

# Energy requirements of racing sled dogs : from quantity to quality

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## A good nutrition program must ...

- ... provide an optimal quality of energy in adequate amounts
- ... minimize the volume and weight of the intestinal bolus
- ... help keep the animal properly hydrated
- ... take into account the dog's body shape
- ... help maximize results of others ergogenic activities
- ... minimize the volume and weight of the intestinal bolus
- ... fill physiological gaps created by stress
- ... be a true preventive factor for stamina related gastrointestinal problems



## How much energy for a racing sled dog ?



The daily requested amount  
in order to maintain  
an adequate bodyweight



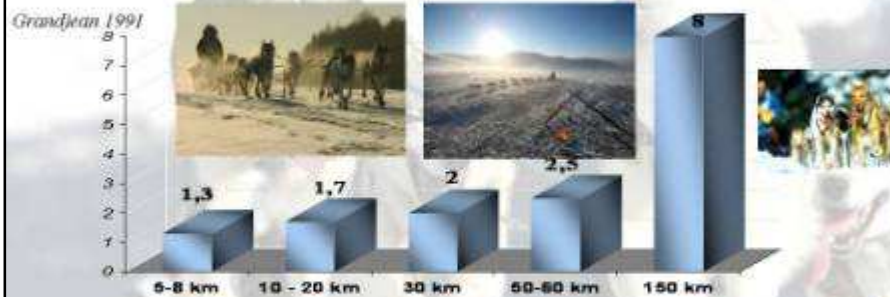
## How much energy for a racing sled dog ?

- ⌚ Sprint Races [4 to 25 km/heat ; 3 days]
- ⌚ Mid distance Races [30 to 60km/heat ; 3 days]
- ⌚ Stage Races [50 to 100 km/day ; 10 to 15 days]
- ⌚ Long distance Races [100 to 200 km/day ; 2 to 4]
- ⌚ Ultramarathon Races [150 to 200 km/day ; 8 to 12 days]



## Evolution of the energetic requirement in endurance efforts

Multiplying factor of the energy requirement vs maintenance



-Variable expense according to the distance and climate

- a 23 kg racing dog on a long distance race (AK) consumes up to 11 000 kcal/d (x 8 / MER); to compare to a cyclist on the « Tour de France »: 8000 kcal /d

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## Energy intake and expenditure of sled dogs during the Alpirod race 1995

- ↳ Measurement of daily energy expenditure using doubly-labelled water method
- ↳ Mean body fat of dogs prior to the race = 4 p100 !
- ↳ Fat loss during the race = 400g/dog

ALPIROD



Dog	Musher
50 km/day ≈ 150 kcalME/kg/day 2800 kcalME/dog/day No difference / place in the team	3300 kcal/day

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## Sustained energy expenditure in Alaskan sled dogs during heavy exercise in the cold

- ↳ Measurement of daily energy expenditure using doubly-labelled water method
- ↳ Temperatures between -10°C and -35°C
- ↳ Training bouts in race conditions of 490 km



170 km/day  
≈ 440 kcalME/kg/day  
11000 kcalME/dog/day  
No difference / place in the team

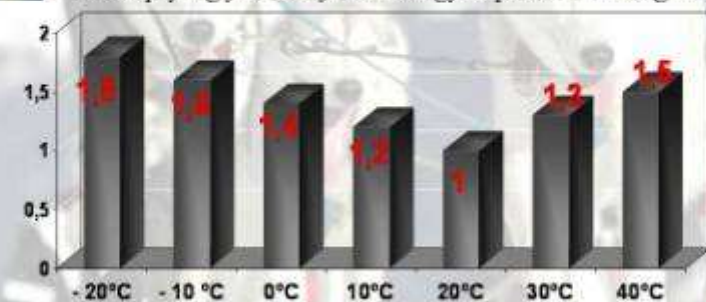
↳ 15 p100 of the energy = cost of thermoregulation

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## Influence of the external temperature on the energy requirement

Multiplying factor of the energy expense in a dog at rest



MacNamara, 1972

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## Evolution of the energy requirements in racing sled dogs.

Case of a dog weighing 20 kg [44lb]

PERIOD	ENERGY REQUIREMENTS [kcalME/day]
MAINTENANCE	1000 – 1200
TRAINING [5 to 8 km/day]	1300 – 1400
TRAINING [10 to 20 km/day]	1700 – 1800
TRAINING [30 km/day]	2000 – 2400
SPRINT RACE	1400 – 1800
LONG DISTANCE RACE	3000 – 4000
IDITAROD	7000 – 8000



## How much energy for a racing sled dog ?



**MORE !**



DURATION OF STAMINA

INTENSITY OF STAMINA

CLIMATE TEMPERATURE

INDIVIDUAL VARIATIONS

GOOD MUSHERS KNOW THEIR DOGS

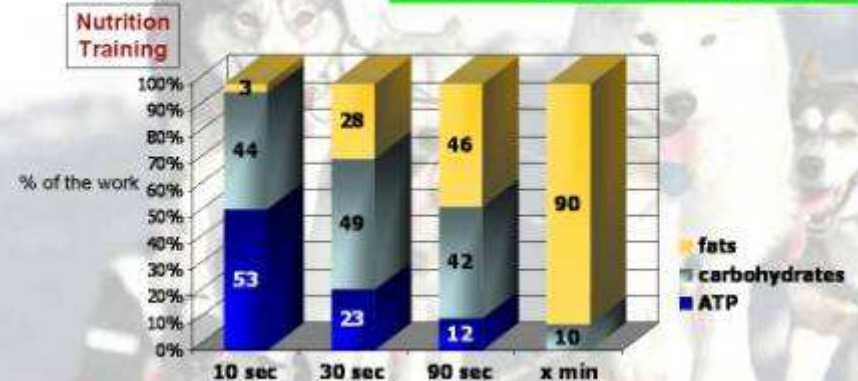
**Food energy : why do we talk about "quality" ?**

**What type of fuel for what type of race ?**

## Aero and/or Anaerobic Stamina

- Anaerobic Alactic
- Anaerobic Lactic
- Aerobic

## Sled Dog exercise physiology



Grandjean 1991

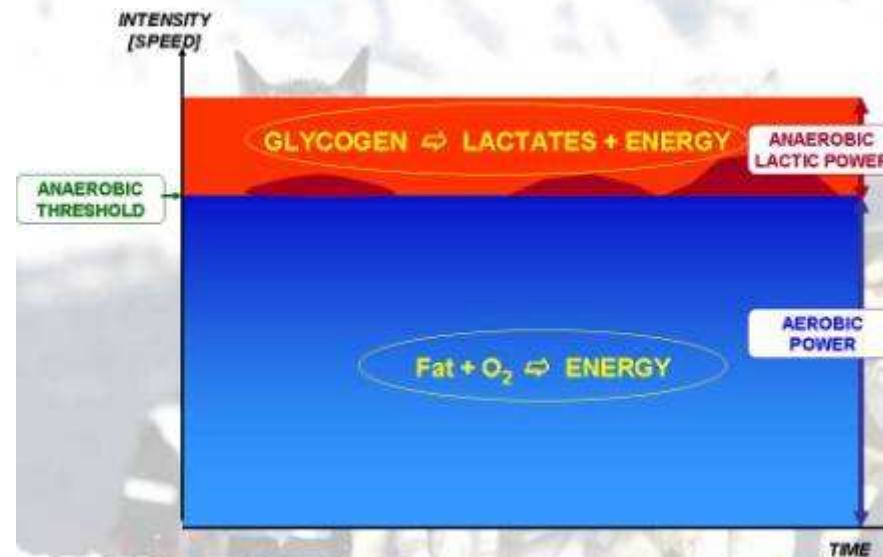
↳ Very High VO<sub>2</sub>max

## Sled Dog exercise physiology

Nutrition  
Training

### Comparative VO<sub>2</sub>max

Performance	VO <sub>2</sub> max [mlO <sub>2</sub> /min/kg]		
	Man	Horse	Dog
Very poor	45	70	80
Poor	55	90	100
Medium	65	110	130
Good	75	130	180
Very good	85	160	220



### Orientation of the metabolism in different types of endurance efforts in sled dogs

TYPE OF EFFORT	ANAEROBIC - LACTIC	AEROBIC
Sprint [4 to 6 km]	+++	+++
Sprint [10 to 20 km]	++	+++
Mid distance	+	++++
Stage race	[+ to ++]*	+++++
Long distance	0	+++++
Ultra-marathon	0	+++++

\* push, or resistance [uphill]

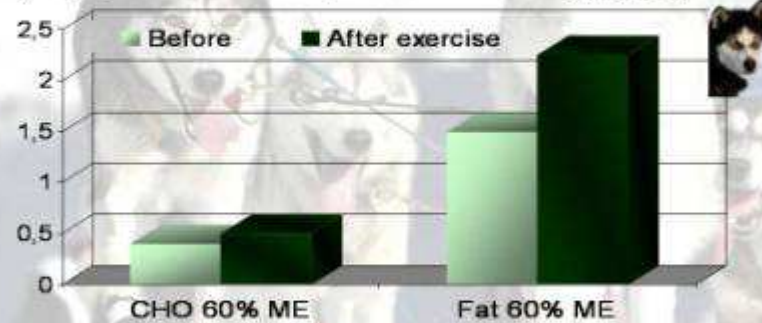
### Historical approach



## Influence of the fat content on the amount of plasma free fatty acids

Plasma free fatty acids concentration (mmol/l)

Reynolds, 1996



- Even before training, a high fat diet encourages the fatty acid consumption by muscles.

## Influence of the fat content on the volume of mitochondria

Reynolds 1996

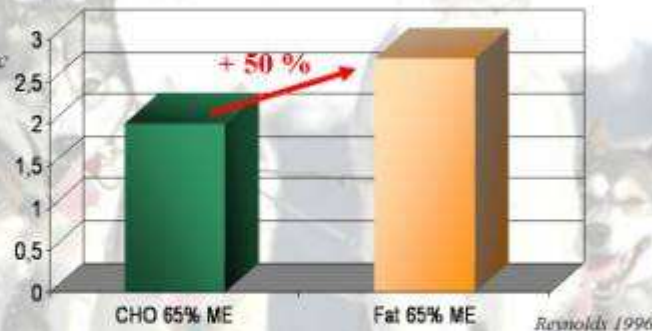
% mitochondrial volume /muscular fibre



- A high fat diet improves the ability to « burn » fat.

## Influence of the diet on VO2 Max

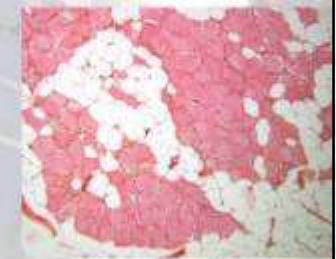
ml O<sub>2</sub>/kg/sec



- A high fat diet increases the quantity of available oxygen for the muscles: endurance is improved.

## A high fat diet pushes back the stage of fatigue apparition

- If the muscles preferably use the fat, glycogen reserves are saved.
  - glycogen reserves can be exhausted within 2 hours
- Fat reserves are almost unlimited.



FOOD	PROT/DM	FAT / DM	CLIN. RESULT
TAYLOR 1959 "Pemmican"	66	28	-
WYATT 1963 "Pemmican"	62	29	-
WYATT 1963 "Nutrican"	30	40	++
ORR 1965 "Pemmican"	63	29	-
ORR 1965 "Nutrican"	22	40	+
KRONFELD 1973 "Seal Meat"	33	66	+
WOLTER 1982 "Far North"	26	50	+
GRANDJEAN 1995 "Alpicroc"	38	40	+++

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## Quality of the energy in racing sled dogs

☞ Energy rapidly and easily disponible on site of utilization (muscle cell)

☞ Balance of the energetic components generating

- a minimum of waste
- a maximal efficiency
- no risk of metabolic « blockage »

⇒ Excellent digestibility

⇒ Easy to metabolize

⇒ Existence of ergogenic helpers

FATS

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Serum of a sled dog  
before and after a race

Pot race serum of a sled dog  
« refrigeration test »



## Quality of the energy in racing sled dogs

« FUNNY FATS »

### DIGESTIBILITY OF FEEDSTUFFS FATS

FEESTUFF	DIGESTIBILITY
Chicken fat	84 – 99
Pork fat	96
Fish oil	97
Butter	95 – 97
Soya oil	96
Peanut oil	97
Corn oil	97
Coco oil	98
Olive oil	97

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# Quality of the energy in racing sled dogs

« FUNNY FATS »

## SHORT CHAINS FATTY ACIDS



- Coco, coprah oil
- Digestive and metabolic utilization similar to water
- No need for acyl-carnitine
- No risk of ketone-bodies production
- « Fast fats »

# Quality of the energy in racing sled dogs

« FUNNY FATS »

## OMEGA 3 FATTY ACIDS



- PUFA
- Essentiel
- Increase cell membrane permeability to O<sub>2</sub>
- Increase cell membrane deformability
- Anti-inflammatory effect
- Omega 6 / Omega 3 ≈ 5

# Quality of the energy in racing sled dogs

« FUNNY FATS »

## OTHER ROLES OF FATTY ACIDS



⇒ Quality of feces



= Fatty Acid + O<sub>2</sub> → H<sub>2</sub>O  
 100 g → 107g metabolic water



= Glycerol → ↑ Intracellular hydration  
 ↑ H<sub>2</sub>O consumption



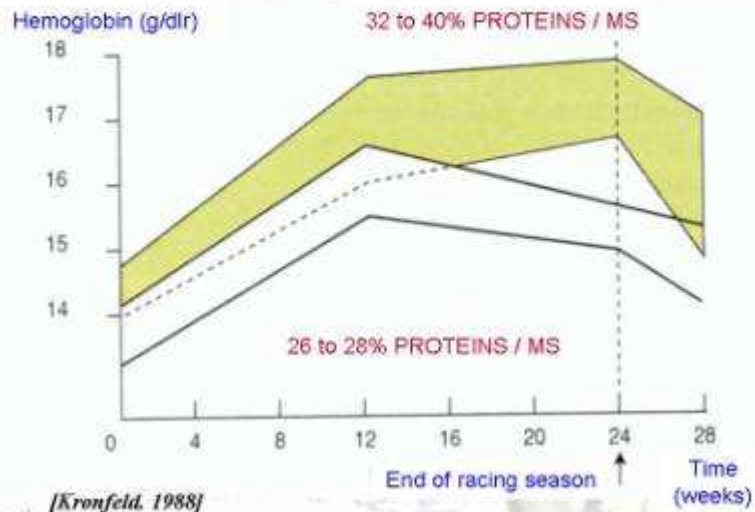
10 à 15 p100 Fat/DM → 30 à 40 p100 Fat/DM

Sprint → Medium → Endurance

↳ 20 p100 of fats as short chain fatty acids

↳ Omega 6 / Omega 3 # 5

## Beware of Proteins / Calories ratio [PCR]



## Prot. Cal. Ratio : from theory to practice...



ME/d	p 100 Proteins/ME		
	30p100	25p100	20p100
1000	75	63	50
2000	150*	125	100
3000	225	188	150
4000	300	250**	200
5000	375	313	250
6000	450	375	300
7000	525	438	350
8000	600	500	400***

- \* → Light training ; Sprint race  
 \*\* → Hard training ; Mid distance  
 \*\*\* → Long distance

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## Prot. Cal. Ratio : from theory to practice...

PCR = 75  
 500 g dry food 4000 kcal/ME/kg and 30 p.100 Prot  
 ☞ Maximal digestive tolerance threshold of nordic dogs for dry food

PCR = 50  
 2 kg dry food 4000 kcal/ME/kg et 30 p.100 Prot  
 ☞ Osmotic diarrhoea → SDDS !  
 500 g dry food + 3 kg meat/fatty fish  
 ☞ Volume → fraction



Need for purified protein sources  
 - high quality (milk, egg isolates, hydr)  
 - powder (volume)

## Power vs speed in racing sled dog

Energy Source	Power developed	Average Speed	Type of race
Oxidation lipid	1	16 km/h [x1]	Iditarod
Oxidation CHO	2	23 km/h [x14]	Mid-dist
Glycogenolysis	4	32 km/h [x2]	Sprint
Phosphagenes	12	55 km/h [x3.4]	few seconds



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## Conception of a complement for racing sled dog



Solution 1

Solution 2

Cplt prot.

+

Cplt fat.

Formulation  
of a unique  
complement

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## Conception of a complement for racing sled dog

Solution 1

**Prot. complement**

- Meat meal [60 p.100]
- Fish meal [10 p.100]
- Egg Powder [15 p.100]
- Caseine + methionine [5 p.100]
- Yeast [qsp]
- Minerals [qsp]
- TE + Vitamins [qsp]

**Fat complement**

- Poultry fat +
  - . PUFA (n-3) [salmon oil]
  - . PUFA (n-6) [Sunflower oil]
  - . SCFA [coco oil]



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## Conception of a complement for racing sled dog

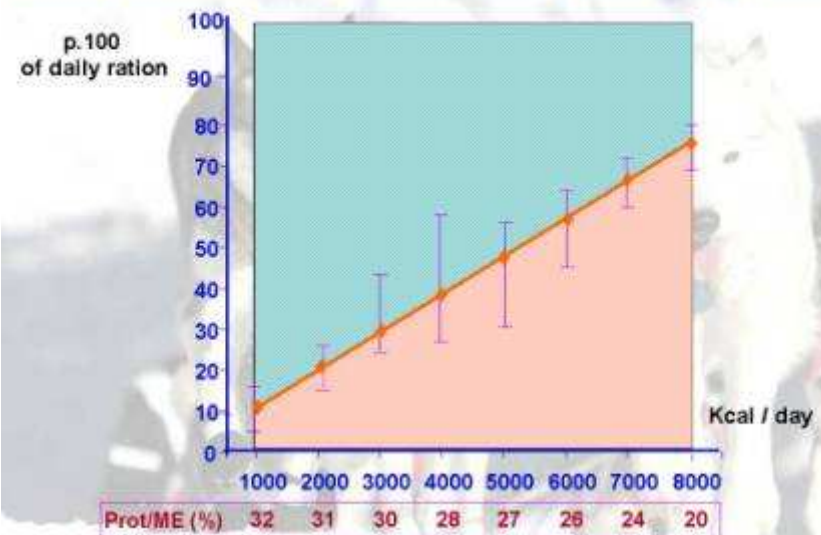
Solution 2

Specific industrial complements  
[40 à 50 p.100 Prot/DM  
40 à 50 p.100 Fat/DM]

- Meat meal [40 p.100]
- Fish meal [10 p.100]
- Egg powder [10 p.100]
- Poultry fat [25 p.100]
- Sunflower oil [5 p.100]
- Coco oil [5 p.100]
- Salmon oil [2 p.100]
- MVC [3 p.100]

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## Dry food [35/20] + Wet Complement [13/28]



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## Practical ration of sled dogs fed with a specialized dry food and a dedicated work complement

Proportion Dry food* Complement**	Kcal ME/kg (%DM)	Prot. (%DM)	Fat	% cal. Prot.***
80/20	# 4 550	37	34	31.5
70/30	# 4 650	38	36	31.6
60/40	# 4 750	39	38	31.6
50/50	# 4 850	40	40	31.7
40/60	# 5 000	41	42	31.8

\* Dry food « 4800 »  
 \*\* Complement « 45/45 »  
 \*\*\* Respect of PCR.



Is there any nutritional consequence  
to the use of high fat diets  
in the racing sled dog ?

Quality of  
Food storage

Ergogenic  
aids

Antioxidants



**Thank you  
Questions ?**

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