

Formulating with consideration of the sulfur AA, taurine and methyl compounds to support the health and longevity of dogs

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My funders and team

Conflicts of Interest: Member of Trouw CA Scientific Board.
 Research program currently funded by: Champion Petfoods, RC Hagen, Smart Earth Camelina Corp, FL Emmert, The JM Smucker Company, Saskatchewan Pulse Growers, NSERC, CFREF, Mitacs, Agriculture & Agri-food Canada.

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Outline

- Protein Quality
- Amino acid requirements and methionine requirements
- Secondary metabolites of methionine
- What DCM has taught us and where we are going
 - Micronutrients and sulfur amino acids
 - Consumer's role

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Protein quality

Protein quality is dependent upon:

1. Protein content
2. Amino acid composition
3. Protein digestibility and amino acid availability compared to the requirements of the species of interest.



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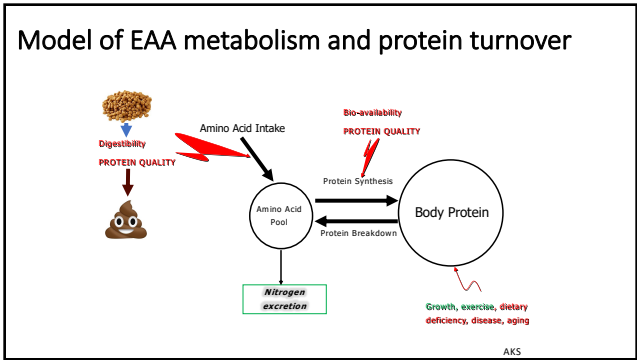
Range in CP and AA content

Source	% CP	LYS	MET	ARG
Milk (skim dried)	~35	2.86	0.92	1.24
Poultry BP meal	~64	3.32	1.11	3.94
Meat and bone meal	~52	2.51	0.68	3.45
Fish meal (white meal)	~63	4.51	1.76	4.04
Soybean meal	~44	2.83	0.61	2.83
Rice (grain, polished and broken)	~7.5	0.30	0.18	0.30
Corn gluten meal	~60	1.02	1.43	1.02
RANGE	7.5-64%	0.30-4.51	0.18-1.76	0.30-4.04

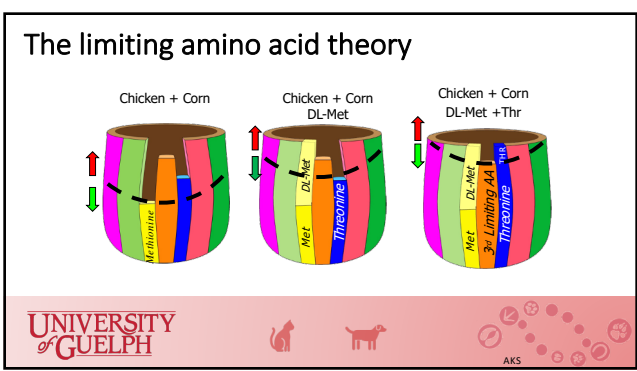
% of ingredient on an as fed basis.



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Protein quality

Protein quality is dependent upon:

1. Protein content
2. Amino acid composition
3. **Protein digestibility and amino acid availability**
compared to the requirements of the species of interest.

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Protein digestibility and bioavailability?

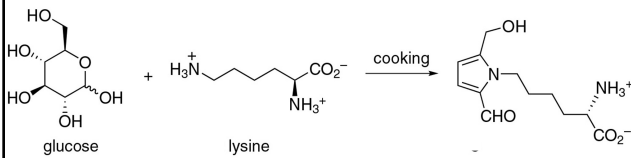
- Although an ingredient may have sufficient total (crude) protein and a good amino acid profile to support whole body protein turnover, the use of protein from that ingredient may also be limited by:
 - Digestibility
 - Metabolic availability
 - Competitive inhibition



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Factors that can affect protein quality

- Bioavailability



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Digestibility of current ingredients in pet food

- Animal proteins are not necessarily superior to plant proteins
- Processing affects bioavailability of ingredients differently
- We need to consider more than the digestibility of protein and ratio of amino acids, but *secondary outcomes*
- While other animal nutrition sectors have values for ingredient digestibility that are additive, we do not have the same in pet.

We need to understand how ingredients interact and what the bioavailability of the final product is.




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Study	Animals	Diet approach	Outcome	> 14 weeks NRC (MR)	Adult maintenance AAFCO (min)
Methionine and cysteine				2.1 g/kg for both Met and Cys	3.3 g/kg Met and 3.2 g/kg Cys
Lysine	Puppies and/or growing dogs	Titration with synthetic or semi-synthetic diets	Weight gain or nitrogen retention	5.6 g/kg	6.3 g/kg
Isoleucine	= OVER	= UNDER	= UNDER	4.0 g/kg	3.9 g/kg
Leucine				6.5 g/kg	6.8 g/kg

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Which life stage? Which life style? Which breed?



Begging the question: Who do we target? What do we need to know to make good decisions?

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Minimum methionine requirements

Hypothesis: Met requirements will differ among small, medium and large breed dogs and be greater than current estimates of the requirement



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Study	Animals	Diet approach	Outcome	> 14 weeks NRC (MR)	Adult maintenance AAFCO (min)
Methionine and cysteine	1. Immature Beagles	Simple titration	Weight gain: 2.1 g/kg Met and 3.5 g/kg Cys	2.1 g/kg for both Met and Cys = 4.2 g/kg TSAA	3.3 g/kg Met and 3.2 g/kg Cys = 6.5 g/kg
	2. Immature Beagles		Weight gain: 2.0 g/kg Met and 1.9 Cys		
	3. English pointer puppies		Weight gain: 2.3 g/kg Met and 2.2 Cys		

No studies to examine whether requirements differ due to:

- Breed differences in sulfur amino acid metabolism
- Interaction among nutrients, most importantly how different ratios of SAA and amounts of cofactors may alter Met and Cys requirements or how they alter taurine synthesis
- Emerging data on how dietary fibre may alter SAA requirements and secondary metabolites



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Minimum methionine requirements (Manuella et al. 2020)

	AAFCO		FEDIAF (110 kcal/kg ^{0.75})		NRC		Miniature Dachshunds		Beagles		Labrador Retrievers		Beagles and Labradors (pooled data)	
	MR	RA	MR	RA	MR	CL	MR	CL	MR	CL	MR	CL	MR	CL
g/100 g DM	0.33	0.40	0.26	0.33	[0.21-0.26]	0.304	0.338	0.458	0.360	0.517	0.360	0.482		
g/Mcal ME	0.83	1.00	0.65	0.83	[0.57-0.70]	0.822	0.914	1.238	0.973	1.397	0.973	1.303		
mg/kg BW					[33.7-45.0]	51.6	57.5	77.9	50.4	72.4	56.0	75.8		
mg/kg BW^{0.75}			85	110	--	--	107.7	147.8	121.8	159.6	118.4	150.5		
g/Mcal ME										0.787				

Harrison et al. 2020






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Minimum methionine requirements (Mansilla et al. 2020)

TAKE HOME:

- Beagles and Labrador retrievers have greater SAA requirements than Miniature Dachshunds
- The SAA requirement may be greater than recommendations from AAFCO and FEDIAF, but the total SAA requirement needs to be measured
- Greater diet consumption may reduce the SAA requirement

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Amino acid requirements (g/100g DM) are likely greater than AAFCO minimum requirements

	AAFCO/NRC RA	Small	Medium	Large
Phenylalanine <small>(Mansilla et al. 2018 JAS)</small>	0.44/ 0.45	0.39	0.40	0.50 ↑
Tryptophan <small>(Tomlinson et al. 2019 JAS)</small>	0.16/0.14	0.18 ↑	0.26 ↑	0.20 ↑
Threonine <small>(Mansilla et al. 2020 JAS)</small>	0.48/0.43	--	0.60 ↑	0.57 ↑
Lysine <small>(Sutherland et al. 2020, TAS)</small>	0.63/0.35	--	0.58 ↑	
Methionine <small>(Mansilla et al. 2020, JAS)</small>	0.33/0.33	0.34	0.50 ↑	0.57 ↑

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We need multiple approaches and outcomes when considering AA



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Plasma SAA concentrations (Morris et al. 2003)




AA, µM	Breed	Dietary Met, % (n=4)								SEM ¹	Breed	Met	Interaction
		0.21	0.26	0.31	0.36	0.41	0.46	0.66	0.66				
Cystine	Dachshunds	84.6	67.6	93.1	49.0	66.2	23.3	45.7	34.0	0.276	0.511	0.794	
	Beagles	46.1	43.2	41.7	34.5	42.4	44.2	36.2	6.9				
	Labradors	45.4	52.4	33.5	39.5	29.8	33.0	40.2	7.1				
Methionine	Dachshunds	26.1	23.1	34.7	43.9	52.4 ¹	63.4 ¹	63.2 ¹	7.0	<0.001	0.016	0.125	
	Beagles	141.0	220.6	199.3	238.5	304.3	222.8	344.9 ¹	51.0				
	Labradors	280.6	285.0	147.6	224.8	194.1	252.2	347.6	41.0				
Taurine	Dachshunds	266.1	227.0	195.6	238.5	226.0	217.6	208.7	25.5	<0.001	0.243	0.882	
	Beagles	175.9	159.4	141.4	176.6	184.5	192.2	177.1	24.0				
	Labradors	133.8	131.3	110.1	126.9	119.3	116.2	127.4	12.8				

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Plasma SAA concentrations (Morris et al. 2003)

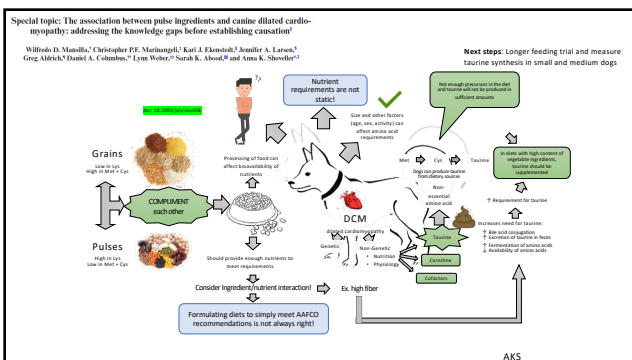


TAKE HOME:

- Despite being fed the EXACT same diets at similar intakes, fed state plasma amino acid concentrations of methionine and taurine differed significantly among breeds and did not differ among dietary treatments
 - Note: This was a short-term diet acclimation and may not have been sufficient to upregulate taurine synthesis
- Labrador retrievers have significantly greater methionine concentrations and lower taurine concentrations compared with Beagles and Miniature Dachshunds, suggesting fundamental differences in SAA metabolism among breeds

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The effects of supplemental taurine, methionine and methyl compounds on SAA metabolism

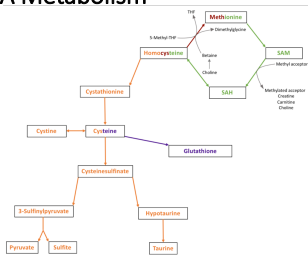
(Under review at JAS)

Consideration: Dietary supplementation of taurine, methionine or methyl compounds will alter SAA metabolism



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SAA Metabolism



Products of transmethylation:

1. Creatine
2. Phosphatidylcholine
3. Carnitine

Methyl Donors:

1. Choline (via betaine)
2. 5-Methyl-THF (circulating form of folate)



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Background

- Taurine plays a major role in contractibility of cardiac tissue and maintaining osmotic conditions in the heart (Galler et al., 1990, Rasmussen et al., 1993, Thurston et al., 1983)
- Taurine deficiency linked to DCM more prevalent in large breed dogs, possibly due to lower taurine biosynthesis rate (Backus et al., 2006, Ko et al., 2007)
- When fed a methionine restricted diet, supplementation of methyl donors folate, choline and betaine provided 8% more methionine in piglets (Robinson et al., 2018)
- Hyperhomocysteinemia has been correlated with heart disease in dogs (Lee et al., 2017)



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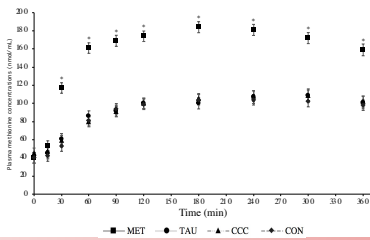
Study Design

- 8 Beagles, pair-housed
- 4x4 Latin Square design
- Three treatments and a control:
 1. Control (CON)
 2. Methionine (MET)
 3. Taurine (TAU)
 4. Creatine, carnitine and choline (CCC)
- Each period lasting 7 days
- Measured plasma amino acids at 0, 15, 30, 60, 90, 120, 180, 240, 300 and 360 minutes after a meal



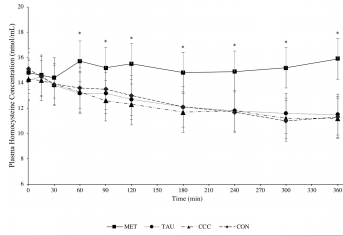
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Results – Plasma Methionine




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Results – Plasma Homocysteine






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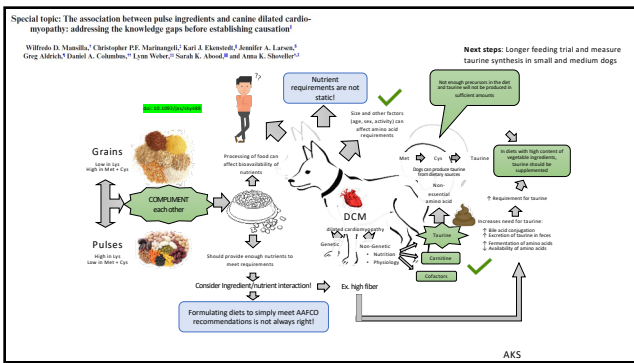
Results – Plasma Taurine 

Summary:

Methionine is equally as effective as a combination of L-carnitine, choline and creatine at supporting taurine status, but only taurine improved taurine concentrations over control. The methyl compounds likely spare the use of methionine for methylation and allow methionine to enter the transsulfuration pathway while keeping homocysteine concentrations the same.

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Grains on the brain: A survey of dog owner purchasing habits related to grain-free dry dog foods

(DOI: <https://doi.org/10.1371/journal.pone.0250806>)

Objective: To identify the factors that are predictive of a dog owner's choice of a grain-free dog food across Canada, USA, France, Germany and the UK

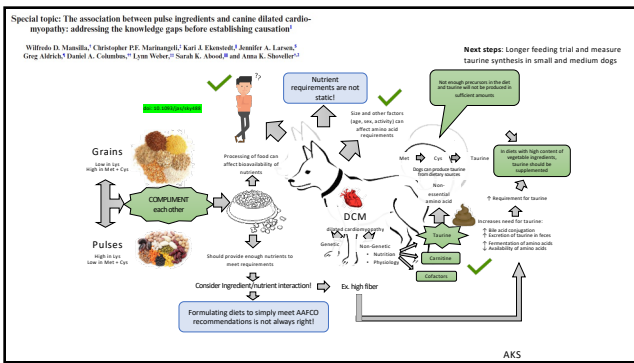
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People who look for dog food with no grain are more likely to...

- Be female
- Believe their dog has an allergy
- Follow 5 or more of their own dietary regimens
- Not include grains in their own diet
- Look for more protein options in pet food, no fillers, no by-products
- Give more other foods on a daily basis
- Rank ingredients as more important
- Static feed (not rotate their dog's kibble)
- Get their information about pet food from pet store staff and online and purchase their pet food from pet specialty stores, vet clinics and online




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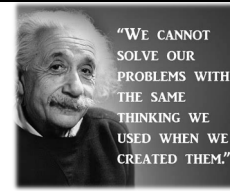


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"If I had an hour to solve a problem, I would spend 55 minutes thinking about the problem and 5 minutes thinking about solutions."
Albert Einstein



"WE CANNOT SOLVE OUR PROBLEMS WITH THE SAME THINKING WE USED WHEN WE CREATED THEM."



Fall in love with the problem, not the solution.
Don White



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