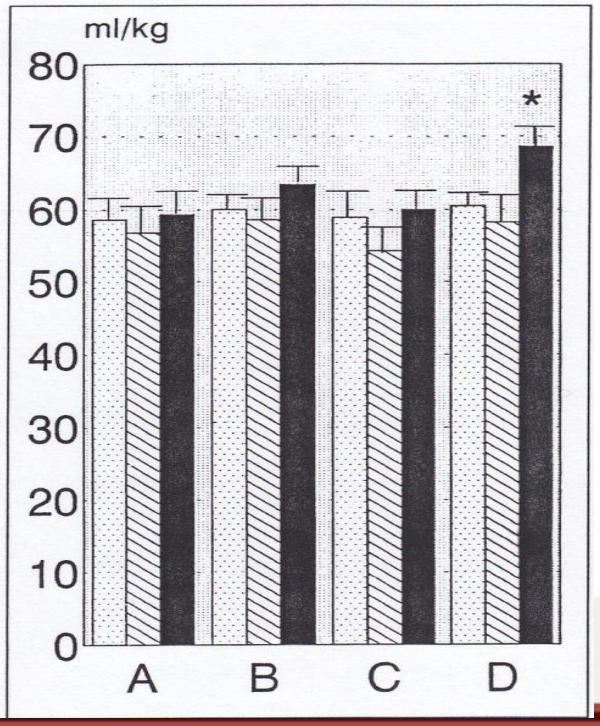
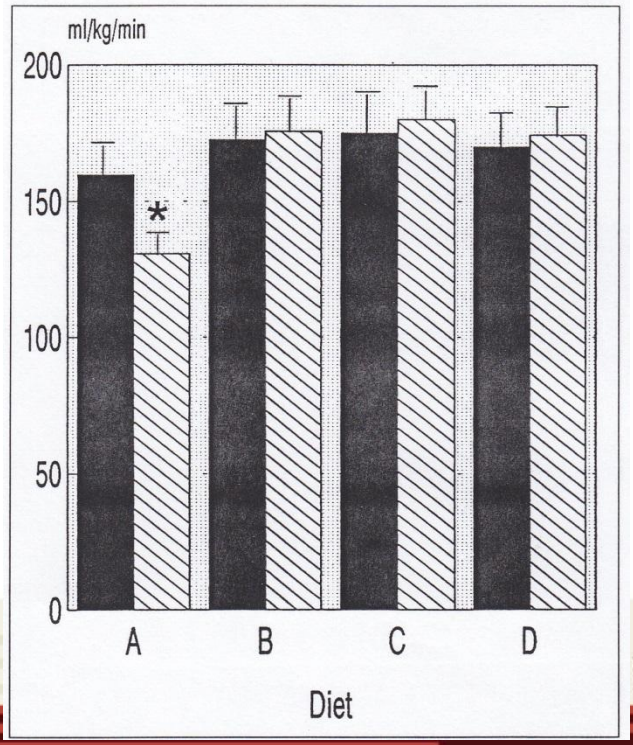


Figure 2—Plasma volume (ml/kg of body weight) as a function of diet and training in 32 adult Alaskan sled dogs. Mean (± SEM) values determined at week 0 (before training) and at week 8 or 12 (after intense training) are represented by dotted, hatched, or solid bars, respectively. *See* Figure 1 for key.



Effect of increased dietary protein and decreased dietary carbohydrate on performance and body composition in racing Greyhounds

Richard C. Hill, VetMB, PhD; Daniel D. Lewis, DVM; Karen C. Scott, PhD; Mayuko Omori, DVM; Melissa Jackson, DVM; Deborah A. Sundstrom, BS; Galin L. Jones, MStat; John R. Speakman, PhD; Celeste A. Doyle, BS; Richard F. Butterwick, PhD

8 Greyhounds fed in cross over design; 12 week arms:
isocaloric exchange: HP ME- 37% protein, MP ME – 24%
HP = 94g/1000 kcals MP = 63g/1000 kcals
Extensive blood work, temperature, TBW , weights , 500km racing

Findings : Significant decrease in racing time on MP diet

Table 1—Effect of diet on average body weight, food intake, metabolizable energy (ME) intake, and race time in 8 racing Greyhounds

Variable	High-protein diet	Moderate-protein diet
Race time (s)*	32.61 ± 0.50	32.43 ± 0.48
Average speed (m/s)*	15.34 ± 0.24	15.42 ± 0.23
Food intake (g/d)	499 ± 111	514 ± 66
ME intake (kcal/kg$^{0.75}$ · d)	150 ± 29	154 ± 17
Body weight (kg)*	32.2 ± 2.9	32.8 ± 2.5

Values are reported as mean ± SD.
*Values differ significantly ($P \leq 0.05$) between diets.

Table 2—Effect of diet on body composition in 8 racing Greyhounds

Variable	High-protein diet	Moderate-protein diet
Total body water (%)	71 ± 7	68 ± 6
Lean body mass (%)	96 ± 9	93 ± 8
Fat mass (%)	3 ± 9	7 ± 8
Plasma volume (ml/kg)	50 ± 10	50 ± 10
Blood volume (ml/kg)	110 ± 15	114 ± 16

Values are reported as mean ± SD; none were significantly different between diets.

COMMON DIETARY CONSTITUENTS

Meats

Traditionally, meat-based diets contain 50 to 70 per cent by weight of meat, supplemented with dry food and, in some cases, offal meats and cooked vegetables to make up the shortfall of energy, protein, and fiber.[2] Muscle meat itself is deficient in a number of vitamins and minerals, particularly calcium, and is low in carbohydrates.[2] Most of the energy contained in meat is provided by the protein content, with increasing amounts contributed by fat, as the fat content is increased.[2]

Many authorities believe that raw meat is a natural food for dogs, and it is best fed coarsely minced or in small cubes, rather than minced to a fine paste.[2] Although cooking tends to make meat more tender and attractive to greyhounds that are poor eaters, overcooking at high temperatures (above 200C [420F]) can destroy some of the protein and fat and inactivates many of the vitamins.[2] Cooking by boiling at 100C (210F) as in preparing stews, or at extrusion temperatures of up to 140C (310F) during gelatinization of dry foods, is less damaging than grilling or roasting meat, for this reason. In larger kennels, bulk meat is stored frozen, then thawed and coarsely minced as required each day. Individual trainers with smaller operations usually purchase frozen, chilled or freshly minced meat from meat suppliers or butcher shops weekly.

Effect of Diet on Hunting Performance of English Pointers

Gary M. Davenport, PhD
Russell L. Kelley, MS
Eric K. Altom, PhD
Allan J. Lepine, PhD

23 dogs – 2 groups: fed Diet A or Diet B.
Diet B slightly lower in protein (24% ME) and fat
Handlers blinded to dietary group
Ave hours work no different

Findings:
- No Major changes in g/kg BW
- Dogs lost weight on Diet B

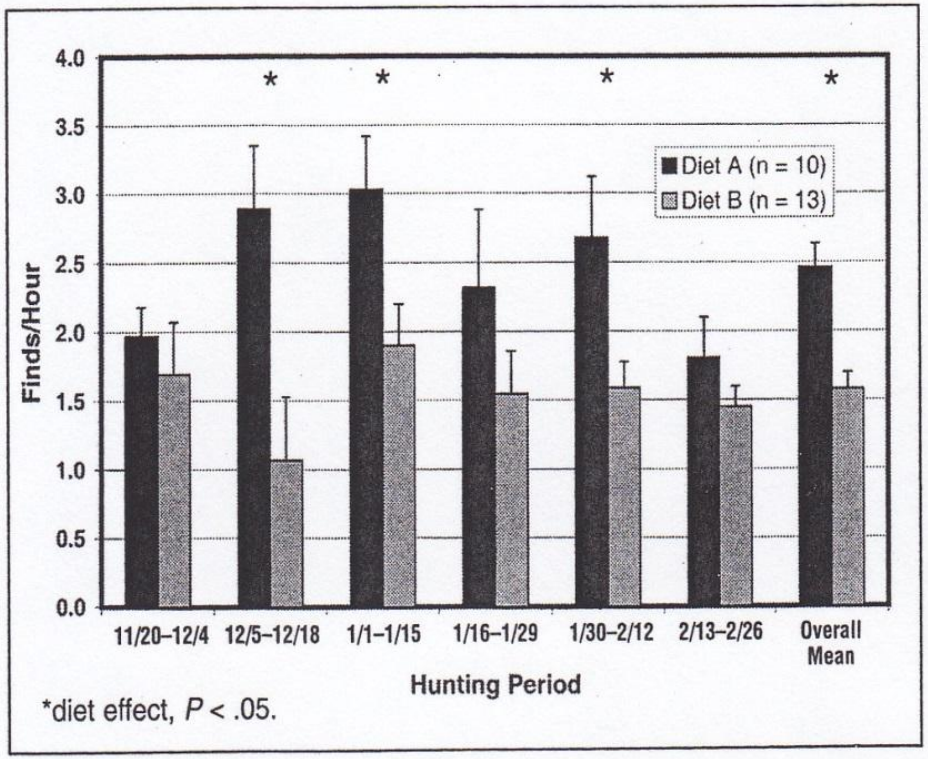


Figure 5. *Hunting performance (finds/hour) of English pointers fed two commercial diets during the quail-hunting season.*

Effect of dietary fat source and exercise on odorant-detecting ability of canine athletes

Eric K. Altom [a,1], Gary M. Davenport [a,1], Lawrence J. Myers [b], Keith A. Cummins [a,*]

18 dogs – 3 groups, 6 dogs per dietary group

Control diet , High Fat PUFA (linoleic), High Sat fat (MCT)

12.9% ME Fat, vs 16.9% ME – all diets 26.5% ME Protein

Dogs further split into groups of 3 –NON Conditioned vs conditioned

Tested over 12 weeks at 0, 4 and 12 weeks – before and after exercise

<u>Findings:</u>

Conditioned dogs did not decrease olfactory capabilities after exercise

Exercise in non-conditioned dogs decreased olfaction by 63%

All Dogs lost Olfactory capabilities to some extent over 12 weeks

MCT high fat diet dogs – lost all olfactory acuity in Non-cond. Dogs

Small groups and large SD

Auburn Health and Performance Program

- A Detection dog facility
- A late night in Montana – lots of Coor's Light
  - Is it fat or is it polyunsaturated fat?
  - Low fat diets allow dogs to run cooler?
    - A Kronfledism….
  - Something's gotta give
    - Carb or protein?

Testing Olfaction: Not so Simple….

- Did you touch the container?
  - Need to mix it up add distractor scents.
- Is there scent from the previous dog?
  - Where did that dog go in the room?
- What is the airflow like in the room?
- Was the scent brought into the room previously?
  - How long ago?
  - Is it on you?
- What technique is the dog using?

Petfood Forum

The Real Problem

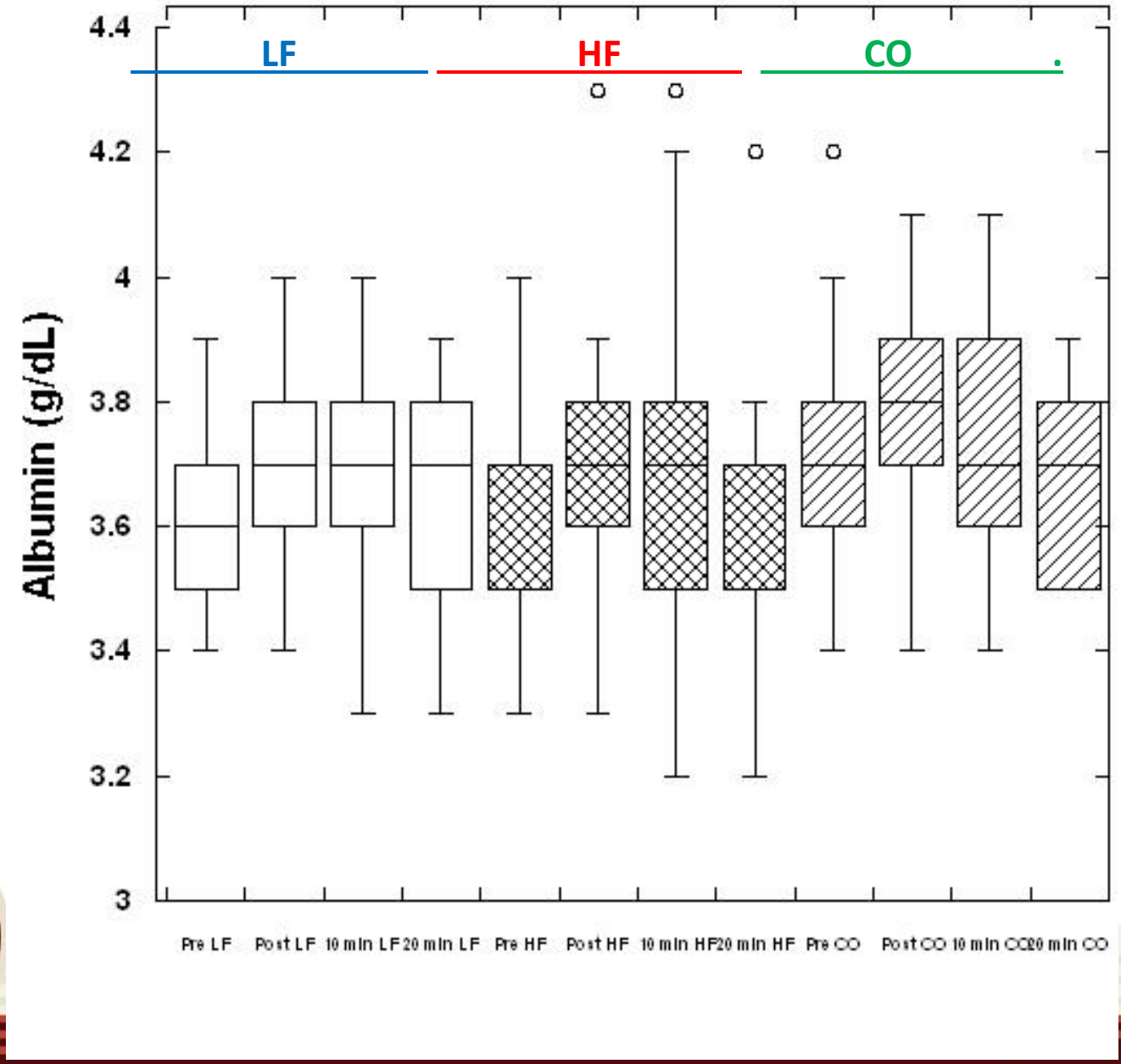
Materials and Methods

- 17 conditioned detection trained Labrador Retrievers
  - Smokeless powder, TNT and ammonium nitrate
- Week 12 – diet trial; cross oveer
- 3 consecutive days of treadmill exercise test
  - (30 min/day @ 12.5 km/hr, at 2.5% incline)
- Vitals measured each day; blood work on third day
  - Pre, Post exercise, 10 minutes post and 20 minutes post.
  - Complete blood count, serum biochemistry, insulin, glucagon, cortisol; heart rate, core temperature, rectal temperature.

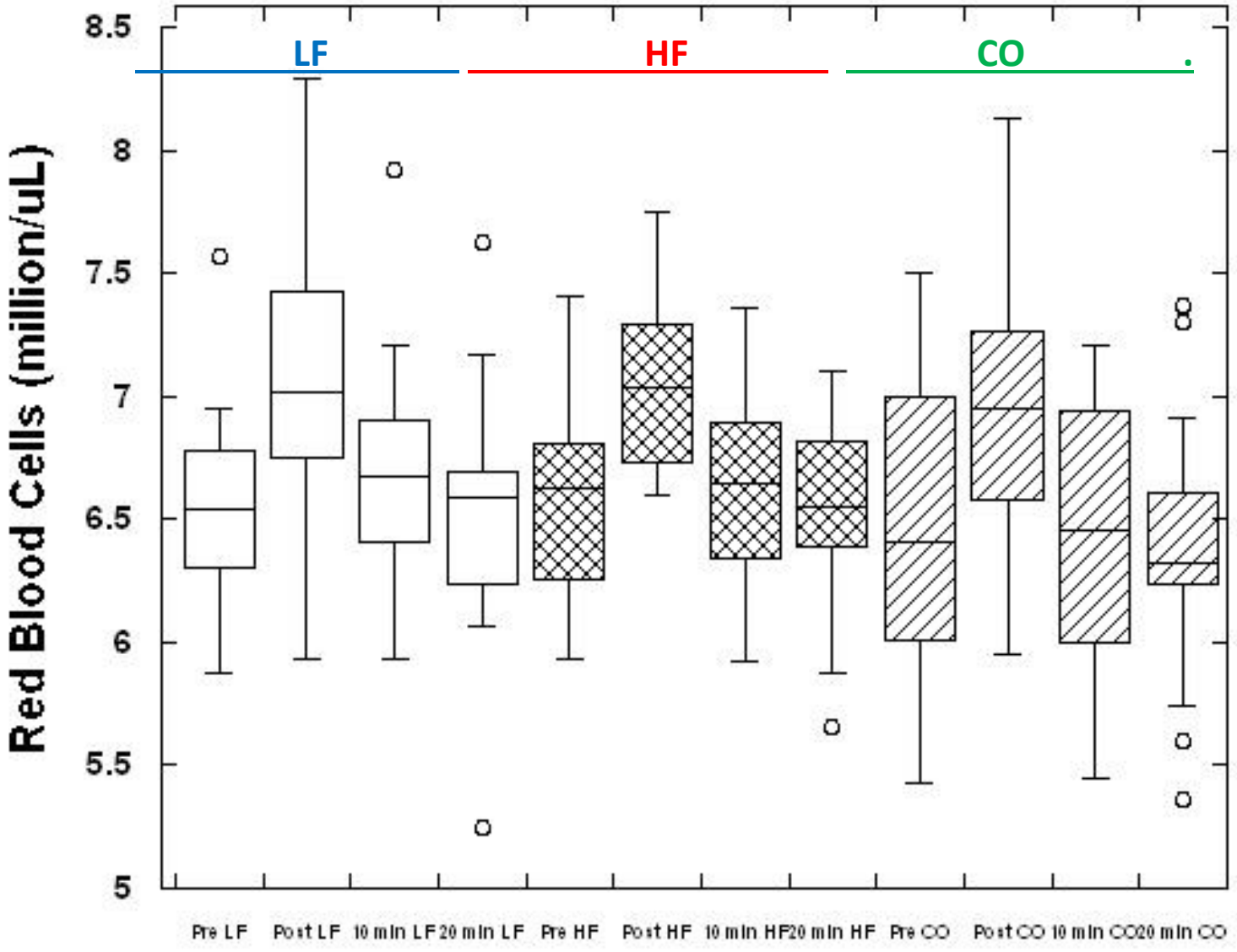
Energy and PUFA

Diet	Protein % ME	Fat % ME	CHO % ME	Protein g/ 100 kcal	Fat g/ 100 kcal	%Fat ME LA	Omega 6/3 ratio
RC 4800 (HF)	27	57	16	7.5	6.7	22%	8.4
RC Medium 25 + Corn Oil (CO)	18	56	26	5	6.5	40%	22
RC Medium 25 (LF)	27	31	42	7.5	3.6	24%	8.4

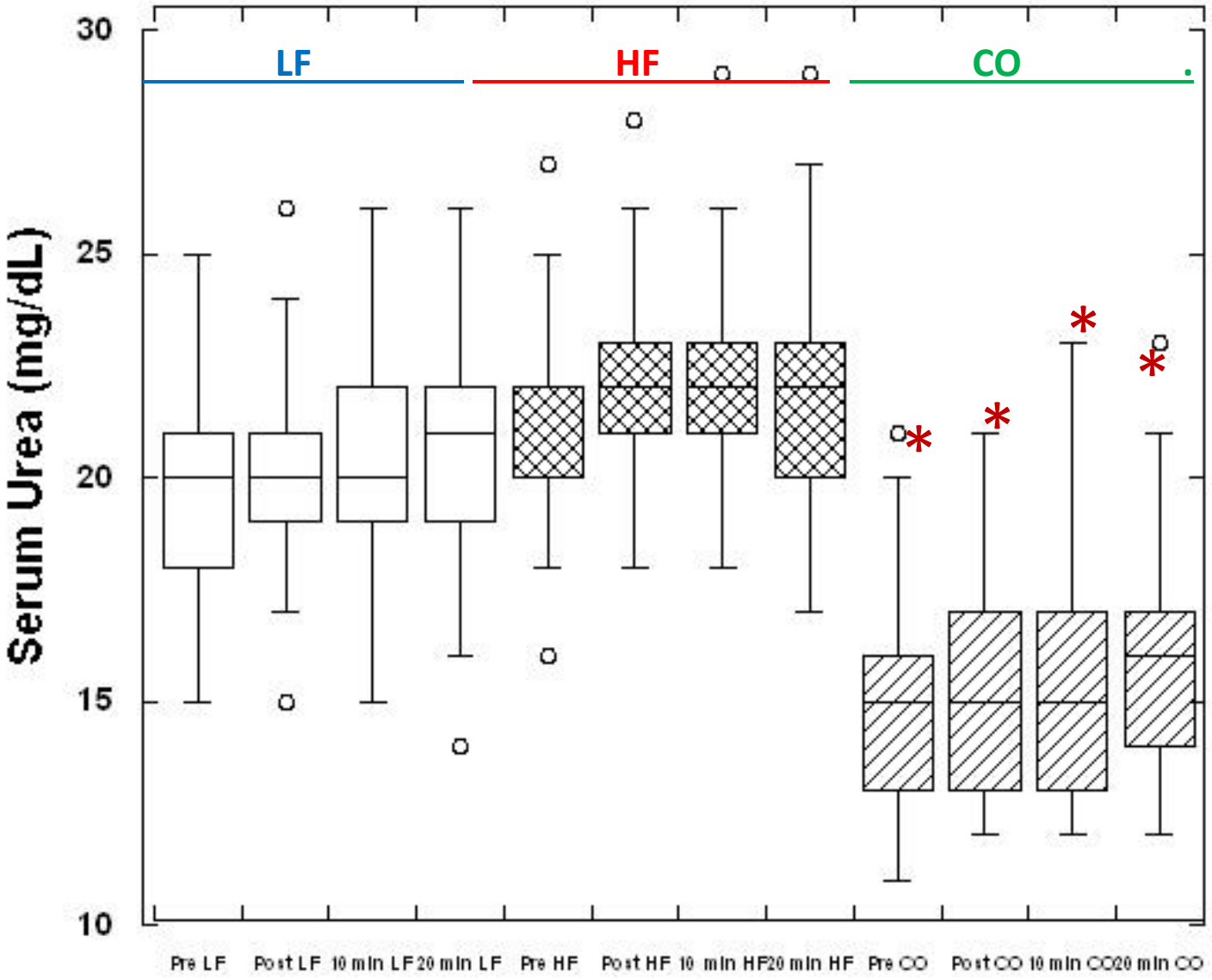
Serum Albumin



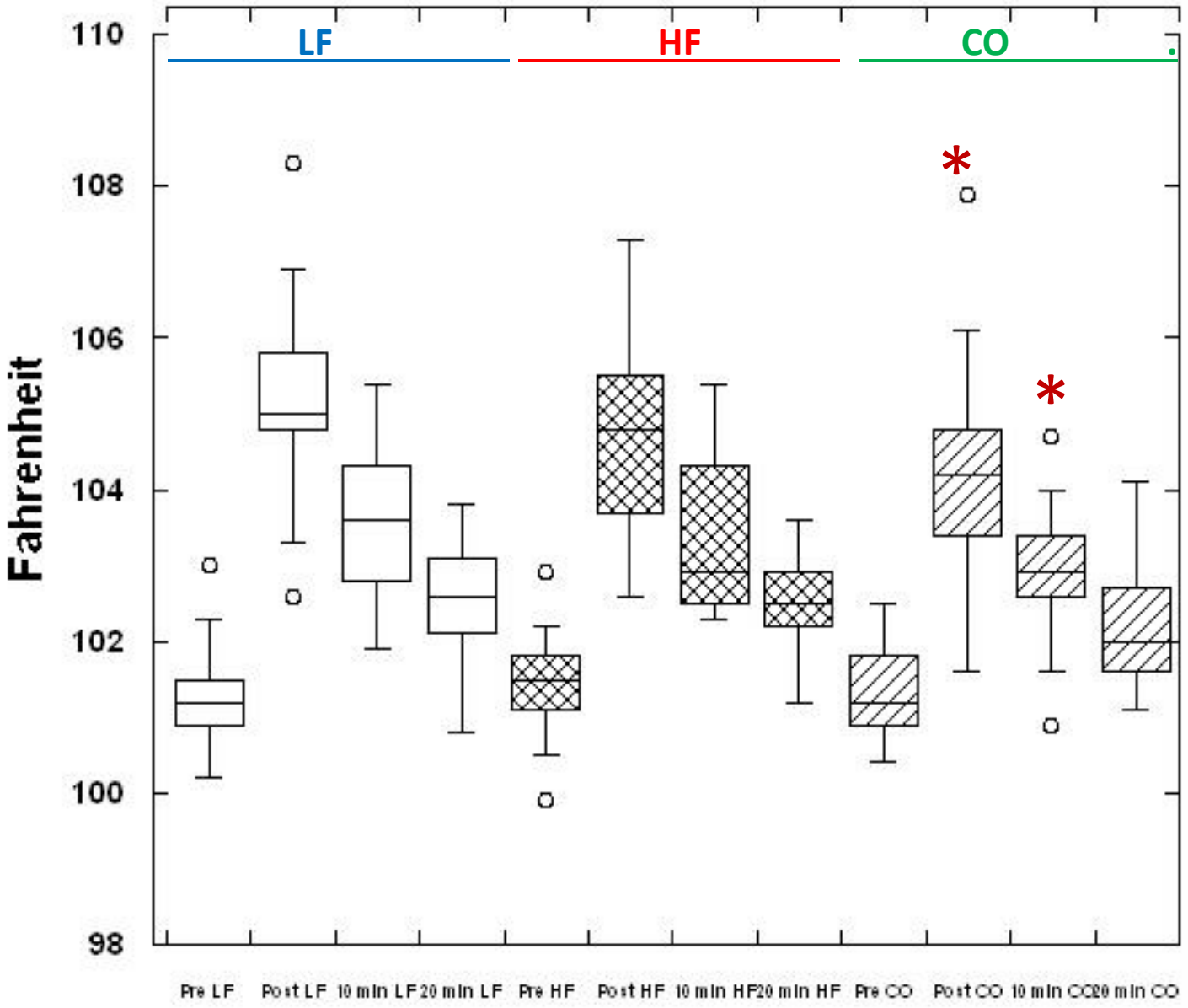
Red Blood Cells



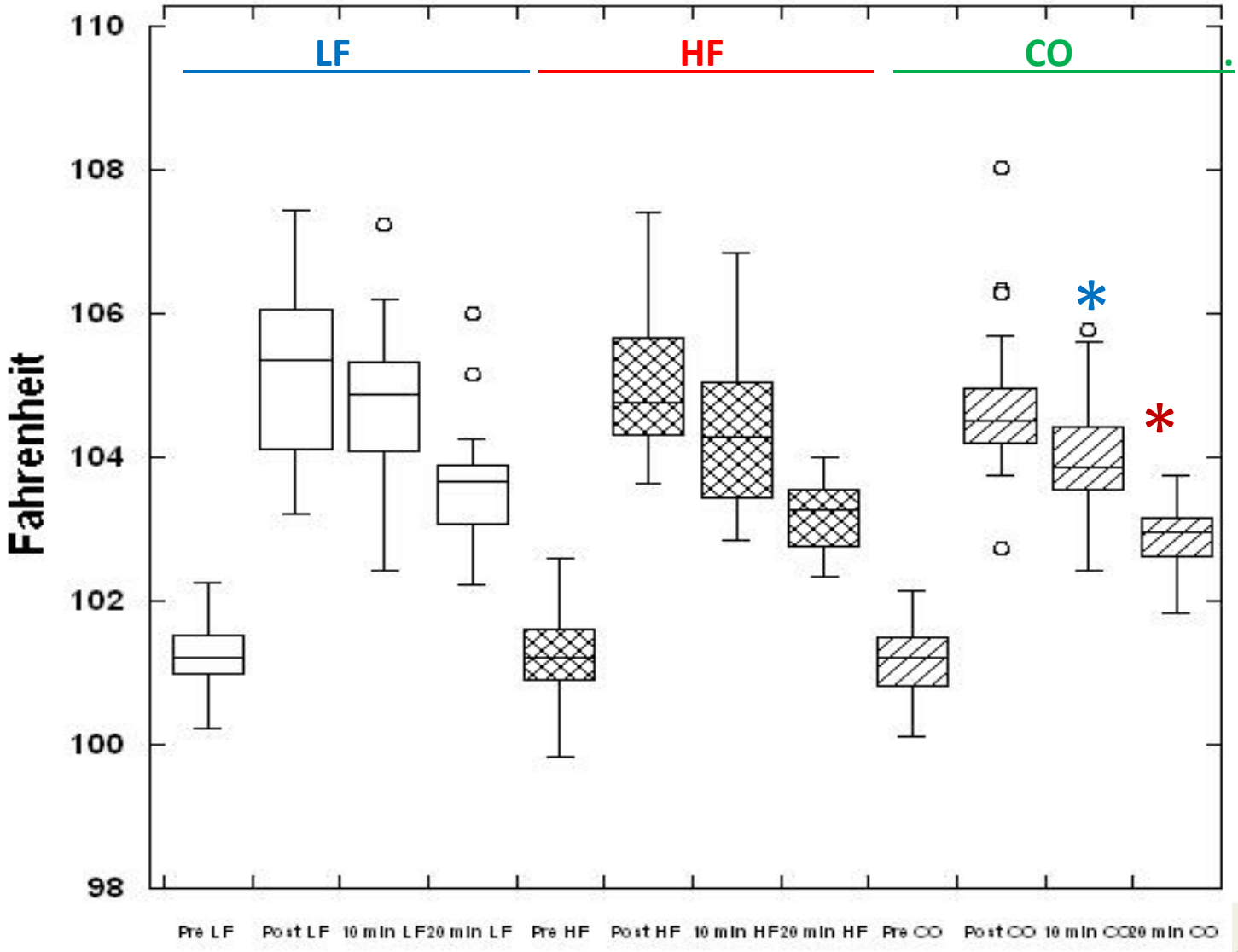
Serum Urea Nitrogen



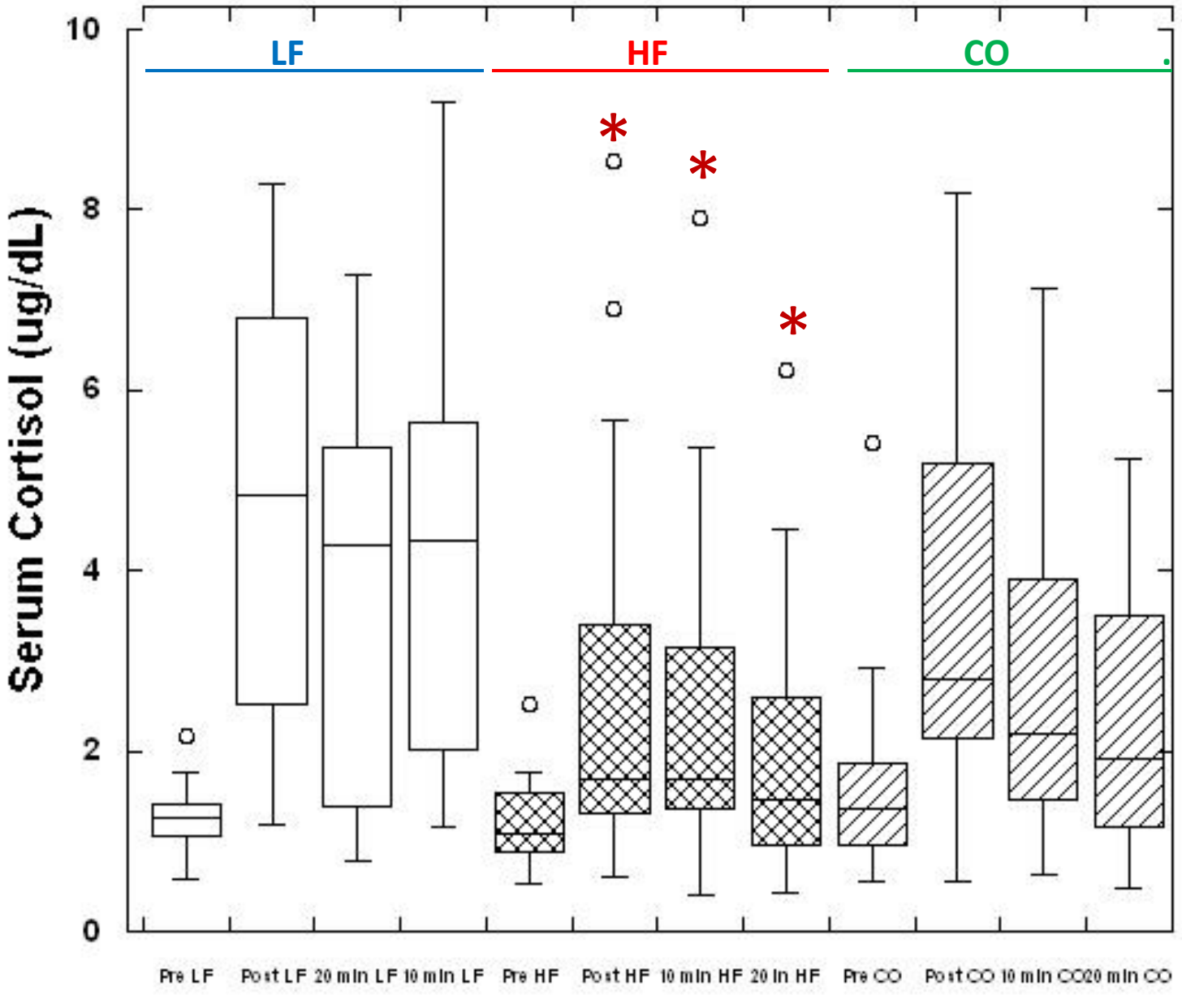
Rectal Temperature



Core Temperature



Serum Cortisol



Scent Thresholds

	SP (g)	AN (g)	TNT (g)
CO	0.015 (0.01-0.1)	0.1 (0.2-2.5)	0.025 (0.01-0.6)
LF	0.02 (0.001-0.6)	0.1 (0.01-2.5)	0.05 (0.004-0.6)
HF	0.015 (0.001-0.1)	0.15 (0.01-0.2.5)	0.05 (0.002-0.3)

Thresholds of scent do not change with diet

Diet and Exercise

Dogs were 1.42 (1.082 – 1.87) times as likely to find a target on the CO diet relative to the HF diet ($p = 0.0099$).

The LF diet was not significantly different from either the high fat diet or the corn oil diet ($p > 0.12305$).

Dogs were 1.49 (1.26 – 1.76) times as likely to find a target prior to exercise relative to after exercise ($p < 0.0001$).

There was no significant effect of Temp, pulse, respiration, on probability of finding the target ($p > 0.25693$).

Conclusions:

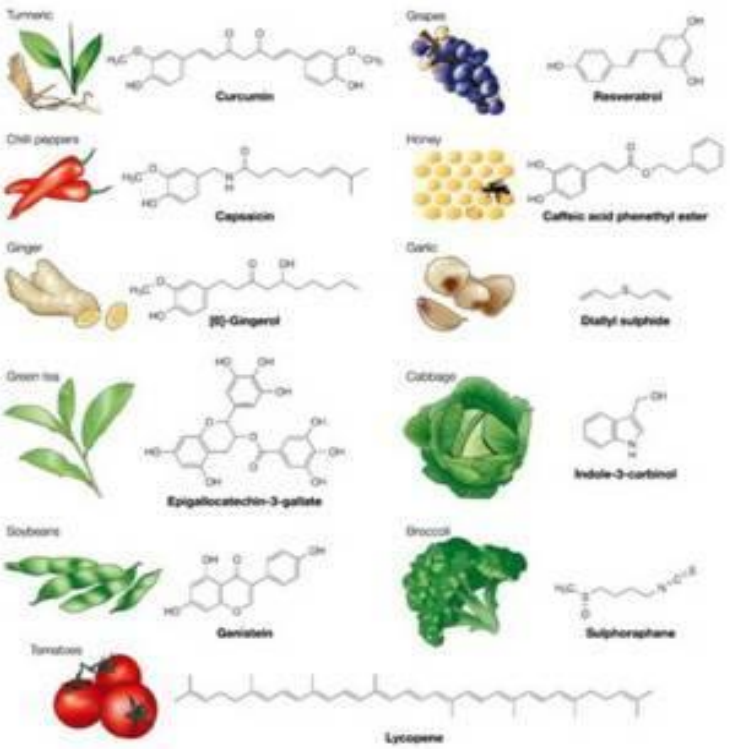
- The study suggests protein at 18% ME with Corn oil as main fat source may be adequate and potentially even advantageous for olfaction
  - Adequate protein synthesis
- A Detection dog on a moderate protein/high fat diet show less thermal stress.
  - Recovery and olfaction performance may be better?
- Higher fat complete and balanced diet was associated with lower serum cortisol concentration.
  - Metabolic stress?
- Influence of diet on olfaction needs further investigation for long term management of dogs working in warm environments.

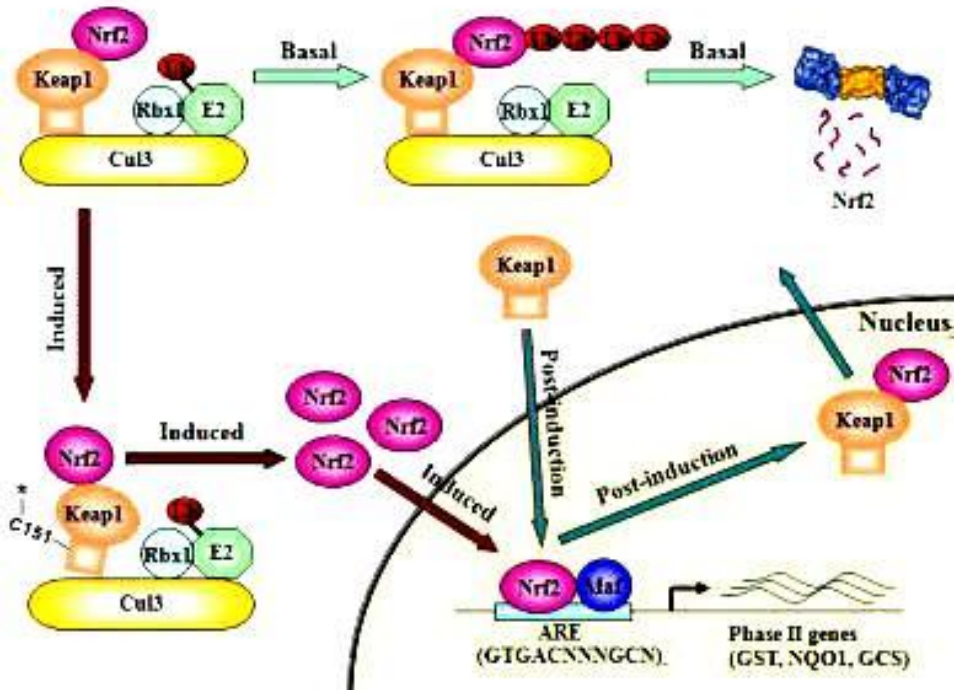
Athletes and Substrates

- Protein - Canine athletes minimally 24% ME
- Fat – will be variable
  - Sprint athletes – 10-15% of DM (20-25% ME).
  - Intermediate athletes – 15-40 % of DM (30-65% ME).
  - Endurance athletes – greater than 50% of DM (>75% ME).
- CHO – will be variable
  - Sprint athletes – 55-60% of DM (50-60% ME).
  - Intermediate athletes – 30-55% of DM (20-50 % ME).
  - Endurance athletes – less than 15% of DM (< 10% ME).

* Is the Paradigms changing depending on the work??

Antioxidants and Supplements

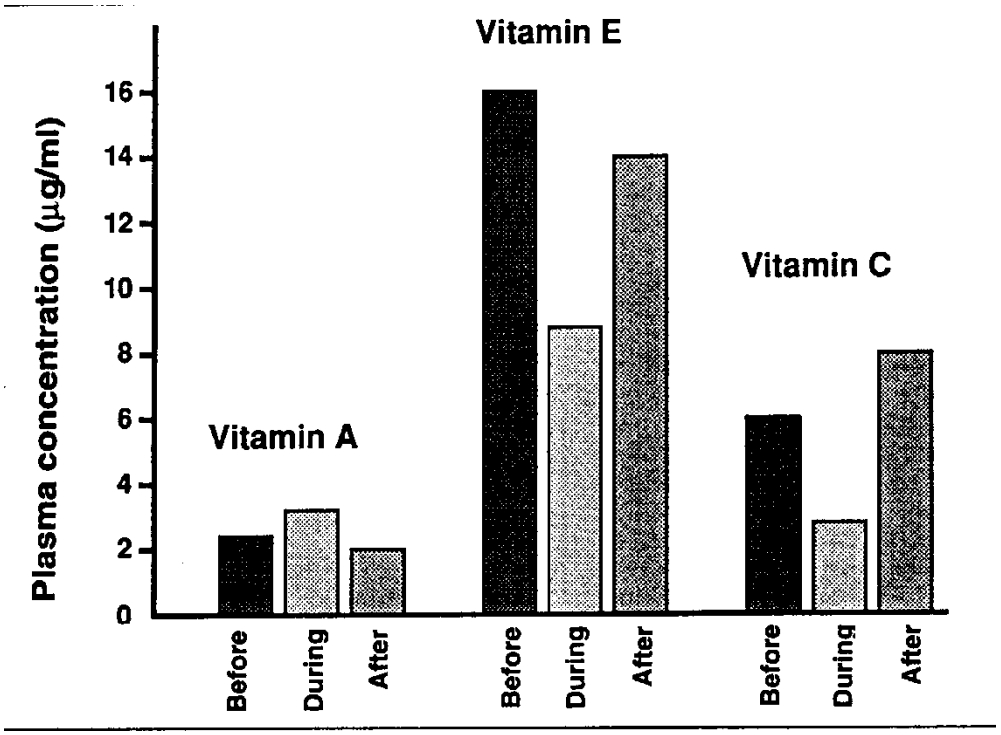




Zhang, 2005

Antioxidants and Exercise

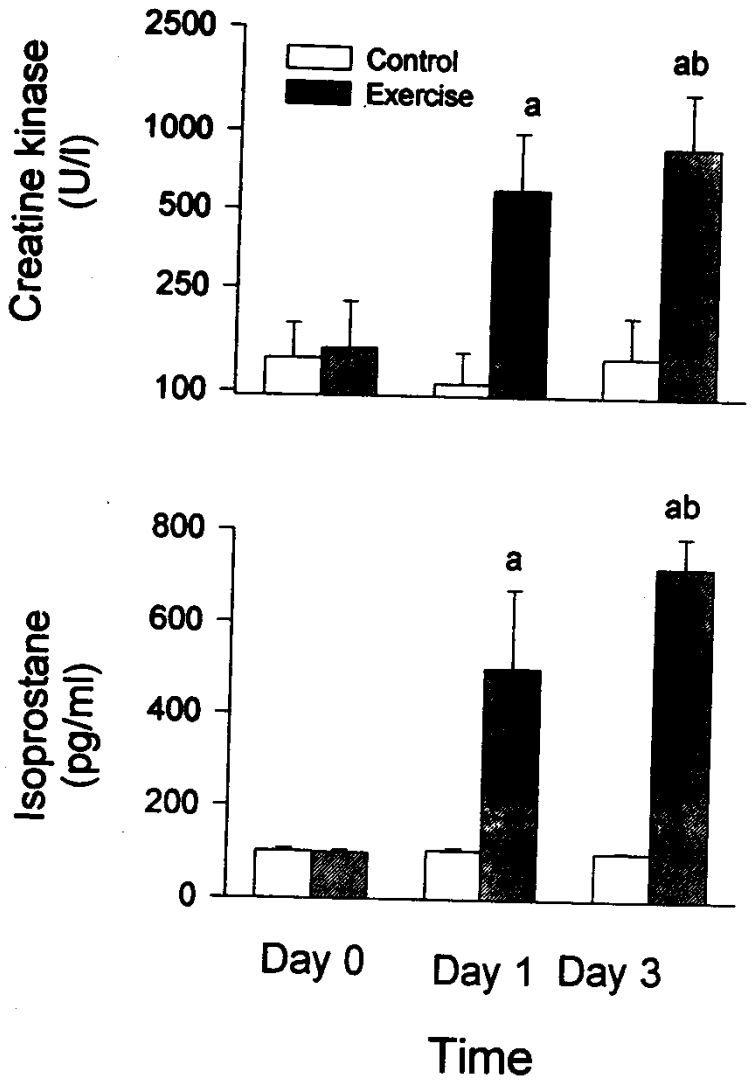
- Preliminary data from Kronfeld et al (1986) showed decrease in antioxidants during exercise.
- After exercise the antioxidant status increased in plasma.
- Suggested 1mg of vitamin C per kcal/ME
  - So 800 to 1200 mg for average sled dog.



Oxidant stress in sled dogs subjected to repetitive endurance exercise

Kenneth W. Hinchcliff, BVSc, PhD; Gregory A. Reinhart, PhD; Robert DiSilvestro, PhD; Arleigh Reynolds, DVM, PhD; Ashley Blostein-Fujii, PhD; Richard A. Swenson

- Definitive increases in CK over three days of strenuous exercise (longer runs than dogs used to at that point in training).
- Isoprostane an indicator of lipid peroxidation definitely increased suggesting oxidative damage.



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Variable	Group	Sample time: Before	Day 1	Day 3
Plasma				
Vitamin E (μg/ml)				
Measured				
	Exercise	19.9 ± 1.2	14.8 ± 0.9*	15.0 ± 1.0*
	Control	20.1 ± 2.6	19.7 ± 2.0	19.8 ± 2.0
Adjusted†				
	Exercise	19.9 ± 1.2	15.4 ± 0.9	16.5 ± 0.9
	Control	20.1 ± 2.6	19.6 ± 2.0	19.8 ± 2.0
Ceruloplasmin (U/L)				
	Exercise	38.8 ±16.8	36.9 ± 16.3	24.7 ±16.7*
	Control	37.8 ± 8.7	28.3 ± 13.6	36.3 ± 12.5
Total antioxidant status of plasma (mmol/L)				
	Exercise	1.7 ± 0.2	1.7 ± 0.2	1.7 ± 0.2
	Control	1.7 ± 0.5	1.7 ± 0.5	1.7 ± 0.2
Serum				
Cholesterol (mg/dl)				
	Exercise	229 ± 25	207 ± 25	199 ± 23
	Control	216 ± 35	209 ± 34	206 ± 34
Total protein (g/dl)				
	Exercise	6.3 ± 0.1	6.0 ± 0.1	5.7 ± 0.1*
	Control	6.1 ± 0.1	6.1 ± 0.1	6.1 ± 0.1
Uric acid (mg/dl)				
	Exercise	0.3 ± 0.1	0.5 ± 0.1*	0.5 ± 0.1*
	Control	0.3 ± 0.1	0.3 ± 0.1	0.3 ± 0.1
RBC				
SOD (U/mg protein)				
	Exercise	173 ± 15	172 ± 20	180 ± 22
	Control	185 ± 35	205 ± 30	198 ± 21
GPX (U/g Hb)				
	Exercise	2.72 ± 0.64	3.18 ± 0.55	2.89 ± 0.82
	Control	2.36 ± 0.64	3.20 ± 0.34	2.25 ± 0.23

Glutathione and superoxide systems not compromised in RBC. Is this the same for muscle.

Association between vitamin E and enhanced athletic performance in sled dogs

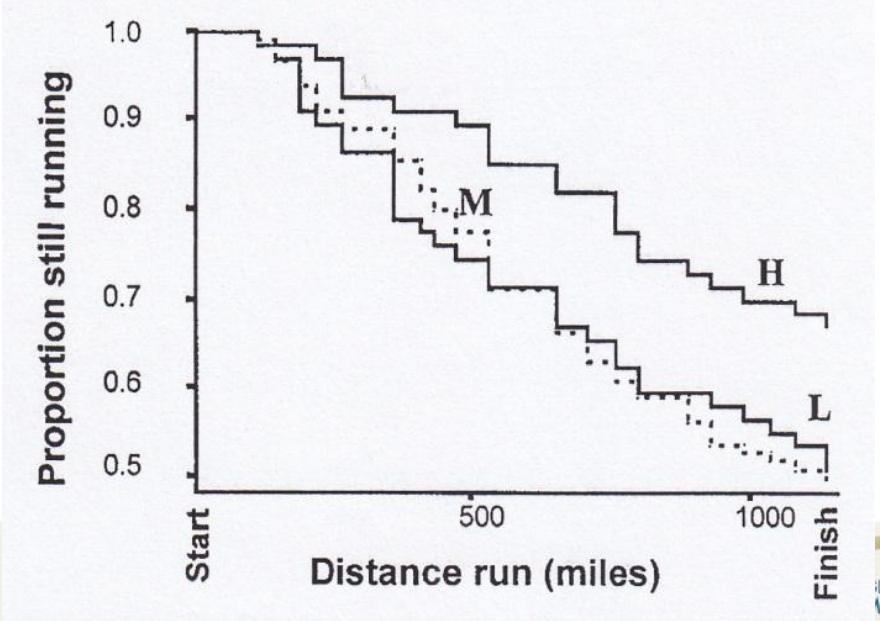
RICHARD J. PIERCY, KENNETH W. HINCHCLIFF, PAUL S. MORLEY, ROBERT A. DISILVESTRO, GREGORY A. REINHART, STUART L. NELSON, JR., KARIN E. SCHMIDT, and A. MORRIE CRAIG

- Pre-racing blood samples form teams 1 month prior to race
- CBC, Serum Chemistry, vitamin E
- 323 dogs with samples before and dropped
- Logistical and linear regression modeling for many variables

Findings:

Vitamin E concentration not associated with drop from race race speed.

Time to drop among dropped dogs inversely proportional to plasma vit E (1.8 times less risk



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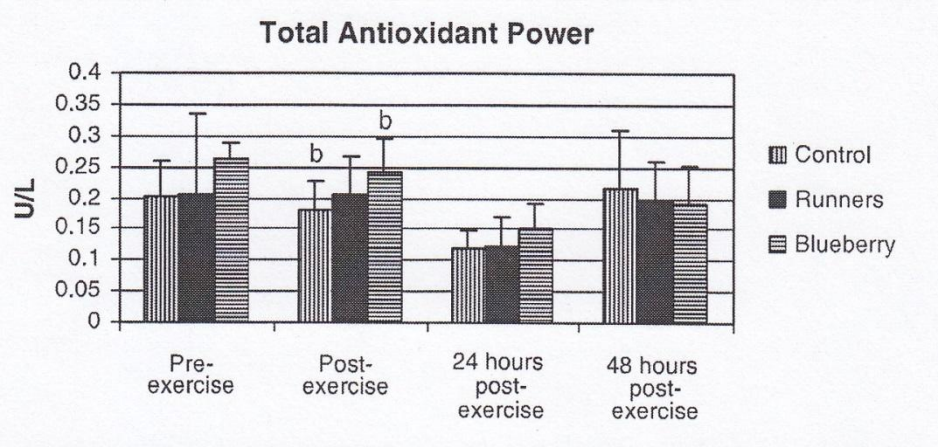
Total antioxidant power in sled dogs supplemented with blueberries and the comparison of blood parameters associated with exercise

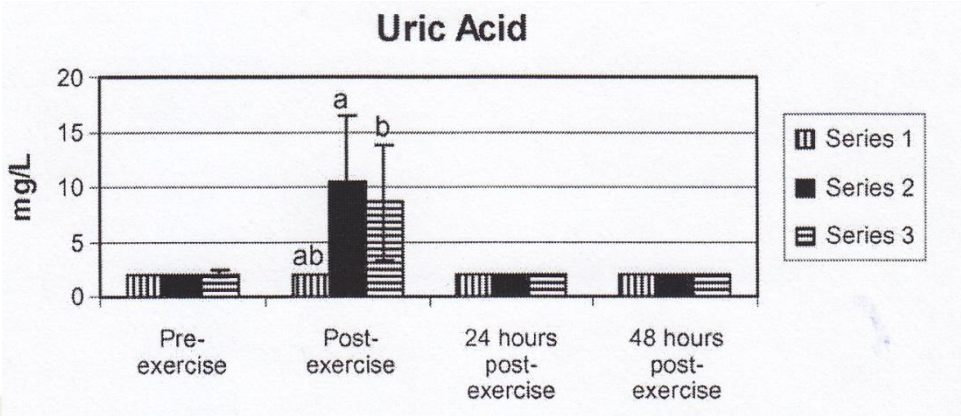
Kriya L. Dunlap *, Arleigh J. Reynolds, Lawrence K. Duffy

Total antioxidant potential increases with Blueberry extract



Uric acid is the major antioxidant that increases after exercise

Amount of blueberry provided to each dog was about 1-2 quarts per day.



No changes in serum isoprostanes

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Supplemental Vitamin C Appears to Slow Racing Greyhounds[1,2]

Rebecca J. Marshall, Karen C. Scott, Richard C. Hill,[3] Daniel D. Lewis, Deborah Sundstrom, Galin L. Jones* and Jean Harper†

- **Could vitamin C be detrimental?**
- **At doses of 1000 mg SID it may cause decrease in performance!**
  - **May exacerbate lactic acidosis.**
  - **Other evidence supports at very high levels antioxidants may be pro-oxidative.**

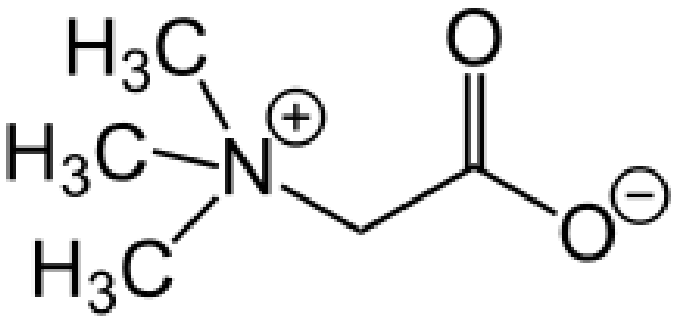
The effect of supplemental vitamin C on racing time and speed in racing greyhounds[1]

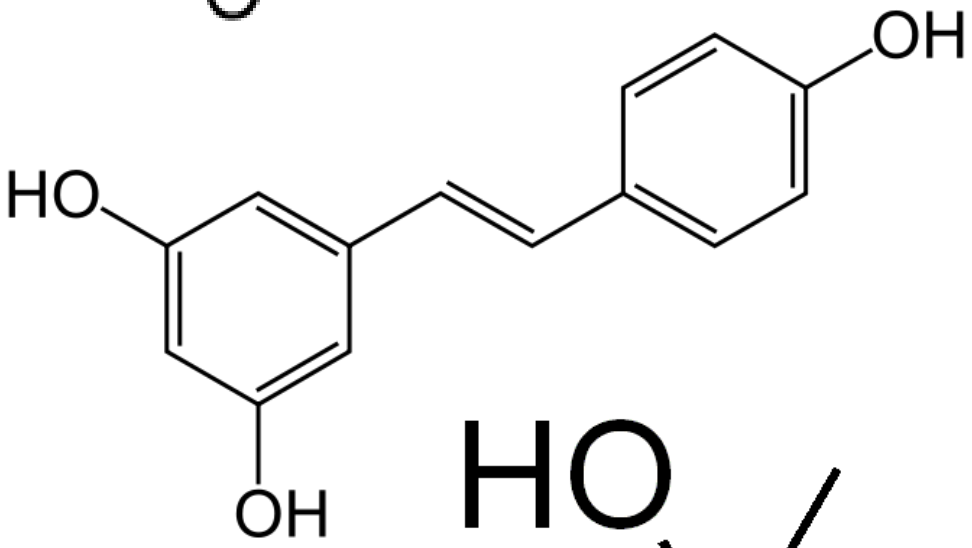
	Treatment			
	No C	C prerace	C postrace	SE
Race time, s[2]	32.52[a]	32.69[b]	32.73[b]	0.18
Speed, m/s[2]	15.38[a]	15.30[b]	15.28[b]	0.08
Body weight, kg	27.8	28.1	28.0	0.4

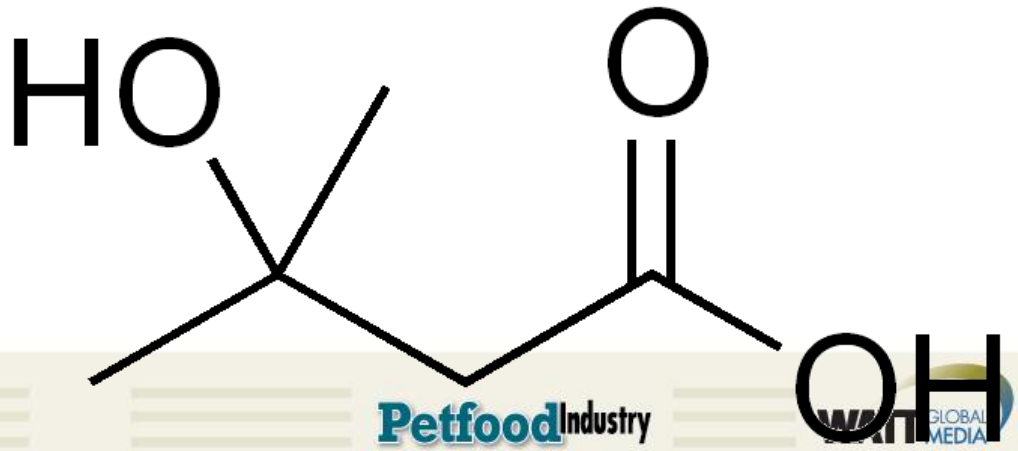
[1] Least-squared means; $n = 5$ greyhounds during wk 2–4 of each diet period.

[2] Means with different superscripts are significantly different with respect to treatment ($P < 0.05$).

Performance Enhancers







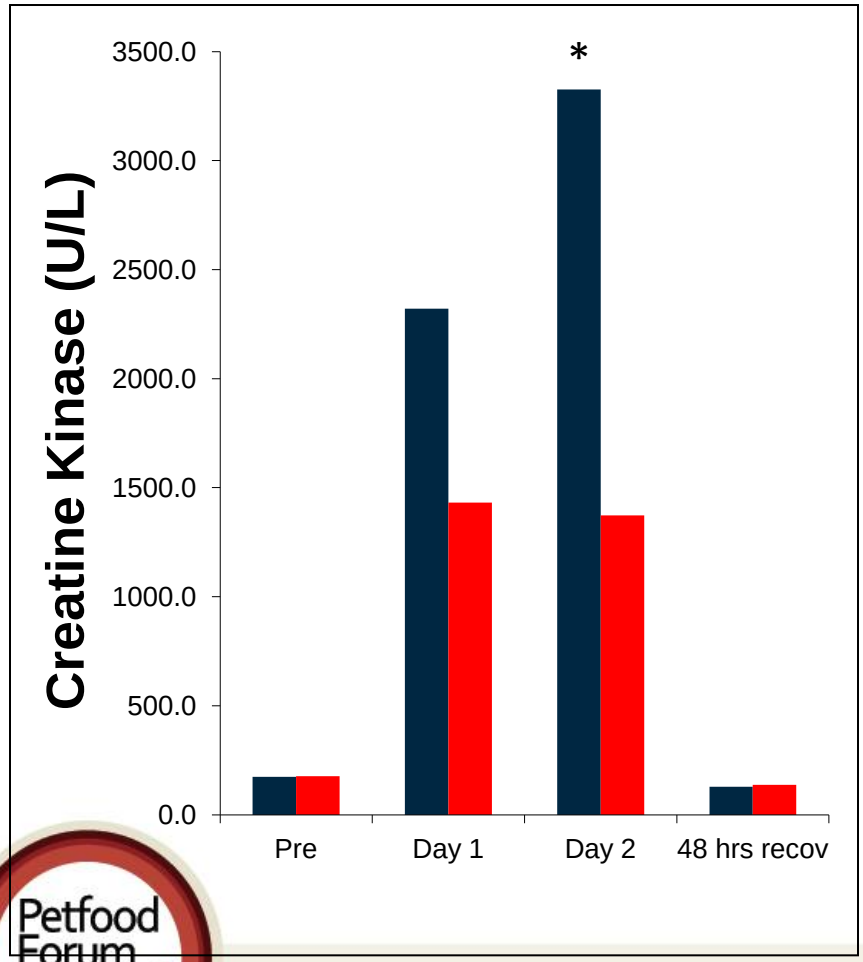
Coyote Hunting Foxhounds

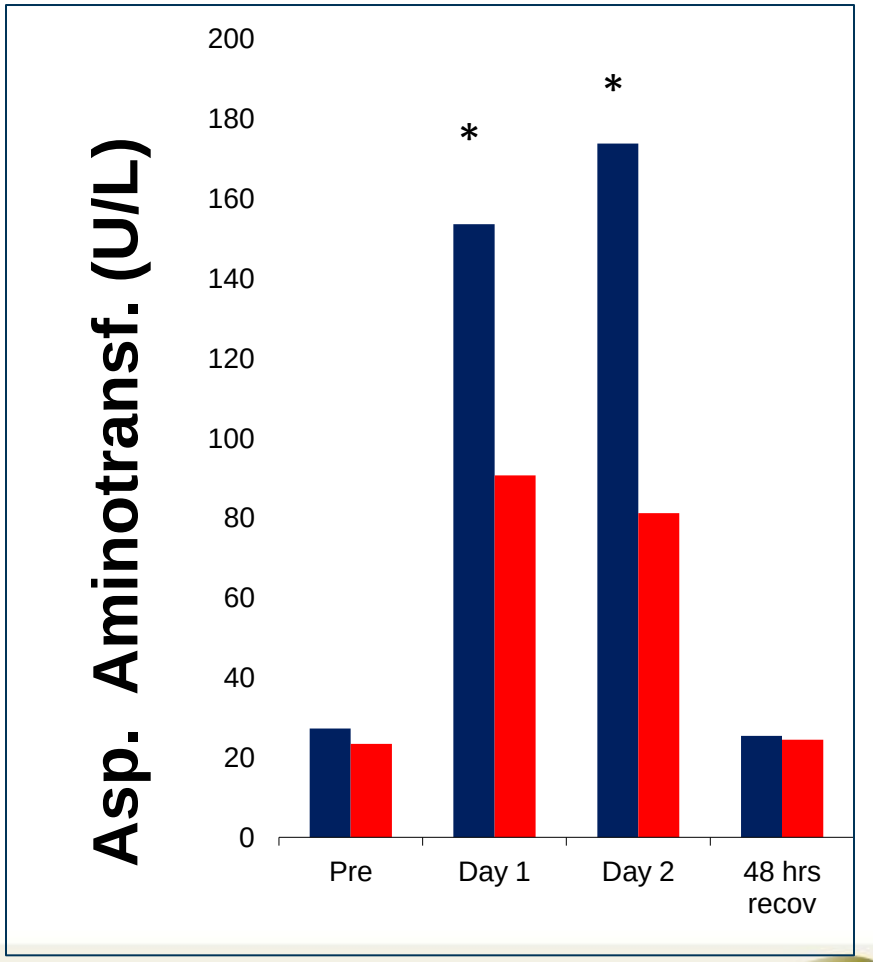
Carolina championships 2013

- **Ten healthy Walker Fox Hounds Midsouthern performance feed**
- **Five control fed dogs (2 kennels)**
- **Five dogs (2 kennels)**
  - **supplemented with a proprietary blend of yeast extract, betaine, magnesium citrate, L-carnitine, sodium bicarbonate, biotin, niacin, pantothenic acid, pyridoxine, and cyanocobalamin which was incorporated into the kibble and fed for 4 weeks before testing.**
- **Serum examined**
  - **Resting, after day1, after day 2, 48 hrs after event.**

Muscle Related Damage

Blue – control Fed : Red – Supplement fed





Points Achieved

- **Supplement Group**
- **20 possible placement points by placing in top 10 for categories**
  - **Endurance – 2 dogs**
  - **Tracking – 1 dogs**
  - **Speed – 2 dogs**
  - **Total – 3 dogs**

- **Control Group**
- **20 possible placement points by categories**
  - **Endurance – 1 dogs**
  - **Tracking – 0 dogs**
  - **Speed – 0 dog**
  - **Total – 0 dogs**

So who do we study and why??

Acknowledgements and Questions?

- Auburn Animal Health and Performance Program
  - Department of Justice
- IAMS Company
  - Glycogen Work
- Trouw USA
  - Foxhound work