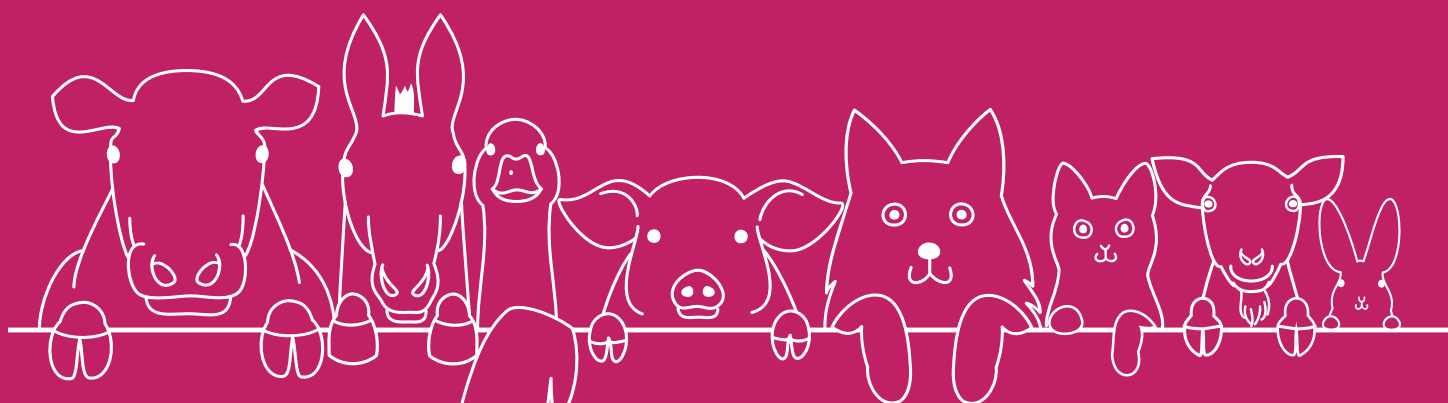


GANs Program

UNIVERSITY OF GUELPH
AUGUST 2020

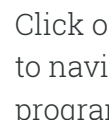
**WHAT DOES THE
FUTURE HOLD FOR
FEEDING ANIMALS?**



GLOBAL ANIMAL NUTRITION SUMMIT

AUGUST 11-15, 2020

UNIVERSITY
of GUELPH



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to navigate the symposium
program book.

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GLOBAL ANIMAL NUTRITION SUMMIT:

From the Chair,

GENESIS – joint conference

The idea for the Global Animal Nutrition Summit was born four years ago when Diplomates of the American College of Veterinary Nutrition and the European College of Veterinary and Comparative Nutrition discussed opportunities to collaborate. A joint conference was on the top of the list. As a member of ECVCN, working at a North American University considered the top food university of Canada, I thought the University of Guelph would be the ideal location. I pitched the idea to Dr. Anna Kate Shoveller, my colleague at the Ontario Agricultural College, who was crazy enough to jump on this train and make this event even bigger, not only including veterinary nutritionists but also animal nutritionists and comparative nutritionists. This is truly a unique conference with the support of nine global animal nutrition organizations!

IMPORTANCE – building bridges

With our sights set on greater future collaborations as a goal, we wanted to build bridges in and across the animal nutrition world. This venue increases visibility of global animal nutrition research by dissemination of research findings to the global scientific animal nutrition community. It also opens opportunities for global networking and collaboration between animal, comparative and veterinary nutritionists in academia, industry, government and veterinary practice. Additionally, our Fuelling Wellness Symposium also helps build bridges with veterinary teams, para-professionals and pet and horse enthusiasts by providing evidence-based nutrition knowledge and a nutrition tool kit to help keep pets and horses healthy.

ORGANIZATION – switch to virtual

We were all set to welcome delegates to the University of Guelph; we had an excellent scientific program and many social events planned to allow delegates to network and discover the beauty of Ontario...and then COVID-19 happened! Switching to a virtual event has been a huge undertaking. This was completely new territory for the organizing committee. We quickly moved out of our comfort zone and at times had little idea what we were doing. Happily, we are proud of what we have achieved in the face of so much change and uncertainty. We are confident that this summit will be one of a kind and look forward to the far-reaching impacts that will stem from the connections made and the dissemination of great research.

TAKE AWAY – passion for animal nutrition

I hope that this summit will make animal nutrition scientists and professionals, graduate students, veterinary teams and other pet and horse enthusiast even more passionate about nutrition. As good nutrition is of the utmost importance to improve life and create healthier futures for animals, people and the environment.

Sincerely,



Dr. Adronie Verbrugghe
Chair of the GANS Organizing Committee

ORGANIZING COMMITTEE



Adronie Verbrugghe, DVM, PhD, DECVCN
Associate Professor
Department of Clinical Studies
Ontario Veterinary College
University of Guelph



Anna Kate Shoveller, PhD
Associate Professor
Department of Animal Biosciences
Ontario Agricultural College
University of Guelph



Sarah K. Abood, DVM, PhD
Assistant Professor
Department of Clinical Studies
Ontario Veterinary College
University of Guelph

Dr. Adronie Verbrugghe graduated as a companion animal veterinarian (DVM) from Ghent University, Belgium in 2005. She completed her PhD focusing with nutritional modulation of carbohydrate metabolism in cats in 2009 and stayed at the same university for two additional years as a postdoctoral fellow. She became board certified for the European College of Veterinary and Comparative Nutrition in 2010. In 2011, Dr. Verbrugghe joined the Ontario Veterinary College (OVC), University of Guelph, as Royal Canin Veterinary Diets Endowed Chair in Canine and Feline Clinical Nutrition. Her research interests include companion animal nutrition, the link between nutrition, gut microbiota, health and disease, alteration of metabolic pathways through nutrition and nutritional modulation of inflammation and immunity.

Dr. Anna Kate Shoveller received her PhD in Nutrition and Metabolism at the University of Alberta in 2004 and is currently an Associate Professor in the Department of Animal Biosciences, University of Guelph. From 2007-2015 she was employed by Procter & Gamble and Mars Pet Care where she added to the knowledge of dog and cat nutrition through investigation in the areas of energy metabolism and nutrient budgets of dogs and cats using indirect calorimetry and applying the indicator amino acid oxidation technique and indirect calorimetry to quantify amino acids requirements in adult dogs. Additionally, Shoveller ladder nutrition to owner noticeable behaviour and often factors behaviour and quality of life into her nutrition and physiology based studies. Shoveller took her industrial experience and returned to academia where she now teaches companion animal and equine nutrition and runs an active comparative nutrition research group primarily focused on amino acid metabolism, protein quality, and macronutrient partitioning in dogs, cats, horses, and pigs. The global focus for the Shoveller lab is optimizing nutrition across mammalian species for health and longevity without compromising the future of our food chain.

Following her veterinary training, Dr. Sarah Abood completed a one-year internship in large animal medicine and surgery at the University of Minnesota. Under the guidance of Dr. Tony Buffington at The Ohio State University, she completed a clinical nutrition residency and PhD. From 1994 to 1999 Dr. Abood worked as a nutrition scientist at the Ralston Purina Company, followed by a sixteen year stint at Michigan State University as Assistant Dean for Student Programs and the small animal clinical nutritionist. In June 2018, Dr. Abood joined the Clinical Studies Department at the University of Guelph where her focus is providing nutrition consultations for in-hospital patients, teaching nutrition to veterinary students, and collaborating on nutrition projects with faculty and graduate students. Dr. Abood's research interests include nutrition support of hospitalized patients, obesity prevention and management, communication skill building, client adherence, alternative diets, veterinary ethics and welfare issues, and business skills and professional development.



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¹Wernimont, S.M., et al. Food with Specialized Dietary Fiber Sources Improves Clinical Outcomes in Adult Cats with Constipation or Diarrhea (in a 2 Month Study). *FASEB J.* 2020;34(1). Some cats may require multimodal management. ²Fritsch, D.A., et al. Food with Novel Fiber Blend improves Clinical Outcomes and Changes Gastrointestinal Microbiome Metabolism in Dogs (in a 2 Month Study). *J Vet Intern Med.* 2019; 33(5):2513. The Hill's Transforming Lives logo, the Hill's Prescription Diet logo, the ActivBiome+ logo, the S+OX SHIELD logo, Hill's, Prescription Diet, and Gastrointestinal Biome are trademarks of Hill's Pet Nutrition Canada, Inc.



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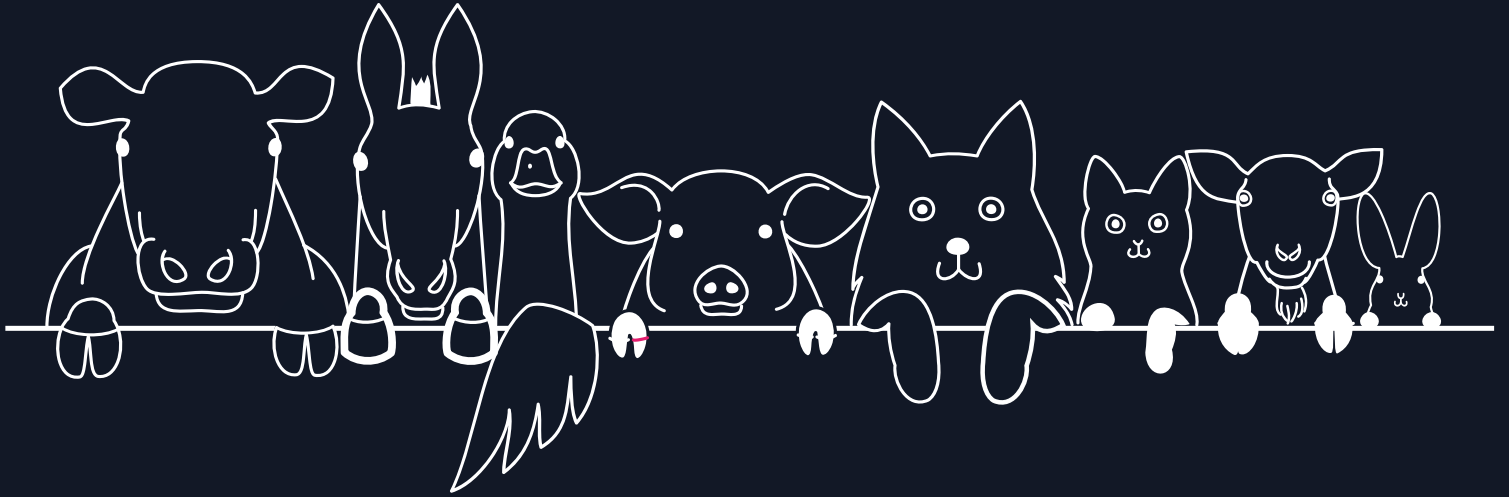
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Sarah Abood (AAVN/CAVN – Canada)
Kara Burns (AVNT – USA)
Aulus Carciofi (ESVCN – Brazil)
Martha Cline (AAVN – USA)
Ellen Dierenfeld (CNS – USA)
George Fahey (ASAS – USA)
Maria Grazia Cappai (ESVCN – Italy)
Jessica Harris (AAVN – USA)
Myriam Hesta (ECVCN – Belgium)
Geert Janssens (ESVCN – Belgium)
Kate Kerr (CNS/ASAS – USA)
Dottie Laflamme (ACVN – USA)
Jackie Parr (ACVN/CAVN – Canada)
Kate Shoveller (ASAS/CSAS – Canada)
Emmanuella Valle (ECVCN – Italy)
Adronie Verbrugghe (ESVCN/ECVCN/CAVN – Canada)

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GOALS OF THE GLOBAL ANIMAL NUTRITION SUMMIT

1

Create a global venue for veterinary & animal nutritionists to share animal nutrition research and discuss common animal nutrition interests.

2

Provide networking opportunities between key opinion leaders in the animal nutrition field.

3

Increase visibility of the animal nutrition organizations among the public by providing a source of data driven nutrition information on animal nutrition to veterinary health care teams and veterinary paraprofessionals.

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GLOBAL ANIMAL NUTRITION SUMMIT

GANS PROGRAM

Please Note: All session times for the GANS Virtual Meeting are Eastern Standard Time (EST).

WED. AUG. 12, 2020

8:30-9:00am

Welcome

Adronie Verbrugghe, University of Guelph, Canada

Session sponsored by



Session moderator

Anna Kate Shoveller, University of Guelph, Canada

9:00-10:00am

The future of protein: Pandemics, the revolution, and beyond.

Evan Fraser, University of Guelph, Canada

Session moderator

Cara Cargo-Froom, University of Guelph, Canada

10:00-10:05am

Poster award

NOVEL INGREDIENT & FOOD FORMULATION

10:05-10:15am

Break

10:15-10:45am

Plant based pet food.

Dodd et al., University of Guelph, Canada

10:45-11:15am

Nutritional quality of hay for horses: we need to know for the future

Hottat et al., Ghent University, Belgium

11:15-11:25am

Break

11:25-11:30am

Poster award

NOVEL INGREDIENT & FOOD FORMULATION

11:30-12:00pm

Camelina - An emerging sustainable high-omega oil.

Grushcow et al., Smart Earth Camelina Co., University of Saskatchewan, Canada

12:00-12:05pm

Closing

Adronie Verbrugghe, University of Guelph, Canada

12:05-12:10pm

Break

MORNING

THURS. AUG. 13, 2020

FRIDAY AUG. 14, 2020

Welcome

Adronie Verbrugghe, University of Guelph, Canada

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Welcome

Adronie Verbrugghe, University of Guelph, Canada

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Transforming Lives™

Anna Kate Shoveller, University of Guelph, Canada

A global outlook on protein food consumption.

Benjamin Bohrer, University of Guelph, Canada

Anna Kate Shoveller, University of Guelph, Canada

Glycemic Index, Glycemic Load, Glycemic Response, the Relevance for Obesity and Co-Morbidities.

Thomas Wolever, University of Toronto, Canada

James Templeman, University of Guelph, Canada

Poster sessions and awards sponsored by



Pet Food

Poster award

**NUTRIENT AVAILABILITY & EFFECTS ON
METABOLISM & HEALTH**

Julia Guazzelli Pezzali, University of Guelph, Canada

Poster award

GUT PHYSIOLOGY & HEALTH

Break

The effects of common processing parameters on pulse ingredients and protein quality.

Cargo-Froom et al., University of Guelph, Canada

Break

Why it can be beneficial to limit the oral intake of phosphates.

Dobenecker, Ludwig-Maximilians-Universität Munich, Germany

Protein quality of yeast biomass in diets for livestock and companion animals: A review of current knowledge.

Dainton et al., Kansas State University, USA

Home-prepared diets and other alternatives; Are they a good option?

Wilson, Stockton, USA

Break

Poster sessions and awards sponsored by



Pet Food

Poster award

**NUTRIENT AVAILABILITY & EFFECTS ON
METABOLISM & HEALTH**

Break

Poster award

GUT PHYSIOLOGY & HEALTH

Macronutrients ratio and nutraceuticals supplementation in working dog nutrition.

Brozic et al., Ghent University, Belgium

Feeding pets, or feeding the microbiota? Prospect of microbiota in dogs and cats.

Lyu et al., Ghent University, Belgium

Closing

Adronie Verbrugghe, University of Guelph, Canada

Break

Closing

Adronie Verbrugghe, University of Guelph, Canada

Break



GLOBAL ANIMAL NUTRITION SUMMIT

GANS PROGRAM

Please Note: All session times for the GANS Virtual Meeting are Eastern Standard Time (EST).

WED. AUG. 12, 2020

12:15-13:15pm

13:25-13:30pm

Welcome Back

Adronie Verbrugghe, University of Guelph, Canada

Session sponsored by



Session moderator

Sarah Abood, University of Guelph, Canada

13:30-14:30pm

Uses, Abuses, Artifacts, and Just Working Properly With Feed Analysis

Dr. Mary Beth Hall, USDA, USA

Session moderator

Sarah Dodd, University of Guelph, Canada

14:30-14:35pm

Poster award

NEW METHODOLOGY

14:35-14:45pm

Break

14:45-15:15pm

A comparative review of tryptophan metabolism and its effects on agonistic behaviours.

Henry et al., University of Guelph, Canada

15:15-15:45pm

The neutral detergent fiber method gives high values that are unexplained by the ingredient list in some commercial cat diets.

Roe et al., University of Florida, USA

15:45-15:55pm

Break

15:55-16:00pm

Poster award

NEW METHODOLOGY

16:00-16:30pm

Dietary 25-hydroxyvitamin D: a Novel and Effective Means to Provide Vitamin D to Dogs.

Backus et al., University of Missouri, USA

16:30-16:45pm

Closing

Adronie Verbrugghe, University of Guelph, Canada

AFTERNOON

THURS. AUG. 13, 2020

FRIDAY AUG. 14, 2020



Transforming Lives™

Driving microbiome nutritional technologies into new spaces: implications for pet health apart from the gut.

Jennifer Radosevich, Hill's Pet Nutrition, USA

Welcome Back

Adronie Verbrugghe, University of Guelph, Canada

Session sponsored by



Advancing Science for Pet Health

No afternoon program

Sarah Abood, University of Guelph, Canada

Tackling Obesity, a Sustainable Future.

Dr. Angelo Tremblay, Laval University, Canada

Caitlin Grant, University of Guelph, Canada

Poster sessions and awards sponsored by



Poster award

OBESITY & ENERGY BALANCE

Break

The lipotropic effects of dietary choline and its potential in companion animal nutrition.

Rankovic et al., University of Guelph, Canada

Omega 3 fatty acids and obese cats – What is the current knowledge?

Baptista-Silva, Hesta, Ghent University, Belgium

Break

Poster sessions and awards sponsored by



Poster award

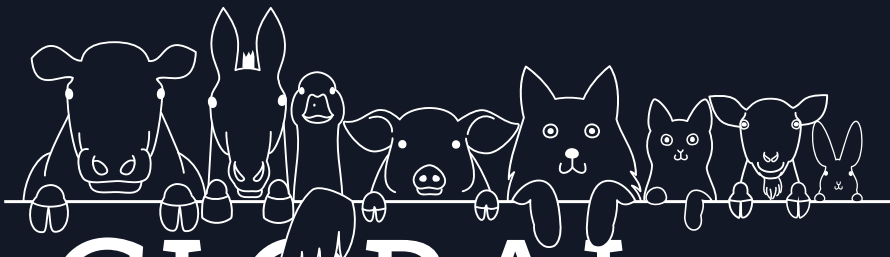
OBESITY & ENERGY BALANCE

Equivalent plasma enrichment between dietary algae-based long chain omega-3 fatty acids and marine fisheries based fish oil in dogs and cats.

Bauer et al., Texas A&M, USA

Mini-review Awards and Closing

Adronie Verbrugghe, University of Guelph, Canada



GLOBAL ANIMAL NUTRITION SUMMIT

KEYNOTE SPEAKERS

**WHAT DOES THE
FUTURE HOLD FOR
FEEDING ANIMALS?**



Evan Fraser, PhD

Director, Arrell Food Institute
Professor and Tier 1 Canada Research
Chair in Global Food Security
Department of Geography, Environment
and Geomatics, College of Social
and Applied Human Sciences,
University of Guelph
Guelph, ON, Canada
frasere@uoguelph.ca

Talk Title: “The Future of Protein: Pandemics, the Digital Revolution, and Beyond”

The global SARS COVID 2 pandemic has exposed both the strengths and weaknesses in our food systems and these will affect how we feed agricultural animals, pets, and ourselves in the coming years. Dr. Evan Fraser will discuss the societal implications of changing national and global food systems and how a pandemic has accelerated innovation for a more sustainable and health-focused approach.

Speaker Bio

Dr. Fraser, Director of the Arrell Food Institute at the University of Guelph, started thinking about agriculture and food systems while spending summers working on his grandfather's fruit farm in Niagara. Today, he holds the Tier 1 Canada Research Chair in Global Food Security, is a Fellow of the Royal Canadian Geographic Society, and a professor of geography at the University of Guelph. Fraser did degrees in forestry, anthropology and agriculture at the University of British Columbia and the University of Toronto. He began his academic career in 2003, at the University of Leeds, where he worked on farming and climate change. He is the author of approximately 70 scientific papers or book chapters, and has written for The Guardian, CNN, The Walrus and Ottawa Citizen. Fraser also authored Empires of Food: Feast, Famine and the Rise and Fall of Civilizations(2010), which was shortlisted for the James Beard Food Literature Award.



Talk Title: “Uses, Abuses, Artifacts, and Just Wrong: Working Properly With Feed Analyses”

Whether formulating diets, making claims on feed composition, or in our research, nutrition work relies on analyses of foods and feeds. One of the challenges we face is deciding whether analytical values we receive are right. Values can be wrong, and it can affect the validity and legality of what we do. For our clients, it can affect the healthfulness of diets we recommend. And does an assay measure what we think it does in different feeds? (Not always.) In this session we will cover the ins and outs of sleuthing feed analysis values, understanding their variability and what they actually measure, and focus on how to apply them soundly.

Speaker Bio

Dr. Hall is a research scientist working in dairy cattle nutrition for the USDA-Agricultural Research Service at the U.S. Dairy Forage Research Center in Madison, WI, USA. Her degrees in Animal Science are from Cornell University and Virginia Tech. Dr. Hall’s research focuses on the non-fiber carbohydrates in dairy cattle diets: their chemical analysis for diet formulation, as well as their digestion and use by dairy cattle and rumen microbes. She currently serves on the U.S. National Research Council committee that is revising the Nutrient Requirements of Dairy Cattle. She lives in Wisconsin with her husband and a varied pack of rescued dogs, which was shortlisted for the James Beard Food Literature Award.

Mary-Beth Hall, PhD

Research Animal Scientist
USDA-ARS, Madison, WI, USA
marybeth.hall@usda.gov



GLOBAL ANIMAL NUTRITION SUMMIT

KEYNOTE SPEAKERS



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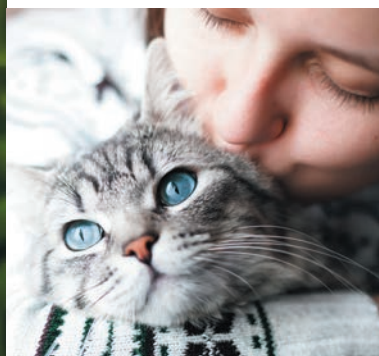
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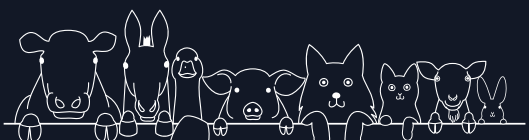
Assistant Professor
Department of Food Science,
Ontario Agricultural College
University of Guelph
Guelph, ON, Canada
bbohrer@uoguelph.ca

Talk Title: “A Global Outlook of Protein Food Consumption”

Animal derived food products are nutritionally dense in dietary protein, vitamins, and minerals. Consumption of these nutrients, especially indispensable amino acids, is important in the human diet for proper growth/development and to help the body repair/regenerate cells. In developed regions of the world, there has been a lost appreciation for the nutritional value of animal derived food products like meat, milk, and eggs. Statistically, this lost appreciation has led to an increase in the population of people who choose to consume plant-based foods as their primary source of protein. This presentation will focus on nutritional density and nutritional value of protein foods, while also providing an outlook on protein food consumption for the future.

Speaker Bio

Dr. Boher is an assistant professor of meat science at the University of Guelph in the Department of Food Science. He began his appointment at the University of Guelph in 2016 following the completion of his graduate education from the University of Illinois at Urbana-Champaign. Ben’s research focuses on several aspects of the meat science and technology spectrum including live animal growth and development, fresh meat evaluation and fabrication, manufacture and evaluation of further processed meat products, nutrient density and nutritional quality of protein foods, and evaluation of non-meat protein foods.



**GLOBAL
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SUMMIT**

**KEYNOTE
SPEAKERS**

Talk Title: “Glycemic Index, Glycemic Load, Glycemic Response – the Relevance for Obesity and Co-Morbidities”

What are the best types of dietary carbohydrate for preventing or treating obesity and its major co-morbidity, type 2 diabetes (T2D)? A major current focus is the WHO recommendation to reduce the intake of added sugars from all foods to <10% energy (50g/day); however, this could be harmful since not all foods containing added sugars are equal. Glycemic index (GI) is a measure of the extent to which carbohydrate foods to raise blood glucose. In Canada, foods can be advertised as having a low glycemic response (GR), but does not allow low-GI claims. I will review the evidence for the role of GI and glycemic load (GL) in the prevention and treatment of obesity and diabetes, discuss the difference between GR, GL and GI and debunk common criticisms of GI.

Speaker Bio

Dr. Wolever obtained a Bachelor of Medicine and Bachelor of Surgery from Oxford University, UK in 1980, a PhD in Nutritional Sciences from the University of Toronto in 1986 and a Doctorate in Medicine from Oxford University in 1993. He is currently a Professor in the Department of Nutritional Sciences, University of Toronto with cross appointments as Professor, Department of Medicine, University of Toronto and Member of Active Medical Staff, Division of Endocrinology and Metabolism, St. Michael's Hospital, Toronto.

Dr. Wolever's research interests are on the effects of dietary carbohydrates on human physiology and metabolism. He is most well known for work on the glycaemic index developed with Dr. David Jenkins and other collaborators. Dr. Wolever has written or co-authored over 340 papers in peer-reviewed scientific journals, and also authored a book entitled: The Glycaemic Index: A Physiological Classification of Dietary Carbohydrate published in 2006 by CABI (www.cabi.org). In 1997 Dr. Wolever founded GI Testing, Inc. to provide confidential GI testing services to industry. To cope with the high demand for GI testing and to enable a wider range of clinical research services to be provided, Glycemic Index Laboratories, Inc. was formed in 2004 and renamed INQUIS Clinical Research Ltd., in 2019 (www.inquis.com); a corporation of which he is President and Medical Director. Dr. Wolever is most proud of his marriage and 3 children aged 31, 29 and 22 years and enjoys orienteering, cycling and recorder playing.



Thomas Wolever, DM, PhD

Professor Emeritus
Department of Nutritional Sciences
Faculty of Medicine,
University of Toronto
Toronto, ON, Canada
thomas.wolever@utoronto.ca



GLOBAL ANIMAL NUTRITION SUMMIT

KEYNOTE SPEAKERS

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Angelo Tremblay, PhD

Professor

Department of Kinesiology
Laval University, QC, Canada
angelo.tremblay@kin.ulaval.ca



GLOBAL ANIMAL NUTRITION SUMMIT

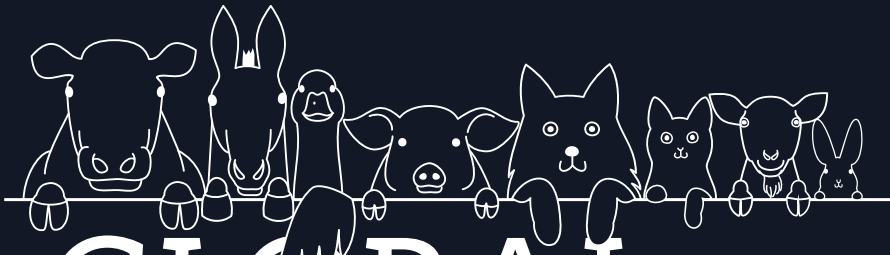
KEYNOTE SPEAKERS

Talk Title: “Tackling Obesity – A Sustainable Future”

Inactive animals fed a palatable high-fat/high energy dense diet are at high risk to accumulate excess body fat. Dogs benefit from walking/jogging and can help their master to adhere to an active lifestyle. However, chemical pollutants are still detected in animal food and may favor body fat gain. With this in mind, targeting the gut microbiota with pre- and/or probiotic supplementation may improve brain function and promote body detoxification.

Speaker Bio

Professor Angelo Tremblay obtained his PhD in Physiology in Laval University, Quebec City, and is currently a professor in the Department of Kinesiology in this university. His investigations are mostly oriented towards the study of factors influencing energy balance in humans with the intent to improve obesity management. Recently, his research has been focused on the study of non-traditional determinants of obesity such as short sleep duration, low calcium/dairy intake, insufficient vitamin intake, suboptimal feeding behaviors, demanding cognitive effort and persistent organic pollutants. He is holder of the Canada Research Chair in Environment and Energy Balance.



GLOBAL ANIMAL NUTRITION SUMMIT

DIAMOND SPONSOR TALK

Talk Title: “Driving microbiome nutritional technologies into new spaces: implications for pet health apart from the gut”

We are beginning to understand how nutrition can influence a pet's microbiome to impact pet health. Interestingly, the nutrition provided for the gut microbiome affects more than just gut health. This presentation will show that nutritional technologies which work through the gut microbiome can also improve biological markers of both kidney and brain health.



Jennifer Radosevich, PhD

Worldwide Director of Research
Hill's Pet Nutrition
jennifer_radosevich@hillspet.com

Speaker Bio

Dr. Jennifer Radosevich is Worldwide Director of Research at Hill's Pet Nutrition where she is responsible for leading the early research team to develop and accelerate new technologies for Hill's products. She oversees the Nutrition Innovation, Bioinformatics and Research Laboratories teams to further research platforms including nutrigenetics, nutrigenomics, metabolomics, and microbiomics. She completed her PhD in Biochemistry/ Molecular Cellular and Developmental Biology at Iowa State University. She has over 25 years industry experience leveraging innovation to further business goals in the agribusiness, human and pet food markets.

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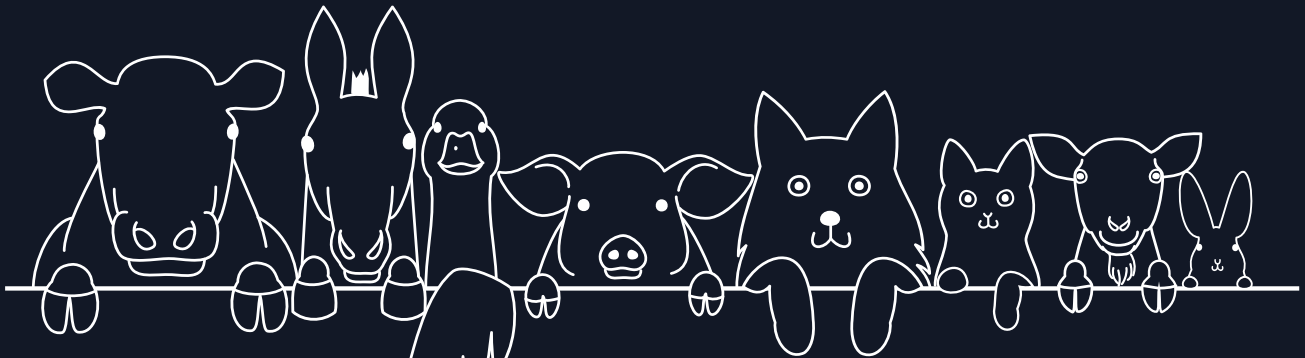


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MINI
REVIEWS

Plant-based pet food

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The concept of feeding plant-based diets to carnivorous pet dogs and cats is relatively novel and presents a polarizing topic among veterinarians and animal nutritionists. A small but potentially growing proportion of pet keepers feed their companions a strictly plant-based diet. Around 10% of dogs and 3% of cats receive plant-based food as part of their diet, with 2% of dogs and 1% of cats eating a strictly plant-based diet. Only vegan pet owners reported feeding a strictly plant-based diet to their pet, with about 25% currently doing so. Veganism is over-represented in the pet owning population than in the general population, particularly in younger demographics, suggesting that this trend appears likely to increase. This mini-review will discuss the motivations of pet owners to feed a plant-based diet, nutritional risks, and the reported effects on cat and dog health.

Though vegans consume a strictly plant-based diet, veganism, as opposed to vegetarianism, is more of a creed or life philosophy as opposed to a diet choice. As such, vegans have been shown to differ significantly from both omnivores (ie: conventional Western diet including animal products such as meat, dairy, eggs and/or honey) and from vegetarians in their motives as well as their actions. Their motivations for their pet feeding practices are more strongly rooted in concern for the rights of farm animals as well as their welfare, leading a greater proportion of vegans to adopt a plant-based diet for their pets. Amongst pet owners who did not feed a plant-based diet, great interest in doing so was reported by vegans and even by a quarter of omnivores, supporting the hypothesis that plant-based feeding trends are likely to grow and that this niche of pet food may be increasing.

Presently, a limited number of plant-based diets for dogs and cats have been brought to market. Of the 26 plant-based pet foods commercially available in Canada, 18 are labelled for dogs, including 1 for puppies and 4 for all life stages; 5 are labelled for cats, including 1 for all life stages; and 3 are labelled for both dogs and cats, including 2 for all life stages. Of these diets, only 5 met the NRC recommended allowance for the intended species and life-stage. The most commonly insufficient nutrients were cholecalciferol, methionine+cystine (SAA), calcium, phosphorus, eicosapentaenoic acid and docosahexaenoic acid (EPA+DHA). Deficiencies of cholecalciferol, calcium and phosphorus are all associated with skeletal abnormalities, particularly in growing dogs. Sulfur amino acid deficiency is less specific, as SAA are ubiquitous in body proteins as well

as playing essential roles in 1-carbon metabolism and generation of antioxidants. Essentiality of EPA+DHA is recognized for normal neural development in growing puppies and kittens. During growth, nutrient requirements are greatest, as protein deposition and skeletal development demand particularly high intake. As such, dietary deficiencies manifest more quickly in growing rather than adult animals. However, little has been documented about the health effects of feeding plant-based diets to pets, with no case reports and few studies published.

Despite the risk of nutrient insufficiencies, owner perception of the health and wellbeing of animals maintained on plant-based diets does not appear to be impaired. Longevity was unaffected when comparing owner-reported lifespan of cats and dogs fed plant- or animal-based diets. Significantly more cats fed a plant-based diet (68%) were reported to be in ideal body condition as compared to those fed an animal-based diet (55%). Owners of cats fed plant-based diets reported fewer health conditions, and ranked their cat's health significantly higher, with 81% considering their cat to be in very good health, compared to 67% of the owners of cats fed meat-based. Unlike cats, for dogs body condition score and number of health disorders were unaffected by diet. Still, owners of dogs fed plant-based ranked their dog's health significantly higher, with 79% considering their dogs to be in very good health, compared to 69% of the owners of dogs fed meat-based. These findings suggest that owners of pets fed plant-based diets generally consider their pets to be in excellent health, and that no body system or disease condition is obviously affected by a lack of animal products in dog or cat diets, though further research using more objective methodology to confirm these findings is indicated.

Nutritional quality of hay for horses: what do we need to know for the future?

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Forages rich in dietary fibers constitute an essential part of the horse diet. Equines ferment structural fibers into energy-yielding short-chain fatty acids (SCFA) in the hindgut. To maintain a normal microbial function, an adult horse should receive at least 1,5% of body weight in dry matter (DM) of forages in his total diet.

Hay is a preserved forage with a minimum of 80% DM. However, there are a lot of different types and qualities of hay, which makes it difficult to design a diet

only based on hay that covers all nutrient requirements of the horse.

High quality hay is more nutrient and energy dense. Grass hay with a low crude fiber (CF) content (CF<280g/kg DM) contains higher energy concentration (7 Ewpa/kg DM). The energy requirement of a standardbred horse in training can be met with only an energy dense forage.

The concept of “nutritional quality” of hay depends on several factors. Plant maturity at harvest is one of the most important factors. Mature plants contain less energy, crude protein and minerals than younger hay at harvest. The type of plant also affects its nutritional quality. There are two main groups of hay: legumes and herbs. Legume hay is higher in proteins and in macrominerals than grass hay. The management of meadows or the storage condition can have an influence too.

In practice, owners not always assess hay quality properly. However, it can easily be estimated by visual, odor and texture examination. Visually, the roughage needs a high leaf and stem ratio and a small stem diameter. The presence of few seed heads or blooms are indicators of a more mature hay. Green hay is usually higher in energy, crude proteins and vitamins than a yellowish one. A fresh sweet smell is indicative of high quality hay. Harsh texture when being squeezed is a sign of poor quality.

Although, the macroscopic examination is a good way to estimate hay quality, nutrient content in hay can also be assessed by chemical analysis. It will give information about the fibrous portion of the plant such as neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL).

Not only nutrient content is important in hay but also nutrient availability. Therefore, digestibility of roughage can be assessed by in vitro or in vivo analysis. In vivo digestibility measurements are usually costly and time consuming. Therefore, research is more focused on in vitro digestibility measurements, traditionally used to simulate digestion by foregut fermenters.

Further studies on nutrient content and digestibility of hay like the Near Infrared Spectroscopy (NIRS) which is based on the absorption of light by samples to predict chemical composition of feed and feces samples, are needed. Sustainability needs to be considered for the future. Methane output and not easily digestible fiber concentration in the diet of a horse are positively correlated. Feeding better hay quality would be more sustainable. In the future, owners and veterinarians should be involved in activities to increase their abilities to perform hay examination.

Camelina – an emerging sustainable source of high-omega oil

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The companion animal nutrition sector is constantly searching for new ingredients that provide sustainable, healthy and traceable sources of fats and oils. Dietary fats and oils are vectors to provide dietary essential fatty acids and fat-soluble vitamins; however, oils vary greatly in their fatty acid composition. While fish oil is most commonly used to increase the omega-3 (n-3) content of animal diets, associated sustainability concerns warrant the exploration and development of alternative sources of n-3 fatty acids. Plant-derived alternatives currently used by feed manufacturers include canola and flax oil and the seed oil of the crucifer Camelina sativa (camelina) has great potential to replace and/or supplement these plant-derived oils. C sativa is an ancient oleaginous plant that yields oil with a fatty acid profile high in α -linolenic (n-3) acid and as such, when utilized in diets, can improve their n-6: n-3 fatty acid ratio, making the diets healthier.

Camelina is a highly sustainable low-input, high-omega crop. It can be grown profitably on land where other oilseeds perform poorly, utilizing less fertilizer and water resources compared to other oilseed crops.

Camelina has a unique seed oil composition with a high content of α -linolenic acid (20 to >35%), eicosenoic acid (11-19%) and tocopherols (Vitamin E), as well as a naturally low level of the undesirable fatty acid erucic acid (<4%), rendering camelina oil well-suited for a variety of food and feed applications. Thus, uses for camelina oil and meal include omega-3 supplements for human and companion animal nutrition, and applications in the livestock, poultry and aquaculture feed sectors. In addition, the recent CFIA-approval of camelina meal as a feed ingredient for broilers and layers and of camelina oil for fish presents an unprecedented opportunity for marketing camelina and its derived products both locally and domestically. In all trials increased levels of omega 3 and in the case of salmonids EPA and DHA levels are also increased. Anti-inflammatory effects are observed in horses and dogs where diets have been supplemented with camelina oil.

This talk will offer an update on the current status of the crop in Western Canada, review camelina-formulated products and describe innovations in production and agronomics.

A comparative review of tryptophan metabolism and its effects on agonistic behaviours

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Tryptophan (TRP) is a dietarily indispensable amino acid in mammals and avian species. In addition to its essential role in protein synthesis, TRP is the precursor of numerous secondary metabolic pathways. The predominant catabolic pathway in most tissues is the kynurenine (KYN) pathway where upwards of 95% of TRP is metabolized into KYN. The KYN pathway further contributes to the synthesis of other neuroactive metabolites such as kynurenic acid, quinolinic acid, and NAD/NADP (Triebwasser et al., 1976; Stone and Darlington, 2002; Richard et al., 2009; Fernstrom, 2013; Jenkins et al., 2016; Badawy, 2017). However, TRP is also the sole precursor of serotonin (5-hydroxytryptamine, 5-HT), a neurotransmitter involved in the control of numerous central and enteric nervous system functions including mood, aggression, anxiety, and addictive and motor behaviours (Sandyk, 1992). However, TRP competes with the large-neutral-amino-acids (LNAA) for access to blood brain barrier transporters, which have the potential to limit the amount of central 5-HT that can be synthesized (Fernstrom, 2013).

In agricultural species as well as in companion animals, TRP has been shown to influence anxiety, stress and aggression related behaviour (Reisner et al. 1996; Rouvinen et al. 1999; Koopmans et al. 2006; Kato et al. 2012; Birkl et al., 2019). Agonistic behaviour such as aggression in dogs, tail-biting in pigs and feather-pecking in laying hens, negatively impact the animal's performance (growth and egg production), health and welfare.

Agricultural environments can be challenging for laying hens and pigs, which are re-housed in large groups with unknown conspecifics multiple times during their lives. Similarly, working and performance dogs are constantly exposed to a multitude of factors, such as rigorous exercise regimens, changing environments, and diet shifts, which can negatively affect their physical and mental wellbeing. These stressful conditions represent major risk factors that have the potential to trigger aggression in dogs, tail biting in pigs, and feather pecking in laying hens (El-Lethey et al., 2000).

In an attempt to understand, alleviate or prevent these behaviours, nutritional interventions, such as supplementation of TRP in excess of its dietary

requirement or supplementation of specific bacteria able to modulate TRP to KYN catabolism, have been explored as a means to increase peripheral TRP and central 5-HT (Lucki, 1998; Gainetdinov et al. 1999; Van Hierden et al., 2004; Mohammad-Zadeh et al. 2008; O'Mahony et al., 2015).

Data indicates that optimization of dietary TRP to LNAA ratio for sled dogs improved serum TRP and 5-HT status while ultimately reducing the prevalence of threatening and negative social ('agonistic') behaviour. Conversely, it appears as though supplemental TRP had no effect on growth or the prevalence of aggressive or aberrant behaviour in grower pigs. Finally, specific bacteria supplementation increased the peripheral plasma TRP concentrations and the TRP to aromatic-amino-acids ratio in young laying hens; however, the analysis of behavioural data is still on-going.

Together, the data suggests that provision of dietary TRP has the potential to influence agonistic behaviour, although these effects may be species-specific and highly variable.

The neutral detergent fiber method gives very high values that are unexplained by the ingredient list in some commercial canned cat diets

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Neutral detergent fiber (NDF) and acid detergent fiber (ADF) methods used to measure fiber in herbivore diets are rarely used in carnivore diets. The aNDF method (DiaryOne, Cornell University) measures fiber as residue after sodium sulfite, amylase, detergent, EDTA, solvents and buffers remove starch, protein, minerals and pectin. In commercial carnivore diets. Nitrogen free extract (NFE), calculated by difference from crude protein, crude fat and ash, provides a measure of carbohydrate content, but does not distinguish digestible and indigestible carbohydrate. The crude fiber (CF) method is used to measure insoluble fiber for regulatory purposes.

Proximate analysis, aNDF, ADF and CF were measured (percent dry matter) in four batches of 16 diets: one dry and canned calcium oxalate prevention diet and one dry and canned adult maintenance diet, chosen randomly from those sold by four US manufacturers. Compared to dry diets, canned diets contained less CF (3±2 vs. 4±3%) and ADF (4±4 vs. 10±2%; p<0.0001). Even after fat extraction, aNDF was markedly

higher in canned diets from two manufacturers (26±14% and 28±11%) compared to canned diets from the other manufacturers (15±5% and 11±3%) and to dry diets from all four manufacturers (15±3%; $p < 0.0001$). High aNDF values were confirmed at UF. Crude protein within aNDF, calculated from the nitrogen content of aNDF residuals, was 13±2%, 6±2%, 5±3% and 2±2% in canned diets from each manufacturer. Even after subtracting residual crude protein and ash from aNDF, aNDF accounted for almost all NFE in high aNDF diets.

Ingredient lists did not include fiber sources that could explain high aNDF values, which suggests that processing affected carbohydrate and protein susceptibility to amylase and solvents. Digestibility of the aNDF fraction in cat diets needs further investigation to determine whether the aNDF method has practical utility in cat diets.

Dietary 25-hydroxyvitamin d: a novel, safe, and effective means to provide vitamin d to dogs

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Vitamin D may have functional roles in dogs beyond sustaining skeletal health and mineral homeostasis. Methods are needed to rapidly and predictably affect change in vitamin D status for evaluation of putative, non-canonical roles of vitamin D in dogs. Suitability of ingested 25-hydroxyvitamin D₃ (25(OH)D₃) for increasing vitamin D status was determined in two successive trials using purpose-bred dogs. Concentrations of 25(OH)D₃ in commercially-available dry dog foods containing animal tissues were also determined. Effects of three oral dosages of 25(OH)D₃ on circulating 25(OH)D concentration were initially studied in six dogs using a randomized complete-block design of 9-week dosing periods with no intervening washouts. The 25(OH)D₃ doses (0, 0.23, and 0.46 µg/kg^{0.75}) and vitamin D₂ (0.33 µg/kg^{0.75}) were given daily on treats prior to presentation of a semi-purified diet. The results indicated a safe and effective dietary inclusion of 25(OH)D₃ that was subsequently used in a single crossover trial. For this, markers of vitamin D status, deficiency, and toxicity were evaluated in seven other dogs maintained for two 8-week periods on a dry-expanded diet supplemented with either HyD® (25(OH)D₃) or vitamin D₃ at an inferred equivalent potency (17.8 µg/Mcal of diet). Results indicated that 1) dietary 25(OH)D₃ was 5-times more potent than vitamin D₃ for changing vitamin D₃ status, 2) food intake, body weight, and clinical hematological, biochemistry, urinalysis indices were not negatively affected at the studied dietary 25(OH)D₃ inclusion, and 3) 25(OH)D₃ variably occurs in

dry dog foods but at low, inconsequential concentrations (< 2.0 µg/kg dry matter).

The effects of common processing parameters on pulse ingredients and protein quality

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Protein, alternative protein sources, and protein quality have been leading nutrition considerations due to a growing global population and the importance of protein in health and well-being. Since the beginning of the 21st century market prices for protein have quadrupled in contrast to late in the 20th century. Subsequently, there is greater demand and competition between human and animal nutrition sectors for high quality protein sources. One group of alternative protein sources of interests are pulses. While all pulses are considered legumes, not all legumes are considered pulses. Pulses are highly nutritious edible seeds, produced from the pods of certain legumes. The Food and Agriculture Organization classifies pulses as “crops harvested solely for dry grains, excluding crops harvested green for food (e.g. green beans) or crops used mainly for oil extraction (e.g. soybean)”. Commonly used pulses include peas, chickpeas, lentils, and beans. Pulses are enriched in carbohydrates, dietary fibre, bioactive compounds, and contain approximately twice the amount of protein as compared to cereal grains. Additionally, pulses supply a significant amount of amino acids, with the exception of sulfur amino acids. However, when combined with cereal grains, which tend to be sufficient in sulfur amino acids, they are complementary ingredients to one another. Yet, pulses also contain anti-nutritional factors which can impact the utilization of nutrients from these ingredients. Anti-nutritional factors present in pulses which may impact protein include: protease inhibitors, polyphenols, and processing related products such as D-amino acids and crossed-linked amino acids (e.g. lysinoalanine). Processing of pulses can be beneficial in reducing or eliminating anti-nutritional factors, for example trypsin inhibitors that are inactivated by heat processing. Common processing methods of pulses include: grinding, soaking, dehulling, boiling, and pressure cooking, while others methods are becoming more widely used and researched such as: roasting, pelleting (animal feed), extrusion, and micronization. However, processing can also negatively impact protein

quality (e.g. reduced protein digestibility of roasted pulses). Finally, there are different methods to assess protein quality of an ingredient or food including: the protein efficiency ratio (PER), protein digestibility-corrected amino acid score (PDCAAS), and digestible indispensable amino acid score (DIAAS). Each of these methods have advantages and disadvantages. This review will provide an overview of the nutritional composition of pulses, the impact of anti-nutritional factors and processing on protein and protein quality related parameters, the methods used to assess protein quality of these ingredients, and how pulses can be incorporated into animal feeds/foods.

Protein quality of yeast biomass in diets for livestock and companion animals: a review of current knowledge

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There are many sources of protein used in animal foods. These are derived from animals (i.e. chicken, meat and bone meal, whey), plants (i.e. soy, corn, wheat) and even insects (cricket meal, black soldier fly larvae). More recently purpose grown single cell organisms (i.e. yeasts and fungi) have become popular. Yeast proteins are economically and environmentally sustainable as they utilize waste products from other industries to provide the necessary nutrients for cell growth without directly competing with the human food supply chain. The first introduction of yeast biomass as ingredients were brewer's dried yeast, derived from *Saccharomyces cerevisiae* fermentation for alcohol production. However, yeast biomass production has begun to utilize other yeast strains and carbon sources which do not compete with human or animal feedstocks. Such examples include *Candida utilis* fed carbon sources from peat moss, fish offal, vinasse (a by-product from sugar and ethanol production), and tree by-products. This innovation provides more protein-rich ingredients for nutritionists to use in situations where cost and/or sustainability for market appeal are valued. The aim of this mini-review is to provide an overview regarding the nutritional composition and utilization of purpose grown yeast biomass as a protein source for production and companion animals.

Macronutrients ratio and nutraceuticals supplementation in working dog nutrition

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The nutrition of working dogs should prepare the organism for high demanding activity and prevent injuries. For that reason, the recommended proportion and source of specific macronutrient, as well as the use of nutraceuticals in the diet, is often an area of interest and research. Strenuous workload will result in an increase of lactate levels, higher activity of creatine kinase and lactate dehydrogenase as a response to overall increased muscle activity and muscle injury. Prolonged fieldwork also leads to depletion of antioxidative capacity and changes in electrolyte balance due to complex metabolic response to workload demands.

Diet should be in accordance with the type, intensity, and duration of the activity. In dogs that are expected to perform a short but high-intensity activity, the daily ration should consist of easily digestible carbohydrates at the level of approximately 50% metabolic energy (ME). On the other hand, for dogs that are expected to work for a prolonged period at medium to high intensity, the carbohydrate portion may be lower, with fat and protein energy levels adjusted at higher rates of ME, according to a specific activity. The additional challenge in working dog nutrition are search, rescue, and hunting dogs' groups. Multifactorial work expected from these particular groups of working dogs includes a prolonged duration of work that combines intervals of different intensities under a variety of environmental conditions and terrains and includes obedience and scent detection.

The reason for the importance of choosing appropriate macronutrient ratio lies in metabolic pathways difference that predominates in short and high-intensity exercise (anaerobic) versus medium to low intensity, prolonged activity (aerobic), where different substrates are used as an energy source (glucose vs fatty acids). Muscles fibers of dogs are predominately oxidative (I i IIa) therefore, they have a high ability to metabolize free fatty acids. That will lead to more efficient utilization of alternative energy sources in aerobic metabolic processes without depletion of

glycogen stores. During work, due to the simultaneous occurrence of reparative and destructive processes, free radical-mediated damage is inevitable, therefore, the use of nutraceuticals with antioxidative and protective properties could benefit the working dog performance. Many of them have multifactorial effects that could benefit specific types of work such as EPA and DHA through proven anti-inflammatory properties, benefit on the olfactory acuity, and impact on learning capabilities. Additionally, newly researched nutraceuticals in the form of honeybee products rich in flavonoids, have shown promising results through attenuating exercise-induced oxidative damage that would benefit recovery.

Working dogs are an irreplaceable part of society, therefore, it is crucial to provide answers that are still lacking and would improve the way we address nutritional guidelines for this heterogeneous group of dogs. Especially when it comes to providing nutritional protocols for specific work intensity and duration as well as beneficial nutraceutical supplementation.

Why it can be beneficial to limit the oral intake of phosphates

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Phosphorus is an important nutrient and to maintain phosphate balance is essential for life. In patients with chronic kidney disease (CKD) phosphorus excretion is compromised and its dietary intake has to be controlled to delay the progression of the disease. The disease complex is called chronic kidney disease – mineral and bone disorder (CKD-MBD) to address the disrupted calcium, phosphorus, and vitamin D homeostasis, secondary renal hyperparathyroidism, osteoporosis and metastatic calcification of soft tissue. However, managing the daily intake of total dietary phosphorus is not enough. It is important to realise that the phosphorus sources have to be taken into account due to their different impact on the body. Solubility is a precondition for absorption of dietary phosphates in the gastrointestinal tract. Highly soluble phosphates are absorbed in higher percentages, causing a different burden to the body compared to poorly soluble sources. An example for such a sparsely soluble source is calcium apatite ($\text{Ca}_5[\text{OH}](\text{PO}_4)_3$), or bone. In contrast, inorganic phosphates such as sodium and potassium phosphates are highly soluble and therefore more available. For nearly a century it was demonstrated in various species that excessive intake of inorganic phosphates (oral, injection) can produce secondary hyperparathyroidism with increased bone resorption and bone loss together with calcification of soft tissue, i.e. in the kidneys and blood vessels. Mackay and Oliver reported already in 1935 of nephrosis and necrosis of the terminal part of

the proximal tubule, followed by calcification related to phosphate supplements, in rats. Their findings were repeatedly verified in rats and other species such as dogs. A direct toxic effect of phosphate loading on the kidneys, also by stimulating cellular calcium absorption together with an increased PTH concentration causing mitochondrial changes, was discussed. Pastoor et al. (1995) demonstrated that in cats an increasing oral phosphate load led to significantly decreased creatinine clearance. In 2008, the Munich group began to research the health implications of supplementing different dietary phosphate sources in cats and dogs in more detail. In cats, an influence of oral phosphates on indicators of renal health has been demonstrated next to a varying renal phosphate excretion depending on the phosphate source. The role of the phosphate source was also examined in dogs, where mainly highly soluble inorganic phosphates cause a disruption of the animal's phosphate homeostasis.

Home-prepared diets and other alternatives; are they a good option?

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The topic of nutrition is currently experiencing increased interest. Whether people are following specific nutrition trends for health benefits, choosing sustainable options, or jumping on the next nutritional band-wagon, eating choices available are plentiful. This is also true within veterinary nutrition, as increasing numbers of people are choosing alternative diet options for their pets. Alternative diets currently available are highly variable and can include home-prepared foods (cooked or raw), freeze-dried foods, toppers, vegetarian, vegan, grain-free, or other alternate sources or trends that are not 'conventional': commercially manufactured kibble or canned food. This mini-review will evaluate the current literature regarding alternative diet options for dogs and cats specifically related to home-prepared diets as well as touch on other trends such as raw food diets, grain-free diets, and plant-based diets.

Reasons for choosing alternative diets are as plentiful as the options that exist: from a desire to have more control over the food ingredients pets consume (i.e. all organic or non-GMO foods), a lack of trust of commercially manufactured 'conventional' foods (due to re-calls and health scares), a perceived or actual health benefit or a feeding strategy that aligns with a persons' own nutritional beliefs (such as eating high protein, ketogenic, vegetarian, or vegan diets), or a desire to simply strengthen the human animal bond through actively preparing the pets' food. However, determining the appropriateness of these alternative options can be difficult due to the sheer volume of options available,

and the mixed information and myth available on the World Wide Web.

Indications for feeding a home-prepared diet may be innumerable as listed earlier, and medical conditions may necessitate nutritional modification to meet specific needs of the pet. Home-prepared diets for dogs and cats for maintenance and disease states, as well certain diet trends such as vegan diets have recently been evaluated for nutritional adequacy and all evaluations found concerning nutritional deficiencies and excesses. A few common inadequacies included protein; amino acids – taurine, arginine lysine, methionine; vitamins - choline, thiamin, vitamins D, & E; minerals - calcium, zinc, copper, & iron. Nutrient excesses were also of concern due to nutrient interactions leading to impaired absorption (i.e. phytate impeding multiple nutrients bioavailability), or toxicities (high liver content of diet leading to hypervitaminosis A). Home-prepared foods can be provided cooked or raw and preparation method can provide additional nutritional imbalances or risks (boiling can leach nutrients; raw feeding increases risk of zoonotic disease transmission). Differences in species nutritional requirements and nutrient interactions requires advanced knowledge and training to appropriately meet the needs of the individual. Current dietary trends such as grain-free or plant-based diets have also been reviewed in the literature and recent pilot research is scratching the surface of these newly emerging topics. Regardless of the source of the home-prepared diet recipes, found in books or online, written by lay people or veterinarians nutritional inadequacy was noted, and solidifies the need for advice of a board-certified veterinary nutritionist or an animal nutritionist with advanced training to ensure nutritional adequacy of any feeding plan.

Feeding pets, or feeding microbiota? Prospect of microbiota in dogs and cats.

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With expeditious development of next generation sequencing, molecular techniques demonstrate a complex and diverse intestinal ecosystem. Many studies have been established to explore the composition, roles and alterations of the canine and feline microbiome. Opportunities for translating microbiome science to new concepts of future foods are a realistic prospect.

Feeding pets = feeding microbiota. Most complex plant polysaccharides are not digested by animals and enter the colon as a potential food source for the microbiota. Intestinal bacteria express carbohydrate-active enzymes, which endow them with the ability to ferment complex carbohydrates generating metabolites such as short-chain fatty acids. Based on this knowledge, canine and feline nutrition research has been devoted to dietary fibers, such as cellulose, oligofructose, inulin, fructooligosaccharides and galactooligosaccharides. The gastrointestinal (GI) microbiota is also crucial to the synthesis of essential vitamins which the host is incapable of producing. Moreover, the diet plays a fundamental role in shaping the composition of gut microbiota and, thus, determines the interrelationship between the gut microbiome and the host. Many nutrition studies have revealed diet-related factors, such as diet types (dry/wet, canned/kibbled, raw/processed) and nutrient composition (e.g. high protein/carbohydrate) affecting the canine and feline microbiome.

Feeding microbiota > feeding pets. The relationship between microbiota and host has profound effects on animal health. Apart from nutritional and metabolic benefits, the microbiota influences the development and maturation of host immunity, brain-gut axis and other systems. The GI microbiota play an essential role on the intestinal structure and function, promotes colonization resistance and provides the host with a microbial barrier. Furthermore, microbiota is likely linked to central nervous system functions and mental disorders, for instance, anorexia in dogs and cats. In addition, the unbalanced microbiome could lead to GI disorders, marked shifts of microbiota were also frequently observed in dogs and cats with various diseases (GI diseases, metabolic diseases, extraintestinal diseases...)

Prospect of microbiota in dogs and cats. Maintenance of a healthy microbiota requires a healthy diet which varies with the age of the host and with disease. The pet food of the future should be designed to not only feed pets optimally, but also feed their microbiota. Beneficial impacts of dietary fibers have demonstrated that microbiota could be used as a biological tool to protect, maintain or promote host health by altering availability of preferred bacterial food sources in the host diet. Future applications of microbiota, such as fecal transplantation, are still expanding in dogs and cats. Furthermore, new designs or new functional ingredients of pet food are prospective, to promote GI and host health and prevent or cure diseases by modulating composition and function of GI microbiota.

The lipotropic effects of dietary choline and its potential in companion animal nutrition

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Obesity is an epidemic of great concern to companion animals due to its negative effects on health and lifespan. Research focusing on micronutrients has aimed to find dietary strategies to combat this problem. A micronutrient that has received little attention in the world of companion animal nutrition is choline. As an essential nutrient, choline is involved in multiple pathways, including neurotransmission, cell signaling, and namely lipid and cholesterol transport and metabolism. Of particular interest are the two main functions choline has in the liver; as a methyl group donor for one-carbon metabolism, and as a precursor for phosphatidylcholine (PC), necessary for the synthesis of very-low-density lipoproteins (VLDL).

Due to its roles in lipid metabolism, research on choline supplementation in animals has focused on growth and weight gain, particularly in livestock. Research in growing livestock, such as poultry and swine, has demonstrated that supplementing choline, or its derivative betaine, decreases fat deposition and increases lean carcass composition. In CTP:phosphoethanolamine cytidyltransferase deficient (Pcyt2^{-/-}) mice, dietary choline supplementation increased triglyceride (TG) degradation in adipose, liver, and plasma, and decreased the production of TG from fatty acids (FA). Moreover, in rats, fatty liver induced by a high fat diet could be reversed within 12 days with choline supplementation. Overall, it is evident that supplementation of choline may have the potential to reduce the onset of weight gain, particularly in growing animals; in addition to providing a potential solution for other diseases caused by the accumulation of fat, such as fatty liver.

Research on choline supplementation in companion animals has been limited. Unpublished research in cats found that growing male kittens, fed to mimic ad lib feeding, gained less weight and overall fat mass when given a daily choline supplement (300 mg/kg BW^{0.75}), compared to a control, post gonadectomy. Concerning the liver, growing kittens fed choline-deficient diets had increased hepatic lipid accumulation. Unpublished research has shown that obese cats fed a high choline diet (18,957mg choline/kg DM) had greater

concentrations of serum cholesterol (CHOL), high-density lipoprotein CHOL (HDL), low-density lipoprotein (LDL), VLDL, and TG, as compared to a control group (4,587mg choline/kg DM); suggesting that choline assisted in mobilizing hepatic lipids. In dogs, research is even more scarce. It is reported that choline deficiency in dogs resulted in decreased food intake, weight gain and accumulation of hepatic lipids, in addition to a decrease in plasma cholesterol concentration. With choline supplementation, these signs were reversed within 5-10 days.

Overall, due to its link with lipid metabolism, it is evident that choline has potential to be a novel nutritional strategy in companion animals for a multitude of reasons, such as preventing obesity and maintaining hepatic health. Future research focusing on establishing necessary doses for lipotropic effects in these animals, as well as the collection of tissue biopsies for the expression of genes related to lipogenesis, lipolysis, and VLDL secretion will be of importance.

Omega 3 fatty acids and obese cats – what is the current knowledge?

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Over the past decades, there has been a dramatic increase in the number of obese animals. The obesity is a low-grade chronic inflammation that contributes as a risk factor for insulin resistance and diabetes mellitus type 2 in humans and cats. Long chain n-3 PUFAs have been demonstrated to play an important role in reducing inflammation on various disorders. Although many studies have been conducted in humans and dogs, very little is currently known about the benefits of omega 3 fatty acids in obese cats.

Obesity and adipokines. The adipose tissue is a storage organ that actively secretes adipokines, such as adiponectin and leptin. Evidence suggests that body fat composition is inversely related to concentrations of adiponectin and directly related to concentrations of leptin. In cats, low adiponectin and high leptin concentrations have been linked with obesity-related insulin resistance. Similarly, diabetic status and body condition were reported to be predictors of low adiponectin concentration in cats. Based on this knowledge, nutritional research has been performed to understand whereas visceral or subcutaneous adipose tissue has more effect in the secretion of adipokines.

Long chain n-3 PUFAs. There is a growing body of literature that recognises the importance of Omega

3 fatty acids in reducing inflammation in chronic inflammatory diseases. Such disorders have been associated with low concentrations of adiponectin. In obese cats, concentrations of EPA are inversely related to insulin and directly related to adiponectin. Previous published research has established that high omega 3 diets can improve glucose control and decrease insulin concentrations in obese cats. Moreover, the n-3 PUFAs do not only improve glucose-stimulated insulin secretion and insulin sensitivity but are likely to have an impact in the expression of cytokines. Although doses of EPA and DHA per metabolic weight of dog have already been recommended for some inflammatory diseases, to date, there are no described doses for cats.

Prospect of long chain n-3 PUFAs in obese cats. Reaching an ideal body weight is especially important for newly-diagnosed overweight diabetic cats. A proper weight loss program in this status enables the remission of the disease. Since increasing the adiponectin concentration in obese cats is likely to help ameliorate the decrease in insulin sensitivity; and knowing that long chain n-3 PUFAs can support this increase, further investigation needs to be done to determine the role of EPA and DHA addressed in a diet for a weight loss program. Furthermore, understanding the physiological changes that occur in an obese cat and aligning these findings with the addition of anti-inflammatory fatty acids in the food, should permit identifying better fatty acids sources and proportions for weight loss diets.

Equivalent plasma enrichment between dietary algae-based long chain omega-3 fatty acids and marine fisheries based fish oil in dogs and cats

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Long-chain omega-3 fatty acids are among the most extensively studied dietary nutrients in both human and animal nutrition. The possibility exists that docosahexaenoic acid (DHA) is an essential fatty acid for dogs and cats based on both structural and functional evidence. Furthermore numerous health benefits have been attributed to eicosapentaenoic acid (EPA) and DHA in both dogs and cats generating a global demand for these nutrients. Meeting this demand, whether via whole marine-fish or marine fish-derived oils, has raised questions of environmental sustainability. The availability of algal-based omega-3 fatty acids of defined EPA and DHA content provides a viable alternative to marine fish-based oils. Earlier studies have shown safety

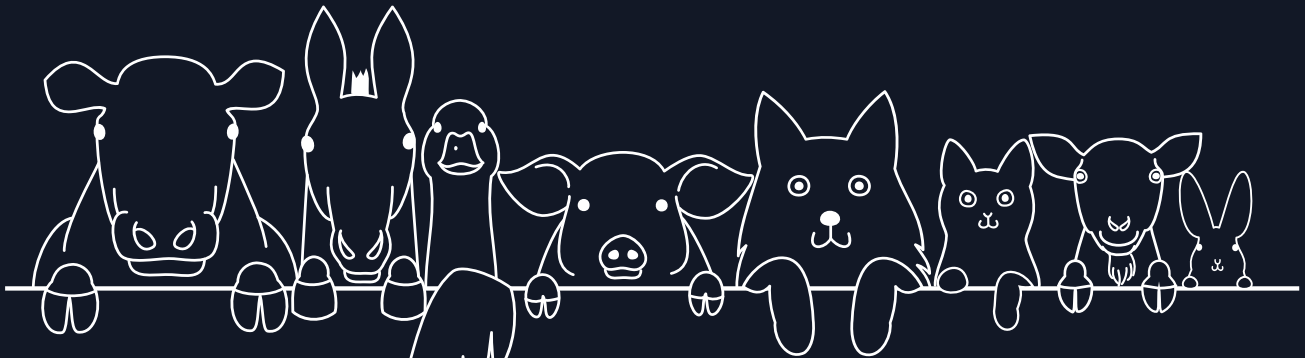
of dietary algae oil for all life stages in dogs and cats and its stability.

For this review, it was hypothesized that dietary EPA and DHA from an omega-3 rich algae oil results in functionally equivalent plasma levels compared with marine-fisheries sourced oils. To test this hypothesis, canine and feline plasma EPA and DHA concentrations was determined in a dose response fashion after feeding algal oil and compared with the published literature where marine fish oil was fed. Four separate studies were performed, two in dogs and two in cats. A low omega-3 basal diet was formulated meeting AAFCO profiles and fed as control. This diet was enriched with increasing amounts of algal oil up to 5.1% w/w at the expense of its fat content. The diets were fed to 30 adult Beagles of both genders (n=10 per group) with blood samples taken at baseline and day 54 or 65 during each respective canine trial. Thirty adult domestic short- and long-haired cats were similarly fed and sampled in the feline trials. Body weights and food intakes were compared showing no differences among the groups. Plasma EPA and DHA concentrations and EPA+DHA combined were determined. Dose response curves (i.e. plasma vs diet omega-3) were graphically compared with marine fish oil literature values.

In dogs, all algal oil group data for EPA, DHA and combined EPA+DHA were observed to lie within the same logarithmic trend line as marine fish oil demonstrating comparable plasma enrichment with either omega-3 source.

Although fewer literature data were available for comparison, results in cats showed plasma EPA concentrations with the algae-based diet to be generally within the same dose response trend line seen with marine fish oil. However, plasma DHA amounts were slightly lower at 5.1% algal oil inclusion by comparison. The combined EPA+DHA amounts were also relatively affected as a result.

The present review demonstrates that algae-based omega-3 oils are a suitable dietary alternative for marine fisheries-based fish oils in companion animals. In cats it appears that some adaptation to DHA feeding at higher inclusion levels occurs. Reasons for this finding include possible tissue conservation with retro-conversion or utilization at higher dietary levels. In sum, the algae oil provides a consistent, safe and sustainable source of dietary omega-3 nutrients compared to the variability typically seen with marine fisheries-derived fish oil sources of long-chain omega-3 fatty acids.



GLOBAL ANIMAL NUTRITION SUMMIT

POSTER PRESENTATIONS

CATEGORY 1: NOVEL INGREDIENT & FOOD FORMULATION

Effect of unconventional feed sources on expression of genes regulating feed intake and pork quality among growing pigs

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This study was conducted to examine the organoleptic qualities and expression patterns of leptin and ryanodine receptor1 gene (RYR1) among pigs fed different unconventional feed sources. A total of 45 growing pigs were randomly assigned to 5 dietary treatments at 9 animals per treatment and 3 animals per replicate. Treatment one (T1) comprise of whole maize (WM) which served as the control, T2: brewers dried grain (BDG), T3: cassava peel meal (CPM), T4: plantain peel meal (PPM) and T5: corn husk meal (CHM) at 35% inclusion in the diet. Data collected and analyzed includes; Meat tenderness, Juiciness, flavor and acceptability. At the end of the feeding trial, three animals per treatment (one animal per replicate) were slaughtered, meat were cooked and presented for organoleptic assessment on a scale of 1-9, with 9 been Extremely tender, juicy, flavored, Acceptable, while 1 was Extremely tough, dry, unflavored, unacceptable. The duodenum and liver were collected and stored using RNALater prior to RNA extraction. Real-time quantitative Polymerase Chain Reaction was performed in 40cycles using the PowerUp SYBR Green reagent and analyzed using the $\Delta\Delta$ -Ct method. All data were subjected to analysis of variance in a completely randomized design. The results showed that the treatment diets had no significant effects ($P<0.05$) on pork tenderness, flavor and overall acceptability, however, treatment diets significantly ($P>0.05$) affected the juiciness of the meat. Leptin and Ryanodine receptor 1 gene were differentially expressed in the liver and duodenum. However, the expression patterns were not significantly different. RYR1 was more abundant in pigs fed Brewers Dried Grain in both tissues. BDG was expressed 17 folds in duodenum and 4 folds in liver as compared to CHM. This study showed promise for the use of unconventional feeding stuffs in pig feeding since the meat were generally accepted for consumption. The study also reveals that Brewers Dried Grain (BDG) increases the expression of RYR1 gene that is the chief cause of porcine stress syndrome that leads to Pale Soft Exudates pork (PSE pork). Therefore, Corn Husk Meal can be used as

feeding stuff for reducing the abundance of this gene and subsequently reduce the risk of porcine stress syndrome among pigs.

Effect of addition of crystalline L-arginine and DL-methionine to diet on productive variables of growing pigs under heat stress

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The present study was conducted with the aim to evaluate during 28 days the effect of extra addition of L-Arginine (L-Arg) + DL-Methionine (DL-Met) to a sorghum-soybean meal based diet upon growth productive variables of growing pigs held under natural heat stress conditions (daily average temperatures ranging from 24.0 to 34.2 °C). Twenty four crossbred pigs (Yorkshire-Landrace x Duroc) with initial BW of 43.6 ± 2.4 SD kg, were individually housed and randomly assigned (n=12, 7 gilts and 5 barrows) to two treatments: a) Standard diet (STD), with 13.0% CP, 0.99% Lys, 0.28% Met, 0.79% Arg, formulated to fill the nutrient requirements (NRC, 2012) of growing pigs, or b) Addition of crystalline L-Arg + DL-Met (STD + 0.20% L-Arg + 0.09% DL-Met; STD+Arg+Met) to Standard diet. Ambient Temperature (AT) and Relative Humidity (RH) were registered in 10 min intervals during the experiment, in order to calculate THI-Index (Rothfusz, 1990). Pigs were fed (ad libitum) in two portions (0700 y 1500 h) daily. Body weight and feed intake were registered in order to calculate ADG, ADFI, and G:F every week. Data were analyzed as a completely randomized design utilizing SPSS. Daily AT registered during the experiment ranged from 24.8 °C (0600 h) to 34.0 °C (1600 h). Daily RH registered during the experiment ranged from 47.7% (1540 h) to 86.6% (0720 h). During the day, THI minimum (78.6) was registered at 0640 h, and THI maximum was 101.3 at 1530 h. There was no effect of treatment upon final BW (70.5 vs 69.4 kg; $P=0.42$). Average daily gain (ADG) was similar between treatments (955 vs 924 g/d; $P=0.31$). Feed intake (ADFI) tended ($P=0.08$) to be less in STD+Arg+Met pigs (2.52 kg/d) compared with STD pigs (2.64 kg/d). Feed efficiency was higher ($P=0.03$) in STD+Arg+Met pigs (0.384) than in STD pigs (0.353). In conclusion, addition of 0.20% crystalline L-Arginine and 0.09% DL-Methionine to a sorghum-soybean meal based diet, contributed to overcome detrimental effects of heat stress in growing pigs.

Fermentation of a variety of animal-derived fermentable substrates in vitro using domestic cat faecal inoculum

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Dietary fibre can be categorised into fermentable and non-fermentable substrates which resist digestion and are instead partially or fully fermented in the colon. Plant dietary fibres (e.g. beet pulp and cellulose) are included in commercial pet foods for their role in satiety and faecal bulk (1). However, of greater interest, is the effect of dietary fibres on the gastrointestinal microbiome for their production of short chain fatty acids (SCFA) such as butyrate, which beneficially effects the colonic environment and host. Nevertheless, cats are obligate carnivores and have evolved to consume minimal amounts of plant dietary fibre (2). However, feral cats do consume entire prey, including animal-derived fermentable substrates such as fur, bones and cartilage (2). Fermentation of the amino acids in these substrates, may produce large concentrations of ammonia, which is detrimental to colonic health. Previous research in vitro showed that Cheetah faecal inoculum was able to ferment collagen, producing similar amounts of SCFA per gram of organic matter as fructooligosaccharide (3). As domestic cats are also obligate carnivores, it was hypothesised that their faecal inoculum would be able to ferment these substrates in a similar manner. This study aimed to assess the fermentability of animal derived fibre analogues to determine which may act like a dietary fibre's in vivo, through assessment of fermentation end products (butyrate and ammonia) and changes in bacterial profiles.

Donor faeces were collected from cats fed either high-protein (PD) (protein:fat:carbohydrate ratio; 75:19:1 (% DM basis)) or high-carbohydrate (CD) (35:20:28) commercial diets for 21 days. Substrates (hydrolysed collagen, cat hair, fresh and freeze-dried bovine trachea, inulin and cellulose) were digested in vitro (4) then fermented for 0, 4, 8, 12 and 24 hours in either PD or CD faecal inoculum. SCFA and ammonia concentrations were measured in the fermentation supernatant, and the DNA pellet analysed using 16S rRNA gene amplicon sequencing.

After 24 hours of fermentation, butyrate concentration was highest in the hydrolysed collagen fermented in the PD inoculum. Ammonia concentration was not significantly higher than the other substrates. In the CD inoculum, fermentation of cat hair produced

the largest butyrate concentration. Diet had the greatest effect on bacterial taxa present in the faecal inoculum. At 0 hours, *Fusobacterium* had the greatest relative abundance in the PD inoculum, while *Prevotella* 9 was greatest in CD inoculum. At 24 hours, both inoculums had an abundance of *Escherichia-Shigella* in the hydrolysed collagen and cat hair substrates, while the PD had an abundance of *Fusobacterium* and CD *Bacteroides*.

All substrates, with the exception of cellulose, were fermented by faeces obtained from the domestic cat, regardless of inoculum sources. The PD inoculum was able to readily ferment high protein substrates due to the protein utilising bacteria present, without a significant increase in ammonia concentration. Increased relative abundance of *Escherichia-Shigella* was likely due to the static in vitro model allowing facultative anaerobes to colonise the system. The results of this study will be used to inform in vivo studies and provides further insight as to the benefits and limitations of in vitro models.

Can a fully plant-based pet food efficiently provide a nutritionally balanced diet?

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Plant-based human food products are nowadays considered as more sustainable than animal-derived products. This could be true for pet food products as well, explaining a potential demand for plant-based pet food. However, requirements for being a complete pet food are much stricter than for food products. The aim of the current study was to find out which level of processing of plant protein sources is necessary to fulfil the FEDIAF recommended nutrient levels for adult dogs. Therefore, a database of plant-based ingredients, including flours, protein concentrates and protein isolates was established. Linear programming was used to formulate recipes that fulfil the FEDIAF recommended nutrient levels for adult dogs, minimising either (i) the number or (ii) the amount of nutrients that need to be supplemented. Moreover, consequences of setting consumer related constraints were investigated. These constraints were excluding soy, gluten, and solanine related ingredients. The results showed that it was possible to obtain recipes without the use of heavily processed ingredients, such as protein isolates concentrates, while still fulfilling the nutrient profile of dogs. The amount of supplementation of missing nutrients was similar to the supplementation to animal-based pet food. When constraints were set, it was possible to obtain recipes without the use of isolates.

However, setting constraints may come at the cost of having to add more supplementation. In conclusion, design of dog food that is complete and efficient, hence formulated with minimally processed ingredients, is possible. Nevertheless, nutritional adequacy should be determined by feeding trials.

Effect of a novel pet food additive on the post-exercise inflammatory response in canines

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Active dogs are exposed to additional stresses and strains over and above those experienced by sedentary dogs. Dietary factors may help in reducing the post-exercise inflammation and promote prompt exercise recovery. The current study tested the effect of Proformix Pet, a proprietary blend of calcium butyrate and polyphenols, on the inflammatory response following exercise.

Twelve dogs (Basset Hounds) were included in this study to assess the effects of a one-hour exercise bout on resolvin D1 (RvD1) and interleukin 1 β (IL-1) following 28 days of a control diet (n = 6) and a diet supplemented with Proformix Pet (n = 6). Blood samples were drawn before the exercise bout (T0), 2 hours post-exercise (T2), and 6 hours post-exercise (T6). These time points were validated through a pilot study looking at inflammatory effects of an hour of hunting in dogs on these specific blood inflammatory markers¹. Plasma samples were analyzed using commercially-available canine-specific ELISA kits. Data were analyzed using a mixed model with repeated measures. Fixed effects that were considered included dog, time, treatment, and interactions.

RvD1 is a specialized pro-resolving mediator derived primarily from eicosapentaenoic acid and docohexaenoic acid. This molecule functions to restore normal tissue homeostasis following an inflammatory event. Its increase in plasma and/or tissue promotes a non-inflammatory state. There was an effect of the time by treatment interaction on plasma RvD1 post-exercise; where there was an increase with time in treated animals (P = 0.02; T0, 489.96 \pm 65.7 pg/ml; T6, 742.31 \pm 65.68 pg/ml). Comparison between the groups revealed greater levels of RvD1 at 6h post-exercise in treated dogs than controls.

IL-1 is the hallmark prototypical pro-inflammatory cytokine. It is a universally recognized inflammatory

signaling molecule that promotes an inflammatory state in tissue. IL-1 has a naturally occurring tissue agonist IL-1 receptor agonist (IL-1ra) which is typically upregulated during times of increased production of IL-1. There was a trend towards significance (P = 0.07) for interaction of time and treatment on IL-1 β ; where there was a rise in IL-1 in control dogs following exercise, but not treated dogs. Specifically, at 2h and 6h post-exercise, there was a trend (P = 0.06; Control 5.14 \pm 0.48 μ g/ml; Treatment 3.88 \pm 0.43 μ g/ml) and effect (P = 0.01; Control 5.80 \pm 0.62 μ g/ml; Treatment 3.80 \pm 0.43 μ g/ml) respectively, for control dogs to have higher IL-1 than treated dogs.

Twenty-eight day supplementation of the Proformix Pet fed to working dogs effectively mitigated post-exercise inflammation, and potentially enhances recovery. These results indicate that working dog diets supplemented with calcium butyrate and polyphenols may help in maintaining mobility. However, long term studies would need to be conducted to validate a continual effect.

No bugs about it: the use of black soldier fly larvae meal in nursery pig diets

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Newly weaned pigs are especially prone to enteric challenges and a post-weaning growth lag, largely due to an immature gastrointestinal tract. To combat these challenges, antimicrobials were historically included in the diets of pigs during the early post-weaning period. Black soldier fly larvae meal (BSFLM) is enriched with both chitin and medium chain fatty acids (MCFA). Chitin acts as an immune stimulant and prebiotic to support a balanced and diverse population of gut microbes while MCFA exhibit anti-inflammatory and antimicrobial properties. The objective was to determine the effect of partially replacing dietary animal proteins and antimicrobials with BSFLM on indices of immune system robustness and gastrointestinal tract development of newly weaned pigs. One hundred and forty-four newly weaned pigs (6.73 \pm 0.39 kg initial BW; 21 days of age) were placed in 24 pens (6 pigs per pen) and randomly assigned to one of four dietary treatments (study d 0; n=6), which were fed over 3 phases (phases 1, 2, and 3 were fed for 7, 14, and 21d, respectively). Two nursery diets were formulated with 25% (LowFF) and 50% (HighFF) of animal protein sources replaced by full fat BSFLM and two commercial nursery diets were used as controls (-CON no antibiotics; +CON with 220mg Aureomycin per kg of complete feed). Individual pig BW and per pen feed disappearance were recorded weekly. On d 8, two pigs per pen were sacrificed to determine organ weights and collect ileum and jejunum samples for intestinal histomorphology measurements. Blood

was collected on d 8, 21, and 37 to determine plasma concentrations of total IgG and haptoglobin. On d 37, two pigs per pen underwent a delayed hypersensitivity test. Skin swelling was measured at 0, 6, 24, and 48hr post-intradermal injection with antigens OVA and CAA as indices of humoral and cell-mediated immune responses, respectively. Pigs fed the -CON had lower average daily feed intake (ADFI) and gain:feed ratio (G:F) in phase 2 versus those fed +CON or the BSFLM diets ($P<0.05$ and $P<0.05$). Overall average daily gain (ADG) (496 ± 10 g), ADFI (743 ± 28 g), G:F, and final BW (27.61 ± 0.34 kg) were not affected by dietary treatments. There were no differences in organ weights, jejunal or ileal villus heights or crypt depths among dietary treatments. There were no differences in total IgG or plasma haptoglobin between dietary treatments at any of the blood sampling times, but pigs fed the +CON, LowFF, and HighFF diets had a more robust immune response to OVA at 6hr after the intradermal injection than those fed the -CON diet ($P=0.078$, $P<0.05$, and $P<0.05$, respectively). Both inclusion levels of BSFLM in nursery diets supported growth performance, gut morphological characteristics, and indices of immune function and were not different from the +CON. Therefore, BSFLM may be a viable alternative to include in nursery diets as a replacement for in-feed antibiotics in the future. Since swine are an ideal model for companion animals, these data indicate that BSFLM may be used as an environmentally sustainable, nutraceutical component in companion animal diets as well.

Thiamine degradation is similar in extruded feline diets during 12-month storage at room and freezing temperatures

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Thiamine (vitamin B1), a water-soluble vitamin, is an essential nutrient in cats. Therefore, it cannot be synthesised in the body and must be consumed in adequate amounts through the diet to prevent deficiency. Thiamine is crucial in a variety of biochemical pathways such as glucose metabolism, amino acid metabolism, and neurotransmission. Deficiency can lead to heart and nervous system related complications with life-threatening consequences.

When formulating diets, the pet food industry follows the Association of American Feed Control Officials (AAFCO) recommendations. Thiamine recommendations set forth by AAFCO indicate adult cats should have a minimum of 5.6 mg/kg per day on a dry matter basis (DMB). Thiamine is highly susceptible to degradation

during processing through exposure to heat, oxygen, and alkaline pH. Furthermore, the presence of anti-thiamine compounds such as thiamine degrading enzymes and sulfites can also lead to large losses. These processing losses must be accounted for in diet formulation. Following manufacturing, thiamine continues to degrade during storage. The extent of degradation is dependant on storage time and conditions. However, studies focusing on the role storage time and conditions play on thiamine concentration in extruded cat food are limited.

In an effort to reduce costs, cat owners may opt to purchase food in bulk to freeze in order to keep it fresh for an extended period. It is currently unknown if freezing extruded pet food has an effect on thiamine concentration. Therefore, the objective of this study was to examine thiamine concentrations in commercially available extruded feline diets stored for 12-months at room and freezing temperature. Twelve diet packages were split in half and subsamples of each half were analyzed in duplicate for thiamine using fluorometry. One half was then stored at room temperature (24°C) and the other half was frozen (-20°C). Duplicate thiamine analyses of subsamples were also performed at two more time points in 6-month intervals up to 1-year. Data were assessed using a mixed procedure (two-factor factorial model with factors time and treatment). All diets were manufactured following AAFCO's 2017 increase in dietary thiamine recommendations. One diet did not meet the minimum recommendation at any time point throughout the study and was removed from statistical analysis. Overall F-tests showed an effect of treatment ($P=0.017$) and time ($P=0.0010$), but no treatment*time interaction ($P=0.9534$). Regardless of treatment, thiamine significantly decreased over time; baseline to 12-months ($P=0.0052$) and 6-months to 12-months ($P=0.0004$). There were no differences between baseline and 6-months ($P=0.4164$). Regardless of time, frozen samples had significantly more thiamine than room temperature samples (26.28 mg/kg DMB and 24.68 mg/kg DMB, respectively). In conclusion, regardless of storage temperature, thiamine in extruded feline diets degraded at a similar rate over a 12-month period. Further research is required, analyzing all essential nutrients, in order to make evidence-based storage temperature recommendations for extruded pet foods.

CATEGORY 2: NEW METHODOLOGY

The development of a novel co-culture system to model diet-based influences on the canine intestinal epithelium

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Changes in diet have a major impact on the composition of the intestinal microbiome of the domestic dog (1). Altering the nutritional profiles of the diet can modulate the relative abundances of faecal bacteria, for example the relative abundance of faecal Firmicutes are increased with increasing dietary carbohydrate levels and decreased with increased levels of dietary protein and fats (2-4). Understanding how diet-induced changes in the gut microbiota influences host health is a key factor in providing diets for optimal pet health and nutrition. However, the knowledge regarding the interactions between diet, intestinal microbial changes and host health in the dog remains poorly understood.

To address this knowledge gap, we have used a novel dual environment co-culture chamber (DECC) (5) in collaboration with a previously established canine intestinal epithelial cell line (cIEC) (6) to investigate the influence of diet on gut health in the dog. We hypothesised that combining these two models would enhance the applicability of the in vitro model and response of the cIECs to stimuli in a manner that is more representative of those in vivo. The aim of this study is to develop the cIEC-DECC model to investigate the immune response and impact on barrier integrity resulting from bacterial challenge and environmental stimulation to better understand the impact of diet and the microbiota on the canine intestinal epithelium.

The cIECs were grown under conventional (aerobic) conditions following previously published methods (6) then seeded onto Transwell® inserts at a density of 1×10^4 cells/cm². Following differentiation at 39°C for 48 hours, the cell culture medium was replenished and cIECs transferred into the DECC. The cIEC-DECC was then placed in an anaerobic workstation at 39°C where in situ measurement of the transepithelial electrical resistance (TEER), a measure of intestinal cell barrier integrity, was conducted. Baseline readings were established for 2 hours then the apical media replaced with anaerobic media leaving the basal media aerobic. These refinements to the methodology for studying cIECs better replicate the in vivo environment within the canine intestine. Following 2 hours of TEER data collection, cIEC were challenged with bacterial lipopolysaccharides (LPS) and TEER measurements continued to be collected every 30 minutes for another 2 hours. The apical and basal media were collected for analysis of the cytokine response and the impact on tight junction expression resulting from LPS challenge determined.

Results from this study will be extrapolated to further describe putative links between canine diet, the gut microbiome, and host health. Our long-term aim is that

these investigations can be used for the optimisation of diets for the domestic dog.

Raw material particle size in extruded diets for dogs and cats

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The effects of raw material particle size (RMPS), particularly in pet food formulations with cereals as starch source, were reviewed considering the implications to extrusion processing and health of dogs and cats. Despite the importance of RMPS, most of the published studies that have evaluated extruded diets for dogs and cats did not describe this parameter nor considered its possible implications on outcomes. Diet processing description is limited without information of the extrusion conditions. Relevant scientific information is being lost with this lack and the implications of processing parameters are not being explored to animal health. The extrusion processing has limited moisture and residence time to cook, and due to this RMPS has important influence on starch gelatinization (SG) [1,2,3,4,5,6]. In a study about rice, corn and sorghum-based diets a linear increase on SG was observed with a decrease on RMPS ($r^2=0.85$; $P<0.001$) [4]. The implications of rice, corn, and sorghum RMPS to total tract apparent digestibility (TTAD) of nutrients and fermentation products on feces are not similar, and the responses should be targeted to each raw material [4]. Experiments failed to detect differences on TTAD from RMPS ranging from 218 ± 1.7 to 338 ± 2.1 μm [3,7]. In our research group experience, only coarsely ground corn- and sorghum-based diets induced significant reduction on TTAD [4]. Regarding SG, results showed that modest cooking (>70%) is enough for TTAD, and only when SG was lower than 65% reductions should be expected [7]. Higher RMPS is associated with higher colon fermentation, specially butyrate formation with possible implications to gut health [3,4,5,6]. The reduction on SG may also increase fecal butyrate levels ($r^2=0.46$; $P<0.01$) [7]. Higher RMPS is additionally associated with increased resistant starch (RS) content of diets [3,5,6]. A study with old dogs identified that the intake of food with lower SG and higher RS may alter colon histology [5]. For cats, sorghum-based formulations with higher RMPS presented lower SG and increased RS content, increasing fecal butyrate and significantly changed fecal microbiome, increasing SCFA-producing bacterial groups [2]. Another possible implication of processing is on glucose metabolism, since dogs fed a corn-based

formulation presented reduced incremental glucose area under the curve (AUC) and mean and maximal insulin concentrations with the increase on RMPS [3]. Old dogs presented reduced glucose AUC, and lower mean and maximum postprandial glucose when fed a diet with higher RMPS, lower SG, and higher RS content [2]. In conclusion, there are potential benefits of using larger RMPS in diets for dogs and cats. Further research is needed to better understand different ingredients and health conditions where these approaches can be applied.

Evaluation of four methods of food processing on canine fecal microbiota

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Conventional commercial pet foods are heat treated during processing to decrease microbial load and to increase storage and shelf-life while maintaining palatability. This processing is similar to the human western diet, which is associated with an increased risk of obesity, diabetes mellitus and its comorbidities, cardiovascular disease and atherosclerosis, renal disease in addition to a range of degenerative diseases. Recently, advanced glycation end products (AGEs) such as carboxymethyllysine (CML), carboxyethyllysine (CEL) and methylglyoxal hydroimidazolone-1 (MG-H1), have been implicated in these diseases and the western diet. It follows that commercial pet foods being subjected to similar processing conditions as the western diet, also contain AGEs potentially acting as contributors to development of the aforementioned diseases in dogs. One aspect of this association is the connection between AGEs and the gastrointestinal microbiome. The term “dysbiosis” describes an imbalance of gut microbes leading to diseases such as inflammatory bowel disease (IBD), obesity, diabetes mellitus, allergy and asthma associated with consuming a western diet. We hypothesized that consumption of different processed diets would cause changes in the fecal microbiome. In this study, four differently processed diets were fed in a Latin square experimental design to eight dogs: heat processed wet food (WF), heat processed dry food (DF), air-dried food (ADF) and raw food (RF). Each diet was fed for four weeks and a stool sample was collected for microbiome analysis via 16S rRNA sequencing at the end of this period. At the end of the 16-week experiment, pooled food samples underwent microbial analysis as well as determination of concentration of three AGEs

(CML, CEL, and MG-H1) using mass spectrometry. This protocol was approved by IACUC. Operational taxonomic units (OTU's) were determined using Qiime followed by statistical analysis using comparative metagenomic platforms: METAGENassist and Galaxy. At the phyla level, our findings matched previous studies with predominant phyla in dogs including Firmicutes, Bacteroidetes, Fusobacteria, Proteobacteria and Actinobacteria. While differences between diets were not apparent at phyla level, when compared by genus, 7 genera were found to be significantly different between diets. Shannon and Simpson indices used to demonstrate alpha diversity between diets both showed significant differences between all diets except between ADF and RF. Beta diversity was determined using principal component analysis (PCA) showing clustering of the RF distinctly from the DF. Microbial analysis of the food showed highest bacterial content in the ADF. Limitations of this study include the small sample size and short duration of the study. In conclusion, processing of commercial pet diets has an effect on the canine fecal microbiome. Further studies are needed to investigate functional changes of the significantly different genera that correspond to the microbial population requiring identification of bacteria at the level of species and strain.

Mass spectrometry-based analysis of serum acylcarnitines reveals an increase in the short chains in obese cats

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Obesity is a growing problem in cats, with a prevalence that varies between 11% and 60% depending on the population. Obese cats are predisposed to comorbidities such as type 2 diabetes and have a reduced quality and duration of life. Research on the metabolic changes associated to obesity could improve its diagnosis, prevention and treatment strategies. Disturbances of free carnitine and acylcarnitines are associated with obesity and insulin resistance in humans. In this study, using a mass spectrometry-based approach, we compared the serum free carnitine and acylcarnitine profile between lean and obese cats.

Seventy-five adult client-owned cats were recruited and divided in two groups according to their Body Condition Score (BCS), in a 9-point scale: “lean”, with

BCS 4 or 5, and “obese”, with BCS 7 to 9. Cats with BCS = 6 were not included. Blood collection was performed in the morning, after a 16-hour fasting period. Serum was harvested within 30 minutes and frozen at -80°C within one hour. Health status was assessed by clinical history, physical examination and laboratory evaluation (complete blood count, clinical chemistry and urinalysis). A t-test was used to compare the concentrations of free carnitine (C0) and 23 acylcarnitines, including short chains (C2 to C6), medium chains (C8 to C14) and long chains (C16 to C20) between the two groups, as well as their age. Spearman's rank test was used to look for correlations between age and carnitine derivatives. Whenever a correlation was found, a linear model was used to verify whether the effect of the BCS category remained after normalizing for the effect of the age.

Fifty-five cats, 31 males and 24 females, aged between 2 and 10 years, were included in the study. These comprised 32 Domestic shorthair, 16 Domestic longhair, 1 Bengal, 1 Persian, 1 Siamese, 1 Sphynx, 1 Tonkinese and 1 Highland lynx. One cat was excluded from the analyses because of insufficient sample volume. Obese cats had higher free carnitine (C0, $p=0.015$), and several short chains acylcarnitines (C3, $p=0.007$; C4, $p=0.019$; 2 isoforms of C5, respectively $p=0.004$ and $p=0.001$) than their lean counterparts. Age was positively associated with one isoform of C5 ($p=0.015$). When normalizing for the effect of the age, the effect of the BCS category on C5 remained ($p=0.006$), and the effect of the age and the interaction between age and BCS were no longer significant.

To the best of our knowledge, this is the first study to report an association between carnitine and acylcarnitine profile, particularly short chain acylcarnitines, and obesity in cats. Acylcarnitines are markers of defective mitochondrial beta-oxidation in humans, and our findings suggest that these disturbances are also present in obese cats. Interestingly, both C3 and C5 acylcarnitines reflect changes in the levels of branched chain amino acids, known as markers of insulin resistance in obese humans. Therefore, our findings suggest that similar changes may happen in feline patients. Further characterization of these changes and their interactions with other markers of feline obesity may provide insight into obesity-related metabolic disturbances in this species.

Hydroxyproline content of commercial cat diets formulated for adult maintenance and to prevent calcium oxalate urolithiasis

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Diets formulated to reduce urinary calcium oxalate (CaOx) concentrations are commonly fed to cats and otters predisposed to forming CaOX uroliths. Carnivores usually consume diets containing little oxalate but can synthesize oxalate from hydroxyproline in collagen. Increasing hydroxyproline in experimental diets from 0.4 to 4.4 g/Mcal increased cat urinary oxalate concentrations by 41% but the hydroxyproline content of cat diets is not well documented

Hydroxyproline content and proximate analysis were measured in four batches of 16 diets: one dry and canned CaOx prevention diet and one dry and canned adult maintenance diet, chosen randomly from diets sold by four US manufacturers. Metabolizable energy was calculated (NRC 2016). Nutrient concentrations differed among manufacturers, between canned and dry, and between therapeutic and maintenance diets ($p<0.0001$). Coefficient of variation among batches was $<10\%$ for most nutrients. Mean hydroxyproline concentration (g/Mcal) was 3.3 in one maintenance diet but <2 in other diets and <1 in two therapeutic and four maintenance diets. Diets contained from 5 to 25 mg hydroxyproline/g crude protein, but which diets contained more collagen could not be deduced from ingredient lists.

Feeding the highest hydroxyproline diet instead of the lowest hydroxyproline diet would potentially increase urine oxalate concentrations by 27%, but other factors may affect urolith formation. Only one maintenance diet contained more than 2 mg hydroxyproline/Mcal, but better documentation of dietary hydroxyproline is needed: to ascertain whether these results are representative of diets sold by other manufacturers; and, to clarify whether dietary hydroxyproline is affecting CaOx urolith formation in carnivores.

The soluble phosphorus content and its potential effect on dietary cation-anion difference in commercial cat diets formulated for adult maintenance and to prevent calcium oxalate urolithiasis

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Inorganic phosphorus soluble in water (solP) is readily absorbed from cat food and excreted in urine. Feeding cats experimental diets containing 3.6 g/Mcal inorganic phosphorus and calcium/phosphorus ratio <1 causes kidney changes but solP in commercial US cat diets has not been documented. Dietary cation-anion difference (DCAD) indicates how diet may affect urine pH

but how increased solP absorption affects DCAD has not been assessed.

SolP was measured in four batches of 16 diets: one dry and canned calcium oxalate prevention diet and one dry and canned adult maintenance diet, chosen randomly from those sold by four US manufacturers. DCAD was calculated assuming either 35% absorption of all phosphorus (Ardente et al. 2017) or 95% absorption of solP. Metabolizable energy was calculated (NRC 2016).

Mean phosphorus content in all diets was 1% dry matter (DM) with calcium/phosphorus ratios from 0.7-1.5. Compared to dry diets, canned diets contained more solP as % of phosphorus ($24 \pm 6\%$ vs. $15 \pm 3\%$) and had a more negative DCAD (mEq/Mcal) whether allowing for 95% solP absorption (-133 ± 25 vs. -107 ± 27) or not (-120 ± 24 vs. -90 ± 28 ; $p < 0.0001$). Mean solP content varied among diets from 0.12 to 0.36%DM (0.3 to 0.8 g/Mcal) and differed among manufacturers ($p < 0.0001$) but not between maintenance and prescription diets ($p \geq 0.08$).

Mean solP content was less than reported in European canned cat foods (1.6%DM and 35% of phosphorus, Lineva et al. 2019) and ten-fold less than diets associated with kidney changes (Alexander et al 2019). Changes in DCAD when allowing for solP content were modest. These findings suggest that solP in these diets is unlikely to substantially affect kidney function or urolith formation but whether diets formulated by other US manufacturers also contain little solP needs to be determined.

CATEGORY 3: NUTRIENT AVAILABILITY & EFFECTS ON METABOLISM & HEALTH

Plasma and whole blood taurine concentrations in dogs fed a grain-free diet with or without methionine, taurine or methyl donor/acceptor supplementation in dogs

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Taurine is a dispensable amino acid in the dog as it can be synthesized from the precursor amino acids, methionine and cysteine; however, taurine deficiency can adversely affect cardiac and retinal health in dogs. In order to assess taurine status in the dog, both whole blood and plasma taurine concentrations are often measured. Currently, there is lack of knowledge surrounding how plasma and whole blood taurine concentrations respond to a meal and to different nutrient supply. Therefore, the objective of the current study was to quantify the plasma and whole blood taurine response following a meal. Eight Beagles were pair-housed and randomly assigned to either the control grain-free diet (CON) or the control diet supplemented with methionine (MET), taurine (TAU) or creatine, carnitine and choline (CCC) in a 4x4 Latin Square Design. Dogs consumed each diet for 7 days and on d 7 a cephalic catheter was placed and a series of blood samples were collected at 0 min (fasted) and 15, 30, 60, 90, 120, 180, 240, 300 and 360 minutes following a meal. Data was analyzed as repeated measures in SAS (Version 9.4) using the PROC GLIMMIX function. Plasma taurine concentrations were elevated at 60 (134 nmol/mL), 90 (122 nmol/mL) and 180 (117 nmol/mL) minutes following a meal and then returned to fasting levels (99 nmol/mL) from 240 to 360 minutes across all treatments ($P < 0.05$). Plasma taurine concentrations were also higher in MET, TAU and CCC compared to CON across time points ($P < 0.05$). Whole blood taurine concentrations were significantly higher at 60 (262 nmol/mL), 90 (262 nmol/mL) and 120 (260 nmol/mL) minutes post-meal across all treatments and returned to fasting levels (238 nmol/mL) at 300 and 360 minutes ($P < 0.05$). Whole blood taurine concentrations tended to be higher in MET and TAU compared to CCC but CON was not different from CCC or MET and TAU across time points ($P = 0.0513$). Interestingly, both plasma (78 nmol/mL) and whole blood (228 nmol/mL) taurine concentrations were significantly lower at 15 minutes post-meal compared to fasting samples across all treatments ($P < 0.05$). This suggests that if a blood sample is collected between 1 to 2 hours after the dog has eaten, both plasma and whole blood taurine could be elevated compared to a fasted sample. Overall, these data strongly suggest that there should be a minimum of 300 minutes between meal consumption and blood collection when assessing taurine status in dogs.

Underlying differences in aromatic amino acid metabolism in young chickens selected for and against feather pecking

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In mammals, aromatic amino-acid metabolism, precisely the rate of the irreversible metabolism of tryptophan (TRP) to kynurenine (KYN), and phenylalanine (PHE) to tyrosine (TYR) contributes to the development of age-dependent behavioural disorders. In laying hens, feather pecking (FP) is a destructive behavioural disorder occurring when one individual forcefully and repetitively pecks at the plumage of conspecifics. It can lead to a decrease in egg production, sparse feather cover, injuries, and cannibalism, making it a major economic and welfare issue. FP in adult laying hens is associated with disruptions in TRP and PHE catabolism and altered central serotonergic and dopaminergic activity. However, the TRP to KYN, and PHE to TYR pathways, and their impact on the development of FP, have not yet been explored in young chickens.

As a part of a larger project, we investigated whether differences in the metabolism of TRP to KYN and PHE to TYR exist in pullets selected for and against FP. White Leghorn pullets originated from two different lines of birds bred for a high (HFP) or low (LFP) feather pecking phenotype (117 ± 2 birds/line). Blood samples from these pullets were collected at 10 and 14 weeks of age, one hour post feeding, and analyzed using high-performance liquid chromatography. A generalized linear mixed model was used to assess differences between the genetic lines on plasma concentrations of TRP, KYN, PHE, and TYR as well as the relevant ratios as an indication of the activity of TRP and PHE catabolism.

Our results revealed line differences, with HFP birds showing lower TRP ($P < 0.0001$) and KYN ($P = 0.0408$) plasma concentrations than LFP birds. KYN/TRP ratio increased over time in both lines (HFP: +18%, LFP: +24%, $P < 0.0001$) primarily because of the increase of KYN concentrations within each line (HFP: +32%, LFP: +30%, $P < 0.0001$). Finally, HFP birds showed lower PHE ($P = 0.0002$) and TYR ($P < 0.0001$) plasma concentrations, but a greater PHE/TYR ratio ($P < 0.0001$) compared to LFP birds.

These results suggest that differences in aromatic amino acid metabolism already exist in young HFP and LFP birds. Together, these underlying differences may help to predict different dietary and environmental needs of young FP and non-FP chickens and contribute to our understanding of early phenotypic markers for FP.

The effects of dietary cysteine intake on oxidation of cysteine and methionine, and on plasma

concentrations of sulfur amino acids in neonatal piglets

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Methionine (Met) is a dietary indispensable amino acid (AA) in piglets; wherein, it is known that cysteine (Cys) has the ability to reduce the Met requirement by 40%. However, effect of dietary Cys on Met is still unclear. Thus, the aim of this study was to determine the effects of graded levels of Cys on Met oxidation (transsulfuration) and Cys oxidation, and on plasma concentrations of Met, total Cys, and total homocysteine (HCY). Gastric catheters were placed in 32 intact male piglets to allow enteral delivery of a chemically defined diet. Piglets received standard chemically based diet for 5 days prior to being randomly assigned to one of the eight test levels of Cys (0, 0.05, 0.1, 0.15, 0.2, 0.25, 0.40, 0.50 g kg⁻¹ d⁻¹) with a fixed concentration of Met (0.25 g kg⁻¹ d⁻¹). Constant infusion of L-[1-¹⁴C] Met and L-[1-¹⁴C] Cys were performed for 6h on d 6 and d 8 in a crossover design to determine Met and Cys oxidation, respectively, through collection of breath and quantification of ¹⁴CO₂. Blood collection was performed at the end of each infusion day for analysis of plasma concentrations of Cys, HCY, and Met. Oxidation of Met and Cys, and plasma concentrations of AA were analyzed using PROC MIXED and PROC GLIMMIX, respectively, in SAS (version 9.4). Met oxidation, expressed as a percentage of Met dose oxidized, decreased as Cys intake increased from 0 to 0.15 g kg⁻¹ d⁻¹ ($P < 0.05$). At higher Cys intake (0.15 to 0.5 g kg⁻¹ d⁻¹), Met oxidation decreased at a slower rate ($P < 0.05$). Cys oxidation was similar ($P > 0.05$) among dietary Cys intakes; however, a significant polynomial relationship was observed between Cys oxidation and Cys intake ($P < 0.05$, $R^2 = 0.37$). Plasma concentrations of Met were not affected by Cys intake ($P > 0.05$) while plasma concentrations of Cys were greater at the highest intake of Cys (0.4 and 0.5 g kg⁻¹ d⁻¹). There were no significant differences in plasma concentrations of HCY as Cys intake increased from 0 – 0.4 g kg⁻¹ d⁻¹; however, plasma concentrations of HCY were lower at the highest Cys intake, 0.5 g kg⁻¹ d⁻¹, compared to all other diets. Increasing levels of Cys leads to a reduction in transsulfuration (Met oxidation), and to an increase in plasma concentrations of Cys that indicates the sparing capacity of Cys of Met through inhibition of the transsulfuration pathway in neonatal piglets. Furthermore, dietary Cys only decreases HCY concentrations when dietary Cys: Met exceeded 1.6 Cys: 1Met.

Investigating the effects of an increased Trp:LNAA ratio on the voluntary activity and behaviour of sled dogs undergoing incremental exercise conditioning

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The indispensable amino acid tryptophan (Trp) competes with large neutral amino acids (LNAA) for transport across the blood brain barrier, where it is converted into serotonin. Increasing the dietary Trp:LNAA ratio may favor Trp transport and increase production of central serotonin, a neurotransmitter associated with the regulation of mood and behaviour. The objective of this study was to investigate the effects of an increased dietary Trp:LNAA ratio on behaviour and activity of sled dogs. Sixteen dogs (9 females, 7 males; average age of 4.8 ± 2.5 ; average body weight of 24.3 ± 4.3 kg) were blocked by sex, age, and body weight and then allocated into treatment (n=8, TRT) and control (n=8, CON) groups. TRT and CON dogs were fed the same dry extruded diet and the TRT diet was additionally supplemented with Trp solution to reach a Trp:LNAA ratio of 0.075: 1 compared to 0.047: 1 for the CON diet. All dogs underwent a 12- week conditioning period where the distance they ran was increased each week. During weeks 0, 6 and 11, voluntary activity levels were recorded for 3 hours on both a rest day and an actively training day. Each week, immediately pre- and post- an exercise bout, a 5-minute video recording was taken to determine the time spent performing agonistic behaviours, posture changes, chewing, digging, jumping, lunging, lying down, sitting and standing. Regression analysis and PROC MIXED of SAS (v.9.4; SAS Institute Inc., Cary, NC) were used to compare differences between treatment groups and week. TRT had no effect on voluntary activity levels during week 0, 6 or 11 ($P > 0.05$). In contrast, time spent performing agonistic behaviours prior to exercise decreased for dogs receiving the Trp supplementation ($R^2 = 0.7111$, $P < 0.05$), while there was no change for CON dogs ($R^2 = 0.1028$, $P > 0.05$) throughout the conditioning period. This research indicates that increasing the dietary Trp: LNAA ratio in sled dogs' diets may help to decrease the occurrence of agonistic behaviours without affecting their voluntary activity.

Effects of essential amino acid supplementation during gestation on progeny performance and carcass quality in feedlot cattle

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Fetal programming is a process by which environmental stimuli can affect a developing fetus during gestation, which can ultimately influence lifetime productivity after birth. Long term effects of fetal programming have been evaluated in highly controlled beef cattle research experiments. However, few studies have considered these effects in an industry applied setting. To support the development of calves during pregnancy, cows have elevated nutrient requirements which includes essential amino acids such as methionine. The objective of this study was to assess if rumen-protected methionine supplementation during gestation would impact steer progeny performance and carcass quality in an applied setting. Sixty-seven gestating cows were randomly assigned to control (CON) or methionine (MET) treatments. Cows had ad libitum access to hay out of a round bale feeder and received either 0.75 kg/head/day of supplement pellet supplying 12 g rumen-protected MET/cow/day or identical pellet with no added MET, once daily in a bunk for approximately eight weeks prior to calving. The 34 steer offspring (MET n=18; CON n=16) were assigned to one of seven pens by weight and fed a corn-based grower diet for 47 days (58% corn silage, 26% alfalfa haylage, 15% soybean meal), followed by a finisher diet for 115 ± 31.5 days (78% high moisture corn, 12% alfalfa haylage, 8% soybean meal) until slaughter. Individual feed intake data were recorded daily using Insentec feeding stations. Body weights were recorded biweekly. Every 28 days, ultrasound images of back and rump fat depths were captured, and blood was collected. Three to four days before slaughter, blood was collected after steers were fasted for 17 hours. Steers then returned to their pens and had access to feed for 5.5 hours, with blood collected a second time (fed). Weight of liver, kidney, kidney fat, and pancreas were recorded at slaughter. Carcass quality, meat quality, and rib composition data were recorded 24 to 48 hours after slaughter. Data were analyzed using PROC GLIMMIX in SAS, with maternal treatment as the fixed effect, and pen as the random effect. Methionine supplementation during pregnancy increased weaning weight (MET: 311 kg, CON: 291 kg, SE =14.8 kg; $P < 0.001$), final weight (MET: 668 kg, CON: 631 kg, SE =16.8 kg; $P = 0.01$), and individual dry matter intake (MET: 13 kg/d, CON: 12 kg/d, SE = 0.5 kg/d; $P = 0.04$) during the finishing phase. However, there were no effect ($P \geq 0.05$) of maternal methionine supplementation for average daily gain or circulating blood metabolites associated with maternal

nutrition status at the beginning of the finishing phase. Hot carcass weight was greater for MET steers (MET: 372 kg vs. CON: 353 kg, SE = 9.5 kg; $P = 0.03$), while organ weights and carcass quality were not affected ($P \geq 0.05$) by supplementation. This study showed that supplementing methionine during late gestation in an industry applied setting improved some offspring performance measures but did not result in enhanced carcass quality.

Effects of metabolizable protein status and essential amino acid supplementation during gestation on progeny performance and carcass quality in feedlot steers

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During gestation, maternal nutrition status can impact a developing fetus, ultimately influencing progeny lifetime productivity. To support rapid development of calves in utero during late gestation, cows have elevated nutrient requirements including metabolizable protein and essential amino acids, such as methionine. The objective was to evaluate if maternal supplementation of protein and rumen-protected methionine during late gestation would impact steer progeny performance, and carcass quality. In a 3 x 2 factorial treatment arrangement, pregnant beef cows ($n=138$) were randomly assigned one of three protein treatments (feeding to meet 90%, 100%, or 110% of metabolizable protein (MP) requirements), with(without) 9 g/day of rumen-protected methionine (MET). Cows were fed these isocaloric diets for ~8 weeks before parturition. Fifty-six steer progeny (90% MET, $n=12$; 90% no MET, $n=14$; 100% MET, $n=9$; 100% no MET, $n=7$; 110% MET, $n=9$; 110% no MET, $n=5$) were assigned to one of seven pens by weight and followed until slaughter. They received a common corn-based grower diet for 47 days (58% corn silage, 26% alfalfa haylage, 15% soybean meal), followed by a finisher diet for 115 \pm 31.5 days (78% high moisture corn, 12% alfalfa haylage, 8% soybean meal). Individual feed intake data were recorded daily using Insentec feeding stations. Body weights were recorded biweekly. Every 28 days, ultrasound images of back and rump fat depths were captured, and blood was collected. Three to four days before slaughter, blood was collected after steers were fasted for 17 hours. Steers then returned to their pens and had access to feed for 5.5 hours, with blood collected a second time (fed). Organ weights were recorded at slaughter. Carcass quality, meat quality, and rib composition data were recorded 24 to 48 hours after slaughter. Data were analyzed using PROC GLIMMIX in SAS, with maternal treatments as fixed effects, and pen as the random effect. Feeding to meet 90% MP requirements resulted in heavier calf weaning

weights compared to 100% and 110% (262 kg, 251 kg, and 245 kg, respectively, SE = 13.9 kg; $P = 0.01$). However, maternal nutritional treatment did not affect ($P \geq 0.14$) average daily gain, dry matter intake, or feed conversion. Increasing maternal protein content tended to reduce blood serum urea concentration (90%: 2.3 mmol/L, 100%: 2.1 mmol/L, and 110%: 1.9 mmol/L, SE = 0.11 mmol/L; $P = 0.08$) at the beginning of the finishing phase. Weight of liver, kidney, kidney fat, and pancreas were unaffected ($P \geq 0.09$) by treatment. Increasing dietary MP content from 90%, 100% to 110% reduced grade fat thickness (15.5 mm, 14.7 mm, and 11.8 mm \pm 1.11 mm, respectively; $P=0.04$) and yield grades (2.7, 2.9, and 2.3 \pm 0.17, respectively; $P=0.04$), but increased lean meat yield (49.5 %, 49.4 %, and 50.6 % \pm 0.3 %, respectively; $P=0.04$). This study shows that maternal protein content may improve steer progeny carcass traits while maintaining animal performance during the finishing phase.

Effects of 12 weeks of incremental conditioning and supplemental dietary tryptophan on pre, mid, and post-exercise heart rate and respiratory rate in sled dogs using real time telemetry technology

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Exercise training and nutritional interventions have dramatic effects on whole body physiology and the dynamic responses associated with exercise. Tryptophan (Trp) is an indispensable amino acid and a precursor of the neurotransmitter and metabolite, serotonin. Serotonin can elicit effects on both cardiac and respiratory systems through receptors in the brain, however the possible interaction with exercise training remains unknown. Therefore, the objective of this study was to investigate the effects of both supplemental dietary Trp and a 12-week incremental exercise regimen on heart rate (HR) and respiratory rate (RR) at various levels of activity in sled dogs. Sixteen client-owned Siberian huskies were used, with a mean age of 4.8 ± 2.5 years and body weight (BW) of 24.3 ± 4.3 kg. Dogs were blocked for sex, age and BW and randomly allocated to receive either a dry extruded control diet or the control supplemented with Trp to achieve a Trp to large-neutral-amino-acid (LNAA) ratio of 0.075: 1 (treatment). All dogs participated in a 12-week incremental exercise regimen with exercise challenges occurring at baseline and every 3 weeks following. During exercise challenges, teams of 4 dogs (2 Trt and 2 Ctl) ran at a pace of 15km per h for 4 km. Heart rate and RR were recorded through use of electrocardiogram electrodes and custom fit thoracic

respiratory bands from EMKA Technologies (EMKA Tech., Falls Church, VA, USA), and these data were gathered prior to (resting), during (working), and following (recovery) each exercise challenge. Data were analyzed using PROC TRANSREG of SAS (v. 9.4; SAS Institute Inc., Cary, NC), followed by PROC GLIMMIX of SAS to compare differences between treatment group and week. To assess the strength of linear relationships between time required for HR and RR to return to resting levels with week, PROC CORR of SAS was used where appropriate. Diet had no effect on HR at any stage of activity ($P > 0.10$); however, through 12-weeks of incremental conditioning, both working and recovery HR decreased from baseline ($P < 0.05$). Reductions in resting HR were evident between the first and second exercise challenges ($P < 0.05$), but no changes occurred thereafter. Time required for HR to recover to resting levels post exercise decreased with increased training duration ($P < 0.05$). Resting and post-exercise recovery RR consistently decreased over the study; however, no such effects were reported with working RR ($P > 0.10$). Recovery time post exercise for RR also decreased over 12 weeks ($P < 0.05$) with treatment dogs' recovering quicker compared to Ctl dogs (Trt: $r = -0.421$, $P < 0.05$; Ctl: $r = -0.307$, $P > 0.10$). Ultimately, these data indicate that exercise, independent of Trp supplementation, had a positive impact on the dogs' capacity to perform bouts of aerobic exercise as seen through reductions in both HR and RR. Trp supplementation had no effect on HR but may have improved the dogs' ability to recover RR following a bout of exercise. Overall, these findings suggest that repetitive bouts of exercise result in an improvement in cardiorespiratory fitness which then aids in performance during mid-distance races.

Apparent digestibility of protein, energy and amino acids of different feed ingredients for rainbow trout (*Oncorhynchus mykiss*)

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The variable nutrient content and digestibility of the most practical feed ingredients of fish diets is a contested issue, therefore, knowledge about the nutritional value of feed ingredients is necessary. A digestibility trial was carried out to determine the apparent digestibility coefficients (ADCs) of macronutrients and amino acids in

various feed ingredients: poultry by-product meal (PBM), turkey meal (TM), feather meal (FEM), porcine meat and bone meal (PMBM), canola meal (CM), sunflower meal (SFM), and corn protein concentrate (CPC) for rainbow trout (75.3 ± 3.81 g, mean \pm SD). A reference diet and experimental diets (consisting of 70% reference diet and 30% of each test ingredient) were prepared. Yttrium oxide was used as an external digestibility marker. Fish were stocked in 50-L fiberglass tanks equipped with settling columns for faeces collection in a semi-recirculated system (24 tanks). Of the test ingredients, the SFM had the highest ADCs for crude protein (95%) ($p < 0.05$) while the FEM (69%) had the lowest values, followed by the CPC (78%) and PBM (79%). The ADCs of crude protein were not significantly different for the TM (84%), PMBM (85%), and CM (87%) ($p > 0.05$). The SFM had the highest ADCs for all estimated amino acids while the FEM had the lowest values among the test ingredients. The ADCs of macronutrients and amino acids of different protein ingredients showed significant differences ($p < 0.05$), indicating their variable availabilities in examined feedstuffs. This variability must be taken in consideration when formulating fish diets.

CATEGORY 4: GUT PHYSIOLOGY & HEALTH

Dietary therapeutic aureomycin improves ileal lysine digestibility independent of gut aminopeptidase n and cationic aa transporter-1 expression in weaning pigs fed crystalline Lys supplemented low-crude protein diets

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An improved understanding of the modes of action of in-feed therapeutic antibiotics for improving the growth performance of weaning pigs may contribute to the development of effective alternative dietary strategies. A total of 72 crossbred (Duroc×Yorkshire×Landrace) barrows, weaned on d 19-21 of ages, were randomly assigned to two low-crude protein (CP) corn and soybean meal-based diets supplemented with crystalline L-Lys, L-Thr, D,L-Met and Trp with or without antibiotic (550 mg

aureomycin/kg diet) for 21 d according to a randomized complete block design. Nitrogen (N) balance was performed on d 15 of feeding for 7 d with 9 pigs from each diet being housed in individual metabolic crates for the collection of total urinary excretion and fecal samples for the last 5 d. The regular and oxidized acid hydrolysis procedures were followed to determine the ileal CP and amino acid (AA) digestibility from both the control (n=18) and the antibiotic (n=20) diets by using titanium dioxide (0.30% in the diets) as the digestibility marker. The enzyme kinetics of the jejunal and ileal tissue homogenate aminopeptidase N (APN) activities were determined in jejunal and ileal samples using L-alanine-p-nitroanilide (0-16 mM) as a substrate. Abundances of both jejunal and ileal APN and the cationic AA transporter-1 (CAT-1) protein and mRNA were examined by Western blotting and quantitative real-time RT-PCR with β -actin as a house-keeping control, respectively. There were no differences ($P>0.05$) in the apparent ileal CP digestibility (control, 67.7 ± 3.7 vs. antibiotic, $76.3\pm1.8\%$;

SEM; n=9) and the apparent N retention (control, 64.8 ± 0.9 vs. antibiotic, $65.5\pm2.4\%$; SEM; n=9) between the two the diets. Antibiotic supplementation enhanced the apparent ileal Lys digestibility (control, 78.4 ± 1.6 vs. antibiotic, $82.4\pm0.9\%$; SEM; $P<0.05$). Although we identified 14 potential N-glycosylation sites within the porcine gut APN protein catalytic pocket, no differences were observed ($P>0.05$) in the APN enzyme kinetics between the two diets in terms of maximal enzyme activity and affinity. Therefore, gut APN functionality was unlikely affected by N-glycosylation because of their similar substrate affinity. Moreover, there were no differences ($P>0.05$) in the jejunal and ileal APN protein and mRNA abundances between the two diets. Although Na⁺-independent CAT-1 is regarded as the primary apical Lys transporter in the gut, no differences were found ($P>0.05$) in the jejunal and ileal CAT-1 mRNA and the jejunal CAT-1 protein abundances between the two diets, and even lower ($P>0.05$) ileal CAT-1 protein abundance was observed in the antibiotic group. Our results collectively suggest that improved growth performances of weaning pigs by dietary therapeutic aureomycin were not attributed to improved efficiency of the digestive and post-absorptive utilization of dietary CP, however, increased apparent ileal Lys digestibility was noted independent of the gut terminal protein hydrolase APN and CAT-1 expression.

Effects of saponins on nematode activity, rumen fermentation and growth performance of growing lambs

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Saponins, one of the most valuable plant secondary metabolites PSM. Yucca Schidigera extract (YSE) contains two active components: a glycol component that binds ammonia and a fraction of steroidal saponins. Thus, the objectives of this study were to evaluate the effect of two source of YSE as source of steroidal saponins on nematode activity, rumen fermentation and growth performance of growing lambs. Eighteen growing crossbred male lambs (30.46 ± 0.25 kg) were divided into three similar groups (n=6) randomly according the body weight BW. Animal were fed on the basal diet (60 % concentrate feed mixtures: 40% wheat straw). The control group 1 fed on: the basal diet without supplementation, group 2: basal diet plus oral administration of 150 μ l of YSE/head/ day (YSE consisted of 150 g commercial YSE powder soluble in 1000 ml water), and group 3: basal diet plus oral administration of 150 μ l of YSE/head/ day (YSE consisted of 150 g local Yucca Schidigera leaves YSL powder soluble in 1000 ml water). Results showed that YSE addition to group 2 and 3 decreased total nematode eggs (Nematodurus species and Trichostrongylus(and Eimeria species per gram feces by 80-100% and yucca extracts give negative response after 30 days. Results indicated that ruminal NH₃-N concentration, acetic, total protozoa and differential were significantly decreased ($P < 0.05$) in group 3 followed group 2 (YSE). Average daily gains (ADG), feed conversion ratio data indicated that group 2 and 3 more efficient than the control. Thus, these results give a recommendation to using YSE as source of saponins to increase sheep parasitic resistance, more stable rumen conditions (increase propionate production, reduce NH₃-N and protozoal populations) help contribute to sheep health and longevity.

Effect of total starch and resistant starch in commercial extruded dog foods on gastric emptying rate in sled dogs

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Diabetes and obesity are among the most common nutrition-related disorders facing the companion animal community today. Research completed in humans suggests that gastric emptying rate (GER) may

be associated with an individual's risk for diabetes and obesity. The following study aimed to investigate the effects of starch source in commercial extruded dog foods on the GER of 11 healthy adult sled dogs (5.63 \pm 0.72 years; mean \pm SEM). This study was approved by the University of Guelph Animal Care Committee (AUP#3650). The four diets tested were classified based on the various starch sources they contained: traditional (corn, wheat), grain-free (peas, lentils, potatoes, tapioca), whole grain (oatmeal, brown rice, rye) and vegan (brown rice, oatmeal, peas, potatoes). Analysis of the total starch (TS) and resistant starch (RS) content of the diets was measured using standard AOAC methods (996.11 and 2002.02). The diets and a control (50% w/vol glucose solution) were fed in an amount that provided 25 grams (g) of available carbohydrates (AvCHO). Each dog received each diet once, and the control twice, in a randomized crossover design. Additionally, 16.30 mg/kg body weight (BW) of Acetaminophen (Ac) was fed to each dog immediately prior to offering the test diet or control. Pre- and post-prandial blood samples were taken at: -30, 15, 30, 45, 60, 90, 120, 150, 180, 210, 240, 270, 300, 360, 420 and 480 minutes. Serum Ac concentrations were assessed via a commercially available spectrophotometric assay, while GER and stomach Ac concentrations were measured using a mathematical model previously described by Stahel et al. (2005). Data was analyzed using a repeated measures ANOVA, followed by a Tukey-Kramer post-hoc test when significance occurred ($p < 0.05$). Treatment and leg were used as the fixed effects, and dog was used as the random effect. The first order slow gastric emptying rate constant (kSB2) and total emptying were significantly ($P < 0.05$) greater when the dogs were fed the grain-free diet compared to the traditional diet ($P = 0.0225$) and glucose control ($P = 0.0124$). The first order fast gastric emptying constant (kSB3) was also significantly ($P < 0.05$) higher when the dogs were fed the grain-free diet in contrast to the traditional ($P = 0.0250$), vegan ($P = 0.0176$) and control diets ($P = 0.0176$). Due to the rate of emptying, the area under the Ac curve was highest for the grain-free diet and lowest for the control ($P = 0.0042$). As hypothesized, the first order elimination constant (kel) did not differ between treatments. Overall, emptying was greater and more rapid in the dogs when fed the grain-free diet, which contained the lowest level of TS ($34.03 \pm 0.23\%$) and the highest level of RS ($0.52 \pm 0.007\%$). This higher GER may increase post-prandial glucose and insulin levels and might therefore play a role in prevention and treatment of metabolic diseases.

Characterizing two multi-functional processive endoglucanases for their potential applications as exogenous cellulases in pig nutrition

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The poor digestive utilization of dietary fiber, particularly the cellulose in commercial swine diets limits the profit margins of Canadian and global swine industry and leads to nutrient emission into the environment. The typical microbial degradation of the natural crystalline celluloses in plant feeds involves the concerted actions of endoglucanases, exoglucanases and β -glucosidases. Recently, a multi-functional processive endoglucanases from the porcine gut microbiome, called p4818Cel5_2A, has been identified and biochemically characterized for its simultaneously digestion ability towards hemi-celluloses and crystalline celluloses in the diets to great potential in swine nutrition application (Wang et al., 2019, Scientific Reports 9:13630). Herein, we have further compared this processive endoglucanases with a truncated thermophilic cellulase termed tCel5A1, from *Thermotoga maritima* (Basit and Akhtar, 2018, Biotechnology and Bioengineering 115:1675-1684). The pre-requisite features for the functional exogenous enzyme were analyzed, including the anti-oxidation stability under air-borne conditions; thermo-stability for the feed pelleting at 80-90 °C for 8-10 min; as well as the resistance to the porcine gastric acidic pH and to the proteolytic actions of pepsin, trypsin and chymotrypsin. Specifically, the p4818Cel5_2A cellulase activities were shown to be enhanced by 40-50% through i) including an artificial anti-oxidant dithiothreitol (DTT) at 5mM in the cell lysis buffer and the CMC substrate buffer; and ii) thoroughly purging the cell lysis and substrate buffers and headspace of incubation vials with pressured N₂. The CMC based cellulase activity assay results suggest that both p4818Cel5_2A and tCel5A1 cellulases are likely susceptible to auto-oxidation under in vitro processing conditions. Further with the three-dimensional modeling of both p4818Cel5_2A and tCel5A1, four residues were identified around the catalytic site of p4818Cel5_2A, relative to only one Cys residue located in the substrate binding site of tCel5A1, indicating that these Cys residues might be associated with the auto-oxidation by air-borne O₂ for both enzymes. Future work on enzyme engineering and/or post-harvesting treatment such as coating may be essential to enhance their functionality as exogenous cellulases.

Intestinal parasitic burden and personality of growing horses may affect the relationship among predicted and measured digestible energy intake and average daily gain: a case report

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The objective was to evaluate the relationships among measured digestible energy intake (DEIM), predicted DEI (DEIP) according to the NRC 2007, and predicted DEI with actual average daily gain (DEIA) of one colt and two fillies. Feed intake and body weight (BW) of Horse 1 (386 kg, 11 mo, Appendix, colt), Horse 2 (312 kg, 11 mo, QH, filly), and Pony 3 (189 kg, 10 mo, Pony of the Americas, filly) were recorded over a 56-d feeding trial to examine if early-study intestinal parasitic burdens would increase the DEI necessary to maintain a body condition score (BCS) of 5 and reduce average daily gain (ADG) potential. Equids arrived and adapted to diets 14 d prior to data collection. Equids consumed 2.5-3.0% BW/d in dry matter intake of fescue hay and mixed grain concentrate. Predicted DEI (DEIP) was determined using the NRC 2007 equation, $DE (Mcal/d) = (56.5X - 0.145) \times BW + (1.99 + 1.21X2) \times ADG$, where X = age in months, BW = body weight in kg, and ADG in kg/d. Mean DEIM was the total DEI required to maintain a BCS of 5.0±0.5/9.0. Digestible energy (DE) was calculated according to Pagan's equation for forage and $3.25812 + (0.0522 \times \text{fat}) - (0.03417 \times \text{fiber})$ from the feed tag for concentrates. Kilogram intake was multiplied by the DE to arrive at the total DEI/d. Scale BW and BCS were measured weekly at 0730 h prior to feeding. DEIP ADG was adjusted using the difference in initial and final BW divided by 56 to arrive at ADG for DEIA. Egg per gram using in-house fecal flotations were performed prior to d 0 and equids were dewormed. Pony 3 exhibited a large rebound in intestinal parasites and was dewormed a second time early-study. Horse personality was rated sedate, average, or alert by a trained equine professional. Results were analyzed by one-way analysis of variance with treatment groups DEIP, DEIM, and DEIA for Equids 1-3 and combined. Significant differences in the means were compared using Tukey's multiple comparisons. Mean DEIM of 24 Mcal/d, 18.87 Mcal/d, and 14.17 Mcal/d and mean ADG of 0.37 kg/d, 0.34 kg/d, and 0.14 kg/d were recorded for Horse 1, Horse 2, and Pony 3, respectively. There was a significant difference ($p < 0.01$) between DEI estimations, with DEIM significantly ($p < 0.001$) greater than DEIP and DEIA for all equids. Horse 1 rated alert with a low parasite burden, yet exhibited approximately ½ the ADG predicted by DEIP despite a 0.91 Mcal/d difference between DEIM and DEIP. Horse 2 rated sedate with low parasitic burden and exhibited no significant

($p = 0.07$) difference in DEIM and DEIP. Pony 3 exhibited a 2x greater difference in DEIM vs. DEIA than DEIP vs. DEIA and a moderate-severe parasitic burden. Pony 3 consumed the most DEIM above DEIP yet gained minimal weight. This study demonstrates the effects of innate factors on DEI. More animals are warranted to fully examine the relationships between predicted and actual DEI in growing horses, as well as the impact of intestinal parasite burden and personality on DE requirements.

Prebiotics plus novel bacterial-derived prebiotic shift fecal microbiota, metabolites, and IgA in healthy adult dogs

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A study of diets containing a novel bacterial-derived prebiotic (Culbac; TransAgra, Storm Lake, IA) and mixed prebiotics was done to evaluate fecal microbiota, fecal metabolites, and gut immune health in healthy female and male adult dogs ($n = 24$; 5.74 ± 2.18 years; 9.30 ± 1.32 kg). The study protocol was first approved by the facility's Institutional Animal Care and Use Committee (Susquehanna, PA) and followed throughout. Four test diets (control, Culbac, prebiotics, and prebiotics + Culbac [Crude Protein 25%, Fat 14%, Fiber 10% as-fed]) were fed twice daily to maintain body weight for 21 days in a randomized-crossover design. Fresh fecal samples were collected on days 0 and 21 for IgA and microbiota evaluation (16S rRNA V4 region and qPCR), and on day 21 for fecal metabolites analysis. Data were analyzed by ANOVA (SAS v9.4, Cary, NC) for between-treatment effects, and paired t-test or Wilcoxon for time effects. Fecal E. coli was significantly ($P < 0.05$) lower with the prebiotics diet versus control, while fecal Fusobacterium was lower ($P < 0.05$) with both prebiotic-containing diets versus control. Fecal Lactobacillus significantly increased ($P < 0.05$) from baseline with the prebiotics diet. Both prebiotic-containing diets elicited greater ($P < 0.05$) fecal acetate, propionate and delta IgA, versus control diet. The prebiotics + Culbac diet decreased ($P < 0.05$) fecal metabolites isovalerate, isobutyrate, phenol, and indole versus control. Overall, prebiotics and prebiotics + Culbac elicited changes in fecal metabolites, IgA, and microbiota that suggest gut health benefits.

What do we know about nutritional requirements of equines after gastrointestinal surgeries and what can be improved?

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Equine postoperative nutritional requirements (NR) are largely unknown. They presumably vary according to case severity, type of surgery, environment, predisposition to diseases, previous nutritional and fitness state. Supportive diets aim to improve wound healing and immunocompetence, shorten hospitalization length and preserve patient's energy and protein reserves. Due to the lack of specific studies in surgical recovering equines, feeding protocols are based on clinical experience, NR of healthy horses and human guidelines. When a proper gastrointestinal function and intake capacity is observed, the enteral route is preferred. Otherwise, parenteral nutrition is suggested. The decrease, up to 20%, in energy requirements, due to postoperative stall confinement and feed withdrawal, likely partially compensates the higher needs during surgical recovery. Therefore, studies recommend meeting the resting energy requirement (RER) of 100 kJ/kg BW/day digestible energy (DE) initially. However, indirect calorimetry showed approximately 10% increased resting energy expenditure in healthy geldings after experimental exploratory laparotomy. Nevertheless, "permissive underfeeding" providing at first 60–70% of RER enterally or 80% via parenteral route to inactive sick horses, other than burn or head trauma cases, was suggested as well. Parenteral nutrition of approximately 75% of RER did not show improvement in recovery after resection and anastomosis of a strangulated small intestine compared with postoperatively starved horses. During the first 3 days, 50% of RER has been recommended to avoid refeeding syndrome in horses nutritionally deprived for several days. Contrarily, overfeeding is associated with poorer outcomes and complications e.g. dehydration, hyperlipidemia, endotoxemia and laminitis induced by hyperglycemia and hyperinsulinemia. After severe injury, protein catabolism occurs despite the availability of other energy sources. Thus, providing the higher end of crude protein requirement (CPR) of healthy horses at rest (1 g CP / 100–200 kJ DE) was proposed to enterally feed sick equines and after surgery. Parenteral formulations containing 1 g CP/100 kJ DE are suggested after exploratory laparotomy and 1 g CP/168–210 kJ DE for colic patients undergoing clinical treatment, due to the higher bioavailability through this route. Colic-associated renal insufficiency may be an exception, since protein waste has a detrimental effect in this case. Supplementation of conditionally essential amino acids e.g. arginine and glutamine, omega-3 fatty acids, butyrate, zinc, selenium and vitamin E have been shown beneficial effects in intestinal integrity and permeability in pigs,

rats, chickens and ponies with intestinal diseases. Despite the unknown postoperative requirements, fiber provision is recommended considering its role in intestinal health, digestion and nutrients absorption. Complementarily, it commonly substitutes simple carbohydrates as an energy source in supportive enteral diets. In conclusion, specific and practical recommendations for feeding equines after gastrointestinal surgeries are lacking due to their uncertain NR. Nowadays, the ideal energy supply is a big subject of debate. More studies about the benefits of supplements, fibers and essential fatty acids during postoperative of horses are still necessary. Determining NR in each case is a promising field for future researches. Then, specialized feeding protocols can be developed, making an adequate outcome possible.

CATEGORY 5: OBESITY & ENERGY BALANCE

Efficacy of a weight loss program in naturally obese client-owned dogs: preliminary results

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Introduction. Veterinarians have to deal with a growing number of obese dogs [1]. These patients deserve special attention because of their higher risk to develop concurrent diseases and their shortened lifespan [2]. Although experimental weight loss programs show high success rates, they do not represent faithfully the actual veterinary daily practice. The aim of this study was to estimate the efficacy of a weight loss program in field conditions.

Animals, material and methods. Twenty-eight naturally obese (body condition score (BCS) ≥ 7 on a 9-point scale [3]) adult privately-owned Labradors and Golden Retrievers were recruited for this study and declared healthy (except for obesity) based on clinical examination, blood biochemistry and CBC count. During the program, all dogs received a specially formulated dry diet. The mean composition of the diet was the following (% Dry Matter): proteins 35, nitrogen-free extract 26, lipids 11, metabolizable energy 315kcal/100g. Dogs first underwent a transition phase of 1 month to acclimate to the new diet. Then, daily metabolizable energy

requirement (MER) was calculated on the estimated ideal body weight (BW) using the equation $MER = 132 \times \text{ideal BW}^{0.75}$ with a correction factor depending on the BCS: 0.6, 0.5, 0.4, respectively for BCS 7, 8, 9/9. The owners weighed their dogs twice a month, and contact was maintained every month by phone or email. Dogs were assessed at the clinic every 3 months, and adjustments to dietary plans were provided when necessary. All data were expressed as mean (\pm SD), except weight loss (WL) rate expressed as median (range).

Results. Four dogs were excluded: one lived in a multi-dog household, raising concern about poor compliance, one lost weight during transition phase and two whose owners failed to comply with the protocol. Dogs were: 13 females (9 neutered) and 11 males (7 neutered). The mean (\pm SD) initial BW was 39.0 ± 5.5 kg with a mean BCS of $7.7 \pm 0.6/9$. The mean BW at the end of the WL phase was 34.4 ± 5.2 kg, with a mean BCS of $5.8 \pm 0.8/9$. The mean energy allocation inducing WL was first 73 ± 10 , and corrected downwards to 71 ± 9 kcal/kg ideal BW^{0.75}. The mean duration of WL was 27 ± 9.5 weeks, with a mean WL of $11.9 \pm 4.1\%$ of initial BW and a rate of WL of 0.45 ($0.35 - 0.61$)% per week.

Discussion. This rate of WL is slower than what is described in experimental studies where the energy restriction can be more severe and environmental factors are easier to control [4], but matches with results of previous clinical studies [5]. Dietary non-observance was the main limitation in this clinical trial. This highlights the difficulties encountered in WL programs in daily practice, as well as its achievability. Active involvement of the owners, constant monitoring and tailoring of the diet to individuals are major factors influencing success.

Conclusion. This study showed that conventional weight loss programs are achievable in clinical practice, with a constant tailoring, but the expected WL rate has to be adapted to the field reality.

Characterization of communication between companion animal veterinarians and clients relating to pet weight

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Introduction: Maintenance of healthy body weight can have significant benefits for the health, quality of life, and longevity of companion animals. Research indicates that weight may be a difficult subject for veterinarians to address with clients, particularly when a pet is overweight

or obese. Optimized communication around weight may improve outcomes of weight management for overweight and obese pets.

Objective: The objective of this study was to characterize the communication processes and content of weight-related conversations occurring between veterinarians and clients.

Methods: Veterinarians in Southern Ontario, Canada were randomly recruited and a sample of interactions with their clients was audio-video recorded. Veterinarians and clients completed respective post-interaction surveys. Recorded interactions have been reviewed for mention of weight, and these segments are currently being analyzed to provide a comprehensive assessment of the communication processes and content specific to weight-related veterinarian-client interactions. Example coding includes who initiated the weight conversation, identified components of a comprehensive nutritional history, the use of humour, etc.

Findings: A total of 911 appointments, involving 60 veterinarians (response rate 19%), were recorded. Of these interactions, 601 contain an exchange involving the mention of a veterinary patient's (dog or cat) weight. Analysis is currently in process, with final results to be presented.

Implications: Findings will provide a detailed description of communication processes and content currently used by veterinarians to engage clients in conversations about an overweight or obese patient. This understanding will identify existing communication gaps in order to inform future research as well as potential best-practices for engaging clients in conversations about an overweight or obese pet.

Assessing pet owners' readiness for behaviour change relating to companion animal obesity

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Introduction: Obesity is a growing concern for companion animals, and often related to factors within an owner's control that can be changed. The transtheoretical model is a theoretical framework of behaviour change that posits that people move non-linearly through stages of change (SOC). Evidence from various human healthcare settings suggests clients are more likely to make successful changes, like those required to address pet obesity, when a health practitioner uses communication techniques appropriate for the client's

current SOC.

Objective: The objective of the current study is to assess pet owners' SOC in relation to managing their overweight or obese pet.

Methods: Pet owners attending a preventive care appointment with their pet are being recruited from conveniently selected companion animal veterinary practices in Southern Ontario, Canada. Participants have been asked to complete a pre-assessment survey gathering demographic information. Next, a researcher body condition scores the pet owner's cat or dog. Participants with a pet at a body condition score ≥ 6 complete a post-assessment survey. The post-assessment survey contains two scales, adapted for use in veterinary medicine, that assess a participant's SOC according to the transtheoretical model.

Findings: Approvals for research involving human participants and use of animals have been obtained. Data collection is currently in progress. Preliminary results will be presented.

Implications: Developing a way to assess and understand the SOC of owners of overweight or obese pets can be used to help inform veterinarian's application of specific communication approaches (e.g., motivational interviewing) that are appropriate for a pet owner's current SOC.

The use of home pet health technology in a multiple cat household weight management program in the US and Canada

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Approximately 60% of cats in the United States are overweight (26% body condition score 6-7/9) or obese (34% body condition score 8-9/9). The purpose of this study was to determine whether a home pet health technology ecosystem (PHTE) was an effective tool in a feline weight management program (WMP) in multiple cat households. A 12-week WMP of indoor-only 2-3 cat households managed by American and Canadian veterinarians were randomized to a technology group (with a PHTE) or traditional group (standard of care without a PHTE). Both groups received Hill's Metabolic prescription weight loss diet, using the Pet Nutrition Alliance calculator to recommend caloric intake for a target of 1% body weight loss per week. Monthly veterinary clinic weigh-ins were recommended. The technology group received a PHTE (digital scale, smart feeder, activity monitor, and webcam), the components of which were based on a pilot study. Body weight, food

intake, behaviors, and device notes were recorded by pet parents. Quality of life was measured at various time points using the validated online tool Vetmetrica. Veterinary/pet parent feedback was collected through a pre and post WMP survey and owner diaries. Approval was obtained from the University of Guelph for animal use and research ethics, and from pet parents for presentation and publication. Twenty of the 51 enrolled cats completed the study; 10 in the traditional group and 10 in the technology group. 60% of cats in the traditional group and a 100% of cats in the technology group lost weight. Average weekly weight loss percentage was significantly higher ($p = 0.022$) in the technology group (0.70%) compared to the traditional group (0.17%). Good client feedback and an excellent Net Promoter Score (NPS) of 80 indicate an overall high satisfaction with the PHTE. Pet parents found the smart feeder was a very valuable addition to the WMP (excellent NPS of 80) followed by a home scale (good NPS of 0). The activity monitor (needs improvement NPS of -40) and the webcam/treat dispenser (needs improvement NPS of -60) while liked by pet parents, were not seen as valuable additions to the WMP. The potential advantage of these devices may have been limited due to the peripheral role they played. Trends in quality of life and activity counts will be presented, as well as behaviors related to smart feeders. Preliminary results suggest that the quality of life metrics improved throughout the WMP while average activity counts remained largely unchanged. These findings suggest streamlining the PHTE for cat weight management with the digital scale and smart feeder as the preferred components.

A survey of Canadian veterinary teams on determination of energy requirements for different life stages and weight loss in dogs

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The determination of energy requirements is an essential component in treating and preventing obesity in dogs. Presently there is no data describing if and how veterinarians (VET) and registered veterinary technicians (RVT) are providing feeding recommendations in Canada. The objective of this study was to assess how veterinary teams are determining energy requirements for different life stages and weight loss in dogs. Ethics approval for this study was obtained from the University of Guelph Research Ethics Board (REB #17-11-001). An internet survey was created using the Qualtrics platform (Qualtrics, 2020) and distributed to veterinary professionals via social media, email, and

postcard distribution at veterinary conferences. The survey contained a total of 51 questions consisting of predominately multiple-choice questions and was formatted into four distinct sections; puppy, adult maintenance, adult weight loss, and demographics. Descriptive statistics were used to summarize the data (Excel 2019, v16.33) and multinomial logistic regressions were employed to assess the effect of demographics (role in veterinary practice, graduating year, practice type, and species examined in practice; SAS Institute Inc. 2020). Of the 343 completed surveys, 80% of respondents provided a specific feeding recommendation with a majority using reference materials such as an online portal or feeding guidelines on the package to determine energy requirements (51%). The number of veterinary professionals determining energy requirements by calculation was highest for adult weight loss (36%) compared to adult maintenance (31%), and puppies (20%). Of those, RVTs were two times more likely to tend toward calculating energy requirements than VETs for puppies ($p=0.0026$), yet no differences were observed for adult weight loss and adult maintenance. Graduates from 2010-2019 were more likely to calculate energy requirements for adult dogs compared to graduates from 1980-1989 (OR 0.324), 1990-1999 (OR 0.448), and 2000-2009 (OR 0.604) ($p=0.0199$). Similarly, the graduates from 2010-2019 were more likely to calculate energy requirements for obese dogs compared to graduates from 1980-1989 (OR 0.281) and 2000-2009 (OR 0.535) ($p=0.0237$). Additionally, veterinary professionals in primary care clinics (OR 0.195) and emergency clinics (OR 0.124) were less likely to tend towards calculating than those in specialty/referral clinics for adult dogs ($p=0.0105$). Lastly, veterinary professionals in mixed animal clinics were less likely to calculate compared to small animal clinics for obese dogs (OR 1.945; $p=0.0237$). Given these findings, it is evident that there is a wide variation in how veterinary teams determine energy requirements and provide feeding recommendations. Further research is required to understand the impact of nutrition education over the next decade and to determine the most reliable energy equations to be used in veterinary practice for dogs of different life stages and those requiring weight loss.

Glycemic response of healthy horses fed through nasogastric tube with a complete enteral nutrition

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Postoperative nutritional support aims to preserve the patient's immunocompetence, favor wound healing

and decrease the hospitalization period. Hyperglycemia has negative effects on these processes and is a risk factor of endotoxemia and laminitis. This phase I study proposed to assess the glycemic response of horses fed with a commercial (Equisave® - Quimtia - Brasil) complete enteral nutrition, determining the safe dosage to be further tested in hospitalized horses. It contains whey protein, pre-gelatinized rice, micronized soy, grinded alfalfa hay, organic minerals, vitamins and probiotics. The product guarantee levels are: moisture (max): 12,5%; crude energy: 4.000 kcal/kg; crude protein (min): 20%; crude fiber (max): 10%; ether extract (min): 9% and ashes (max): 6%. Eight 3-4 years old healthy experimentation Arabian geldings, average body weight (BW) of 299,38 ± 19,6 kg, were kept in a paddock with hay and water ad libitum during the trial. The treatments (TREAT) consisting of 0% (only water), 50%, 75% and 100% of the recommended dose (1kg product/100kg BW) were solubilized in a 3 water/1 product ratio. Single fractional induction through nasogastric tube, adequate to gastric capacity, occurred after 12 hours of fasting. The animals and treatments composed a double latin square (DLS) with 3 days of washout. Blood was collected from jugular vein in tubes with Fluoride/Sodium EDTA at 25, 35, 45, 55, 65, 80, 95, 110, 125, 145, 155, 170, 180 minutes, 6, 9 e 12 hours after feeding. Plasma glycemia was measured by Randox Rx Daytona (Randox®, UK) with GL 3815 commercial kit. Data were analyzed by Statistical Analysis System (SAS Institute Inc., 2010) (confidence interval: 95%). The means and standard deviation of the area under the curve (AUC) were: 0% = 70384,81 ± 6214,07; 50% = 107698,47 ± 20388,38; 75% = 119288,13 ± 19850,43 e 100% = 123532,53 ± 16923,05. The means (mg/dL) and standard deviation of the glycemia were: 0% = 101,75 ± 10,03; 50% = 171,08 ± 42,84; 75% = 179,60 ± 41,71 e 100% = 183,66 ± 38,08. Through GLM procedure, the period, DLS and animal in the DLS had statistically equals AUC ($P>0,05$). Studentized Tukey's test showed that TREAT 50%, 75% and 100% had statistically equals AUC and glycemia means ($P>0,05$), different than TREAT 0% ($P<0,05$). The glycemic peak of all TREAT occurred 180 minutes after induction. Processed carbohydrates source e.g. pre-gelatinized rice favors the absorption in small intestine, affecting the glycemic peak. The return to basal glycemia (around 95 mg/dL) occurred between 9 (50%) and 12 hours (75 and 100%). The intestinal microbiota profile, although not evaluated, and the high protein content may have contributed to the retarded peak and prolonged hyperglycemia. Standard commercial concentrates commonly cause a quick glycemic increase, and the beneficial effect of a delayed peak was observed during this product's test. Concluding, the different doses that represent a caloric increment had similar effects on glycemia that may compromise the animals' health. It is recommended to reformulate the product suiting the protein and fast-digesting carbohydrates content. A digestibility essay is suggested before proceeding to clinical trials.

The effects of varying amylose levels in different diets on digestibility and glycemic response in canines

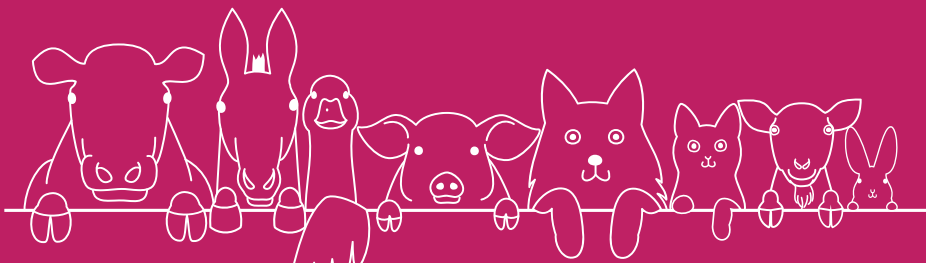
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Many pet owners feed their beloved pets commercially prepared diets that are formulated to meet nutritional requirements based on standards set by the Association of American Feed Control Officials (AAFCO). Some of the commercially fed diets for dogs incorporate pulses, resulting in a low-glycemic response. The slow release of glucose into the blood stream is caused by decreased rates of digestion due to increased amounts of amylose in pulse crops. Starch in high-amylose crop varieties tends to have a high gelatinization temperature and can better preserve the granular and crystalline structure during processing, which shows greater resistance to amylolysis. For this study, it is hypothesized that dog diets with higher levels of amylose will produce a low glycemic response due to decreased rates of digestion. To establish the glycemic response, six diets were formulated using either grains or pulses at an inclusion level of 20% available starch with varying

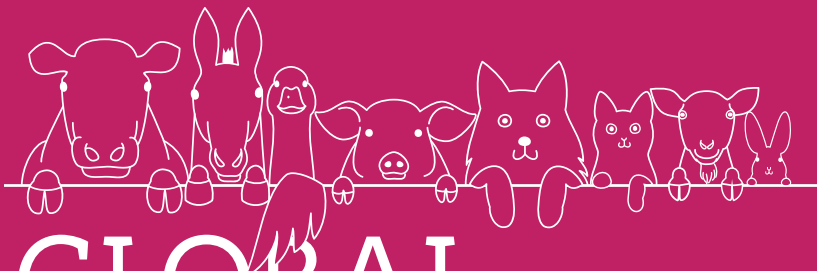
amylose content. A grain-based diet was formulated using rice, while pulse-based diets consisted of smooth pea, wrinkled pea, semi-wrinkled pea, faba bean, or lentil. Beagles (n=8, 4 females, 4 males; spayed/neutered, 2-4 years of age) were fed the 6 different test diets for 7 days in a randomized, cross-over, blinded design. At the end of each feeding period, beagles were fasted overnight and subjected to a glycemic test. Data from the glycemic test will be compared to the digestibility of starch of each diet, which will vary based on amylose levels. Results from data collected demonstrated grain containing diets, such as the rice diet, had the highest glycemic response. The diet containing rice also had the lowest content of amylose, allowing for greater digestibility. In contrast, pulse-based diets with higher levels of amylose than rice showed a lower glycemic response, among which the semi-wrinkled pea and the faba bean-based diets exhibited the lowest glycemic response after consumption. Furthermore, diets containing higher concentrations of amylose resulted in a lowered glycemic response in dogs due to altered rates of digestion and nutrient absorption. Diets promoting a lowered post-prandial glucose response are ideal to feed to dogs as they aid in preventing obesity and diabetes. Incorporating pulses with higher amounts of amylose could be utilized in dog diets to promote a low glycemic response and ultimately improve animal health.



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