The WALTHAM®
International Nutritional
Sciences Symposium 2013

From pet food
to pet care –
bridging the gap

Abstracts

October 1-4, Portland, Oregon, USA
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of the WALTHAM® International Nutritional Sciences Symposium Abstract Book accept no responsibility or liability whatsoever
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Welcome to the WALTHAM International Nutritional Science Symposium 2013 here in “the City of Roses” – Portland, Oregon. WALTHAM has proudly hosted nutritional sciences symposia for decades, bringing together world-class academics and researchers to further the understanding of nutrition for companion animals.

Celebrating 50 years of innovative science in 2013, WALTHAM is a leading science institute focussed on advancing the frontiers of research into the nutrition and health of companion animals. Since its first original science publication in 1963, WALTHAM has pioneered many important breakthroughs in the field of pet nutrition and human-animal interaction, often working in partnership with world-leading academics. As part of Mars Petcare®, WALTHAM continues to collaborate with the world’s foremost scientific institutes, driving forward our vision of A Better World for Pets™.

WALTHAM is proud to be hosting the 2013 symposium with Banfield Pet Hospital®, a leading provider of high quality preventive health care, an essential component of which is good nutrition. Banfield shares the belief that evidence-based research is essential to generate the knowledge and tools required to help pets live healthier, happier lives. WALTHAM would also like to acknowledge the co-sponsorship of the American College of Veterinary Nutrition and the European College of Veterinary and Comparative Nutrition and thank both organizations for their continued energy in supporting academics and clinicians working in the companion animal nutrition field.
The WALTHAM® International Nutritional Sciences Symposium 2013
in partnership with Banfield Pet Hospital®
October 1-4, 2013, Portland, Oregon, USA

FROM PET FOOD TO PET CARE – BRIDGING THE GAP

TUESDAY, 1 OCTOBER

6:30 - 9:00  Welcome Reception at The Governor Hotel, Heritage Ballroom (4th floor)
Registration, cocktails and canapés

WEDNESDAY, 2 OCTOBER

7:00 - 7:45  Coffee and continental breakfast in the Grand Ballroom (3rd floor)
WINSS Scientific Sessions – Heritage Room (4th floor)

8:00 - 8:30  Opening Session: Karyl Hurley
Welcome to Portland & Banfield: Jeff Klausner
Introduction to Mars & WALTHAM: David Macnair

Session I: The Microbiome

8:30 - 9:15  PLENARY: Role of the oral and gut microbiome on health: Dietary implications
Rob Knight

9:15 - 9:45  Bridging the Gap: The animal perspective
Kelly Swanson

9:45 - 10:05  Deep Illumina-based shotgun sequencing reveals dietary effects on the structure
and function of the fecal microbiome of growing kittens
Oliver Deusch

10:05 - 10:25  Age and sources of carbohydrates and protein affect digestibility, fecal microbiota
and fermentation products of dog*
Ana Paula Judice Maria

10:25 - 10:45  Coffee break

10:45 - 11:05  The effects of diet format on in vitro assessment of faecal water toxicity in the
domestic cat
David G Thomas

11:05 - 11:25  Validation of a new method based on an image-analysis system for the
measurement of dental plaque accumulation in conscious dogs
Vincent Biourge (for Alessandra Pontiroli)

11:25 - 11:45  Olfactory performance in trained detection Labrador Retrievers on three
different diets: Fat affects olfactory performance
Joseph J Wakshlag (for Thomas C Angle)

*Eligible for the Student Research Awards
11:45 - 12:05  Serum chemistry and electrolytes alterations in sled dogs before and after a 1600km race: Dietary sodium and hyponatremia
Joseph J Wakshlag

12:05 - 1:00  Lunch: The Grand Ballroom (3rd floor)

**Session II: Nutrition for Life**

1:00 - 1:50  **PLENARY: Impact of nutrition on the ageing process**
John Mathers

1:50 - 2:20  **Bridging the Gap: The animal perspective**
Richard Butterwick

2:20 - 2:40  **Effect of high phosphorus intake on renal parameters in cats is influenced by phosphorus concentration in urine**
Britta Dobenecker

2:40 - 3:00  **Effect of age, gestation and lactation on fecal immunoglobulin A and calprotectin concentrations in dogs**
Hanna Mila

3:00 - 3:30  **Coffee break**

3:30 - 3:50  **Estrogen replacement effects on insulin sensitivity and glucose tolerance in at-risk cats for feline diabetes**
Allison M Wara

3:50 - 4:10  **Synergistic beneficial effects of curcuma extract, green tea extract and hydrolysed collagen in bovine chondrocytes in monolayer culture**
Fanny Comblain

4:10 - 5:00  A discussion with the Food and Drug Administration: Jarrod Kersey
Foods that claim to treat disease: Bill Burkholder
Update on Federal Food Safety Regulations: Charlotte Conway

5:00 - 6:00  **Break**

6:00 - 8:00  **Poster Session:** First hour even-numbered posters, second hour odd-numbered posters. Cocktails and canapés provided. Posters will be displayed in several rooms on the 2nd floor (Library, Card, Billiards and Lodge rooms). Posters will remain up all day on Thursday, but will be removed by Friday morning.

**THURSDAY, 3 OCTOBER**

7:00 - 8:00  **Coffee and continental breakfast in the Grand Ballroom (3rd floor)**

8:15 - 8:30  **Mars Family Values**
Pamela Mars Wright

**Session III: Macronutrients**

8:30 - 9:15  **PLENARY: The nature of nutrition**
David Raubenheimer

9:15 - 9:45  **Bridging the Gap: The animal perspective**
Wouter Hendriks

*Eligible for the Student Research Awards*
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<tr>
<th>Time</th>
<th>Session Title</th>
<th>Speaker(s)</th>
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<tr>
<td>9:45 - 10:05</td>
<td><em>Effects of dietary macronutrient composition on the fasted plasma metabolome of healthy adult cats</em></td>
<td>Ping Deng</td>
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<td>10:05 - 10:25</td>
<td><em>Macronutrient intake regulation during gestation and lactation in domestic cats</em></td>
<td>Adrian Hewson-Hughes</td>
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<td>10:25 - 10:45</td>
<td><strong>Coffee break</strong></td>
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<td>10:45 - 11:05</td>
<td><em>Reactive lysine content in commercially available pet foods</em></td>
<td>Charlotte van Rooijen</td>
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<tr>
<td>11:05 - 11:25</td>
<td><em>No adaptation of faecal calcium excretion to low calcium intake in adult dogs</em></td>
<td>Ellen Kienzle (for Julia K Mack)</td>
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<td>11:25 - 11:45</td>
<td><em>Energy required for trotting is inversely proportional to leg length in small dogs</em></td>
<td>Richard Hill</td>
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<td>11:45 - 12:05</td>
<td><em>Dietary gamma-linolenic acid supports arachidonic acid accretion and associated Δ-5 desaturase activity in feline uterine tissues</em></td>
<td>John E Bauer</td>
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<td>12:05 - 1:00</td>
<td><strong>Lunch: Grand Ballroom (3rd floor)</strong></td>
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**Session IV: HOT Topics in Nutrition**

Interactive sessions: Be prepared to vote, discuss, share and learn from other participants! Moderator: Ian Macdonald

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<th>Time</th>
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<tr>
<td>1:00 - 1:15</td>
<td><em>Nutrition Society and introduction to hot topics</em></td>
<td>Ian Macdonald</td>
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<td>1:15 - 1:45</td>
<td><em>Linking energy to nutrient requirements</em></td>
<td>Richard Hill</td>
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<td>1:45 - 2:15</td>
<td><em>Sustainability: An issue for the pet care industry?</em></td>
<td>Kelly Swanson</td>
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<td>2:15 - 2:45</td>
<td><em>The power of population data</em></td>
<td>Liz Lund</td>
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<td>2:45 - 3:00</td>
<td><strong>BREAK</strong></td>
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<td>3:00 - 3:30</td>
<td><em>Nutritional value of animal versus plant protein</em></td>
<td>Andrea Fascetti</td>
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<td>3:30 - 4:00</td>
<td>*Biotechnology: What does it mean for the pet food industry?</td>
<td>Steve Rizk</td>
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<td>4:00 - 4:30</td>
<td><em>Senior life-stage or life-style?</em></td>
<td>Richard Butterwick</td>
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**Gala Dinner:** Buses leave for the Oregon Museum of Science and Industry at 6:00pm. Return shuttles leave at 10:00pm. Smart business/cocktail dress

*Eligible for the Student Research Awards*
FRIDAY, 4 OCTOBER

7:00 - 8:00  Coffee and continental breakfast in the Billiards Room (2nd floor) and Renaissance Room (3rd floor)

8:20 - 8:30  Opening comments
Richard Butterwick

Session V: Healthy Weight Management

8:30 - 9:15  PLENARY: Obesity: What do we know from the human condition?
Theresa Nicklas

9:15 - 9:45  Bridging the Gap: The animal perspective
Alex German

9:45 - 10:05  Validation study of a non-invasive method for estimation of energy expenditure in dogs*
Caroline Larsson

10:05 - 10:25  Modulation of food intake in male neutered cats by ingestion of estrogen-like substances in food*
Sara M Hunsucker

10:25 - 10:45  COFFEE BREAK

10:45 - 11:05  Insoluble fiber delays gastric emptying and colonic filling time of dogs fed kibble diets*
Raquel Silveira Pedreira

11:05 - 11:25  Long-term outcomes of weight management in obese cats*
Alex German (for Shelley L Holden)

11:25 - 11:45  The effect of reducing dietary energy density via the addition of water to dry diet on body weight, energy intake and physical activity in adult neutered cats
Janet E Alexander

11:45 - 12:05  Associations between longevity and body condition in domestic dogs
Carina Salt

12:05 - 12:15  Student Research Award for Best Oral and Poster Presentation:
Denise Elliott

12:15 - 1:00  CLOSE OF WINSS AND LUNCH: Boxed lunches provided for travellers. Lunch will be served on the 2nd floor in the Billiards, Library and Card Rooms

1:20 - 5:00  Optional visits to Banfield Hospitals, Headquarters and Banfield Applied Research & Knowledge (BARK) Open House; meet in lobby of Governor Hotel at 1:20pm

*Eligible for the Student Research Awards
From pet food to pet care – bridging the gap

KEYNOTE SPEAKERS
Rob Knight, PhD
Associate Professor, Department of Chemistry and Biochemistry and BioFrontiers Institute, University of Colorado

Rob Knight did his undergraduate degree in biochemistry at the University of Otago in his native New Zealand, then his graduate work with Laura Landweber in the Department of Ecology and Evolutionary Biology at Princeton University. He completed his thesis on the origin and evolution of the genetic code, which won the CGS/UMI Distinguished Dissertation Award for the Life Sciences, in 2001.

He then performed postdoctoral work with Mike Yarus in the department of Molecular, Cellular and Developmental Biology at the University of Colorado, on the abundance of functional RNA molecules in random-sequence pools.

He is an Associate Professor in the Department of Chemistry and Biochemistry and BioFrontiers Institute at the University of Colorado, and an HHMI Early Career Scientist. His lab currently studies RNA evolution and the human microbiome.

His work includes studies from the molecular and cellular levels to large-scale human intervention trials. He has a particular interest in diet-gene interactions and in the role of epigenetic mechanisms in mediating the effects of diet on health.

Richard Butterwick, PhD
Principal Nutrition Scientist, WALTHAM® Centre for Pet Nutrition, Melton Mowbray, Leicestershire, UK

Richard Butterwick is Principal Nutrition Scientist at the WALTHAM Centre, providing leadership and expertise on nutrition related matters for Mars Petcare. After graduating from the Department of Agricultural Biochemistry and Nutrition, Newcastle University, UK in 1985, Richard obtained his PhD in 1990 from research on the metabolic and nutritional consequences of growth hormone treatment in dairy cows.

After completing his PhD he spent a short sabbatical lecturing preclinical studies at the Samora Machel Veterinary School, Lusaka, Zambia, before joining the Department of Paediatric Endocrinology at St Bartholomew’s Hospital, London working on growth disorders and insulin like growth factors.

In 1991 Richard joined the WALTHAM Centre and worked on the research and development of veterinary clinical diets, with emphasis on the management of obesity, gastrointestinal disease, neonatal and post-operative nutritional support.

Since then he has led several research programmes, covering a broad spectrum of nutritional areas in dogs and cats, including energy requirements and obesity, digestive function and health, probiotics, growth and development, and oral health. Richard has published widely in the field of dog and cat nutrition and is a member of a number of professional bodies.
David Raubenheimer was born and grew up in Cape Town, South Africa. He graduated with a BSc and MSc at the University of Cape Town, before moving to Oxford in 1987 to do a PhD in insect nutrition. In 1991 David took up a Postdoctoral Fellowship at the University of Cape Town, and in 1992 returned to Oxford as Lecturer in the Zoology Department and Tutorial Fellow at Magdalen College.

In 2003 David moved to New Zealand, where he took up a position at the University of Auckland and in 2008 was appointed Professor of Nutritional Ecology in the Institute of Natural Sciences at Massey University.

In 2013 he was appointed to the Leonard P. Ullmann Chair of Nutritional Ecology at the University of Sydney, where he is Nutrition Theme Leader across the Charles Perkins Centre, the Faculty of Veterinary Science and the School of Biological Science.

He is also a Professor in the New Zealand Institute for Advanced Study, and a Theme Leader in Gravida: The National Research Centre for Growth and Development (New Zealand). David’s research focuses on comparative nutritional ecology, with an emphasis on field studies.

His work spans marine and terrestrial systems, and diverse species including insects, spiders, fish, birds and mammals, among them humans and non-human primates.


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Professor Wouter H. Hendriks
Head and Chair of the Animal Nutrition Groups, the Department of Animal Science, Wageningen University and the Faculty of Veterinary Medicine, University of Utrecht, Netherlands

Wouter Hendricks the co-founder of the Centre for Animal Nutrition in the Netherlands. Before these appointments, he held concurrent positions as Head of the Department of Animal Nutrition and Physiology of the Institute of Food, Nutrition and Human Health and Director of the Centre for Feline Nutrition, all at Massey University in New Zealand. In these capacities, he managed and directed active research programs that examined aspects of general mammalian and avian nutrition and physiology as well as specialized nutrition of nonruminants (including cats, dogs, horses, pigs and poultry). He is an expert in comparative animal nutrition, digestive physiology, and feed evaluation. Currently his research focus includes various aspects of companion animal nutrition such as food processing in relation to the Maillard reaction, feline nutrient metabolism, digestive physiology and health, diet composition in relation to oxalate formation as well as the effects of nutrition on behaviour. He has more than 140 peer reviewed publications and currently supervises more than 40 PhD scholars. He received his Ingenieur degree in Animal Nutrition from Wageningen University and his Ph.D. in Monogastric Nutritional Physiology from Massey University, New Zealand.

Theresa A. Nicklas, DrPH
Professor of Pediatrics at the USDA/ARS Children’s Nutrition Research Center, Baylor College of Medicine, Department of Pediatrics

Prior to moving to Baylor College of Medicine, Dr Nicklas, was Chair and Professor of the Department of Food and Nutrition at North Dakota State University for 2½ years. She has 14 years experience in spearheading the dietary studies of the
The Bogalusa Heart Study and she continues to be an active consultant for this premier study. The Bogalusa Heart Study is an epidemiologic investigation of the early natural history of cardiovascular disease and the environmental determinants in a biracial pediatric population, which began in 1973.

She was Chairperson of the school nutrition intervention-working group of the multi-center trial called the Child and Adolescent Trial for Cardiovascular Health, which was implemented in 96 schools across four states. She was Principal Investigator of a four year NIH grant focusing on increasing fruit and vegetable consumption of high school students. One of her current research interests is looking at eating patterns that are associated with or predictive of obesity between childhood and young adulthood. She is also studying the environmental influences on eating habits of preschool children. Dr Nicklas has published more than 250 scientific papers, six book chapters and five monographs.

She is author of the American Dietetic Association position paper on Dietary Guidance for Healthy Children Ages 2-11 years and she served on the 2005 Dietary Guidelines Advisory Committee. Her areas of expertise are cardiovascular health and nutritional epidemiology, child nutrition, and health promotion and chronic disease prevention.

**Alex German, BVSc(Hons), PhD, CertSAM DipECVIM-CA, MRCVS**

Royal Canin Reader in Small Animal Medicine, Department of Obesity & Endocrinology, Institute of Ageing & Chronic Disease, and School of Veterinary Science, University of Liverpool

Alex German qualified, with honours, from the University of Bristol in 1994. After two years in mixed practice he returned to Bristol to undertake a PhD, and then a residency in small animal internal medicine.

He moved to the University of Liverpool in October 2002, where he holds the position of Royal Canin Reader in Small Animal Medicine. He became a Diplomat of the European College of Veterinary Internal Medicine in September 2004, and a Royal College of Veterinary Surgeons' Recognised Specialist in Internal Medicine in 2006. His clinical and research interests include gastroenterology, and comparative obesity biology.

**Kelly Swanson, MS, PhD**

Associate Professor, Department of Animal Sciences and Division of Nutritional Sciences University of Illinois at Urbana-Champaign, US

Kelly Swanson received his PhD in Nutritional Sciences at the University of Illinois in 2002. After post-doctoral training in functional genomics, he became Assistant Professor in the Department of Animal Sciences at the University of Illinois in 2004. He was promoted to Associate Professor with indefinite tenure in 2009. Dr Swanson has established himself as a leader in companion animal nutrition and nutrigenomics, primarily in the areas of gastrointestinal health and obesity.

His research program has gained international recognition, highlighted by nearly $7 million in research support (~$3 million when serving as PI), 66 invited lectures, 83 peer-reviewed publications, and many review articles, international research collaborations, awards, and service on FOUR editorial boards.

The overall goal of his research program is to use genomic biology to study nutrition-related problems in ‘obesity’ and ‘gastrointestinal health,’ with primary emphasis on the nutritional status and health of dogs and cats. His lab uses molecular techniques to assess dog and cat intestinal microbiota and exploits other genomic assays to characterize tissue transcriptome changes due to dietary manipulation, weight gain/obesity, and aging. He has trained 19 graduate students and postdocs. Dr Swanson also teaches companion animal nutrition to veterinary, undergraduate, and graduate students, and has been named to the ‘List of Teachers Ranked as Excellent’ nine times over the past six years. On campus, he is the Pre-Vet Club faculty advisor, has served as mentor for many undergraduate research projects, and serves on several campus committees.
WHAT CAN STUDIES OF THE HUMAN MICROBIOME AND OF MODEL ORGANISMS INFORM US ABOUT THE ROLE OF PET MICROBIOMES IN NUTRITIONAL AND DRUG RESPONSES?

Zhenjiang Xu and Rob Knight
HHMI and BioFrontiers Institute, University of Colorado at Boulder

Introduction to microbiome studies
Recent advances in parallel sequencing technology and analytical techniques have led to a tremendous explosion in studies of the human microbiota (the collection of microbes that inhabit us) and microbiome (the genes these microbes carry) in a culture-independent manner. These studies have transformed our understanding of the role of microbiota on human health. The human body houses up to $10^{14}$ microbial cells and their contribution to physiology, disease and behavior is increasingly appreciated. For example, randomized clinical trials of fecal transplant show that when antibiotics fail, it can cure persistent *Clostridium difficile* associated disease with up to 90% efficacy. Animals harbor similarly enormous number of microbes. Studies in domestic pets are beginning to catch up, and can take advantage of the tools and databases developed for biomedically-oriented human and mouse studies.

Relationship of the pet microbiome to the human microbiome
Recent microbial studies reveal highly complex microbial ecosystems in gastrointestinal (GI) tract of mammals generally. As in the human gut microbiota, *Firmicutes* and *Bacteroidetes* are the predominant taxa in horses, cats, and dogs. They are likely critical in defending against transient pathogens and aiding in digestion, as has been shown directly in mouse studies. GI microbiome dysbiosis is found in canine and feline diseases such as diarrhea and inflammatory bowel diseases (IBD). Intriguingly, the alterations in bacterial assemblages of dogs and cats with IBD resemble dysbiosis in humans with IBD. *Clostridium* clusters XIVa and IV, which produce beneficial short-chain fatty acids, are depleted in both human and dogs with IBD. The extent to which conclusions transfer across species is thus an exciting frontier in microbiome studies, critical for translational medicine from mice to humans but also potentially useful for applying the results more broadly to domestic pets.

Although behavior obviously mediates the establishment and alteration of host microbial symbionts, the microbiome may also be surprisingly important in shaping human and animal behavior. Metabolism of both drugs and diet is known to impact both psychiatric disorders and the gut microbiota, suggesting an association between the two. In rodents, the microbiome appears to affect models of autism and brain development. The microbiome can even change the mating preferences of fruit flies, alter social interactions in hyenas, and affect preference of malaria mosquitoes for specific hosts, probably through chemical signals such as odorants.

Companion animals usually have close physical contact with humans, facilitating exchange of microbes between them. For example, the skin, oral and fecal microbial communities of cohabiting family members are more similar to each other and adults share more microbial taxa with their own dogs than they do with others’ dogs, especially for skin microbes. The exposure to a broadly diverse microbial community resulting from dog ownership can be beneficial. Pet ownership, in early but not later years of life, is associated with decreased risk of allergic disease. Even prenatal pet ownership may matter. Mothers without pets deliver infants with elevated concentrations of cord blood immunoglobulin E (IgE), which has been linked to an increased risk for subsequent allergies. However, it is important to note that companion animals and livestock can also be reservoirs of pathogens. For example, ST398, a methicillin-resistant *S. aureus* (MRSA) strain, has adapted to infect pigs, human and other livestock. Understanding the balance between these positive and negative factors, and understanding the implications of differences in the human microbiota for the health of pets, remain essentially unexplored but exciting areas for future development.
Inter-relationship between diet, gut microbial ecology and metabolism

The dietary effect on gut microbiota and health is confounded by variations in host genotypes, environmental exposures, etc. Nevertheless, mounting evidence shows that diet is a primary driver to modulate gut microbiota. Unexpected and vast variation in the composition and structure of gut microbiota exists between individuals. It has been suggested that the adult human gut microbiota can be categorized into three “enterotypes” based on the dominant genera (Bacteroides, Prevotella, or Ruminococcus)25, but statistical support for this classification is weak and it only applies to Western populations. However, the ratio of these major taxa is likely important and is driven by dietary effects26. *Prevotella* is enriched in people who had high-fiber diets, whereas *Bacteroides* is associated with a typical “Western” diet high in protein and fat. Gnotobiotic mice provide a powerful tool for studying the effects of individual nutrients on the microbiome, in terms of species abundance and microbial gene expression, and ultimately health in response to controlled diet changes14,27. The germ-free animal model can also be colonized with microbial communities from other animal donors such as dogs and cats to study their dietary impact.

The gut microbiota affects nutrient acquisition, energy harvest, and host metabolic pathways, imbalance in which can cause metabolic syndrome, obesity, and diabetes, and other autoimmune diseases. A shift in the relative abundance of the *Bacteroidetes* and the *Firmicutes* is associated with obesity in both human and mice28. The obese microbiome is better at harvesting energy from the diet27. Western diet and the associated gut microbiota may also drive the increasing cases of inflammatory diseases29. The fiber in the diet can stimulate the growth of species such as *Prevotella* and *Xylanibacter* that can digest it. The fermentation of fiber, in turn, provides short-chain fatty acids and other beneficial lipid metabolites that are recognized by G-coupled receptors GPR43 and 41 in immune cells, endocrine cells, and adipocytes to maintain colon mucosal health and regulate energy metabolism and immunity30,31. The intake of dietary fiber correlates with decreased inflammation32. Probiotics and prebiotics are thus gaining increasing attention, and have already been shown to promote health of animal gut microbial ecosystems also33.

Prospects for future research

Vast resources have been invested in studies of the mouse and human microbiome, including the Human Microbiome Project and the Metagenomics of the Human Intestinal Tract (MetaHIT). The expanded understanding of the diversity of the human microbiome, and its underlying causes and consequences, will also help answer questions about the microbiome of other animals, including domestic pets, as suggested by the resemblance of microbial dysbiosis between human and canine IBD10 and by the convergence in gut microbiomes across mammals driven by diet34. Building on these studies, projects such as American Gut (http://www.microbio.me/americangut/) now provide an opportunity to general public and their pets to participate. Studies of animal microbiomes, from an integrated perspective obtained from human and mice microbiomes, will thus foster a deeper and broader understanding of host-microbiome interaction and offer great promises to promote animal health in the future.

References:


IMPACT OF NUTRITION ON THE AGEING PROCESS

John C. Mathers

Human Nutrition Research Centre, Institute for Ageing and Health, Newcastle University, Campus for Ageing and Vitality, Newcastle upon Tyne, NE4 5PL UK

Demographic changes
For nearly 200 years, human life expectancy has been increasing at approximately two years per decade and shows no signs of having plateaued. Much of the early benefit derived from reduced childhood mortality but, since the mid-20th century, the gains have been due mainly to reduced mortality in later life.

Biology of ageing
Ageing is characterised by progressive, time-dependent loss of function and increased likelihood of death. This loss of function includes widely-recognised, relatively rapid processes such as the loss of female fertility following the menopause and much more insidious declines in brain volume and in skeletal muscle mass which can lead to cognitive and physical frailty. Importantly, ageing is the major risk factor for most common chronic diseases including cancers, cardiovascular disease and stroke and dementia. Although there is good evidence for a genetic contribution to variation in longevity, there is no evidence that ageing per se is genetically determined (or programmed). Instead, the ageing phenotype appears to result from the gradual accumulation of damage to all the cell’s macromolecules - DNA, proteins and lipids. This damage includes mutations in both the nuclear and mitochondrial genomes, aberrant epigenetic markings and the accumulation of oxidation-damaged and misfolded proteins. Most macromolecular damage is likely due to three main sources viz. chronic inflammation, oxidative damage/ redox imbalance and metabolic stress.

In a recent review, López-Otín et al. (2013) proposed nine tentative hallmarks of ageing which are common to many organisms including mammals. These hallmarks include: genomic instability, telomere attrition, epigenetic alterations, loss of proteostasis, deregulated nutrient sensing, mitochondrial dysfunction, cellular senescence, stem cell exhaustion and altered intercellular communication. In selecting these hallmarks, López-Otín et al. (2013) looked for factors which met the following criteria: i) it occurs during ageing, ii) experimental enhancement of the factor accelerates ageing and iii) experimental amelioration of the factor slows ageing and so increases healthy lifespan. Evidence for the 3rd criterion was often limited.

Nutritional modulation of the ageing process
For almost 80 years, it was been apparent that nutrition modulates the ageing process. The earliest unequivocal evidence for the impact of nutrition on ageing came from studies in rodents showing that dietary restriction (DR) – providing animals with less food than they would eat under ad libitum conditions – increased lifespan and reduced (or delayed) the development of age-related diseases. DR (usually energy restriction while ensuring adequate nutrient supply) is now a very well-established experimental paradigm which extends lifespan and healthspan in many species. Whether it does so in humans is not known and both practical and ethical constraints mean that a direct test of the hypothesis is challenging. Two recent studies have attempted to test the hypothesis in another primate - rhesus monkeys. One of these studies reported apparently greater longevity in the DR monkeys whereas the other found no effect on lifespan. However, in both studies the DR animals were leaner and had a lower burden of age-related disease. Translating these outcomes to humans suggests that avoiding obesity may improve healthy ageing and, indeed, there is strong evidence for greater risk of death when BMI is in the overweight and, especially, obese ranges.

Since the ageing phenotype is the result of the accumulation of damage to the cell’s macromolecules, nutritional interventions which reduce ageing must do so because they reduce the amount of damage sustained by the cell and/or because they enhance the capacity of the cell, tissue or organism to repair, or to cope with, that damage. Genetics-based studies have strengthened the evidence for the plasticity of the ageing process and it is apparent that modulation of a relatively
small number of pathways central to energy and nutrient sensing and to cellular defence are key to understanding how nutrition influences ageing.

**Dietary patterns and human ageing**

Nutrition is critical for health and wellbeing at all stages in the life-course and, indeed, the nutrition of one generation may influence ageing in the next generation. Whilst nutrition has immediate effects on metabolism and health, nutritional exposures can have very long legacies. This is exemplified by the impact of maternal nutrition during pregnancy and nutrition in early post-natal life on ageing (reviewed by Langie *et al.* 2012).

It is probable that many dietary factors including total energy intake relative to energy needs (which determines the risk of obesity), specific nutrients and other non-nutrient bioactive constituents, individually and collectively, influence the accumulation of macromolecular damage within the cell and, therefore, the ageing process. Investigation of such complex interrelationships is challenging especially in human epidemiology with difficulties in exposure measurement (Fave *et al.* 2009) and with substantial risks of confounding. The more recent focus on dietary patterns offers promise not only in identifying associations with health ageing but also in providing the evidence base for the development of public health interventions. The strongest evidence for links between a dietary pattern and ageing are those for the Mediterranean Diet (MD) - a diet characterised by high consumption of plant-based foods, moderate-to-high consumption of fish and low intakes of dairy foods and meats and meat products. Adherence to the MD is also associated with substantial reductions in risk of many major age-related diseases and a recent human intervention study has demonstrated primary prevention of cardiovascular disease with MD-based interventions (Estruch *et al.* 2013).

This is an exciting time for research on nutrition and ageing and there is reason to hope that we will soon have a better understanding of the molecular mechanisms through which nutrition can enhance healthy ageing. At a public health level, we need effective interventions to improve dietary behaviour so that we can reap the rewards in greater health and wellbeing in later life (Mathers, 2013).

**Further reading**

In humans lifespan has consistently increased over recent years and this phenomenon shows no signs of abating, advancing on average two years per decade (Mathers, 2013). There are limited data on lifespan changes in companion animals, although anecdotally it would appear that lifespan in ‘pet’ populations has also increased. Comparison of lifespan in feral and pet cat populations provides some evidence for this; average life expectancy in pet cats is around 12 to 14 years (Taylor et al. 1995; Banfield, 2013), which is much higher than reported median lifespan in feral cats of 4.7 years, (Levy et al. 2003). It is not known what factors contribute to the striking difference in lifespan between feral and pet cat populations, although accidents, diseases, parasites, availability of food, and the stresses of multiple and frequent pregnancies may all contribute.

Over recent years the provision of good healthcare and the availability of complete and balanced foods have undoubtedly contributed to improvements in health, wellbeing and mortality in the companion animal. In pets, as in humans, there is increasing interest in interventions that promote ‘health and wellbeing’ into later life, and extend these beyond their current limits. There is a plethora of products and services directed to the ageing pet population, and this segment is likely to grow with the increasing size of the ‘ageing’ pet population. Terms like ‘senior’ and ‘geriatric’ are commonly used to describe pets in this life stage and these are usually assigned based on the chronological age of the pet. This approach is somewhat arbitrary, and may not reflect the real ‘biological’ age of the pet, and many owners recognise the onset of ‘old age’ through subtle changes in their pets’ behaviour such as decreased activity, loss of cognition, loss of appetite, changes in body weight, or other changes in behaviour rather than based on a set chronological age.

Development of successful interventions to prolong lifespan will be dependent on advancing our knowledge and understanding of the fundamental biological processes that influence ageing. In humans it is thought that the accumulation of random molecular damage in the macromolecules of all cells is the major determinant of lifespan, and this results in age dependent defects in cellular function, and reduced function at a tissue level which manifest as age related frailty, disability and disease (Mathers, 2013). Many factors, both endogenous and exogenous are thought to contribute to the cellular and tissue damage that contribute to the ageing process.

Reproductive status has been shown to impact life span in pets, and is of particular significance because of the high level of pet sterilization in many parts of the world. A recent study showed that sterilization increased lifespan in dogs, (Hoffman et al. 2013), although the mechanism for this effect is not clear. Body size in dogs is another factor known to influence lifespan. Dogs are unusual because of the wide variation in adult body size, and the strong association between this phenotype and lifespan. Small breeds are expected to live about 10-14 years, whereas large and giant breeds have much shorter life spans, typically 5 - 8 years, (Michell, 1999). A recent study suggests that size differences in lifespan is a result of large and giant breed dogs simply ageing faster than their smaller counter-parts (Kraus et al. 2013), defying the assumed wisdom that one human year is equivalent to seven dog years.

There is a growing body of evidence on the influence of diet on longevity and lifespan. Dietary energy restriction has been extensively studied in rodent models, and has been shown to have a generally positive impact on lifespan. However, there is limited evidence that this effect translates to humans (Mathers 2013). One study has looked at the effect of energy restriction in dogs, and this reported an increase in median lifespan which was associated with a delay in the development of orthopaedic diseases, which is a common age related issue in the breed studied (Kealy et al. 2002). Energy restriction is unlikely to be a practical solution for most pets, or humans, and in reality the consequences of excess energy intake ie obesity, has far greater potential relevance to lifespan. In
humans the relationship between obesity and lifespan is well-established, and in countries where obesity is now at ‘epidemic’ levels, such as the USA, there is the worrying phenomenon of a potential halt and even decline in lifespan (Olshansky et al. 2005). In dogs and cats the impact of obesity is also known to be associated with various diseases, (German, 2006), and there is also evidence that obesity shortens lifespan in dogs (Salt and Morris, 2013).

Dogs and cats have had a long association with humans, and today they are the most popular companion animal. The nature of this association has changed from one where they have been a beast of burden, or even source of food, to a position where they are referred to as a ‘companion animal’, better reflecting the role they fulfil as ‘family’ members. As cherished family members, owners desire long and healthy lives for their pets. The development of interventions to extend healthy and well being, in pets, and humans, beyond their current limits will be dependent on gaining fundamental knowledge and understanding of the biological processes that influence ageing. However there are some specific challenges in companion animals that potentially limit progress in this field. Currently there are limited data on lifespan in pet populations, and this restricts our ability to track changes over time, or identify associations with any changes in lifespan. In addition ‘cause of death’ is often recorded as ‘euthanasia’ rather than the underlying medical condition. Addressing these data gaps may help identify specific issues that impact on lifespan in the companion animal.

References
A challenge for nutrition

“Everything should be made as simple as possible, but not simpler”

Albert Einstein was no nutritionist, but in this quote he articulates one of the most challenging issues in nutritional science: identifying the appropriate level of complexity for answering questions and solving problems. Nutritional science is dispersed among pockets of expertise that are sparsely connected, each with its own combination of strengths and limitations. An important example concerns the relationship between detailed data and synthetic theory. The more applied nutritional sciences, such as human nutrition, production animal nutrition, and companion animal nutrition, have produced a tremendously detailed account of the nutritional biology of a few economically important species, but are limited by the theory needed to interpret this maelstrom of information. Nutritional science at the ecological end of the spectrum, on the other hand, has tended to apply theory-laden, detail-sparse approaches that are generally applicable across a diversity of animals, many of which are poorly researched from a nutritional point of view. Optimal foraging theory, for example, uses models inspired by economic and evolutionary principles to predict the foraging behaviour of animals, in which nutrition is often reduced to little more than a requirement for maximising energy gain.

Both ends of the detail-theory spectrum have been productive, as have attempts to integrate the two e.g., by applying foraging theory to farm animals, and detailed nutritional analysis to some species of wildlife. We propose, however, that nutritional science can benefit from integrated approaches that make better use of theory to guide the collection of data and of data to inform the development of theory. This will provide the basis for building models that are complex enough, but no more complex than is necessary for the problem at hand. As detailed in our recent book (Simpson & Raubenheimer 2012), such models can be used in conjunction with data to learn how the components interact in producing biological outcomes.

Towards a solution: Nutritional geometry

Nutritional geometry is a framework that we have developed for identifying the nutritional factors that influence the functional responses of animals, and learning how these interact in producing their effects. The approach is based on a geometric space, called a nutrient space, in which each axis represents a nutrient that is selected for inclusion in the model. The nutrient space provides a platform upon which relevant aspects of the animal and its environment can be defined in common terms and their interrelationships identified and measured.

A specific application might, for example, model the role of the macronutrients protein (P) and carbohydrate (C) in the diet choice of an animal. The amount of these nutrients that is optimally required by the animal over a period of, say, one day, is represented in the model as a point that is plotted at the intersection in the nutrient space of the separate daily requirements for P and C - this point being called an intake target. Foods are plotted as lines radiating from the origin, called nutritional rails, each with a slope that is determined by its P/C ratio. As the animal eats, it ingests the nutrients in the same proportion as they are in the food, and its nutritional state thus “moves” along the nutritional rail for the food that it is eating.

The challenge for the animal is to select foods that enable it to “navigate” to the intake target. One way to do this is to select a nutritionally balanced food - i.e. one that has the same P/C ratio as is required. The nutritional rail for such a food intersects with, and thus provides a direct route to, the intake target. By contrast, a nutritionally imbalanced food constrains the animal to a route that is offset from the target. However, by mixing its intake from two foods the animal could construct a path composed of multiple segments with trajectories parallel to the respective rails, and in this
way “zig zag” to any point in the area that is between the rails. By combining its intake from foods that jointly encompass the intake target, the animal can therefore satisfy its nutrient needs even if none of these foods is on its own nutritionally balanced. Such foods are nutritionally complementary with respect to the animal’s requirements.

An important question is how the animal responds when it has available only non-complementary nutritionally imbalanced foods and is therefore unable to reach the target. In this case the animal cannot satisfy its needs for both nutrients, and has to settle on an excess of one nutrient and/or a deficit of the other. The excesses and deficits settled on by animals in this predicament are an important, but widely neglected, metric in nutritional science. Firstly, the balance of these excesses and deficits provides a measure of the relative priority assigned by the regulatory systems to different nutrients. Secondly, the difference between target intakes and actual intakes provides a powerful means for relating variation in the intake of specific nutrients to the consequences of such variation - for example, in terms of growth, reproduction and health.

**Appropriate complexity**

Nutritional geometry therefore provides a quantitative framework for relating variation in food composition to the homeostatic regulatory responses of the animal on the one hand, and the functional consequences of dietary variation on the other. This approach has been applied in laboratory studies to examine a range of fundamental questions in nutrition, including the relationship between diet and mate choice, between diet and immunity, the nutritional determinants of lifespan, and the causes of the human obesity epidemic. It has also been used in the applied context of animal feeds, including production animals, companion animals and the formulation of supplementary feeds for critically endangered species, and has recently been extended to understanding the nutritional ecology of wild animals outside of the laboratory.

Collectively these studies suggest that the most powerful insights yield from models with more than one dimension, but it is in general not necessary to go much beyond two dimensions. This might reflect a fundamental truth: perhaps biological systems struggle to integrate across multiple dimensions, and are therefore more likely to evolve solutions in a low-dimensional space. Alternatively, there might be many instances yet to be discovered that are more complex, requiring analyses in hyper-dimensional space. We will find out only by approaching the future with versatile tools for identifying and working at the appropriate level of complexity - the level that is as simple as possible, but no simpler.

THE NATURE OF CANINE AND FELINE NUTRITION

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The physiological requirements (minimum and maximum) for nutrient of cats and dogs for maintenance have been the focus of much research over the past century. These requirement estimates (NRC 2006) can be considered to represent the limits of the adaptation capacity of domestic cats and dogs in relation to dietary nutrient concentrations.

Recent studies (Hewson-Hughes, et al., 2011, 2012, 2013) into the selection and regulation of macronutrient intake by adult cats and dogs showed both species to select a diet composition consistent with their carnivorous nature. In addition, cats were shown to be able to regulate food selection and intake to balance macronutrient intake despite differences in moisture and textural properties of the food. Independent of the these studies, a recently published literature based study (Plantinga et al. 2011) showed that protein:fat:carbohydrate intake of free-roaming feral cats is 52:46:2% by energy indicating the true carnivorous nature of cats. These studies clearly align dietary nutrient profile in feral cats, free-choice macro-nutrient intake of domestic cats and the well-known metabolic adaptations of this species. Explanation of the once called “metabolic idiosyncrasies” of cats, have now, through feeding ecology research and empirical studies, a clear explanation. Evolutionary pressures arising from the ingestion of a diet consisting exclusively of animal tissues has led to multiple nutrient-related adaptions of several metabolic pathways which translate through to feeding preferences in domesticated cats.

The scientific confirmation of the absence of identical or similar specialised metabolic pathways has led many scientists to question the once firm carnivorous classification of our domesticated dogs. This “omnivorous dog dogma” has developed over the past 40 years and has found its way into authoritative scientific reference books (NRC 2006, Hand, et al., 2010), nutritional concepts in pet nutrition, and as a general view. Selection and regulation of macronutrient intake by adult dogs, however, showed a protein:fat:carbohydrate 30:63:7% by energy, indicative of a true carnivorous nature.

Domesticated dogs (Canis l. familiaris) diverged from gray wolves. In the beginning, the carnivorous gray wolves (C. lupus), the dog’s ancestors (Savolainen, et al., 2002), scavenged kills or took wounded animals that escaped the hunt of nomadic hunter-gatherers (Driscoll, et al., 2009). The co-existence with humans intensified when humans became sedentary and started cultivating grasses and legumes around 12,000 years ago and their waste attracted proto-dogs (Driscoll et al. 2009; Coppinger and Coppinger, 2001). These dogs adopted the omnivorous lifestyle of humans. Breeding efforts during the last 3,000-4,000 years and in particular over the past two centuries have resulted in the remarkable morphological and behavioural diversity of dogs we know today (Driscoll et al. 2009; Driscoll and MacDonald, 2010). The majority of the remarkable morphological diversity of form among dog breeds has a simple genetic basis dominated by less than four quantitative trait loci. Recent evidence shows that three genes (AMY2B, MGAM and SGLT1) involved in starch digestion and glucose uptake were the target of selection during domestication (Axelsson, et al., 2013). This recent study also shows that other metabolic traits observed in dogs, like capacity to down-regulate amino acid catabolism and the synthesis of sufficient amounts of essential nutrients such as niacin, taurine and arginine, were unaffected by domestication. Dogs typically differ in these traits from carnivorous cats and in this respect resemble omnivorous humans, pigs and rats. The apparent contradiction between the dogs’ recognized ‘omnivorous’ traits and their ancestral carnivorous ecology has, hitherto, been left unexplained.

The scientific literature on the foraging ecology of free living gray wolves was recently reviewed and the nutrient profiles of the described diets calculated. Wolves typically hunt in packs on large ungulates but also opportunistically scavenge a varied but essentially animal-based diet.
(Mech and Boitani, 2003). In addition, consumption of vegetal material is low with rumen contents not being consumed. The 50 diets evaluated contained on average 35.5g protein, 13.2g fat and 0.8g carbohydrates per MJ ME. However, nutrient intake of gray wolves changes markedly throughout the year due to differences in prey availability. During periods of abundant prey availability, wolves ingest large amounts of highly nutritious animal tissues, with feast meal weights of up to 22% of their body weight, and preferential consumption of internal organs such as liver. During prolonged periods of low prey availability, wolves resort to scavenging on low-nutritious leftovers like bones and hide or consume prey parts they cached for later consumption. During these periods of famine, wolves were required to conserve body proteins and maintain a synthesis capacity for essential nutrients such as arginine, niacin, taurine, vitamin A and long-chain polyunsaturated fatty acids from dietary or endogenous precursors for on-going metabolism similar to humans, rats and pigs. In rats and pigs, however, the fluctuating nutrient intake is not only modulated by food availability but also food composition (vegetal and animal matter) while in wolves this has been modulated predominantly by a feast and famine lifestyle. The array of metabolic traits shaped by this lifestyle enabled carnivorous wolves to metabolically thrive on relatively lower-nutritious prey components but also on human food wastes. The metabolic capacities to synthesize these nutrients that dogs, pigs and rats share, reflect a fluctuating nutrient intake rather than a common omnivorous feeding history. This explanation derived from feeding ecology helps to improve our understanding of the dog’s (digestive) physiology and metabolism and may contribute to the ongoing optimisation of foods for our pet dogs.

References
OBESITY – WHAT DO WE KNOW FROM THE HUMAN CONDITION?
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Parenting style and parenting practices
It is well-documented that parenting significantly influences children’s development. Parenting style describes the attitude and general approach parents use to raise their children (Baumrind, 1971). Baumrind (1971) first described parenting style based on two dimensions of parental behavior: responsiveness/nurturance and demandingness/control. Based on these two dimensions, four categories of parenting style have been described: authoritative, authoritarian, indulgent and uninvolved (Maccoby & Martin, 1983). In contrast to styles, parenting practices are specific behaviors that parents use to accomplish their childrearing goals (Darling & Steinberg, 1991). Parenting styles are considered distinct from parenting practices. Parenting practices and the meaning of those practices are thought to be embedded in the larger style in which they are expressed (Darling & Steinberg, 1991).

Parenting style: Parenting dimensions of demand/control and response/nurturance are used to categorize parents into one of four parenting styles reflecting the emotional climate a parent creates with the child: authoritative (high demand, high response) characterized by parental involvement, nurturance, and structure; authoritarian (high demand, low response) characterized by restrictive, punitive, and power-assertive behaviors; indulgent (low demand, high response) characterized by warmth and acceptance in conjunction with a lack of monitoring of the child; and uninvolved (low demand, low response) characterized by little control and involvement with the child. The authoritative parenting style has been associated with multiple positive child outcomes including: higher academic achievement in adolescents, less high risk adolescent behaviors, greater child maturity, as well as improved weight status of the child (Mandara, 2003).

Parenting practices: Context related parenting intended to influence specific child behaviors has been used to link parenting to child outcomes. For example, food parenting practices include such behaviors as pressuring the child to eat, restricting access to certain foods, and teachable moments (encouraging fruit and vegetable intake in children by discussing their positive benefits to the child).

Parenting behaviors linked to child consumption and weight status
Most studies linking parenting to child consumption and weight have focused on a set of highly controlling food parenting practices. The effect of these practices on child outcomes has been shown to be fairly consistent across experimental, cross-sectional, and longitudinal studies (Faith, Scranlon, Birch, Francis, & Sherry, 2004). For example, food restriction has been shown to have counterproductive effects on child food preferences in that the restricted food becomes more desirable to the child (Ventura and Birch, 2008). Restriction has been associated with higher child intake of restricted foods and higher child weight across multiple studies (Faith et al., 2004). More recently, general parenting styles - the broader approach to parenting - have been linked to the development of childhood obesity (Rhee et al., 2006; Olvera & Power, 2010). For example, Rhee and colleagues (2006) found that children of authoritarian parents (those who are more strict) were almost five times as likely to be obese compared to children of authoritative parents (high demand, high response). Both paradigms regarding childhood obesity are problematic - research on food parenting practices has targeted specific practices (e.g., restriction, pressure to eat) without considering the broader range of practices that parents use and the context of that use. Research on general parenting styles has failed to define the mechanisms through which these global dimensions of parenting shape development in the eating domain.

More recently, the concept of feeding styles has been introduced into the literature which embeds how parents interact with children around eating within the general parenting style framework. Re-
search on this new conceptualization has shown associations between an indulgent feeding style, less optimal child eating behaviors, and higher weight status across multiple studies (Hughes et al., 2005; 2008; 2011; Hennessy et al., 2010; 2012; Tovar et al., 2012). These findings are similar to other research on parental permissiveness and child weight suggesting that too little control may not support the development of a good relationship with food, particularly given the current obesogenic environment (Rhee et al., 2006; Olvera et al., 2010).

**Both high and low parental control is problematic**

Researchers posit that when parents are highly controlling of their children’s food intake, children learn to focus more on external than internal cues of fullness. This leads to children eating beyond fullness thus contributing to childhood overweight/obesity. Although this idea explains why high levels of parental control can contribute to overeating in children, it does not explain why low control in parenting/feeding styles has been associated with less optimal child eating behaviors and childhood overweight.

One possible mechanism is suggested by Jansen and colleagues (2007). In their study, both high and low levels of restriction in food parenting (as assessed by a parent questionnaire) were related to the amount of snacks children consumed in a laboratory setting. This research suggests that some intermediate level of parental control may be most effective in the development of child eating behaviors.

The current literature on parental influences on child eating behaviors and weight status show that some food parenting practices (e.g., restriction) may not foster the development of a good relationship with food. However, the literature on food parenting practices does not take into account the general parenting context within which these food parenting practices are expressed. Further research is needed that takes a closer look at the very complex dynamic that takes place between parents and children around food and the mechanisms within these interactions that foster the development of childhood obesity.

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STYLE OVER SUBSTANCE: WHAT CAN PARENTING STYLES TELL US ABOUT OWNERS, PETS AND OBESITY?

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Obesity is a major concern to human health, and is a global epidemic. Its major importance comes from the fact that it predisposes to many diseases, including type II diabetes mellitus, metabolic syndrome, cardiovascular disease, arthritis and certain types of neoplasia. The rapid increase in prevalence of adult obesity over the last 20 years has been alarming, but of greater concern is the occurrence of obesity in children, where there is a global trend for increasing prevalence (Wang and Lobstein, 2006).

Various factors are said to be responsible for the development of childhood obesity including rapid early-life weight gain, socioeconomic status, time spent watching television, sleep duration (Danielzik et al., 2004; Reilly, et al., 2005). Additionally, parental weight status also exerts a strong positive influence on the development of obesity, with obesity in children being more likely if their parents are obese (Danielzik et al., 2004). This effect is thought to be related both to nature, through transmission of genetic predispositions, and also nurture, not least parental attitudes to which children are exposed regarding feeding habits, use of food rewards, and exercise. Indeed, the term ‘family food environment’ has been coined to summarise this association (Birch and Davison, 2001; Campbell, et al., 2006). The understanding of such influences has improved in recent years with greater knowledge of parenting styles and behaviours (cf. Nicklas, pp23-24).

Four parenting styles have been recognised, namely authoritative, authoritarian, indulgent and uninvolved (Maccoby & Martin, 1983). Too much parental control, as with the authoritarian style, is associated with higher weight status in the children (Faith et al., 2004), suggesting that food restriction or pressuring children to eat certain foods can be counterproductive (Ventura and Birch, 2008). Conversely, indulgent feeding styles can also have negative consequences and, where, control is too lax, a poor relationship with food develops, which may also lead to weight gain (Hughes, et al., 2005).

As in humans, obesity is a growing concern in companion animals, with recent estimates suggesting that 34-59% of dogs (Lund et al., 2006; Colliard et al 2006; Courcier et al., 2010) and 27-39% of cats (Lund et al., 2005; Colliard et al., 2009; Courcier et al., 2012) are overweight or obese. As in humans, there are many disease associations, including diabetes mellitus, osteoarthritis, and respiratory disease (German, 2006). Further, metabolic derangements are known to occur (Tvarijonaviciute et al., 2013a), whilst there are alterations in renal function (Tvarijonaviciute et al., 2013b). All in all, obesity adversely affects quality of life (German et al., 2012a), and shortens lifespan (Kealy et al., 2002).

The obvious parallels between human and companion animal obesity is, perhaps, not surprising given the fact that all are outbred species, sharing the same environment. Furthermore, the care that people provide for their pets, mirrors that which parents provide for children. Indeed, there are similarities between the interactions between owners and their dogs, and between parent and child (Archer 1997). As with childhood obesity, owner factors are known to influence the prevalence of obesity in dogs, with factors such as owner age, diet and feeding habits, and socioeconomic status all having an influence (Courcier et al., 2009 & 2012; Kienzle and Bergler, 1998; Kienzle et al., 1998; Robertson 1999 &2003). Further, studies have shown that the dogs of overweight people are more likely to be overweight than the dogs of owners in ideal weight (Holmes et al., 2007). In light of this, the next question is to consider whether styles of dog ownership exist, and what part they may play in the obesity in pets.

A brief search of the literature suggests that little information exists regarding pet ownership styles and practises, which parallel the parenting styles discussed above. In one recent study, owners typically displayed one of three different ‘orientations’ towards their pet, “dominionistic,”
“humanistic,” or “protectionistic (Blouin 2013). Dominionistic owners value pets in terms of their functional value (e.g., protection); humanistic owners view their pets as surrogate humans and have a close attachment; whilst protectionistic owners have a general high regard for animals, and all pets, viewing them as valuable companions and free-thinking creatures. However, it is unclear as to whether and how such orientations relate to the parenting styles described above. Further, to the author’s knowledge, no attempt has, as of yet been made to relate such orientations to companion animal obesity. This is, therefore, an area in much need of development.

Clearly, therefore, the veterinary and animal nutrition community have a lot to learn about the basics of pet ownership styles, and what role they may be in the current obesity epidemic. It would be fascinating to know whether, and by how much, ownership styles differ amongst the various pet species, and even amongst breeds. It would also be interesting to determine what owner factors are responsible for development of a particular style; put another way, from where do owners learn their particular style?

So how might the concept of ownership styles help with the topic of pet obesity? Firstly, greater understanding might help us to understand better what factors are associated with failure of weight loss. In this respect, it is now well established that weight management is not perfect: although many dogs and cats do successfully lose significant amounts of weight and reach their target (German et al., 2007 & 2008), such findings disguise the fact that many do not1. Further, those reaching their target are at risk of subsequent weight regain, with approximately half rebounding2. It would be fascinating to explore the extent to which styles of pet ownership may influence success with weight programmes. In this respect, most current weight management strategies require the owner to exert control over both the amount and type of food fed, and also the denial of certain foods (including treats), akin to an authoritarian style. Owners with other styles might find such strategies difficult to adopt, predisposing them to fail. Most problematic would likely be those preferring and indulgent feeding style. Further, although the use of an authoritarian style may enable other clients to succeed in slimming their pet, this strategy might then increase the likelihood of subsequent regain during the maintenance phase. Those foods denied during weight loss become more desirable both for the pet (increasing the likelihood of food stealing or consumption in excess if offered) and the owner (since a period of denying such food might increase the desire of the owner subsequently to feed it as a reward).

A further challenging area for weight management is the reluctance of veterinarians to discuss the topic of obesity with clients, as highlighted by a recent study suggested that the topic is raised in only 1 in 100 dog and cat consultations3. Given the current prevalence in dogs and cats (see above), it is evident that most owners of overweight companion animals, receive no specific guidance from their veterinarian. Clearly, therefore, this is a topic that many veterinarians find challenging and difficult to raise with clients. However, perhaps knowledge of pet ownership styles could help, since they may form a basis for general discussion on pet ownership, making it easier for the veterinarian to introduce concerns regarding feeding practises and obesity. In time, specific strategies could be developed for different the owner styles, enabling greater tailoring of the approach than is currently possible.

Finally, knowledge of pet ownership styles could ultimately be used to help in obesity prevention. In this respect, if certain styles were known to predispose to obesity, then targeted owner education could then be applied to those owners with styles likely to predispose to weight gain. A recent study has identified that different populations of cat exist that respond differently to long-term ad libitum feeding (Serisier et al., 2013). Some cats are unable to regulate their food intake, leading to gradual lifelong weight gain, whilst others maintain stable weight and optimal body condition lifelong, presumably by regulating intake. It might be prudent for owners with an indulgent feeding style, to be paired with the food regulators, since they can be free to feed what they wish, without the risk of undesirable weight gain developing in their cat.

In summary, the concept of parenting styles and its role in childhood obesity is fascinating, and
knowledge developed in this field may have relevance to pets, not least those prone to obesity. It remains to be seen to what extent these styles are mirrored in pet populations, and what use we can make of such knowledge.

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From pet food to pet care – bridging the gap

ORAL ABSTRACTS
DEEP ILLUMINA-BASED SHOTGUN SEQUENCING REVEALS DIETARY EFFECTS ON THE STRUCTURE AND FUNCTION OF THE FECAL MICROBIOME OF GROWING KITTENS

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Introduction
Despite being obligate carnivores, cats are fed a wide range of dietary macronutrients within commercial diets. Little is known regarding the feline gastrointestinal microbiome and how it is impacted by diet. Using 16S RNA analysis, changes in diet (protein:carbohydrate ratio) do affect fecal microbiota of growing kittens. However, to investigate potential functional differences deep Illumina shotgun sequencing is required. An investigation into microbial structure and function in these animals is reported here.

Materials and methods
Fresh fecal samples were collected from kittens fed a moderate (n=6) or high-protein (n=6) diet at eight, 12 and 16 weeks of age. DNA was extracted, prepared with Illumina's TruSeq kit and sequenced on a HiSeq2000. After trimming, short reads underwent taxonomic and functional annotation using a composition vector approach.

Results
578 microbial genera (230 families) and 6,886 enzyme functions (280 pathways) were identified in feline fecal samples. Species’ richness and diversity was greater for the high-protein microbiome. Structural comparisons indicated significant differences between diets in 324 genera and 138 families. 2,013 functions (194 pathways) showed significant differences between diets. An issue with this amount of information is managing the data to assist biological interpretation. We therefore applied a permutation approach and identified 10 pathways containing more significant functions than expected at random, of which six were related to amino-acid metabolism.

Discussion and conclusions
This is the largest and most comprehensive analysis of the feline gastrointestinal microbiome to date. It provides an overview of the taxa and gene functions present and how they are impacted by the dietary protein:carbohydrate ratio. The more diverse structure of the high-protein diet might reflect a more specialized microbiome. As anticipated, our permutation approach reduced the number of pathways to a more manageable set. The reduced data set identified six pathways readily interpretable to the study design.
AGE AND SOURCES OF CARBOHYDRATES AND PROTEIN AFFECT DIGESTIBILITY, FECAL MICROBIOTA AND FERMENTATION PRODUCTS OF DOGS

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Introduction
The effects of age and diets with different carbohydrates and protein sources on digestibility, fecal microbiota composition and activity were evaluated in dogs.

Materials and methods
A non-fermentable insoluble fiber-based diet (IF; 34% poultry meal and 10% sugarcane fiber), a fermentable fiber-based diet (FF; 34% poultry meal and 10% beet pulp), and a soybean meal-based diet (SM; 30% SM, 11% poultry meal and no fiber source addition) and two age groups (adult-2.6±0.9 and old-10.2±1.1 years) were used in a 3x2 factorial design totaling six treatments. Six dogs were fed each diet during 22 days, and nutrient digestibility (fecal collection days 11-15), volatile fatty acids (VFA; days 16-18) and fecal microbiota (pour plate method; days 21-22) were evaluated. Data were analysed with ANOVA, considering age and diet effects and their interactions (P<0.05).

Results
Except for fat, nutrient digestibilities were lower for IF, intermediary for FF, and higher for SM diet (P<0.02). Interaction of diet x age was verified for dry matter, protein, fat and energy digestibilities, with the old group presenting lower digestibilities than adults when consuming the FF diet (P<0.05). No age effect was verified for IF and SM. The partial solubility of beet pulp fiber may have negatively affected the digestibility of old dogs. A diet effect was verified for fecal VFA, with lower total short-chain fatty-acids and higher branched-chain fatty-acids, and fecal pH for IF (P<0.05), and higher propionate and lower butyrate, isobutyrate and isovalerate for SM (P<0.05). These findings may suggest different fermentation pattern of IF and SM fibers (P<0.05). For total aerobes and anaerobes, lactobacillus and bifdobacterium a diet x age interaction was verified, with adults group fed IF having lower fecal counts (P<0.05), meanwhile no change was observed for old group.

Discussion and conclusions
Fermentable fiber interferes with nutrient digestibility of old dogs. Fecal microbiota of old and adult dogs respond differently to dietary changes.
THE EFFECTS OF DIET FORMAT ON IN VITRO ASSESSMENT OF FAECAL WATER TOXICITY IN THE DOMESTIC CAT

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Introduction
There is increasing interest in the effects of diet on intestinal health in companion animals, with a particular focus on intestinal microbiota composition. Currently, interpretation of dietary changes on microbial populations is based largely on health outcomes in rodents. For example, high protein diets in the domestic cat increase the levels of Proteobacteria; these bacteria have been associated with disease in rodents. We hypothesised that dietary format will alter microbial composition and the soluble content of intestinal digesta and this will affect the health of the intestinal tract. This will be assessed by measuring the effects of faecal water extracted from cats fed either a moderate protein:fat:carbohydrate (kibbled) or high protein:fat:carbohydrate (canned) diet on the expression of genes involved in intestinal health in CaCo-2 cells.

Materials and methods
Eighteen mixed sex domestic short-haired adult cats were maintained on either a moderate protein:fat:carbohydrate kibbled (35:20:28 % DM; n=9) or high protein:fat:carbohydrate canned (45:37:2 % DM; n=9) diet. Both diets were formulated to meet all nutrient requirements for growth, gestation and lactation according to the Association of American Feed Control Officials. Fresh faecal samples were obtained from the cats and mixed (1:1) with phosphate-buffered saline and faecal water was extracted. CaCo-2 cells were treated with 10% faecal water for 24 hours. The expression of the DNA repair genes (MSH2 and MLH1) and key genes altered in colon cancer (TP53 and KRAS) were quantified in the CaCo-2 cells using probe-based real-time PCR.

Results
Based on this assay, cats fed canned diets had higher relative fold change of MLH1 compared to cats fed kibbled diets ($P<0.05$). TP53, KRAS and MSH2 were unaffected by diet.

Discussion and conclusions
Faecal water extracted from cats fed canned diets increased the expression levels of genes involved in DNA repair in CaCo-2 cells. Changes in gene expression will be correlated to changes in microbial populations observed.
VALIDATION OF A NEW METHOD BASED ON AN IMAGE-ANALYSIS SYSTEM FOR THE MEASUREMENT OF DENTAL PLAQUE ACCUMULATION IN CONSCIOUS DOGS

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Introduction
Conventionally, in veterinary medicine, indexes such as Logan Boyce assess the dental plaque coverage over the crown surface, despite their discontinuity and the need of anaesthesia. A gingival contour plaque index was implemented for conscious dogs, but it requires visual measurements along the gingival margin with a graduated probe (Scherl et al., 2007).

The aim of this study was to validate a new method for dental plaque assessment in conscious dogs based on an image-analysis system.

Material and methods
The new method was adapted from the previous image-analysis method validated on anesthetized dogs (Mariani et al., 2011). It consists of four steps: disclosing the plaque with Red DC # 28 (Reveal®), standardizing picture taking of the dental arches, manually contouring the crown surface on the picture using Photoshop® CS4 and a graphic tablet (G-Pen M712®) and finally, analysis of the disclosed plaque, in order to calculate a plaque/tooth surface ratio. The repeatability of the last three steps of the dental plaque analysis was evaluated on eight teeth from six dogs with six repetitions. The image-analysis measurement was compared to a manual contouring measurement for validation. The first two steps were the same as above, while the subsequent step of plaque contouring was performed manually by a trained and expert examiner on 50 teeth. All dogs were conscious and carefully trained to the plaque disclosure and picture taking steps.

Results
The new automated method was repeatable with a mean plaque ratio of 47.48%, an average coefficient of variation of 11.58±SEM=0.37% and a good correlation (r² Kendall=0.706) with the manual method of plaque contouring performed by an expert.

Discussion and conclusions
The study validated the new method of dental plaque coverage assessment on the tooth surface of conscious dogs.
OLFATORY PERFORMANCE IN TRAINED DETECTION LABRADOR RETRIEVERS ON THREE DIFFERENT DIETS: FAT AFFECTS OLFATORY PERFORMANCE

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Introduction
Improving canine detection capabilities and the influence of exercise on detection are areas of interest in recent anti-terrorist initiatives. Previous work suggests that dietary fat might influence canine olfaction. This study evaluated whether olfactory performance could be influenced by forms of dietary fat and exercise.

Materials and methods
Seventeen detection dogs were trained and certified to identify explosives. They were fed three different diets (57% ME fat, 27% ME protein; 32% ME fat, 27% ME protein or 57% ME fat, 18% ME protein via corn oil addition) for 12 weeks in a blinded 3x3 Latin square design. After 12 weeks, olfactory testing was performed using a scent wheel that contained eight positions in an olfaction laboratory. Each position consisted of a steel basket with a glass dish that held the target and distracting odors. The target odors were 0.001-1.0 grams of explosives. The dogs completed eight to 12 scent trials before and after a 30 minute treadmill exercise. A mixed-effects logistic regression model was used to examine how diet, pre- or post-exercise, trial number, odor, mass of target, target position influenced the probability of dogs alerting on the target.

Results
Dogs were 1.42 (1.082-1.87) times as likely to find a target on the high polyunsaturated fat diet relative to the high fat diet ($P=0.0099$). The low fat diet was not significantly different from either the high fat diet or the high polyunsaturated fat diet ($P>0.1230$). Dogs were 1.49 (1.26-1.76) times as likely to find a target prior to exercise relative to after exercise ($P<0.0001$).

Discussion and conclusion
Dogs provided the corn oil showed higher olfactory acuity. The exact reasons are unclear, however the higher relative amount of linoleic acid may play a role in olfactory sensation which warrants further examination of optimal diets for detection dogs.
SERUM CHEMISTRY AND ELECTROLYTES ALTERATIONS IN SLED DOGS BEFORE AND AFTER A 1600KM RACE: DIETARY SODIUM AND HYPONATREMIA

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Introduction
Sled dogs are known to develop numerous serum biochemical changes due to exercise. Previous studies have suggested that hyponatremia and hypokalemia develop during endurance racing. The aim of this study was to determine if serum biochemical alterations are similar to previous reports, and if electrolyte alterations are still present with current feeding practices utilized by mushers.

Materials and methods
Serum chemistries were obtained from 26 Alaskan Huskies (18-28kg), belonging to three different teams, before and after a 1,600km race. Meals and snacks were analyzed to determine daily macronutrient and electrolyte intake.

Results
Numerous biochemical alterations were observed including significant differences in serum total protein, albumin, globulin, aspartate aminotransferase, creatine kinase, triglyceride, non-esterified fatty acids and urea nitrogen \( (P<0.05) \). Serum electrolyte status revealed a mild yet significant decrease in serum sodium \( (P=0.002) \); and serum potassium was not significantly different \( (P=0.566) \). Further examination of the sodium intake across the three teams revealed two teams with an average daily intake of 7.92 (650mg/1000kcals and 7.71g/dog/day (910mg/1000kcals) and the other team consuming 5.44g/dog/day (540mg/1000kcals). Regression analysis shows a strong correlation between serum sodium decrease and sodium intake per 1000 kilocalories \( (R=0.98) \) with serum sodium concentrations being significantly higher in the former two teams \( (P=0.047) \) after racing compared to the team with a lower sodium intake.

Discussion and conclusions
Post-race hyponatremia was mild and hypokalemia was not evident in our population compared to what has been reported, while other serum biochemical changes were similar. Current diets contain increased commercial dog food consumption leading to increased electrolyte intake compared to meat-based diets. These findings suggest that consumption of approximately seven grams (700mg/1000kcals) of sodium per day may prevent the hyponatremia associated with endurance exercise in Alaskan sled dogs.
EFFECT OF HIGH PHOSPHORUS INTAKE ON RENAL PARAMETERS IN CATS IS INFLUENCED BY PHOSPHORUS CONCENTRATION IN URINE

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Introduction
Pastoor et al. (1995) reported a reduced creatinine clearance after feeding a High P diet (867mg P/MJ ME, Ca/P 0.4/1, 28 days) to healthy adult cats. In the present study we repeated this experiment varying Ca/P ratio and P source.

Materials and methods
Thirty-six healthy adult cats were divided into control and trial groups (≥ 6 cats/group, crossover). The controls received a balanced meat-rice diet (Ca/P 1.3/1). The trial groups ate the same diet with 879-903mg P/MJ ME with increasing Ca/P ratios of 0.4, 0.9 and 1.3/1, the latter with either Ca- or Na-monophosphate as P source. Endogenous creatinine clearance, glucosuria, microalbuminuria, water and mineral balance were determined.

Results and discussion
Creatinine clearance decreased in cats eating High P with a Ca/P of 0.4/1. The table shows the incidence of glucosuria and microalbuminuria in all groups. An exchange of Ca-monophosphate against Na-monophosphate in diet High P Ca/P 1.3/1 increased urine volume and renal P excretion. The reaction of markers of renal health was related to urine P concentration (table).

Conclusion
Safety of high P intake is influenced by Ca/P ratio, P source and urine volume.

Table: Renal parameters and urine P

<table>
<thead>
<tr>
<th>P source</th>
<th>Creatinine clearance</th>
<th>Glucosuria [%]</th>
<th>Microalbuminuria [%]</th>
<th>Renal P excretion [mg/kg BW]</th>
<th>Urinary P content [g/kg]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control Rice &amp; meat</td>
<td>No effect</td>
<td>5</td>
<td>2</td>
<td>17±6</td>
<td>1.3±0.6</td>
</tr>
<tr>
<td>High P Ca/P 0.4/1 Na- &amp; Ca-monophosphate</td>
<td>Decreased</td>
<td>69</td>
<td>69</td>
<td>114±20</td>
<td>5.8±1.4</td>
</tr>
<tr>
<td>High P Ca/P 0.9/1 Ca-monophosphate</td>
<td>No effect</td>
<td>85</td>
<td>31</td>
<td>79±14</td>
<td>5.6±1.2</td>
</tr>
<tr>
<td>High P Ca/P 1.3/1 Ca-monophosphate</td>
<td>No effect</td>
<td>0</td>
<td>0</td>
<td>25±5</td>
<td>1.5±0.3</td>
</tr>
<tr>
<td>High P Ca/P 1.3/1 Na-monophosphate</td>
<td>No effect</td>
<td>50</td>
<td>0</td>
<td>83±15</td>
<td>3.4±0.5</td>
</tr>
</tbody>
</table>

Reference
EFFECT OF AGE, GESTATION AND LACTATION ON Fecal IMMUNOGLOBULIN A AND CALPROTECTIN CONCENTRATIONS IN DOGS

Grellet, A.1, Heilmann, R.M.2, Mila, H.3, Feugier, A.1, Grützner, N.2, Suchodolski, J.S.2, Steiner, J.M.2, Chastant-Maillard, S.3

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Introduction
Several biomarkers for gastrointestinal inflammation and immunity have been described for humans to help limit invasive diagnostic procedures, but to date little is known about them in dogs. The purpose of this study was to evaluate the effect of gestation, lactation and age on fecal IgA and calprotectin concentrations in dogs.

Materials
Seventy-six adult control dogs, 28 puppies and 17 pregnant and later lactating bitches were included into the study. Puppies were followed between the ages of four and nine weeks and bitches from the second month of gestation until the end of lactation. Fecal IgA and calprotectin concentrations were quantified and results analyzed by the Aspin Welch test. Data are presented as medians and ranges. A p-value of 0.05 was considered significant.

Results
Lactating bitches had significantly lower fecal calprotectin concentrations compared to control dogs (4.5 [2.9-24.3] µg/g vs. 10.2 [2.9-102.9] µg/g, P=0.001). Fecal calprotectin concentrations were significantly higher in puppies between 4-6 weeks of age (35.5 [7.6-295.8] µg/g) than in puppies between 7-9 weeks of age (22.2 [2.9-58.8] µg/g; P=0.016) and also in adult dogs (10.2 [2.9-102.9] µg/g; P=0.008). Fecal IgA concentrations were significantly lower in bitches during their second month of lactation (7.02 [0.4-20.7] mg/g) compared to control dogs (11.8 [2.5-21.5] mg/g; P=0.003). Puppies between 7-9 weeks of age had fecal IgA concentrations that were significantly lower than in younger puppies (4.2 [0.3-13.1] mg/g vs. 10 [0.5-29.3] mg/g; P=0.001).

Discussion and conclusions
The effect of age on fecal calprotectin and IgA concentrations is consistent with findings for another fecal biomarker (alpha1-proteinase inhibitor concentration) in dogs and could be explained by several phenomena, such as an increased intestinal permeability during the development of the digestive tract in very young dogs, a (dys)regulation of the intestinal microbiota or an influence by the type of diet.
ESTROGEN REPLACEMENT EFFECTS ON INSULIN SENSITIVITY AND GLUCOSE TOLERANCE IN AT-RISK CATS FOR FELINE DIABETES

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Introduction
Feline diabetes mellitus is an increasingly prevalent disorder that is associated with decreased insulin sensitivity and secretion. Because estrogen reputedly modulates insulin release and action, oral replacement of gonadal estrogen lost with neutering was hypothesized to improve indices of glucose homeostasis in at-risk cats (obese, neutered, male gender) by increasing insulin sensitivity and glucose tolerance and restoring physical activity to pre-neuter conditions.

Materials and methods
Six adult, neutered, overweight (BCS 6-9/9) male cats were randomly assigned to two groups of three in a single crossover trial. 17β-Estradiol (E2; 1.0µg/kg) or vehicle (Vh; ethanol, 1.0µL/kg) was orally administered once daily for a period of 14 days with a seven day washout period. On days 9-11 of each treatment block, physical activity was measured by collar-mounted accelerometers (Actical: Philips Respironics). On days 13 and 14, intravenous insulin tolerance tests and intravenous glucose tolerance tests were conducted, respectively.

Results
E2 administration compared to Vh reduced feed intake by a mean of 18% without significantly impacting body weight. Activity counts were overall increased during E2 treatment and appeared to vary proportionately with % body fat but the effect was not significant. The rate of change of glucose clearance from plasma was lower ($P<0.05$) with E2 versus Vh treatments (-1.81%/min and -2.34%/min respectively). Plasma insulin area-under-the-curve concentrations were decreased by 22.5% with E2 but insulin sensitivity indices during treatments of E2 (0.56) and Vh (0.61) were not significantly different.

Discussion and conclusions
Estrogen administration increased physical activity and mildly decreased glucose tolerance. Results may indicate a negative impact of oral estrogen replacement on indices of B-cell function. However, they may reveal down regulation of insulin production during E2 treatment, reflecting a reduced requirement for insulin to achieve glucose homeostasis.
SYNERGISTIC BENEFICIAL EFFECTS OF CURCUMA EXTRACT, GREEN TEA EXTRACT AND HYDROLYSED COLLAGEN IN BOVINE CHONDROCYTES IN MONOLAYER CULTURE

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Introduction

This study aimed to investigate the effects of curcuma extract, green tea extract and hydrolysed collagen, alone or in combination, on the production and gene expression of inflammatory and catabolic mediators by primary bovine chondrocytes.

Material and methods

Primary bovine chondrocytes were cultured in monolayer until confluence and then incubated in the absence or in the presence of recombinant porcine IL-1β (10-11M) and with or without curcuma extract, green tea extract and hydrolysed collagen, at the concentration of 12.5µg/ml, alone or in combination. Cell viability was determined by measuring lactate dehydrogenase release. After 24h of incubation, interleukin-6 (IL-6), inducible NO synthase (iNOS), cyclooxygenase2 (COX-2), metalloproteinase3 (MMP-3), A Disintegrin and Metallopeptinase with Thrombospondin Motifs (ADAMTS)4 and ADAMTS5 gene expressions were determined by real time PCR. After 48h of incubation, nitric oxide (NO) and prostaglandin E2 (PGE2) production was quantified.

Results

Cell viability was not affected by these compounds, neither by IL-1β. Curcuma extract alone inhibited IL-1β stimulated NO and PGE2 production and IL-1β stimulated IL-6, iNOS, COX-2, MMP-3 and ADAMTS4 gene expression. Green tea extract or hydrolysed collagen alone did not inhibit inflammatory and catabolic mediators synthesis. When they were combined, curcuma extract, green tea extract and hydrolysed collagen inhibited IL-1β stimulated NO production and IL-1β stimulated IL-6, iNOS, COX-2, MMP-3 and ADAMTS4 gene expression with a higher magnitude than curcuma extract alone. ADAMTS5 gene expression was not inhibited by these compounds added separately, while the combination of curcuma extract / green tea extract / hydrolysed collagen was efficient.

Discussion and conclusions

These in vitro results indicate that curcuma extract, green tea extract and hydrolysed collagen act synergically to inhibit the production of inflammatory mediators and the expression of genes involved in catabolism and inflammation. These findings provide a preclinical basis for the in vivo testing of this combination.
A DISCUSSION WITH THE FOOD AND DRUG ADMINISTRATION

Foods that claim to treat disease
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Under United States law, pet foods that claim to treat a disease meet the legal definition of a drug as well as animal food. For years, pet food manufacturers and researchers in several disciplines involving nutrition and healthcare have been interested in determining the effects nutrients, ingredients or complete diets may have for treating, mitigating or curing disease. However, when claims are made to diagnose, cure, mitigate, or treat a disease, the animal food product could be regulated as an unapproved new animal drug. Under US law, drugs for people or animals are required to have approval from the US Food and Drug Administration (FDA) prior to being marketed, and are unsafe and adulterated, by definition, if they do not have an approval from FDA. Dog and cat food products have been marketed to treat diseases for more than 50 years, but none have been approved by FDA for their indicated uses. In September of 2012, FDA published a draft Compliance Policy Guide (CPG) that indicates the agency’s position on pet foods that claim to diagnose, cure, mitigate, or treat a disease and factors the agency will consider for taking regulatory action. The CPG states priority for enforcement will be for pet food products that: 1) are marketed as alternatives to approved new animal drugs; 2) contain unapproved food additives or ingredients otherwise unacceptable for use in animal foods; 3) include words or vignettes on product labels that indicate diseases for product use; and, 4) are sold directly to the public outside of a valid veterinarian-client-patient relationship thereby circumventing veterinarians for direction and evaluation of treatment outcome. Researchers and marketers should also realize that treatment effects identified using diseased animals may be drug effects, and are not automatically transferable to healthy animals.

Update on Federal Food Safety Regulations mandated by FSMA and FDAAA
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With the passage of the Food and Drug Administration Amendments Act (FDAAA) and the Food Safety Modernization Act (FSMA), Congress directed the Food and Drug Administration (FDA) to update the regulations that help protect the American food supply. The early warning surveillance system and reportable food registry required by FDAAA have been implemented. The regulations for ingredient standards, processing standards, and labeling standards, are still under development and review. The updated pet food labeling standards are likely to require information similar to the Association of American Feed Control Officials (AAFCO) model regulations in a format similar to the labels of other FDA regulated products. FSMA is designed to give FDA more authority to protect the safety of food for humans and animals. The key components of FSMA are prevention; enhanced partnerships; updated inspection, compliance, and response tools; and import safety. Prevention is the cornerstone of FSMA.

The proposed rule for preventive controls for human food was published in January and requires facilities to prepare and implement a written food safety plan that includes hazard analysis, risk based preventive controls, monitoring procedures, corrective actions, verification, and record keeping. The proposed rule for preventive controls for animal food has not published yet, but is expected to be very similar to the proposed rule for human food.

Both proposed rules represent a historic change in federal regulation of animal food with the creation of pet food specific labeling requirements and a new risk-based food safety system. These rules are being reviewed to minimize the burden on regulated industry. The proposed preventive controls for animal food are expected to publish sometime in late fall and the proposed pet food labeling standards sometime later. Interested parties will be able to submit comments on both proposed rules.
EFFECTS OF DIETARY MACRONUTRIENT COMPOSITION ON THE FASTED PLASMA METABOLOME OF HEALTHY ADULT CATS

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Introduction
Metabolomics has been widely used in humans for dietary assessment and identification of biomarkers for food intake and diseases. However, the application of metabolomics to feline nutrition has been very limited. The objective of this study was to characterize the feline blood metabolome and identify how it changed in response to dietary macronutrient composition.

Materials and method
Twelve neutered male adult domestic cats were fed four nutritionally complete diets [control, high-fat (HF), high-protein (HP), high-carbohydrate (HC)] at amounts to maintain ideal body weight and body condition score. Cats were randomly allotted to diets in a 4x4 Latin square design experiment for a total of 64 d (four 16-d periods). Overnight fasted plasma samples were collected in the morning of d 16 and subjected to liquid/gas chromatography and mass spectrometry.

Results
Principal component analysis showed that metabolite profiles of cats fed HP, HF, and HC dietary regimes formed distinct clusters. Gamma-glutamylleucine, 3-hydroxyisobutyrate, and 3-indoxyl sulfate were identified by random forest analysis to distinguish cats fed the three macronutrient-rich diets. Cats fed the HP diet had metabolite profiles associated with decreased nucleotide catabolism, but increased amino acid metabolism and ketone bodies indicating a greater use of protein and fat for energy. Cats fed the HP diet had a significant increase in metabolites associated with gut microbial metabolism. Cats fed the HF diet had metabolites indicative of increased lipid metabolism, including free fatty acids, monoacylglycerols, glycerol-3-phosphate, cholesterol, ketone bodies, and markers of oxidative stress.

Discussion and conclusions
The use of a holistic metabolomics approach in cats may identify signatures indicative of specific dietary nutrient intake, metabolic status, or disease. In this study, macronutrient-rich diets primarily altered markers of amino acid and lipid metabolism, with little changes in markers of carbohydrate and energy metabolism. Moreover, the HP diet influenced metabolites originating from gut microbial metabolism.
MACRONUTRIENT INTAKE REGULATION DURING GESTATION AND LACTATION IN DOMESTIC CATS

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Introduction
We previously described a macronutrient intake target in adult domestic cats. If the amounts of macronutrients eaten are to meet the metabolic requirements of the animal then the intake target should change in response to physiological demands of the animal. Here we investigated whether macronutrient intake changed during gestation and lactation in cats.

Materials and methods
Seventeen adult female cats were offered a choice of three different wet foods (% metabolisable energy from protein/fat/carbohydrate for each food: 42/24/34; 70/25/5; 41/55/4; all nutritionally complete for gestation/lactation) in separate bowls throughout gestation and lactation. A mixed model was fitted for seven measures: energy intake (kJ); protein, fat and carbohydrate intake (g and %energy) in each phase (gestation, lactation) with day, day 2, litter size (small=1–3, large=4–5 kittens) and their interactions as fixed effects and cat as the random effect. The threshold p-value for statistical significance was corrected to 0.05/14=0.003571.

Results
Protein, fat and total energy intake increased significantly with no effect of litter size during gestation. A significant effect of litter size was seen on total energy intake during lactation (P<0.001). Protein intake in lactation increased from 28.3g (95% confidence interval 24, 33.4) to 50.7g (43.1, 59.6) in cats with small litters and from 44.6g (39.4, 50.6) to 79.8g (70.5, 90.4) in cats with large litters. Fat intake doubled during lactation from 9.2g (7.3, 11.7) to 18.4g (14.5, 23.3) in cats with small litters but tripled in those with large litters from 14.6g (12.2, 17.5) to 43.4g (36.3, 52). During lactation the % energy from fat selected in the diet significantly increased while % energy intake from protein and carbohydrate declined.

Discussion and conclusions
These data confirm that the energy demands of lactation were greater than gestation particularly as the number of offspring to support increased. In response to these changing energy demands cats altered their macronutrient intake accordingly, progressively shifting towards composing a diet providing a greater proportion of energy from fat.
REACTIVE LYSINE CONTENT IN COMMERCIALLY AVAILABLE PET FOODS

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2Laboratory of Food Chemistry, Wageningen University; 3WALTHAM Centre for Pet Nutrition, Melton Mowbray, Leicestershire, UK

Introduction
The Maillard reaction occurs during processing of ingredients and pet foods. During this reaction, the ε-amino group of lysine reacts with reducing sugars to become unavailable for metabolism. Previous studies reported reactive lysine (RL) contents in commercial pet foods up to 60% lower than total lysine (TL). The aim was to determine TL and RL contents of commercial pet foods and to evaluate whether RL levels meet minimal lysine requirements (MLR).

Materials and methods
Sixty-seven extruded, canned and pelleted pet foods for growth and maintenance were analysed for proximate nutrient composition, TL and RL (guanidination). Metabolisable energy (ME) was calculated using modified Atwater factors for dogs and cats and calculated NFE values. RL was expressed on ME basis and compared with the MLR for maintenance and growth (NRC, 2006).

Results
In dog foods, average RL/TL ratios were 0.88 for extruded, 0.97 for canned and 0.85 for pelleted foods, with the lowest ratio of 0.77. In extruded and canned cat foods, average ratio was 0.92 and 0.90, respectively, with the lowest ratio of 0.67. The RL contents of all dog and cat foods were higher than MLR.

Discussion and conclusions
The low RL/TL ratios in pelleted foods are surprising as generally milder processing conditions are used during pelleting than during extrusion or canning. The ingredients used in pelleted foods may already have contained bound lysine before processing. Therefore, ingredients rather than processing might be the key factor influencing protein quality in pet foods. According to nutrient requirements, MLR reported in NRC (2006) relate to 100% bioavailability. However, ileal RL digestibility values in adult dogs were reported to be between 80 and 94%. Six dry foods for growing dogs could be at risk meeting MLR for dogs between four and 14 weeks of age in case bioavailability of RL is lower than 76%. Therefore, it would be prudent to measure RL content of foods for growing dogs.
NO ADAPTATION OF FAECAL CALCIUM EXCRETION TO LOW CALCIUM INTAKE IN ADULT DOGS

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Introduction
A meta-analysis of calcium (Ca) digestibility studies in adult dogs (mainly ≤ four weeks) suggests no adaptation in faecal Ca excretion occurs in response to low Ca intake. We hypothesized that either dogs do not adapt efficiently to a low Ca intake by increasing Ca absorption or that adaptation takes longer than four weeks.

Materials and methods
Six adult Beagles and five adult Foxhound crossbreds were fed a diet designed to provide Ca at minimum requirement with a Ca:P ratio of 0.6:1. For four months prior to the trial the dogs were fed complete and balanced dog food. During this period baseline blood samples were collected for bone degradation marker analysis (serum crosslaps) and a digestion trial was carried out. Dogs then moved into the low Ca test phase (~60 mg/kg metabolic body weight) and digestion trials and blood sampling were repeated at weeks 7, 14, 21 and 28.

Results and discussion
All dogs remained healthy. Apparent Ca digestibility changed from positive (pre-trial) to negative (low Ca) without any significant increase throughout the whole low Ca trial period. There was no significant decrease of faecal Ca excretion during the low Ca period. Serum crosslaps (see figure) increased significantly during low Ca period.

Conclusion
Adult dogs fed Ca in amounts approximately matching minimum requirements showed a negative apparent Ca digestibility and an increase in bone degradation markers over a period of more than six months. This shows clearly that dogs do not adapt to low Ca intake by increasing absorption efficiency even after a long time-period. That may explain why adult dogs develop clinical signs of Ca deficiency when fed un-supplemented home made diets for a prolonged period.

References
ENERGY REQUIRED FOR TROTTING IS INVERSELY PROPORTIONAL TO LEG LENGTH IN SMALL DOGS

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Introduction
Energy expenditure (EE) for running is proportional to distance travelled irrespective of speed in many species and declines with increasing body mass with an exponent of approximately -0.33. This suggests that EE for running declines proportionately with increasing leg length.

Materials and methods
To test this hypothesis, EE was measured using indirect calorimetry in healthy pet dogs of similar body weights but different leg lengths (six miniature Dachshunds, five Jack Russell Terriers, and five Italian Greyhounds) habituated over 2-3 months to wear a mask while standing or trotting on a horizontal treadmill. Dogs were exercised for 10 min per speed for a total of 40 min per session two to three times weekly.

Results
Among the three breeds, respectively, mean body weights were 5.7, 6.9 and 6.1kg, mean heights to the greater trochanter were 18, 24 and 32cm, dogs were able to trot at speeds of up to 6, 8 and 10 kph, and mean EE for trotting was 1.3, 1.0 and 0.6 kcal.kg-1.km-1. Mixed linear regression showed that EE for trotting differed with leg length (P<0.0005) but there was no evidence of an effect of speed or a speed-height interaction. The mean EE was regressed against height to the trochanter. Linear regression gave an equation: EE=2.22-0.05xlength (R2=0.73). Regression of the logarithms of each parameter gave an exponent of -1.43 (R2=0.71).

Discussion and conclusions
EE for trotting decreases as leg length increases but the rate of decrease is greater than the rate of increase in leg length.
DIETARY GAMMA-LINOLENIC ACID SUPPORTS ARACHIDONIC ACID ACCRETION AND ASSOCIATED Δ-5 DESATURASE ACTIVITY IN FELINE UTERINE TISSUES

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Introduction
Feline lipid metabolism is unique among animal species. Arachidonic-acid (AA) is essential for feline reproduction but conversion of dietary linoleic acid to AA is rate limited by low Δ-6 desaturase. The possibility exists that dietary -linolenic acid (GLA) may provide for AA synthesis via bypassing this initial rate-limiting step. This study investigated AA accretion in reproductive tissues with GLA feeding.

Materials and methods
Twenty-six adult female domestic shorthair cats were divided into three groups and fed complete/balanced diets containing either High linoleic acid, Low linoleic acid, or High-GLA for 300 days prior to ovariohysterectomy. Plasma was obtained 1-2 days prior to this time and uterine, ovarian, and associated adipose tissues were reserved for lipid analysis. Fatty acids of plasma phospholipid (PL) and tissue lipids were determined after total lipid extraction/fractionation. Statistical analyses utilized Shapiro-Wilks, one way ANOVA, and Tukey multiple comparisons at $P<0.05$ significance.

Results
Plasma-PLs were significantly increased in both GLA and its chain elongation product, di-homo GLA (DGLA), with the High-GLA group compared to the two linoleic acid diets. Uterine tissue-PLs also were significantly increased in both DGLA and AA. However, ovarian tissues and adipose tissues were only increased in DGLA.

Discussion and conclusions
DGLA and AA enrichment of uterine tissues is likely to supply essential eicosanoid precursors for reproduction when GLA is fed. This finding is consistent with an active Δ-5 desaturase in uterus. By contrast, this enzyme may not be active in ovary given that increased DGLA, but not AA, was observed. Earlier reports concluded that AA was not necessary for fertilization (an ovarian function) but required for successful pregnancy (a uterine function). Adipose tissue DGLA may be a reservoir for AA synthesis by other metabolically active tissues upon mobilization. Dietary GLA may meet feline AA requirements in the absence of an animal-based preformed AA source.
VALIDATION STUDY OF A NON-INVASIVE METHOD FOR ESTIMATION OF ENERGY EXPENDITURE IN DOGS

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Introduction
To provide guidelines for an appropriate nutrition of dogs, a reliable and feasible method for investigations of their energy expenditure (EE) would be very valuable. The 13C-bicarbonate tracer technique (13C-BTT) has been used to assess EE in several species of animals, and in humans. This stable isotope method is based on the 13C kinetics in breath CO₂ after administration of 13C labeled sodium bicarbonate (NaH₁³CO₃). After administration, the ratio between 13C and 12C in samples of expired air, collected over a sufficient period of time, can be used to estimate the CO₂ production rate, which is needed in the equation for estimation of EE. By using oral administration, the method can be completely non-invasive, making it an appropriate method for studies in dogs. The aim of this study was to validate the oral 13C-BTT against indirect calorimetry, for the estimation of EE in dogs.

Material and methods
Eight dogs were included in this study, and individually kept in a respiration chamber for approximately five hours. The CO₂ production and O₂ consumption were measured continuously by means of an open-air-circuit respiration unit. Simultaneously, the ratio between 13C and 12C in expired CO₂ was measured online using an infrared isotope analyzer, after an oral dose of NaH₁³CO₃, making comparison between the methods possible. Energy expenditure was statistically analysed using the mixed procedure in SAS with method and dog as fixed effects.

Results, discussion and conclusions
The results showed no significant differences ($P>0.05$) between the two methods used for estimation of EE, suggesting that the oral 13C-BTT can be used as a non-invasive method to obtain reliable estimates of EE in dogs during resting conditions. However, there were significant differences ($P<0.001$) in estimated EE between individual dogs.
MODULATION OF FOOD INTAKE IN MALE NEUTERED CATS BY INGESTION OF ESTROGEN-LIKE SUBSTANCES IN FOOD

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Introduction
Subcutaneously (SQ) administered estrogen potently inhibits ad libitum food intake in male neutered cats. Because a similar sensitivity may occur with ingested xenoestrogens in food, we hypothesized that 17β-estradiol (E2), zearalanone (ZEA), and bisphenol A (BPA) in food at low concentrations will affect food intake in adult (1-6yrs) neutered-male cats (4.4-8.6kg).

Materials and methods
Three randomized complete block experiments were conducted with 14-day blocks where estrogenic substances were consumed five successive days followed by 9-day washout. Experiment One was an 8-week E2 dose response trial on eight cats voluntarily consuming on a kibble placebo, 0.5, 1, or 2µg E2/kg body weight (BW). Experiments Two and Three were 12 weeks long with six cats and six treatment blocks – positive (SQ E2), interaction (SQ E2 with highest ZEA or BPA), and negative controls, and three dietary ZEA (0.04, 0.3, and 1 ppm) or BPA (0.6, 3, and 5 ppm) levels. Diet was top-dressed with corn oil (1%) variably containing ZEA or BPA.

Results
All three E2 doses reduced (P<0.01) food intake, but there was no significant intake difference between 1 and 22µg E2/kg BW. Compared to control, intake during SQ E2 with and without ZEA was less (P<0.01) but not significantly different at all ZEA levels. Compared to control intake, there was no significant intake effect of BPA. However, at the lowest dietary BPA inclusion, intake was greater (P<0.01) than during SQ E2 treatments. Intake variation appeared to be the greatest at the lowest and highest dietary inclusions of BPA and ZEA.

Discussion and conclusions
Ad libitum food intake is reduced by E2, supporting potential for oral E2 in obesity treatment. At the dietary inclusions studied, ZEA/BPA results were inconclusive and individual responses varied. Research in a larger population may reveal individual variance in intake sensitivity.
INSOLUBLE FIBER DELAYS GASTRIC EMPTYING AND COLONIC FILLING TIME OF DOGS FED KIBBLE DIETS

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Introduction
It is generally believed that diets with high fiber content may alter the gastrointestinal transit time, however, this was little studied in dogs fed kibble diets. The effect of insoluble non-fermentable fiber inclusion on extruded diets was evaluated over the gastric emptying time (GET), colonic filling time (CFT), small intestine transit time (SITT) and orocolic transit time (OCTT) of dogs.

Materials and methods
Fourteen beagle dogs were fed two diets, a control diet (maize, poultry by-product meal, poultry fat, and supplements) without fiber addition (9% of dietary fiber [DF]) and the same diet added with 10% of sugarcane fiber in substitution of maize (SF; 17% of DF). Dogs were fed (130kcal/kg0.75) once a day during 15min for 7-d of adaptation, and at the 8th-d immediately after meal received orally one gelatin capsule containing 12 radiopaque markers with 1.5mm of diameter (Konsyl Pharmaceuticals, Fort Worth, Texas USA). Later, dogs were radiographed hourly during 15 continuous hours and markers located and counted. GET and CFT were computed counting markers that left the stomach and enter the colon. SITT was determined by the difference among mean residence time of markers in stomach and colon, and OCTT was considered the time for the first marker enter into the colon. Data were submitted to analysis of variance ($P<0.05$).

Results
The time for 50% and 75% of GET increased from 0.7±0.3h to 6.7±2.0hr ($P=0.020$) and 1.4±0.5h to 7.6±2.0hr ($P=0.042$), respectively for dogs fed diets with sugarcane fiber. In the same manner, the time for 50% CFT increased from 4.0±0.7h to 7.3±0.8 hr ($P=0.048$). However, the SITT and the OCTT did not differ between diets ($P>0.05$).

Discussion and conclusions
The inclusion of 10% of insoluble fiber (sugarcane fiber) delays the GET and CFT of dogs fed kibble diets, but not the SITT and OCTT.

Keywords: colon; gut transit time; sugarcane fiber
LONG-TERM OUTCOMES OF WEIGHT MANAGEMENT IN OBESE CATS
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Introduction
Feline obesity is a prevalent medical disease and the main therapeutic strategy is dietary energy restriction. However, there are currently no data regarding long-term outcome. The purpose of this study was to investigate if cats maintain their target weight following a successful weight loss programme, and to identify and explore any influencing factors in a cohort of client-owned cats that had naturally occurring obesity.

Materials and methods
The study involved 26 cats that had successfully completed a weight management programme, enrolled between December 2004 and July 2012. After weight loss, cats were transitioned onto a maintenance regime and periodically weight checked. A follow-up review of the cases was conducted in early 2013 when veterinary surgeries and owners were contacted to provide current weights and feeding practices.

Results
The median duration of follow-up was of 954d (72-2162d). Ten cats (39%) maintained their completion weight, four (15%) lost >5% additional weight, and 12 (46%) gained >5% weight. Seven cats, 58% of those rebounding, had regained over 50% of their original weight lost. Multiple logistic regression demonstrated that age was negatively (odds ratio [OR] per year of age: 0.95; 95% confidence interval [CI] 0.92 P=0.0236) and mean energy intake during weight loss positively (OR 1.35; 95% confidence interval [CI] 1.05-1.96, P=0.0223) associated with the likelihood of regaining weight. When the current data for cats were compared with a similarly conducted study in dogs1, the likelihood of rebound was similar (P=0.999), although cats that rebounded were more likely to regain >50% of their original weight lost than dogs (P=0.0497).

Discussion and conclusions
These results suggest that weight regain, after successful weight loss, is common in obese cats, most commonly affecting young cats and those with a greater energy intake during weight loss.

Reference
THE EFFECT OF REDUCING DIETARY ENERGY DENSITY VIA THE ADDITION OF WATER TO DRY DIET, ON BODY WEIGHT, ENERGY INTAKE AND PHYSICAL ACTIVITY IN ADULT NEUTERED CATS

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Introduction
Cats do not increase their caloric intake to compensate fully for dietary energy dilution. In a previous study comparing the effects of adding water to a dry diet, cats gained significantly less body weight and were more active when fed a diet hydrated to a total moisture content (tmc) of 50%. The dietary moisture contents used in this study were not equivalent to commercially available diets (6-80% tmc) and cannot be used to determine whether there is a potential dose response effect of energy dilution on body weight or physical activity levels. This study was designed to address these questions.

Materials and methods
Sixty-nine adult cats were randomised into three groups. For four weeks cats received 100% of their daily individual maintenance energy requirements (DIMER) of dry diet (6% tmc) or dry diet hydrated to 40% or 80% tmc. Activity (accelerometer), intake, body weight and composition (Dual-energy X-ray absorptiometry) were measured. For the following four weeks, the cats received the same diets at 200% of their DIMER and the measurements were repeated.

Results
When offered 200% DIMER the intake (Kcal) of cats fed the 80% tmc diet was significantly ($P<0.01$) less than those fed the 6% tmc diet. Cats fed 200% DIMER of the 6% tmc diet increased body weight and % body fat significantly ($P<0.01$) while those offered the 40% or 80% tmc diets did not. The activity levels of cats fed the 80% tmc diet were significantly ($P<0.01$) higher than those offered the 6% or 40% tmc diet.

Discussion and conclusions
When offered food in excess of their requirements, cats fed hydrated diets did not compensate for the energy dilution and did not gain body weight or body fat. Furthermore, when fed at the higher tmc the cats were more active. The data suggest that dietary energy dilution by addition of water may be a useful strategy for healthy body weight maintenance in overfed cats.
DIETARY L-CARNITINE PREVENTS ADIPOSE TISSUE GAIN IN ADULT DOMESTIC SHORT-HAIRED CATS

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Introduction
L-carnitine (LC) is included in diets to improve weight loss and reduce hepatic lipidosis due to studies that have demonstrated improved energy and fat metabolism in overweight cats subjected to caloric restriction (CR). Additionally, dietary LC resulted in positive effects on energy and fat metabolism in overweight cats that were fed to maintain BW.

Materials and methods
The objective of this study was to investigate whether feeding lean (BCS≤3.0) and overweight (BCS>3.0) adult cats diets (17.8% fat, 35% protein) containing either 100ppm of LC (LC+) or no supplemental LC (CON) and offered feed representing 120% of metabolizable energy requirement (MER) resulted in differences in total energy expenditure (EE), metabolic fuel selection, BW, and body composition. Cats (n=20, 4±1.2 yrs) were stratified for BCS and then within a stratum randomly assigned to one of two diet treatments and fed for 16 weeks. BW was measured weekly, and measurements of respiration calorimetry, and body composition were taken at baseline and at intervals throughout the study. A mixed, repeated measures, ANCOVA model was used.

Results
Both LC+ and CON treatments gained BW (P<0.05) throughout the study, as would be expected. There were no differences in BW between treatments at any time point during the treatment period (P>0.05). In contrast to previous studies under CR or maintenance, there were no differences between treatment groups in EE or RQ (P>0.05). Body fat (g) and body fat: lean mass ratio was greater in cats fed CON in contrast to cats fed LC+ (P<0.05).

Discussion and conclusions
These results suggest that diets containing LC and fed ad libitum will result in less fat gain than diets that do not contain LC and may be beneficial for the health and well-being of cats. Further research is necessary to elucidate the mechanism of action of this physiologically significant outcome.
ASSOCIATIONS BETWEEN LONGEVITY AND BODY CONDITION IN DOMESTIC DOGS

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Introduction
Previous research has demonstrated a link between obesity and life span in kennelled animals. The aim of this study was to examine the effects of being overweight in mid-life (taken to be around 7.5 years old) on the lifespan of neutered client-owned dogs. The data used were collected during normal primary care consultations by Banfield Pet Hospitals® in the United States.

Materials and methods
Associations between body condition and lifespan were examined separately for 10 individual breeds. To augment body condition score data recorded directly by veterinary staff, predicted scores were used, obtained from a linear discriminant analysis based on actual weight, recommended weight and demographic variables.

For each breed, groups of neutered dogs identified as having a high probability of being of a ‘normal’ or ‘overweight’ body condition between 6.5 years and 8.5 years of age were then balanced on gender, age, year of visit, longitude and latitude, using coarsened exact matching (CEM). Median base size per breed was 546 dogs. Within each breed, lifespan differences in the two groups were then analysed using a Cox proportional hazards model.

Results
Five of the breeds showed statistically significant effects of body condition on the risk of death. Moreover, the chance of a dog surviving to at least 13 years of age was greater in the normal group compared to the overweight group in every breed and gender, by a median of 10.9% (interquartile range =7.8-12.5%).

Discussion and conclusions
This study therefore shows that adverse effects of obesity on lifespan can be seen in a large general population of neutered pet dogs and demonstrates the importance of dog owners taking care to ensure their pets maintain a healthy body condition score during mid-life.
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5. *Food digestibility is not decreased in healthy senior cats.* Salas Mani A, Manuelian CL, Garganté M, Sanchez N, Compagnucci M, Jeusette I, Vilaseca LI, Torre C.


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20. *Evidence of inflammaging in the gastrointestinal mucosa of dogs.* de Oliveira Sampaio Gomes M, Maria APJ, Gering AP, Zaine L, Yoshitoshi FN, Marques de Sá LR, Carciofi AC.

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85. Changing the energy density of the diet using air: A possible strategy for weight management. Serisier S, Feugier A, Cochet J, Biourge V, German AJ.

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91. American Academy of Veterinary Nutrition & WALTHAM Research and Student Travel Awards. Sarah Abood

92. European Society of Veterinary Comparative Nutrition & WALTHAM Research and Student Travel Awards. Geraldine Blanchard
P1) THE EFFECT OF A 48-HOUR FAST ON TAURINE STATUS IN DOGS

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Introduction
Diagnosis of dietary-induced dilated cardiomyopathy (DCM) in dogs requires a complete diet
history and analysis of whole blood (WBt) and plasma taurine (Pt) concentrations. The effects of
fasting and feeding on circulating concentrations of Pt and WBt in dogs are unknown. In this study
we have measured taurine status during a 48-hour fast and subsequent re-feeding.

Materials and methods
Twelve adult Labradors were fed a commercial complete and balanced dry food, to individual
energy requirements for 12 weeks. Baseline samples were taken four hours after feeding, four
weeks, two weeks and 19 hours prior to fasting. Dogs were fed then fasted for 48 hours and
samples taken 1, 2, 3, 5, 12, 24, 36 and 47 hours post-feeding. Dogs were re-fed and sampled at 1, 8
and 24 hours. Mixed model analysis was used to model both Pt and WBt measurements (α=2.5%).

Results
All Pt and WBt concentrations were within the taurine adequacy reference range, mean baseline
concentrations of Pt and WBt were 95.39µmol/L and 269.41µmol/L. Throughout the fasting period
the Pt was not significantly different from baseline until 47 hours of fasting when Pt was 43.46µmol/L
higher than baseline. WBt was significantly less than baseline (mean decrease 51.76µmol/L) except
at 47 hours when it was not significantly different. Re-feeding caused a significant drop in WBt. Pt
and WBt returned to baseline within 8 hours.

Discussion and conclusions
Forty-eight hours of fasting does not result in Pt or WBt measurements indicative of a risk of tau-
rine deficiency, therefore time of sampling for diagnosis of DCM in relation to time of feeding may
not be as critical as in cats.
P2) COMPARATIVE METHODS TO MEASURE COLOUR ENHANCEMENT IN ORNAMENTAL FISH

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Introduction
Fish colouration plays an integral role in communication and camouflage, and is not only influenced by genetic predisposition and physiological mechanisms but also abiotic factors such as environment and diet. From a retail and consumer standpoint colouration is very important when valuing fish in the aquarium trade. Fish deposit carotenoid pigments within specialised chromatophore cells, and are incapable of de novo synthesis, hence they must obtain carotenoids through dietary means. The measurement of colouration in fish can vary from colour fans, colorimeters and photography with computer aided identification software.

Materials and methods
This study reports the effect of a range of commercially available feeds on the colour of common goldfish (Carassius auratus) when fed for 16 weeks. Two different methods were employed to quantify colouration; every two weeks photographs and colorimeter measurements were taken behind the goldfish operculum. Photographs were taken under standardised conditions and analysed retrospectively in Adobe Photoshop using the colour dropper tool reading in the RGB colour space. The colorimeter gave instant colour measurements at sampling time in the L*a*b* colour space.

Results
Both methodologies established that goldfish orange colouration was significantly enhanced (ANCOVA, \(P<0.05\)), with the same differences between diets being identified.

Discussion and conclusions
Consequently, either method is effective at quantifying colour change in goldfish. However, method choice may be more suitable between fish species. Larger fish of uniform colour, i.e. goldfish would favour the use of the colorimeter, as data are immediate, although no further measurements can be taken. Conversely, photography enables the measurement of smaller patterned fish, allows retrospective colour measurements and has a quicker fish handling time, although photograph processing is lengthy. Further physiological measurements of colour will also be discussed, including chromatophore enumeration (colour intensity and size), and carotenoid concentrations via HPLC extraction from fin tissue samples.
P3) EFFECTS OF PUBERTY AND TIMING OF GONADECTOMY ON THE PLASMA METABOLOME OF YOUNG CATS

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Introduction
Metabolic profiling was used to identify dynamic biochemical changes associated with neutering per se and age at neutering.

Materials and methods
At eight time points between 19 and 52 weeks of age, 23-hour fasted blood samples were taken from kittens neutered at either 19 weeks of age (Early Neuter (EN), eight males and seven females) or 31 weeks of age (Conventional Neuter (CN), seven males and seven females). Cats were fed a single batch of a nutritionally-complete dry diet to maintain an ideal body condition score. Plasma metabolites (370) were analysed using GC-MS and UHPLC-MS-MS. Data were analysed using mixed models, correlation and Principal Component Analyses (PCA), separately for gender.

Results
PCA indicated that age was a major driver of variance in the plasma metabolome. Univariate analyses indicated that most metabolites had similar levels between genders at the start and at the end of the study. Comparing data within gender at each time point, 50 metabolites varied significantly (FDR q<0.05) between the EN and CN groups. One example of metabolic differences between gender and age at neutering is in felinine metabolism. Four felinine-associated metabolites (correlation >0.79 within gender CN groups) increased significantly in entire males compared to neutered males, from 21-37 weeks (up to 8-fold higher at 31 weeks) and dropped acutely within two weeks of neutering. There was no significant difference in these metabolites between EN and CN females until 33 weeks of age, when all four metabolites increased (up to 2-fold) in CN and remained significantly different for at least six weeks post-neuter.

Discussion and conclusions
Metabolic profiling provided insights into the effect of development, gender, neutering and age at time of neutering in kittens. Despite dynamic changes, there is little evidence to suggest the age at neutering (19 and 31 weeks of age) affects the plasma metabolome beyond one year of age.
P4) RETROSPECTIVE STUDY OF ENDOCRINE DISORDERS IN OBESE CATS

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Introduction
Obesity is a nutritional disorder that is associated with multiple hormonal alterations. We investigated the endocrine profile of naturally-acquired obesity in cats.

Materials and methods
Fifty-six client-owned, neutered, overweight cats (32 females and 24 males) were included in the study. The overweight had been estimated (≥15% ideal BW) by veterinarians during clinical visit. Blood samples were collected before and 1h30 after IM tetracosactide injection, for the evaluation of cortisol, insulin-like growth factor (IGF1), total thyroxine (TT4), insulin, leptin and prolactin plasma concentration. All assays had been previously validated for use in healthy cats (4≤BCS≤6) in our laboratory. Statistical analysis was carried out using the non-parametric tests and Spearman’s correlation analysis.

Results
Most cats (83.9%) were European breed and the remaining 16.1% purebred. The mean age of cats was 6.5±3.4y (1 to 16y). The average BW was 8.7±2 kg for males and 7.0±1.5 kg for females. 58.9% of cats received a commercial therapeutic diet. IGF1 concentration was higher than the reference range in 80.3% of cats and prolactinaemia in 35.7%. Interestingly, TT4 concentration was lower than the reference range in 55.3% of cats. According to insulin and glucose values, 46.4% of cats were insulin resistant and 10.7% diabetic. Only ten out of the 56 cats exhibited an adrenocortical disturbance. Overall, none of 56 cats was free of any hormonal disturbance.

The BW, IGF1 and basal insulin concentration significantly differed between genders (P<0.05). The IGF1 values significantly changed according to BW (P<0.05). Both IGF1 and leptin concentrations were positively correlated with BW (P<0.05).

Discussion and conclusions
These results show the high prevalence of hormonal disturbances in obese but otherwise apparently healthy cats. An extensive endocrine evaluation is therefore crucial in order to prescribe any subsequent medical treatment which missing could result in failure of the nutritional therapy.
P5) FOOD DIGESTIBILITY IS NOT DECREASED IN HEALTHY SENIOR CATS

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Introduction
Fat digestibility was shown to present an age-related decline in cats (Harper, 1998) for unknown reasons. Subclinical gastrointestinal diseases can affect food digestibility. Serum fPLI and vitamin B₁₂ concentration are markers of subclinical pancreatitis or gastrointestinal diseases. The aim of this study was to evaluate food digestibility in apparently healthy senior cats, with either B₁₂ deficiency or high fPLI, compared to senior cats with these values in reference range.

Materials and methods
Apparently healthy (based on physical exam, serum biochemistry and CBC) senior cats (11.8±0.6y) were selected and divided into three groups according to fPLI and B₁₂ serum concentrations: Control group (C) (fPLI: 2.38±0.43µg/L; B₁₂: 721.8±1141ng/L) (n=5); Group F (fPLI: 5.17±0.51µg/L; B₁₂: 700.8±85.8ng/L) (n=6); Group B (fPLI: 2.72±0.33µg/L; B₁₂: 200.1±26.3ng/L) (n=5). All cats were fed the same commercial dry diet and a digestibility trial was conducted. Data were statistically analyzed with Kruskal-Wallis one-way ANOVA and Mann-Whitney U-test incorporating Bonferroni correction. Significance was established at \( P<0.05 \).

Results
Group B cats showed decreased fat digestibility versus control cats. Digestibilities and measured metabolisable energy (mME) were respectively for group B and C: dry matter 83.04±0.99 vs. 87.6±0.37%; protein 86.27±1.24 vs. 89.84±0.37%; fat 83.9±3.01 vs. 92.9±0.71%; mME 4496.3±64.3 vs. 4767.6±14.4 calEM/kgDM. No significant differences were observed between groups C and F, nor between groups B and F, even though C group showed the highest values for all the parameters.

Discussion and conclusions
Senior (>10y) cats with fPLI and B₁₂ in reference range seem to maintain a high digestibility of gross nutrients; however a significant decrease of fat digestibility has been observed in cats with low serum B₁₂ but not in cats with increased fPLI (indicative of subclinical chronic pancreatitis). Results suggest that decreased food digestibility is not present in all senior cats but could be a characteristic of cats with subclinical chronic gastrointestinal disease, as indicated by low serum B₁₂ levels.
P6) RELATION BETWEEN B12 DEFICIENCY IN CATS AND AGE, GASTROINTESTINAL INFLAMMATION AND PANCREAS DYSFUNCTION

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Introduction
Feline chronic pancreatitis occurrence increases with age (De Cock et al., 2007). Blood vitamin B12 has been proposed as a marker of gastroenteric or pancreatic disease in cats (Simpson et al., 2001). The aim of this study was to determine whether a correlation between age and vitamin B12 deficiency in cats exists and if this could be explained by pancreatic dysfunction.

Material and methods
Sixteen adult [<10y (3-9y), A] and forty-eight senior cats [≥10y (10-17y), S] apparently healthy and without evident signs of gastrointestinal disease (based on physical exam, CBC and serum biochemistry) were included. Serum vitamin B12 (B12), fTLI (feline trypsin-like immunoreactivity) and fPLI (feline pancreatic lipase immunoreactivity) concentrations were analyzed after an overnight-fast. Abdominal ultrasonography was performed in cats with low B12 concentration to evaluate signs of gastrointestinal inflammation. Data were statistically analyzed using the Student t-test and Pearson correlation. Significance was established at $P<0.05$.

Results
In S cats B12 concentration was lower and fPLI higher than in A cats. Among S cats, 15% (7/48) presented B12 deficiency (<300ng/L), 8% (4/48) a severe increase in fPLI consistent with pancreatitis (>5.4µg/mL), 4% (2/48) presented both alterations and 12.5% (6/48) a slight increase in fPLI (3.6-5.3µg/mL). By contrast, A cats did not have B12 deficiency and only 6% (1/16) had a slight increase in fPLI. None of the cats presented fTLI consistent with EPI (<12µg/L). Considering all cats (n=64), B12 concentration negatively correlated with age and fPLI ($P<0.05$). All cats with B12 deficiency showed gastrointestinal inflammation (as seen by ultrasonography) suggestive of gastritis or IBD.

Discussion and conclusion
Senior cats had lower B12 concentration compared to adult, being frequently more related to subclinical gastrointestinal inflammation rather than to subclinical pancreas dysfunction (as suggested by serum fPLI and fTLI concentrations). Serum B12 concentration, as a marker of subclinical gastrointestinal inflammation, could be an interesting analyte for use in routine evaluation of senior cats.
P7) PILOT STUDY TO DETERMINE THE EFFECTS OF FEEDING RESISTANT STARCH ON APPARENT TOTAL TRACT MACRONUTRIENT DIGESTIBILITY, FECAL CHARACTERISTICS, AND FECAL FERMENTATIVE END-PRODUCTS IN HEALTHY ADULT DOGS

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Introduction
The benefits of consuming whole grains have been greatly studied in humans, but little research exists on their effects in dogs. Previous research has demonstrated the benefits of feeding dietary fiber and prebiotics to dogs. Feeding whole grains, which contain a great deal of resistant starch (RS) when minimally processed, may have similar beneficial effects on the canine gastrointestinal tract. The objective of this study was to test the effects of RS in healthy adult dogs.

Materials and methods
Twelve adult Miniature Schnauzer dogs (8 males, 4 females; mean age: 3.3 ± 1.6 years; mean BW: 8.4 ± 1.2 kg; mean BCS: D/ideal) were randomly allotted to one of three treatment groups, which consisted of different amounts of RS supplied in a biscuit format. Dogs received either 0, 10, or 20 g biscuits/d (estimated to be 0, 2.5, or 5 g RS/d) that were fed within their daily caloric allowance. A balanced Latin square design was used, with each treatment period lasting 21 days (d0-17 adaptation; d18-21 fresh and total fecal collection). All dogs were fed the same complete and balanced canned diet to maintain BW throughout the study. Data were evaluated for effects of treatment using SAS.

Results
Dogs fed 5 g RS/d had lower (P=0.03) fat digestibility than dogs fed 0 g RS/d, but dry matter, organic matter, and crude protein digestibilities were not affected. Resistant starch consumption numerically decreased fecal pH and numerically increased fecal butyrate, but these outcomes did not reach statistical significance.

Discussion and conclusions
These pilot data suggest that feeding RS to dogs can impact beneficial effects on the gut health of adult dogs however the minor changes observed in this study suggest the RS doses provided to the dogs were too low. Further work is required to assess the dose of RS required to effect gut health.
P8) CHANGES IN BLOOD METABOLITES AND OXIDATIVE STRESS MARKERS IN AMERICAN FOXHOUNDS UNDERGOING ENDURANCE EXERCISE OVER SEVERAL MONTHS
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Introduction
Repeated bouts of exercise in the form of racing, hunting, or herding may contribute to oxidative stress, nutrient depletion, and reduced muscle recovery. The objective of this study was to compare changes in blood metabolites and oxidative stress markers in American Foxhounds undergoing unstructured endurance exercise over several months.

Materials and methods
Thirty-six adult American Foxhound dogs (29 males, 7 females; age: 4.5±2.7 years) were studied from October 2012 to March 2013. Prior to the study, all dogs consumed a commercial diet for 16 weeks. After collecting baseline blood samples, dogs were assigned to a standard performance diet (control) or NUTRO® Natural Choice® Adult High Endurance Formula (treatment). Dogs were balanced by gender, age, body weight, and athletic performance between diets. For at least 8 h/day, dogs were group housed in a play yard by treatment and housed in a group lodge at night. During the study, dogs ran approximately 22 kilometers/bout (1-2 outings/wk). Blood samples were collected after 40, 75, 138, and 201d on study. Data were evaluated for effects of diet, month, and interaction between diet and month using SAS.

Results
All blood metabolites were similar at baseline and serum chemistry profile remained within normal ranges throughout the study. Over time, plasma taurine and vitamin E concentrations decreased (P<0.05) in dogs fed the control, but were maintained or increased (P<0.05) in dogs fed the treatment diet. Also, plasma creatinine and triglycerides were lower (P<0.05) and blood P and ALP were higher (P<0.05) in dogs fed the treatment diet.

Discussion and conclusions
Vitamin E and taurine status of dogs appear to be affected by extended endurance exercise. These data suggest dogs undergoing endurance exercise may benefit from supplementation of vitamin E and taurine to minimize oxidation and maintain taurine status.
P9) CARDIAC ECHOGRAPHY AND WHOLE BLOOD TAURINE IN HEALTHY GREAT DANES

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Introduction
Taurine deficiency has been associated with DCM in dogs but a relationship between taurine deficiency and DCM has not been established in Great Danes. Echocardiography is the gold standard for the diagnosis of DCM. The main purpose of this study was therefore to assess cardiovascular function and whole blood taurine(WBT) status in healthy Great Danes.

Materials and methods
Adult (>2 yrs) Great Danes were included on a volunteer basis at French dog shows following an informed consent of their owners. Dogs had a clinical and cardiovascular examination performed by a veterinary cardiologist. A blood sample was taken and assayed for WBT as described by Fascetti et al., 2003. A dietary history was obtained over a phone interview.

Results
Twenty-five Great Danes (13 males/12 females), from 22 breeders were included. Mean age±SD, 3.6±2yrs. Mean body weight was 67±7kg. No abnormality was detected on the cardiovascular exam of 22/25 dogs. 3/25 dogs showed decreased fractional shortening (FR<25%). No dog showed DCM nor left ventricular enlargement. WBT was measured in 24 dogs: 321±42 µmol/L. Dietary history was available from 18/22 breeders. Four breeders fed dry food only, dry food represented more than 90% of the calories in six other breeders and the last eight breeders fed ground chicken carcasses and/or beef meat based diets. Mean caloric and protein intake were 162±43 Kcal/kg0.75, 13±4 g/kg0.75, respectively. WBT was not different between dietary managements (Mann-Whitney-Wilcoxon-test).

Discussion and conclusions
This study suggests that diets used by French Great Dane breeders provide sufficient sulfur amino acids and taurine to insure safe WBT levels. The high level of intake and the quality of protein used might explain this observation. A reduction of the shortening fraction might be an early sign of DCM and owners were instructed to follow the cardiovascular status of their dogs.
P10) THE EFFECT OF LONG-TERM FEEDING OF SKIN BARRIER FORTIFIED DIETS ON THE TWO YEAR INCIDENCE OF ATOPIC DERMATITIS SYMPTOMS IN LABRADOR RETRIEVERS  

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Introduction  
Canine atopic dermatitis (CAD) is a common skin disease in dogs. Higher rates are seen for certain breeds such as the Labrador retriever. Evidence indicates a key role for skin barrier impairment in CAD development. We have investigated the effect of diets fortified to promote skin barrier during the first year of life on the incidence of Atopy symptoms compared to non-fortified control diets.  

Materials and methods  
Eleven pregnant Labrador retriever dams were randomly fed a diet enriched in Pantothenate (50mg), Nicotinamide (325mg), Histidine (1.85g), Inositol (350mg), Choline (392mg), (/Mcal; Diet A) or an unsupplemented control diet (Diet B) from five weeks pre-term. Eighty puppies were subsequently enrolled, 33F, 47M. Whole litters were then fed one of two diets, supplemented or not, corresponding to that fed to their mother, for a period of one year. The frequency of itch-associated behaviour (scratching, licking, rubbing, gnawing), as well as diagnoses of allergy, were followed for two more years via owner questionnaires. All owners were blinded as to the diet fed to their dogs throughout the entire study period.  

Results  
There was no difference in the growth rates of the two groups of dogs by 12 months. Following the two-year follow-up, significantly fewer dogs on the supplemented diets A(8.3%) had reported signs of skin itching compared with dogs on control diets B (30.3%; P=0.04, Chi-square).  

Discussion and conclusions  
Results suggest a beneficial impact of the supplemented diet on the development of atopic skin symptoms.
P11) PROTEIN QUALITY OF INSECTS AS POTENTIAL INGREDIENTS FOR PET FOODS

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Introduction
Insects have been proposed as a high quality, efficient and sustainable dietary protein source. This study evaluated the protein quality of a selection of insect species.

Materials and methods
Insect and reference substrates are shown in Table 1. Substrates were analysed in a dried and ground form for DM, ash, fat, N, AA and for in vitro N digestibility (IVND) (Hervera et al., 2009). The AA scores for dogs (AAS-d) and cats (AAS-c) were calculated according to Kerr et al., (2013).
[ NB: AA analysis is pending, literature values are currently reported]

Results
Results are shown in Table 1. First limiting AAs in substrates were generally Met+Cys and Thr.

Table 1. Composition (% of DM), in vitro N digestibility (IVND) and AA scores for dogs (AAS-d) and cats (AAS-c) of substrates.
N/: not available.

<table>
<thead>
<tr>
<th>Substrates</th>
<th>Ash</th>
<th>Fat</th>
<th>CP</th>
<th>IVND</th>
<th>AAS-d</th>
<th>AAS-c</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insects</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Housefly pupae</td>
<td>5.6</td>
<td>19.2</td>
<td>62.5</td>
<td>84.3</td>
<td>64</td>
<td>80</td>
</tr>
<tr>
<td>House cricket</td>
<td>5.3</td>
<td>17.7</td>
<td>70.6</td>
<td>91.7</td>
<td>60</td>
<td>64</td>
</tr>
<tr>
<td>Yellow mealworm</td>
<td>3.9</td>
<td>33.9</td>
<td>52.0</td>
<td>91.3</td>
<td>135</td>
<td>108</td>
</tr>
<tr>
<td>Lesser mealworm</td>
<td>4.1</td>
<td>22.2</td>
<td>64.8</td>
<td>91.5</td>
<td>94</td>
<td>93</td>
</tr>
<tr>
<td>Morio worm</td>
<td>3.0</td>
<td>39.6</td>
<td>47.0</td>
<td>92.0</td>
<td>61</td>
<td>49</td>
</tr>
<tr>
<td>BSF larvae</td>
<td>12.6</td>
<td>12.8</td>
<td>56.1</td>
<td>89.7</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>BSF pupae</td>
<td>13.9</td>
<td>19.7</td>
<td>52.1</td>
<td>77.7</td>
<td>36</td>
<td>45</td>
</tr>
<tr>
<td>Six spot roach</td>
<td>3.6</td>
<td>25.1</td>
<td>66.3</td>
<td>76.4</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Death’s head cockroach</td>
<td>3.9</td>
<td>22.0</td>
<td>65.0</td>
<td>78.4</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Argentinian cockroach, female</td>
<td>4.4</td>
<td>24.5</td>
<td>64.4</td>
<td>83.8</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

References
Soybean meal                 | 6.8 | 2.5  | 51.6| 94.7 | 90    | 72    |
Fish meal                    | 19.9| 9.2  | 71.0| 85.7 | 104   | 79    |
Poultry meat meal            | 15.4| 12.8 | 69.1| 87.9 | 90    | 77    |
N/A: Not applicable

Discussion and conclusions
Yellow mealworm and lesser mealworm have the highest protein quality in terms of IVND and AA scores. The lower IVND of BSF pupae than larvae is likely caused by a higher cuticular protein-sclerotisation. Future studies should focus on aspects like safety and variability within insect species.
P12) EVALUATION OF THE OWNER’S PERCEPTION IN THE USE OF HOMEMADE DIETS IN THE NUTRITIONAL MANAGEMENT OF DOGS

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Introduction
Many dog owners see homemade diets as a way of increasing their bond with their pets. However, commercial diets and modifications on the recipe might generate nutritional unbalances. The present study evaluated how dog owners use homemade diets and their perception and adherence to the original recipe.

Material and methods
Forty-six dogs who were being fed for at least six months on homemade diets were enrolled on the study. Owners were interviewed by phone, and after listening to all possible answers, selected the one which best matched their opinion. The results were evaluated through descriptive statistics.

Results and discussion
Forty-one owners (89.1%) prepared homemade food for their dogs. Thirty-five (76.1%) considered it an easy task to prepare the diet, but nine (19.6%) reported that preparation was difficult. Fourteen (30.4%) owners admitted to having made modifications to the recipe. Only seven (15.2%) used a domestic scale to weight the food and 22 (47.8%) used spoons/cups according to the prescription. However, five (10.9%) used volumetric objects and 12 (26.1%) defined the amount empirically. Fifty per cent of the owners reported that they restricted or did not supply oil and salt to the dogs, due to health concerns. Regarding vitamin and mineral supplementation, 30 (65.2%) reported they added exactly the prescribed amount and 13 (28.3%) did not provide any supplementation to their animals. More than 70% of the owners believed that their dog liked the food and for 69.6% the homemade diet was an effective tool to help in clinical treatment.

Conclusions
Although homemade diets can be of use for the nutritional management of several diseases, not all owners are able to prepare them. Even when properly instructed by a veterinarian, many did not adhere to the recipe in the long-term and the diet was therefore unbalanced.
**P13) INTEREST OF A PRE-EXERCISE NUTRITIONAL SUPPLEMENTATION ON WORKING DOGS SERUM INFLAMMATION AND OXIDATIVE STRESS MARKERS EVOLUTION DURING A STANDARDIZED MID-INTENSITY EXERCISE**

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**Introduction**

Fat level increase, and anti-oxidants addition had been used in food to improve endurance and prevent oxidative stress in the dog. However, the impact of a dedicated supplementation before and during exercise has not been studied yet. The aim of the study was to evaluate the impact of such a supplementation on serum inflammatory and oxidative stress markers.

**Material and methods**

A crossover study was performed on 12 search and rescue Belgian Shepherds, fed and trained the same way. Each dog was its own control and performed two exercise sessions (two 20 minutes runs at 14km/h separated by five minutes rest) at a 14-day interval period (with and without supplementation). Royal Canin® energy supplement containing 40% fat based on dry matter (short and medium chain fatty acids), anti-oxidants (vitamin A, E, C and green tea polyphenols), B group vitamins and L-carnitine was used. Blood samples were performed before exercise (T0), at the end of exercise (T2), and 24h after the end of exercise (T3). Serum inflammatory markers (IL-1β, IL-8, IL-10 and IL-15) were assessed by qRT-PCR, and oxidative stress markers (Advanced Oxidation Proteins Products, GSH and isoprostanes) by spectrophotometric methods. Statistical analysis was performed according to data distribution using Tanagra© or Statistical Analysis System© softwares. Non-parametric tests were used when datas were not normally distributed. Analysis of variance or covariance was performed on normally distributed data.

**Results**

Serum inflammatory markers assessment showed IL-1β and IL-8 gene expressions were increased only in control group at T2 (P<0.05). IL-10 and IL-15 were not affected by supplement intake at T2. Advanced Oxidation Proteins Products were higher at T2 compared to T0 in both groups (P<0.05), and were significantly higher in control group compared to supplemented group (P<0.05).

**Discussion and conclusions**

Supplementation has an impact on inflammation and oxidative stress markers during a mid-intensity exercise in the dog.
P14) VETERINARIAN-INITIATED LONG-TERM DIETARY RECOMMENDATIONS: PRACTITIONERS’ MANAGEMENT OF CLIENTS’ RESPONSES

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Introduction
A growing body of research using the qualitative methodology of conversation analysis has investigated treatment decision-making in human medicine by analyzing actual recordings of doctor-patient talk rather than relying on traditional retrospective reports and vignette studies. Conversation analysis, however, has rarely been used to explore veterinary decision-making. This study begins to address this gap by investigating an important domain of treatment decision-making through analysis of real-time, real-life recommendations for long-term dietary change in the interests of disease intervention and prevention in companion-animal practice.

Materials and methods
The sample consisted of 41 sequences in 37 appointments video-recorded in small companion-animal clinics in Ontario, Canada in which veterinarians initiated recommendations for long-term changes in the diets of canine and feline patients. Conversation analysis was used to transcribe and analyze the orderly design and details of veterinarians’ and clients’ turns at talk in these sequences.

Results
Variations in clients’ responses to recommendations ranged from weak or strong agreement to passive or active resistance. Weak agreements involved brief responses (e.g., “Okay”) which were difficult to gauge in terms of clients’ commitment to change. Active resistance involved accounts as to why dietary change was inappropriate, e.g., because the client was already addressing the health concern or impossible, e.g., due to patient preferences. Veterinarians rarely pursued agreement following passive or active client resistance, typically changing the topic. However, in a minority of active resistance cases, veterinarians successfully negotiated by affiliating with or accommodating clients’ resistant accounts collaboratively.

Discussion and conclusions
These findings indicate the need for communication strategies: a) early on in consultations (to pre-empt client resistance); and b) before the end of consultations (to secure greater adherence to long-term dietary treatment recommendations). These strategies are considered in relation to challenges in veterinary medicine in securing adherence to treatment recommendations generally, and to dietary recommendations specifically.
P15) THE IMPORTANCE OF QUESTION DESIGN IN MAXIMIZING NUTRITIONAL HISTORY-TAKING

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Introduction
Communication research on question design in human-medical consultations reveals that patients’ answers are often designed to match the requirements of a physician’s question. The impact of question design on clients’ answers has not been widely explored in veterinary research. One veterinary task that could benefit from such research is nutritional history taking, as the accuracy of patient nutritional assessments and recommendations will depend on the information elicited from questions asked during this task. Consequently, this study examined how specific aspects of diet questions affected clients’ answers. A key aim was to provide evidence-based guidance for communication training on nutrition.

Materials and methods
The study drew on 284 video-recorded veterinarian-client-patient appointments, involving 17 companion-animal veterinarians. Conversation analysis, an established analytic technique for examining medical conversations, was applied to interactions involving a veterinarian-initiated question relating to a patient’s nutrition in order to examine the orderly design and details of different speakers’ turns at talk.

Results
A nutrition-related discussion was identified in 172 visits. Of those, 100 appointments included a sequence(s) of diet talk beginning with a veterinarian-initiated question investigating the patient’s nutritional history, providing a total of 101 questions (one appointment involved questions about two patients). The predominant question form (75/101) was a question preface with “What . . . ?” that used singular rather than plural diet categories to elicit dietary information e.g., What food is Tigger on?. Such questions were found to restrict the information clients provided to just brand e.g., Science Diet or brand plus sub-type information e.g., Science Diet, hairballs of only one food item. Further questions about what the patient was eating tended to seek clarification about the one food item the client’s answer (to the “What . . . ?” question) had provided. Consequently, diet discussions (and later recommendations) often only remained focused on one food item.

Discussion and conclusions
This research provides important insights into how the design of veterinarians’ (or staff members’) nutritional-history questions can influence the gathering of an accurate and complete nutritional history.
P16) EVALUATION OF EIGHT DOG COMMERCIAL DIETS ACCORDING TO NUTRITIONAL CRITERIA AND APPARENT DIGESTIBILITY

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Introduction
A French consumer association magazine has recently scored eight dog commercial dry diets (from grocery, private label, and specialty brands) according to several nutritional criteria (18 points for protein-to-calorie ratio and collagen content; 21 points for acid ether extract, omega 3 PUFA content and omega 6/3 ratio; 34 points for vitamins and minerals; 12 points for feeding guidelines; and 15 points for mycotoxin contamination for a 100 point total). The aim of our study was 1) to evaluate the apparent digestibility of these diets, and 2) to score these diets according to digestibility results and to compare with the scoring of the magazine.

Materials and methods
Six Beagle adult dogs (8.6 kg±0.9, body condition score 5/9) were enrolled in this study. The eight commercial diets were tested successively. A 7-day adaptation period was followed by a 5-day collection period. Diets were scored according to energy, crude protein and acid ether extract apparent digestibility coefficients, digestible protein-to-calorie ratio, and ash content. Each of the five criteria was scored from four to 20 points.

Results
Crude protein, acid ether extract, and ash content range was 20.7-30.6, 7.8-18.8, and 4.9-12.1%, respectively. The range of energy, crude protein and acid ether extract apparent digestibility coefficients was 72.6-87.7, 70.4-82.5 and 76.1-95.4%, respectively. Apparent digestibility coefficients differed among diets (P<0.001). Protein-to-calorie ratio range was 38-64 digestible crude protein/Mcal ME. The magazine scoring was between 42 and 75/100 while ours was between 36 and 88/100. Although there was no correlation between the results of the two scoring systems, the same two diets presented the lowest scores in the two systems.

Discussion and conclusions
These results show that the evaluation of commercial diets should take into account multiple nutritional aspects. Especially, analytical and biological (digestibility) criteria should be considered as complementary.
**P17)** *IN VITRO DISAPPEARANCE CHARACTERISTICS OF SELECTED CATEGORIES OF COMMERCIAL TREATS*

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**Introduction**

The pet treat is a $3 billion industry. Pet owners desire treats with adequate nutritional profiles, functional benefits, long-lasting properties, and an interactive nature. Therefore, it is pivotal to understand the digestion characteristics and safety of treats produced by different processing methods and having variable nutritional composition. The objective of this study was to measure *in vitro* disappearance characteristics of selected categories of commercially available treats.

**Materials and methods**

*In vitro* procedures developed by Boysen and Eggum (1991) were modified to handle larger sample sizes. Nineteen non-ground treat samples were evaluated in triplicate. Pre-weighed treats were incubated for 6h in a fluid simulating gastric contents (HCl; pepsin), and incubated an additional 18h in fluid simulating small intestinal contents (e.g., pancreatin). Following incubation, *in vitro* dry matter disappearance (DMD) was calculated and photographs were taken. Data were analyzed using the Mixed procedure of SAS.

**Results**

*In vitro* DMD of selected treats varied widely. For the gastric phase, DMD ranged from 6.9 to 88.8%, whereas intestinal phase resulted in a DMD range of 10.7 to 100.0% (*P*<0.05). Because of differences in treat composition and size, they were divided into categories: biscuits, bones, chews, dental, meat products, and rawhides. In general, bones were the least digestible in both gastric and intestinal phases. Meat products and rawhides had a DMD of 71.5 to 100% after the intestinal phase, while biscuits had values above 93%. Chew and dental treats varied the most, with DMD of 54.5 to 100% (*P*<0.05).

**Discussion and conclusions**

Understanding the DMD of commercially available treats is important to verify their safety for consumption and potential digestibility. These data indicate wide variation in DMD among and within different treat categories. This information will assist the pet industry in providing adequate feeding guidelines for treats, in addition to providing a pictorial representation of treat disintegration properties.
INTRODUCTION

Dogs participating in endurance exercise, including herding, hunting, and racing have a higher energy requirement and may be more susceptible to nutrient depletion, electrolyte imbalance, and metabolic stress. The objective of this study was to investigate the acute response to unstructured endurance exercise in American Foxhounds fed a nutrient-fortified endurance diet.

MATERIALS AND METHODS

Thirty-nine adult foxhound dogs (32 males, 7 females; age: 6.2±3.1 y and BW: 36.3±5.3 kg) were randomly allotted to a standard performance diet (control) or NUTRO® Natural Choice® Adult High Endurance Formula (treatment). Dogs were balanced by gender, age, body weight, and athletic performance between diets. After 80d on study, blood samples were collected via jugular puncture at baseline (0h), and at three and 25h post-exercise (ave: 17.7km run over 2-3hr). Plasma taurine and complete amino acid profile, serum chemistry, and creatine kinase were measured. Data were analyzed as repeated measures using SAS.

RESULTS

Serum chemistry profile remained within normal ranges throughout the study. A significant (P<0.05) diet x time interaction was observed for Ca, ALP, and most amino acids (AA). Plasma taurine and essential AA were increased (P<0.05) after exercise and remained higher (P<0.05) in dogs fed the treatment diet, including the BCAA (isoleucine; leucine; valine). Creatine kinase increased sharply after 3h and returned to baseline after 25h, but was not altered by diet. A significant (P<0.05) diet effect was noted for serum BUN, P, K, Cl, cholesterol, and glucose.

DISCUSSION AND CONCLUSIONS

These data indicate that dogs undergoing a moderate bout of exercise do not suffer from electrolyte imbalance, but may benefit from added dietary taurine/protein. Because a greater plasma BCAA:tryptophan ratio has been reported to improve performance and delay fatigue in canine and human athletes, this may be an area to study in the future.
P19) NUTRITIONAL EVALUATION OF PROTEIN SOURCES FOR CAT FOODS

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Introduction
Little information regarding the digestibility of protein sources for cats is available complicating a more technical use of these ingredients in the formulation of pet food. The digestibility of high-ash meat and bone meal (HAMB), high-ash poultry by-product meal (HAPM), soybean meal (SBM), corn gluten meal (CGM) and micronized whole soybeans (MWS) was determined for cats by the substitution method.

Materials and methods
Fifty-five mixed-breed cats were used in the digestibility trials. A basal diet (BD) was formulated for cat maintenance and five test diets produced by mixing 70% of BD and 30% of the test ingredient. After mixing and grind, all diets were extruded under similar conditions and submitted to digestibility evaluation (total collection of feces) using between seven and 12 cats per diet. The apparent digestibility of the protein sources was calculated by the substitution method, considering the digestibility of the BD, test diet and the substitution level of the ingredient.

Results and discussion
HAPM, CGM, and MWS had higher digestibility of dry matter (75.4%, 89.6%, 86.5%), organic matter (95.9%, 94.4%, 87.5%), crude protein (87.2%, 92.6%, 87.2%), gross energy (93.9%, 89.2%, 86.5%), and metabolizable energy content (4.11kcal/g, 5.14kcal/g, 5.33kcal/g), respectively. The HAMB showed low dry matter digestibility (46%) and metabolizable energy content (2.37kcal/g), and SBM was the protein source with the lowest digestibility values (62.6% for DM; 64.9% for OM; 79.1% for CP; 66% for GE). No data about ingredient digestibility (not diet digestibility) were found to compare to the results.

Conclusions
HAPM, CGM, and MWS are good protein sources for cat food. However, HAMP and SBM should be used with more attention regarding their moderate to low DM digestibility and energy content.
P20) EVIDENCE OF INFLAMMAGING IN THE GASTROINTESTINAL MUCOSA OF DOGS

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Introduction
The gastrointestinal mucosa is subject to alterations according to diet, stress, aging, or disease, changes that can affect gut physiology, influencing the absorption and metabolism of nutrients, as well as its ability to protect the body. The present study compared histological aspects of the gastrointestinal tract of dogs of different age groups.

Materials and methods
Thirty-one healthy Beagle dogs were divided into three age groups: Puppy (0.83±0.001 years, n=10), Adult (5.3±0.48 years, n=10) and Old (10.7±1.25 years, n=11). Animals received the same dry kibble diet for 40 days, and were fasted for 12h, anesthetized and submitted to an endoscopic procedure for collecting biopsies of the stomach and small and large intestinal mucosa. The biopsies were fixed in 10% formalin and processed according to standard techniques with paraffin embedding. Serial sections of 4mm were stained with hematoxylin-eosin and assessed for biopsy adequacy and semiquantitatively regarding the presence and intensity of alterations. Data were evaluated with Kruskal-Wallis test (\(P<0.05\)).

Results
In general terms, no alterations were verified on Puppy and Adult, but the Old group presented histological aspects of discrete gastritis, enteritis, and colitis, characterized by a discrete infiltration of intraepithelial lymphocytes (IEL) and lymphocytes and plasma cells (LP) in the mucosa of stomach (affected/total evaluated; 6/11), duodenum (8/11), ileum (2/9) and colon (4/11), and a moderate infiltration of IEL and LP in colon’s mucosa (1/11).

Discussion and conclusions
This low grade inflammation demonstrates the presence of inflammaaging in the gastrointestinal mucosa of the Old group (inflammaging is characterized by an imbalance between inflammatory and anti-inflammatory networks, resulting in a low grade chronic pro-inflammatory status on the elderly), a relevant aspect not previously described in dogs. This could be related to previously shown altered fermentation products concentration on feces of old dogs (Gomes, et al., 2011), aspects that requires further studies to investigate possible dietary compensations.
**P21) BEAGLES AS MEDIUM AND FOXHOUND CROSSBREDS AS LARGE BREED DOGS SHOW A COMPARABLE CORRELATION BETWEEN HEART RATE AND OXYGEN CONSUMPTION**

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**Introduction**

Requirements for maintenance energy requirement (MER) does not include energy expenditure for strenuous exercise which needs to be estimated separately. Due to the large number of influences, different measurement techniques and limited information, the estimation of energy requirement for exercise in dogs is challenging. In other species the relation between heart rate and oxygen (O₂) consumption has been established as simple and economic tool in this context. The aim of this study was to compare the correlation between heart rate and O₂ consumption in Beagles and Foxhound crossbreds.

**Materials and methods**

In seven Foxhound crossbreds (FBI, f, 4-6 y, 24-34 kg, resting heart rate 67-112 bpm) and 10 Beagles (f, 1-2.5 y, 12-15 kg, resting heart rate 72-101 bpm) respirometry was used to measure energy metabolism at rest and during exercise at different running speeds (treadmill) with simultaneous measurement of heart rate. Basic data were gathered before training, following a period of six weeks of endurance training, and after nine weeks of detraining.

**Results and discussion**

With an accuracy of about 80% the heart rate and O₂ consumption during exercise showed a positive relationship (P<0.0001). On a body weight basis the regression lines were more or less parallel with a considerable difference of the intercept. However, based on metabolic body weight in both breeds the relation can be described in one equation.

**Conclusions**

Basing the equation on metabolic body weight is a promising tool to develop predictive equations for oxygen consumption through heart rate measurement in dogs covering a larger number of breeds. This can be used to establish an easy and affordable tool to assess the increased energy requirement of individual sporting or working dogs. Further research is necessary.
P22) NAA FOR EVALUATING MINERAL NUTRIENTS IN COMMERCIAL DOG FOOD

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Introduction

Neutron activation analysis (NAA) is an analytical technique for measuring chemical elements with a potentially high metrological level in a large variety of applications. The direct analysis of samples without any chemical processing and the multi-element capability are two important features that make NAA especially useful for the ample characterization of solid materials.

Materials and methods

Here, NAA was applied for assessing mineral nutrients in commercial dog food. Ninety-five samples of dry dog food for puppies (n=32) and adults (n=63) of various brands were acquired in the local market of Piracicaba city, Brazil. Subsamples (350g) were ground in a knife mill and test-portions of 250mg were packed in polyethylene vials for irradiation with neutrons. Both short and long irradiations were carried out, allowing the detection of radionuclides with short (<12 hours) and long (>12 hours) half-lives. Short irradiation provided the measurement of Ca, Na, Cl, Mg, Cu, Mn and I, while long irradiation provided the measurement of P, K, Fe, Zn and Se. Data were compared to the reference values from the Association of American Feed Control Officials (AAFCO).

Results

A satisfactory agreement with the AAFCO reference values was observed for K, Na, Cl, Fe, Cu, Mn and I in the 95 dog food samples. For Ca, eight samples of adult dog food and one of puppy dog food presented values above the maximum limit (2.5%). P showed two samples of adult dog food and one of puppy dog food below the minimum limit (respectively 0.8% and 0.5%). Mg had three samples of adult dog food above the maximum limit (0.3%). Zn presented three results for adult dog food and one of puppy dog food below the minimum limit (120mg/kg). Se was above the maximum limit (2.0mg/kg) in one sample of puppy dog food.

Discussion and conclusions

NAA proved to be a suitable analytical tool for characterizing the profile of mineral nutrients in dog food, allowing the determination of all chemical elements with reference values established by AAFCO.
P23) AMINO ACID PROFILES OF SELECTED SPECIES: A SEARCH FOR ALTERNATIVE PROTEIN AND TAURINE SOURCES FOR USE IN ANIMAL FEEDS

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Introduction
In response to global economic duress and heightened consumer awareness of nutrition and health, sustainable and natural ingredients are in demand. Identification of alternative sources of nitrogen and amino acids, including taurine, may help meet dietary requirements while fostering sustainability and more natural feeding approaches. To identify alternative sources of protein for animal diet formulation, we analyzed a selection of substrates including plants, marine algae, and insects.

Materials and methods
Twenty plants, 18 marine algae and five insect species were analyzed. All samples were freeze-dried, hydrolyzed and filtered prior to amino acid analysis using an automated amino acid analyzer. Samples for amino acid determination were analyzed in duplicate and averaged. Nitrogen was analyzed by combustion and crude protein (CP) was determined by calculation. All results are reported on a dry matter (DM) basis.

Results
All insects exceeded both the canine and feline minimal requirements (MR) for growth of all essential amino acids (EAA) and CP. While some plants and marine algal species exceeded the canine and feline MR for growth for EAA and CP, no appreciable amount of taurine was found in any plants. Taurine concentration in insects was variable but high, with the greatest concentration found in ants (6.4mg/g) and adult flesh flies (3.3mg/g). Taurine was also high in some macroalgae, especially the red algal species: Mazaella spp. (4.1mg/g DM), Porphyra spp. (1.2mg/g DM) and Chondracanthus spp. (6.5mg/g DM).

Discussion and conclusions
Preliminary results suggest that insects and some marine algal species may be practical alternatives to more traditional protein and supplemental taurine sources in pet foods. Safety, bioavailability, palatability and source variability of alternative items as feed ingredients should be investigated prior to incorporation into canine and feline diets.
P24) POST-CASTRATION VARIATIONS IN WEIGHT GAIN IN A COHORT OF YOUNG ADULT MALE CATS

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Introduction
To investigate the six month post-castration weight gain and body weight (BW) change in a cohort of cats matched in age, background, husbandry conditions, and parental lineage.

Materials and methods
Twenty, specific-pathogen free, young intact male domestic short-haired cats ranging from 2.0-2.3 years were used in this prospective cohort study. All cats consumed the same dry maintenance diet at least six months prior to and following castration. Cats were group housed, had ad libitum food and water access, and were weighed once a week. Weight gain in these cats was retrospectively analyzed for associations to the pre-conception BWs of the queen.

Results
All cats gained weight after castration. The mean ±SD BW at the start of the study was 4.67±0.70kg and at the end of the study was 5.93±1.38kg. One pair of siblings showed a considerable difference in weight gain (1.37kg and 2.81kg). The pre-conception BW of the queens was significantly correlated with the offspring’s initial BW (ρ=0.65, P=0.01), the offspring’s final BW (ρ=0.67, P=0.01) and the offspring’s percentage BW change (ρ=0.54, P=0.04).

Discussion and conclusions
Diverse differences in post-castration weight gain were observed between individual cats of similar backgrounds and housing conditions. These variations in weight gain may be influenced by maternal obesity at conception. Implementation of effective methods to prevent weight gain at pre-conception and post-neutering may be a strategy for preventing obesity and obesity-related disorders in cats.
P25) ORAL IMMUNIZATION BY ANTI-PORPHYROMONAS IGY REDUCES PORPHYROMONAS GINGIVALIS AND PLAQUE IN DOGS

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Introduction
Periodontitis is one of the health problems that most affect adult dogs. The major pathogen associated with periodontitis is *Porphyromonas gingivalis*. Thus, the dietary addition of anti-*Porphyromonas* immunoglobulin Y (IgY-AP) from hyperimmunized eggs has the potential to reduce periodontitis in dogs, constituting the aim of this study.

Materials and methods
We used 14 adult dogs randomly assigned. The animals were fed twice daily during four weeks two isonutritive diets: control (n=7), without IgY-AP and test (n=7), with inclusion of 0.4% egg powder containing IgY-AP (Globigen PG, EW|Nutrition, Visbek, Germany). At 0, two, and four weeks we assessed the 3rd incisors, canines, 3rd and 4th premolars, and the 1st molars for the total bacterial count (TBC) and *P. gingivalis* population by PCR; gum, plaque, calculus, and halitosis indexes; hypersalivation; and pocket depth. The indexes ranged from 0 (absent) to three (strong presence). The plaque area was measured by digital photographs in software. The data were analyzed by Mann-Whitney-Wilcoxon test ($P<0.05$).

Results
The content of *P. gingivalis* (0.02 vs. 0.49% of TBC) and TBC 0.43 vs. 0.62 ng/µL decreased ($P<0.05$) in dogs fed IgY-AP for two weeks compared to those fed the control diet, respectively. The plaque area of dogs fed IgY-AP decreased ($P<0.05$) after four weeks, compared with the control diet (8.2 vs. 8.7 cm², respectively). The other variables did not differ ($P>0.05$) between treatments.

Discussion and conclusions
Oral immunization by IgY-AP reduces *P. gingivalis* and plaque in dogs. The non-interference of IgY-AP on halitosis and gingivitis of dogs may be due to the low level of these variables in the studied dogs (median = 1) or due to the short experimental period.
P26) BODY CONDITION OF DOGS FED DIETS CONTAINING SOYBEAN HULLS

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Introduction
Obesity is a growing problem in dogs. Thus, it is increasing the need for obese dog foods, which contain high fiber to dilute the calories and to reduce energy absorption. Soybean hulls (approximately 72% total dietary fiber, TDF), co-product of soybean meal, presents a reduced cost and high availability as a fiber source. We aimed to evaluate the body condition of dogs fed diets containing 0% (0SH) or 16% (16SH) soybean hulls replacing corn.

Materials and methods
Twelve adult dogs were completely randomized (n=6/treatment) and received 0SH diet (28.0% protein; 14.4% TDF; 17.9MJ/kg metabolizable energy, ME) according to their maintenance energy requirements, or the same amount (g/kg body weight0.75) of the 0SH of 16SH diet (29.3% protein, 24.9% TDF, 15.8MJ/kg ME) twice daily during 56 days. The animals were evaluated in day 0 and 57 for body weight, body condition score (BCS, 1, thin to 9, obese), thickness of subcutaneous adipose tissue in the L7 vertebra with ultrasound (L7), canine body mass index (CBMI), and body fat (BF). Data were analyzed by t-test (P<0.05).

Results
The variation (final - initial) of body weight (-0.58 vs. -0.49kg), BCS (-1 vs. -1), L7 (-2 vs. 0.35 mm), CBMI (-0.85 vs. -0.63 kg/m²), and BF (-5.0 vs. -5.4%) of dogs fed diets 0SH and 16SH, respectively, did not differ (P>0.05).

Discussion and conclusions
Diet 16SH with restriction of 11.4% in ME does not change the body condition of adult dogs. Further studies evaluating soybean hulls only in overweight/obese dogs may be conducted, because they may present different response to the evaluated group that showed BCS between four to seven (ideal to overweight).
P27) FEEDING FREQUENCY OF SOYBEAN HULLS DIETS ON FOOD INTAKE AND BEHAVIOR OF DOGS
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Introduction
Fibers aid in satiety and enable low calorie consumption/g of feed intake. Allied with feeding management, fibers may contribute to anxiety reduction during weight loss in overweight/obese dogs. Among fiber sources, soybean hulls (SH) have a reduced cost and high availability. We aimed to evaluate the consumption and behavior of dogs fed diets without (0SH) and with 16% SH (16SH), one (1x) or two (2x) times a day.

Material and methods
Eight Beagle dogs: four males and four females, 11.3±1.6 kg body weight (BW), 4.1±0.1 years old, were used. Two diets, 0SH: 28.0% protein, 14.4% total dietary fiber (TDF), 4.28kcal/g metabolizable energy (ME) and 16SH: 29.3% protein, 24.9% TDF (75% insoluble fiber), 3.77kcal/g ME and two feeding frequencies: 1x and 2x, were evaluated in a 4x4 Latin square in factorial arrangement 2x2 (n=8/treatment). Each period was composed of five days of adaptation and five days of data collection. We supplied 50% more ME than the requirement. Food intake was recorded. The behavioral test consisted of 24 hours of uninterrupted sweep sampling (observations every 10 minutes). Variables evaluated were: sleeping, stereotyped behavior, vocalization, etc.

Results
The consumption (g/kgBW0.75/animal/day) of diets 0SH (47.1g) and 16SH (46.4g) did not differ (P>0.05). However, ME consumption (kcal/kgBW0.75/animal/day) was higher (P<0.05) in dogs fed 0SH (201.6kcal) compared with 16SH (174.9kcal). Consumption in g and kcal was higher (P<0.05) in dogs fed 2x (52.7g and 211.9kcal), when compared with 1x (40.7g and 164.6kcal). There was no interaction between diets x feeding frequencies and no differences in dogs' behavior (P>0.05).

Discussion and conclusions
Diet with 16SH, despite reduce ME intake, does not restrict consumption in Beagles, which consumed less only when fed 1x, probably due to gastric restriction.
P28) ALTERATIONS OF OXIDATIVE PARAMETERS AFTER ACUTE STRESS IN DOGS

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Introduction
Oxidative stress occurs when the rate of production of free radicals exceeds the working capacity of the antioxidant defense system of the body. This study evaluated the alterations of some oxidative parameters after acute stress in dogs.

Materials and methods
Twenty adult beagle dogs (12.4±1.5kg) consuming the same diet for 60d were included. To simulate the stress, dogs were housed in pairs in transport boxes (1.0m x 1.5m x 1.0m), placed in a trailer attached to a truck, and transported for a period of 15 minutes. Animals were not familiar with the procedure. Blood collection was performed immediately before and after three hours of the transportation to evaluate the modifications in the following oxidative parameters: thio-barbituric acid reactive substances (TBARS), total antioxidant capacity (TAC), sequestration activity of the radical 2,2-diphenyl-1-picryl-hydrazyl (DPPH), protein carbonylation (PC), total glutathione (TG), alpha-tocopherol (αToc) and Retinol (Ret). Data were compared by Student’s T-test (P<0.05).

Results
PC, TG and αToc did not change, although numerical differences were observed. Significant differences were observed for the TBARS, DPPH, TAC and Ret (P<0.05; Table 1).

Discussion and conclusions
The model was effective to induce modification in the oxidative parameters. Lipid peroxidation (evaluated by TBARS) increased and the consumption of the antioxidants occurred during this period. Despite this, the enzymatic and cellular antioxidant defense system responded effectively, verified by increasing of the antioxidant capacity (DPPH and TAC). The parameters studied showed sensitivity to changes induced by acute stress in dogs.

| Table 1. Parameters of oxidative status in dogs before and after the transport |
|-----------------|-----------------|-----------------|----------------|----------------|----------------|----------------|
| Period  | TBARS (absorbance) | DPPH (%decoloration) | TAC (eqTROLOX) | PC (nmol/mg) | TG (µmol/L) | αToc (µmol/L) | RET (µmol/L) |
| Before  | 0.040 | 5.070 | 0.422 | 17.03 | 48.60 | 52.13 | 2.30 |
| After   | 0.048 | 6.195 | 0.552 | 20.63 | 51.44 | 48.37 | 1.86 |
| P       | 0.043 | 0.006 | 0.007 | 0.280 | 0.150 | 0.353 | 0.024 |
P29) A MODERATE FAT, LOW ENERGY DRY EXPANDED DIET REDUCES WEIGHT AND BODY CONDITION SCORE GAIN FOLLOWING NEUTERING IN CATS

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Introduction
Neutering is commonly associated with significant weight gain in the weeks following surgery. Neutering is a major risk factor for obesity. Obesity has significant impacts on the health of cats and its prevention is easier than treatment. This study was conducted to evaluate the effectiveness of a moderate fat, low energy dry expanded diet* in reducing weight gain in pet cats over the six months following neutering.

Materials and methods
Cats were enrolled at neutering and randomly assigned to two dietary treatments in participating Banfield veterinary clinics. Cat owners in the intervention group were instructed to feed the trial diet at maintenance (77.6 kcal/kg BW0.711/day). Instructions in the control group were to feed the cat’s regular diet according to recommendations. Body weight and condition (5-point scale) were measured by veterinarians at enrollment, two weeks, and one, two, three, four and six months after surgery. Body condition was compared between baseline and each subsequent visit, controlling for enrollment age and sex. Weight gain over time was tested using the SAS MIXED procedure using dietary group, time and sex as fixed effect and cat as a random term.

Results
The trial was completed by 187 cats (87 females and 100 males; mean±SD age, 5.2±0.8 months; weight, 2.8±0.6 kg) from 51 veterinary clinics. Compared with baseline, the odds of being scored as overweight was 3.8 times as great for cats in the control versus intervention group (95% confidence interval 2.0-7.5). Rate of weight gain differed significantly ($P<0.05$) between diet groups and between sexes.

Discussion and conclusions
Feeding the trial diet exclusively reduced the incidence of cats becoming overweight in the six months following neutering.

*Veterinary Care Nutrition™ Feline Weight Control™ Royal Canin, Rolla, MO, USA 5.5% moisture, 35% protein, 10% crude fat, 9.3% crude fiber, 10.2% ash, 30% NFE
P30) DIETARY MANAGEMENT OF HEREDITARY COPPER-ASSOCIATED HEPATITIS IN THE LABRADOR RETRIEVER

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Introduction
Hereditary copper-associated hepatitis in the Labrador retriever is characterized by gradual hepatic copper accumulation. Therapy is aimed at creating a negative copper balance by metal chelators, like D-penicillamine. Life-long continuous D-penicillamine therapy may lead to a deficiency of copper and zinc and gastrointestinal side effects are often encountered. Therefore, the aim of the current study was to investigate the effect of a low copper, high zinc diet as an alternative treatment.

Materials and methods
Affected Labrador retrievers were diagnosed through evaluation of a liver biopsy and copper quantitation therein. After undergoing D-penicillamine therapy dogs were maintained on a diet containing 1.3±0.3mg copper and 64.3±5.9mg zinc/1000 Kcal and evaluated for copper re-accumulation by a liver biopsy every six months. An hepatic copper concentration over 800 mg/kg dwl was considered a risk for developing copper-associated hepatitis.

Results
Sixteen affected Labrador retrievers with an hepatic copper concentration of 1590±767 dwl underwent chelation therapy for a mean period of 10.9±4.2 months. Before and during treatment, dogs were fed different kibble diets, of which no data were available. Normalization of hepatic copper was confirmed in a liver biopsy prior to the start of the study. During the diet trial, hepatic copper re-accumulated at a mean rate of 21±28 dwl/month (range: -3.8-103.1mg/kg dwl per month). The diet was capable of maintaining hepatic copper concentration below 800mg/kg dwl in 12 dogs during the follow-up period of 17-39 months. Four dogs re-accumulated hepatic copper above 800mg/kg after a median dietary treatment time of 15.7 months (range 6-20 months).

Discussion and conclusions
A low copper, high zinc diet can be a valuable alternative to continuous D-penicillamine administration for long-term management of dogs affected with copper-associated hepatitis. Variation in copper re-accumulation rate between individual dogs should be considered in determining re-biopsy intervals.
P31) EARLY GROWTH IS RELATED TO METABOLIC MARKERS AND CARDIAC HYPERTROPHY IN CATS

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Introduction

Cats’ early nutrition and growth may interact with the genetic predisposition for hypertrophic cardiomyopathy (HCM) and modify phenotypic expression of this disease. To understand better the relationship between early growth and HCM, the objective was to assess echocardiographic findings in a colony of adult cats with respect to early growth patterns and metabolic variables.

Materials and methods

Male and female colony cats ≥ three years of age for which growth curves during the first year of life were available were eligible for the study. Physical examination and echocardiography (2-D, M-mode, and Doppler echocardiography) were performed on all cats. Body weight, body condition score (9-point scale), and head length and width were measured. Circulating glucose, insulin, NT pro-BNP, and insulin-like growth factor (IGF-1) concentrations were measured and growth data were collected for each cat. Stepwise multivariate analysis of variance and multivariate logistic regression were performed.

Results

Twenty-eight cats (20 males, eight females, all neutered) were enrolled. Median age was 5.3yrs (range, 3.2-6.8yrs). Body condition scores ranged from 4-9 (median, 5.5) and body weight at the time of the study ranged from 2.7-7.2kg (median, 4.8kg). Variation in body weight was apparent by six months of age [median, 3.4kg (range, 2.2-4.5kg)] and even more by one year of age (median, 4.2kg (range 2.2-5.6kg). Median percent change in weight from 6-12 months was 23% (range, 0-39%). Cardiac abnormalities included a cardiac murmur (n=7; 24%), gallop (n=3; 10%), and arrhythmia (n=1; 4%). Fourteen of 28 cats (50%) had echocardiographic evidence of left ventricular hypertrophy (IVSd or LVWd ≥ 6 mm). Weight at six and 12 months, head size, NT pro-BNP, and IGF-1 were significantly associated with left ventricular hypertrophy.

Discussion and conclusions

Prospective studies are needed to better understand potential associations between early growth, left ventricular hypertrophy, and HCM.
Introduction
Degenerative mitral valve disease (DMVD) affects approximately 11% of all dogs. The pathophysiologic causes of DMVD remain unclear but serotonin (5-hydroxytryptamine [5HT]) is thought to play an important role. Dogs with DMVD have higher serum 5HT concentrations compared with controls but the cause for elevated 5HT concentrations is unknown. There are a number of ways in which diet could alter serotonin concentrations, but dietary factors that could influence the development of DVMD through alterations in serotonin have not been investigated. Therefore, the purpose of this pilot study was to measure dietary serotonin, ergotamine, and amino acids, particularly tryptophan, as possible dietary factors that could influence plasma and mitral valve serotonin concentrations.

Materials and methods
Thirteen diets were selected based on a previous study comparing dogs with and without DMVD and diet histories from clinical cases. Diets were analyzed for amino acids (amino acid analyzer), ergotamine (HPLC), and the indoleamines, 5HT and melatonin (ultra-performance liquid chromatography-Time-of-Flight mass spectrometry).

Results
There was a wide range in macronutrient and amino acid concentrations in the 13 diets tested. No essential amino acids were below the AAFCO minimum. Taurine is not considered an essential amino acid for dogs but if diets were compared to the AAFCO Cat Food Nutrient Profile, nine of the 13 diets were below the minimum for taurine. Tryptophan ranged from 0.47-1.32g/1000kcal (median=0.66g/1000kcal). All 13 samples tested had ergovaline concentrations <100 ppb. One sample tested positive for serotonin and melatonin was detected in eight foods.

Discussion and conclusions
Diets had a wide range in all amino acids tested. Additional research is needed on the effects of varying dietary intake of serotonin, tryptophan, and other factors such as indoleamines, on cardiac valve metabolism.
Introduction
Obesity is a prevalent medical condition in dogs caused by the excess accumulation of fat, and this negatively affects quality of life, longevity and the risk of developing associated pathologies. However, it is not clear how frequently veterinarians in first-opinion practice record dogs being overweight or obese in medical records, and what factors determine when they do.

Methods
Data sourced through the Small Animal Surveillance Network (SAVSNET) were used to determine the relative frequency of veterinarians recording obesity or overweight in dogs presented to United Kingdom first-opinion practices. Cases were identified using a search of the clinical record free text for a range of relevant keywords or phrases. A case-control study was then conducted to compare dogs that the veterinarian recorded as being obese or overweight, with a control group of obese dogs where a diagnosis of obesity or overweight was not recorded.

Results
Following a review of 49,488 consultation records, 671 dogs were identified as obese or overweight, from the keyword search, suggesting a relative frequency of 1.4%. Using binary logistic regression, dogs were more likely to be recorded as obese or overweight when the consultation was for osteoarthritis (odds ratio [OR] 6.0, \(P<0.001\)) or lameness (OR 2.1, \(P=0.006\)). Further, dogs that had been microchipped were less likely (OR 0.6, \(P=0.02\)), and dogs that were members of a practice pet health scheme were more likely (OR 3.7, \(P=0.04\)) to be recorded as being obese or overweight.

Discussion and conclusions
These results suggest that overweight and obesity are under-diagnosed in first-opinion practice. However, a presentation for orthopaedic disease appears to be a key prompt for recording weight status. Further studies are now warranted to determine the reasons for such marked under-diagnosis.
P34) OWNER MISPERCEPTION OF CANINE BODY CONDITION PERSISTS DESPITE USE OF BCS CHART

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Introduction
Canine obesity is a prevalent disease, but many owners are unaware of the problem, partly due to owners’ misperception of their dog’s body shape. Body condition scoring (BCS) is a simple method of assessing body composition, but whether they can reduce owner misperception is not clear. The aim of this study was to determine the effect of using a BCS system on owners’ ability to estimate the body composition of their dog.

Methods
Information from 110 dog owners attending three UK veterinary practices was gathered, by interview questionnaire, between March and April 2013. First, owners were asked to determine their dog’s body condition without guidance, and then reassess their dog’s body shape using a 5-point BCS chart.

Results
Most (85/110, 77%) owners commented that the BCS chart improved their ability to estimate the condition of their dog correctly. However, there was only weak agreement between owner estimates and those of the primary investigator (REJ), both with (kappa=0.28, P<0.001) and without (kappa=0.32, P<0.001) the use of the BCS chart. The majority of owners incorrectly estimated their dog’s body condition both using (71/110, 64%) and not using (72/110, 65%) the BCS chart (P=1.00), and underestimation was most common (with BCS 63/71, 89%; no BCS 66/72, 92%; P=0.57). Owners of overweight dogs more commonly misperceived their dogs’ body condition than the owners of underweight and ideal weight dogs, both with (BCS 4-5: 64/75, 85%; BCS 1-3: 5/35, 14%, P<0.001) and without (BCS 4-5: 61/75, 81%; BCS 1-3: 10/35, 28%, P<0.001) the use of the BCS chart.

Discussion and conclusions
This study shows that use of a five-point BCS chart does not improve accuracy of owners’ perception of their dog’s body shape, despite the accompanying perception among most owners that it does.
P35) EFFECTS OF HIGH AND LOW FAT DIETS ON ENERGY METABOLISM, BIOMARKERS OF HEALTH AND BEHAVIOR IN HEALTHY, ADULT CATS

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Introduction
The effects of dietary carbohydrate and fat on feline health are not well understood. The effects of feeding diets moderately high in fat (HF; N=10; 34% fat, 26% carbohydrate) or carbohydrate (HC; N=10; 11% fat, 47% carbohydrate), and an equivalent amount of metabolizable energy/kg BW, once daily for 84 days, were investigated in healthy, adult cats (3.5 ± 0.5 yr).

Materials and methods
Indirect calorimetry, fasted blood samples, activity, play and cognition were collected at baseline, and at intervals throughout the study. Body composition was measured by DXA at baseline and on day 84. Data were analyzed using a mixed, repeated measures, ANOVA.

Results
Cats fed the HF diet experienced a significant increase in BF (+0.25 kg; P=0.0006) and BW (+0.14 kg, P=0.04) during the study period in contrast to cats consuming the HC diet that experienced no change in BF or BW (P=0.76) throughout the treatment period. Energy expenditure were similar (P=0.36 (fasted), P=0.09 (fed)) and respiratory quotient declined and increased with HF (0.7990±0.004) and HC (0.8523±0.005) diets, respectively (P<0.0001). Cats receiving the HC diet were numerically less insulin sensitive (G:I= HC: 0.73, HF: 0.90; P=0.33). Activity declined with exposure to both diets (P=0.0005) but was not different between treatments (P=0.25). Cognitive performance was superior for cats consuming the HC diet (P=0.04) and there was no effect of diet on play (P=0.39).

Discussion and conclusions
Overall, cats adapt to dietary macronutrient content, but both HC and HF diets present risk for adiposity driven by different metabolic and behavioral mechanisms.
P36) MEASUREMENT OF IN VITRO FERMENTATION OF STARCH SOURCES BY USING FECAL INOCULUM FROM DOGS WITH OR WITHOUT DIGESTIVE SENSITIVITY

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Introduction
Some breed dogs, such as German Shepherds, are prone to produce soft stools. This predisposition could be due to a specific microflora and a better ability to ferment undigested residues. The aim of this study was to study the in vitro fermentation characteristics of different starch sources using inocula from dogs with or without digestive sensitivity.

Materials and methods
Fresh feces samples from German Shepherds (GS) and Miniature Schnauzers (MS) were used as inocula for in vitro fermentation. The samples, diluted and filtered, were incubated at 39°C under anaerobic condition with three different starch sources: conventional or high-amylose corn (CS or HCS) and potato (PS). These starch sources were characterized by their indigestible starch levels: HCS>PS>CS. Fermentation studies were performed during 0, 4, 6, 8 and 24h. Gases production, pH and fermentative by-product concentrations (SCFA, ammonia) were measured.

Results
Gases and SCFA produced during fermentation were affected by the starch source: CS>PS>HCS. When PS and HCS were used, ammonia concentrations increased from 0 to 8h then strongly decreased at 24h in GS. This decrease was not observed in MS. With CS supplementation, ammonia concentrations significantly decreased after four hours in both breeds. After 24h, the highest SCFA concentrations and the lowest pH were found for GS whatever the starch sources (P<0.01). Breed difference was much higher when PS and HCS were used.

Discussion and conclusions
These results suggest that fecal microbiota of GS presents higher capacity to ferment indigestible starches than that of MS. The highest SCFA concentrations and the lowest pH and ammonia levels found when GS stools were used could hence suggest a high fermentative activity of the microflora of this breed and could explain, at least in part, its relative digestive sensitivity.
P37) INFLUENCE OF NUTRITION AT YOUNG AGE ON CANINE HIP DYSPLASIA IN GERMAN SHEPHERD DOGS: A CASE-CONTROL STUDY FROM FINLAND

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Introduction
Canine hip dysplasia (CHD) is one of the most common orthopedic problems seen in small animal practice. To be able to analyze the relationship between different type of food items or feeds and disease, data were gathered through a huge owner-oriented internet questionnaire: The DOGRISK data.

Materials and methods
All German Shepherd dogs (GSD) with well-answered questionnaires and verified official hip radiographs were chosen: Those with severe CHD as the case group and with healthy hips (A/A) as the control group. Associations between diseases and 54 food items served at ages 2-6 months (n=54 severe/103 healthy) as well as >6-18 months (n=49/81, respectively) were analyzed using the Mann-Whitney U-test and the difference in percentage of ingested dry, other commercial, home-cooked, or BARF diets were analyzed using the independent t-test.

Results
The diet at 2-6 months of age showed a significant association between the following raw food items and being free from CHD: raw offal, meat, bone, cartilage, tripe, fish, and animal oils ($P=<0.001-0.024$) whereas cooked meat, bone and cartilage significantly associated with an increase in CHD ($P=<0.005-0.037$). The diet at >6-18 months of age showed a significant association between the following raw food items and being free from CHD: raw offal, meat, bone, cartilage, tripe, and fish as well as cooked sausage ($P=<0.001-0.024$) whereas cooked meat, table scraps, bone and cartilage significantly associated with an increase in CHD ($P=<0.005-0.044$). At 2-6 and 6-18 months of age the dogs were eating significantly more BARF in the healthy group, compared to the CHD group ($P=0.004$ and $0.001$, respectively) although 75% of all dogs were eating dry food a couple of days a week to daily, at both ages.

Discussion and conclusions
Results are interesting. Prospective clinical studies are needed.
P38) IN-HOUSE METHOD FOR DETERMINATION OF APPARENT DIGESTIBILITY OF CANINE DIETS

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Introduction
An in-house digestibility method using privately-owned dogs may be a useful tool for epidemiological studies. The aim was to develop a simple method that would suit such studies using the whitening agent TiO2 as an indigestible marker.

Materials and methods
Forty privately-owned, healthy male and female dogs of various breeds were included in this study. Selection of eligible dogs was based on an owner questionnaire. Mean±SEM age and BW of the dogs was 6.2±0.6 yr (range 1.0-13.0yr) and 22.3±2.5 kg (range 5.0-43.2kg).

Owners were provided a commercial dry extruded diet supplemented with a commercially available TiO2 containing kibble (final dietary TiO2 content: 0.77g/kg). Dogs were fed the diet for seven consecutive days at 115kcal*BW0.75. On day seven, owners were asked to collect all feces during 24h and store feces at -20°C. Fecal samples were freeze-dried, ground and analyzed for GE, DM, OM, N, EE, crude fiber (CF), and Ti. Apparent fecal digestibility (in %) was calculated as described by Bosch et al. (2009, Br J Nutr. 102:318).

Results
Data of 39 dogs were ultimately used. Mean±SEM apparent fecal digestibility of GE, DM, OM, N, EE and, CF was 83.7±0.71, 77.4±0.79, 83.0±0.61, 77.7±0.81, 94.3±0.51 and 30.3±4.85, respectively. No significant differences were observed in nutrient digestibility due to gender or breed.

Discussion and conclusions
The SEM values of the digestibility coefficients observed here are similar to SEM values found under controlled conditions (e.g., Bosch et al., 2009). The in-house digestibility assay described here may be a promising tool to determine digestibility of dietary nutrients for epidemiological purposes under free living conditions rather than confined conditions of a laboratory setting. Owner compliance, however, is a potentially limiting factor. Further studies need to compare this in-house digestibility method to the standardized apparent fecal digestibility assay using kenneled dogs.
P39) INSULINEMIC RESPONSES OF HORSES AND PONIES FOLLOWING A 12-WEEK ADAPTATION TO A DIET CONTAINING MICRONIZED MAIZE

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Introduction
The aim of this study was to compare the insulin responses of different breeds of horses and ponies following adaptation to twice-daily meals rich in starch.

Materials and methods
Four Standardbred horses, four mixed-breed ponies and four Andalusian horses initially in moderate body condition score (5.5 ± 0.2 out of 9; no difference in BCS or age between breed groups) were fed concentrate meals at 8am and 4pm each day. The meals contained micronized maize (mixed in soaked soybean hulls and lucerne chaff), and the amount of maize was gradually increased each week over 12 weeks, reaching a final amount of 3.41g/kg BW in weeks 11 and 12 (approximately 2.2g/kg BW of starch, divided equally between the two meals). All had ad libitum access to pasture hay throughout the study. After the 12-week diet acclimation, all animals had serial postprandial blood samples collected via a jugular catheter over a 14-hour period. Plasma was harvested and analysed for insulin.

Results
There was no difference between groups in the time to consume the meals. Peak insulin concentrations following the AM meal were significantly higher in ponies (mean 157.1 µIU/mL [range 68.4 – 387.5]) and Andalusian horses (88.7 [74.6-111.9]) than in Standardbred horses (27.0 [19.6 – 31.0]; P<0.05). Peak insulin responses following the PM meal showed a slightly increasing trend in ponies (201.8 [64.9-506.3]) and Andalusian horses (108.4 [90.9-137.7]) compared with the AM meal, but was not significantly different in Standardbred horses (29.9 [23.5-35.2]).

Discussion and conclusions
These data show that there are breed-related differences in insulin responses following adaptation to a diet of twice-daily meals containing starch (micronized maize). The increased peak insulin concentrations observed in ponies and Andalusian horses most likely reflect lower insulin sensitivity and may relate to the increased susceptibility of these breeds to laminitis.
Introduction
Periodontitis is widely recognised as being one of the most common diseases in dogs. In this study we have sought to compare rates of periodontitis and calculus diagnosis in dogs of the most popular breeds visiting Banfield veterinary hospitals in the United States.

Materials and methods
A database of more than 27 million veterinary records was examined. Since continuous records were not available for the majority of dogs we chose to use “lifelong prevalence” as our measure of periodontitis. This is the proportion of the population that has suffered from the condition by a particular age. To account for client turnover in the database, prevalence curves for the different breeds were constructed from Loess-smoothed Kaplan Meir survival curves. These were then compared using functional analysis techniques.

Results
A strong inverse relationship between breed size and lifelong prevalence of periodontitis and calculus was identified. Little evidence was found to support a strong association between head shape and either periodontitis or calculus. Finally, mixed breed dogs in the same size range as small breeds have significantly less periodontitis suggesting that small size is not the only driver of disease.

Discussion and conclusions
We have provided information on the prevalence of periodontitis for the most popular breeds and suggest that small dog breeds especially are likely to benefit from a good oral care regime.
P41) OVERWEIGHT CAT OWNERS: PARTICIPANT AND PET CAT CHARACTERISTICS IN THE RURAL MIDWESTERN UNITED STATES

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Introduction
Pet ownership is thought to impart health benefits. The obesity epidemic has impacted both people and pets in the Midwestern United States (US). The study objectives included: 1) description of non-overweight/obese v. overweight/obese cat owners [NOO v. OO] and their cats, and 2) detection of differences between groups.

Materials and methods
An approved, cross-sectional, convenience sampled, descriptive study was undertaken in the rural Midwestern US. Participation was voluntary and un-incentivized. Inclusion criteria consisted of: informed consent, >18 years, owning a cat and having only one cat per household. Missing data were classified as “missing” but not removed. Data were analyzed using a variety of techniques. Self-reported owner weight classification was based on established Body Mass Index [wt-kg/ht-m2] cutoffs of 25.

Results
NOO (n=55) owned a cat for (µ±SD) = 5.8±4.5 versus 4.5±3.5 years for OO (n=39). NOO were younger (P<0.03) than OO, had fewer health problems (P<0.04), took fewer medications (P<0.04), engaged in more exercise (P<0.02) and ate less fast food (P<0.03). NOO v. OO characteristics included: female (84% v. 62%), Caucasian (86% v. 100%), active (77% v. 51%), non/former smokers (86% v. 100%). NOO v. OO cats’ characteristics included: age=6.6±4.5 v. 5.4±4.1 years, owner initiated activity 20.4±26.9 v. 15.5±21.2 min/d, treated 0.9±0.7 v. 0.7±0.6x/day and 3.3±2.5 v. 3.8±4.1 treats/session. NOO v. OO’s cats were 93% v. 97% neutered, 57% v. 74% female, 21% v. 12% pure bred, 86% v. 82% ad lib fed, 23% v. 24% overweight/obese and 42% v. 31% were fed table scraps.

Discussion and conclusions
Normal-weight v. overweight owners have differing dietary and lifestyle profiles and these differences may impact cat care and health. Findings may be important for marketing, health care provision (both owner/cat) and education. While there are significant limitations to this study, further investigation is warranted.
P42) PET OWNERSHIP OVER AGE 50: CHARACTERISTICS OF OLDER OWNERS VS. NON-OWNERS IN THE RURAL MIDWESTERN UNITED STATES

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Introduction
Pet ownership can improve quality of life for older adults. Older persons in the rural mid-section of the United States (MWUS) have increased disease and disability. The objective of these analyses was to 1) describe the characteristics of older pet owners versus non-owners and 2) to discern differences between groups.

Materials and methods
An approved, cross-sectional, convenience sampled, descriptive, voluntary, un-incentivized, informed study was done in the rural MWUS. Inclusion criteria for owners consisted of: >18 years, owning a cat or dog and having only one pet per household. Non-owners were recruited continuously until a match was obtained to owner demographics. Data were analyzed using a variety of techniques after being split by age >50 years.

Results
Split analyses resulted in matched older pet owners (OPO) versus non-pet owners (NPO) usable pairs (n=84); cat owners (CO) versus non-cat owners (NCO) pairs (n=29) and dog owners (DO) versus non-dog owners (NDO) pairs (n=55). No statistically significant differences were found between PO and NPO for dietary, physical activity or lifestyle characteristics, with exception of PO having fewer numbers of documented health conditions [P<0.03]. CO had significantly greater Body Mass Indices [BMI=wt-kg/ht-m2] (µ=29.6±8.2) than DO (µ=23.2±5.2) [P<0.02]; less physical activity [P<0.02]; duration of activity [P<0.05] and took fewer supplements [P<0.003]. CO and NCO differed significantly on health conditions (P<0.008) and DO versus NDO showed significant differences between BMI (µ=25±4 v. µ=27±6, P<0.04). OPO’s pets feeding, activity and other characteristics were also described.

Discussion and conclusions
While OPO and NPO did not differ for most dietary and lifestyle characteristics, OPO evidenced fewer health conditions nonetheless. CO and DO differed from one another and their matched NPOs on several parameters, including BMI. While there are limitations to this study, the information may be useful for targeting older adults for marketing campaigns and health messages.
P43) OVERWEIGHT AND OBESE DOG OWNERS: PARTICIPANT AND DOG CHARACTERISTICS IN THE RURAL MIDWESTERN UNITED STATES

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Introduction
Owning a dog has been linked to better health. The obesity epidemic impacts both people and pets in the Midwestern United States (MWUS). The study objectives included: 1) description of non-overweight/obese v. overweight/obese dog owners [NOO v. OO] and their dog, and 2) detection of differences between groups.

Materials and methods
An approved, cross-sectional, convenience sampled, descriptive study was done in the rural MWUS. Participation was voluntary, un-incentivized and informed. Inclusion criteria consisted of: >18 years, owning a dog and having only one dog/household. Data were analyzed using a variety of techniques.

Results
NOO (n=101) owned a dog for (μ±SD) 6±3.8 years versus 5.1±3.4 years for OO (n=113). Data with missing weight categories (n=25) were removed from analyses. NOO were aged 40.8±13.7 and OO were 41.5±12.2 years and were not statistically different. NOO trended towards fewer health problems (P<0.06), took fewer medications (P<0.02), took more supplements (P<0.03) and ate less fast food (P<0.05) and more fish (P<0.001). NOO v. OO non-pet related physical activity levels were not statistically different. NOO v. OO characteristics included: female (77% v. 49% [P< 0.001]), Caucasian (96% v. 93%), active (41% v. 43%), non/former smokers (85% v. 77%).

NOO v. OO dogs' characteristics included (μ±SD): age=6.6±3.9 v. 5.7±3.4 years; owner initiated activity 44.6±63.0 v. 27.2±26.4 min/d; treated 2.1±1.7 v. 2.1±1.6 times/day and 1.4±0.7 v. 1.5±1.1 treats/session. NOO v. OO’s dogs were 94% v. 88% altered, 61% v. 53% female, 23% v. 7% Labrador Retriever, 46% v. 45% ad-lib fed, 14% v. 23% overweight/obese and 62% v. 52% fed table scraps. OO provided fewer supplements to their dogs (P<0.003).

Discussion and conclusions
Normal-weight v. overweight owners have differing profiles which may impact dog care and health. Findings may be important for marketing, health care provision (both owner/dog) and education.
P44) FREQUENCY OF CANINE DISEASE-CAUSING MUTATIONS IN MIXED BREED DOG POPULATIONS

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Introduction

Owners of mixed breed dogs and their veterinarians often assume such dogs will exhibit “hybrid vigor,” and thus they will be unaffected by inherited genetic diseases, potentially leading to a missed diagnosis. We examined the frequencies of genetic mutations for seven published canine genetic diseases (hyperuricosuria, cystinuria, myotonia congenita, primary lens luxation, factor VII deficiency, phosphofructokinase deficiency and pyruvate kinase deficiency) in a large, mixed breed population.

Materials and methods

DNA samples from more than 100,000 mixed-breed dogs typed in conjunction with breed analysis on the commercially available Wisdom Panel® Breed Identification DNA tests were also typed for these seven diseases using forward and reverse SNP sequencing on a Sequenom platform.

Results

Of the seven diseases, three (hyperuricosuria, factor VII deficiency, and primary lens luxation) were observed with reportable frequency, indicating that the other four are rare in the US mixed-breed population. The most commonly observed genetic disease state identified in this mixed-breed population was hyperuricosuria which is caused by homozygous mutated alleles of the gene SLC2A9. This gene mutation has been observed in several breeds, including Dalmatians, Bulldogs, and Staffordshire Bull Terriers. Dogs homozygous for the SLC2A9 in our data set were analyzed for their breed makeup and the majority had at least one great-grandparent of a breed known to carry this mutation.

Discussion and conclusions

Taken together, our results indicate that three of these genetic diseases, though low in frequency, can still occur in mixed breed dogs and should still be considered clinically appropriate.
**P45) OPTIMAL SELECTION: USING A GENETIC TOOL TO EXAMINE DIVERSITY WITHIN A DOG BREED TO INCREASE LITTER SIZE & DECREASE INDIVIDUAL HOMOZYGOSITY**

**Hughes, A.1, Dibley, M.2, Davison, S.2, Fretwell, N.1**  
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**Introduction**  
Many pure-breed dog populations have a limited gene pool and as such, are similar to an endangered species where it is critical to consider the entire population, as well as the individuals involved in each breeding. To make breeding decisions, breeders are incorporating family history, phenotype assessments, and utilizing limited genetic information including inbreeding coefficients and specific disease or trait DNA tests. Unfortunately, these resources may not provide a complete overview of a dog’s potential genetic contribution to the breed. We investigated using a multiplex set of SNP markers to evaluate chromosomal haplotypes and homozygosity values within the Dandie Dinmont Terrier breed.

**Materials and methods**  
DNA samples were typed at more than 300 different SNPs across the genome; homozygosity was calculated and the haplotypes inferred utilizing Phase software. Haplotypes for potential mates were compared to evaluate the suitability of each possible cross based on predicted offspring homozygosity and maintaining rarer chromosomal haplotypes in the breed. A “breeding score” summarizes the potential heterozygosity across the chromosomes allowing all potential breedings to be ranked by a single, inclusive factor.

**Results**  
Within the Dandie Dinmont Terriers, we identified chromosomes with a large degree of heterozygosity and others that have lower diversity. Initial litters have shown decreased offspring homozygosity compared to their parents and a noted increase in litter size. Feedback from the breeders has been very positive and they are reporting healthy puppies, some of whom are competing successfully in AKC conformation. Longer term studies are underway to monitor health and physical traits in these dogs.

**Discussion and conclusions**  
While Optimal Selection should not be the only means of determining a desirable breeding, the diversity of the individuals should be included as a factor in order to maintain the genetic health of the entire breed. It is now available for use in more than 150 breeds.
P46) EVALUATION OF A PERFORMANCE ENHANCING SUPPLEMENT IN AMERICAN FOXHOUNDS DURING EVENTING

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Introduction
Enhancing performance through dietary measures is constantly sought as some supplements have shown modest performance enhancement in rodents and humans. A pilot study was undertaken to evaluate the effect of a performance enhancing supplement on the tracking performance in American Fox Hounds during a field championship.

Materials and methods
Ten dogs were assigned to two different groups. Group A received a commercial kibble containing 27% protein and 20% fat dry matter and Group B received the same diet with the addition of a proprietary supplement (yeast extract, betaine, magnesium sulfate, selected B vitamins) for eight weeks before the field event. Blood was collected pre-event, immediately following day one and day two of the event (Five hour event average speed 5.6 miles/hr) and 24 hours after day two. Blood chemistry, complete blood cell counts and cortisol concentrations were analyzed. In addition, competition performance was documented for all dogs using a points system for tracking events. Non-parametric analysis of variance over time was tested with post hoc examination of significant results at each time point.

Results
Many chemistry and CBC parameters changed significantly due to exercise. Post hoc analysis showed a significant decrease in AST, CPK, and urea for Group B on days one and two of exercise. Dogs in Group B out-performed dogs in Group A in the competition based on tracking scores (Group B - 3 dogs placed; Group A - 0 dogs)

Discussion and conclusion
This study suggests that endurance hunting endurance dogs develop changes in serum chemistry due to the metabolic stress of the event. Serum markers of musculoskeletal integrity appear to be mitigated by the addition of this proprietary supplement, resulting in better performance. Though intriguing, follow-up controlled studies are needed to ensure that the enhanced performance was not biased due to lack of randomization.
P47) EVALUATION OF THE WEIGHT-LOSS RATE AND BODY COMPOSITION IN INTACT AND NEUTERED OWNED OBESE DOGS

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Introduction
Neutering is associated with increased obesity. We compared the weight loss rate and requirements of energy intake to weight loss of intact and neutered owned dogs.

Materials and methods
Sixteen owned adult obese dogs, eight intact (four males and four females) and eight neutered females, mean age mean age 6.4±3.6 and 6.6±4.1 years, body condition scores (BCS) of eight (in a nine point scale), body fat content was 37.6±2.3% and 44.9±2.7%, respectively. Dogs were fed with a high-protein and low-starch diet (ME, 3.16Kcal/g as fed). Dogs were fed twice daily and sessions of exercise (20 min/d) were recommended. Body weights and BCS were recorded biweekly. Average weekly body weight loss rate was calculated. Body composition was determined before and after the weight-loss program by the deuterium oxide dilution method.

Results and discussion
Median percentage weight loss was 20% (10.0-27.2) and 19.2% (13.4-28.6) and median rate of weight loss was 0.85% (0.42-1.19) and 0.75% (0.35-1.12) per week in intact dogs and neutered dogs, respectively. During the period, food consumption of the high-protein diet was 64.6 (50.9-77.8) and 57.0 (30.9-72.3) kcal/kg target BW(0.75)/d in intact dogs and neutered dogs, respectively (P>0.05). This amounts correspond, respectively 57.6% (47.4-71.8) and 52.0% (27.0-76.0) of the maintenance energy requirement. Body composition assessed by the deuterium oxide dilution method allowed calculation of the composition of the body weight loss. Total body weight loss was 11.3 kg (5.7-14.1) and 5.3 kg (2.0-21.9) and its fat content 82% (72-89) and 78% (50-87) (P>0.05) for the intact dogs and neutered dogs, respectively. Both groups maintained their lean body mass.

Conclusions
Although rates of weight loss did not differ statistically between intact and neutered dogs, our data suggest that neutered dogs required more reductions in energy intake to weight loss. Diet allowed safe and efficient weight loss and avoided lean body mass losses.
P48) FECAL MICROBIOTA OF DOMESTIC CATS FED RAW WHOLE CHICKS VERSUS AN EXTRUDED CHICKEN-BASED DIET

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1University of Illinois, Champaign, Illinois, USA; 2MR DNA (Molecular Research LP)

Introduction
Extruded cat foods differ greatly in macronutrient distribution compared to wild-type diets (i.e., small rodents, reptiles, birds, and insects). They are relatively high in carbohydrate (30 to 60% versus <10% on DM basis) and lower in protein and fat content. This variability in dietary nutrient concentration and ingredient source likely impacts fecal microbial populations.

Materials and methods
Fecal samples were collected from neutered male domestic cats (n=8; mean age=5.7 y). A completely randomized design was utilized to test the impacts of two dietary treatments: 1) chicken-based extruded diet (n=3 cats; dry matter: 95%, crude protein: 38% DM, fat: 14% DM; PG Petcare, Cincinnati, OH); and 2) raw 1 to 3 d-old chicks (n=5 cats; dry matter: 25%, crude protein: 70% DM, fat: 21% DM; My Pet Carnivore, Indianapolis, IN). Cats were adapted to diets for 10 d, prior to fresh fecal collection (<15 min from defection). Fecal bacterial DNA was isolated and amplicons of the 16S rRNA V4-V6 region generated and analyzed by 454 titanium pyrosequencing. Data were analyzed utilizing the Mixed Models Procedure (SAS Inst., Cary, NC).

Results
Feces of cats fed 1-3 d-old chicks had higher (P<0.05) proportions of the following bacterial genera: Pseudobutyribibrio (4 vs 1%), unidentified Lachnospiraceae (15 vs 5%), and Peptococcus (9 vs 3%), and tended to have higher (P<0.10) proportions of Eubacterium (5 vs 3%). Feces of cats fed extruded diet had higher (P<0.05) proportions of Megasphaera (15 vs 1%) and Lactobacillus (8 vs <1%) and tended to have higher (P<0.10) proportions of Megamonas (12 vs <1%).

Discussion and conclusions
These results demonstrate that feeding an extruded diet can lead to large shifts in fecal bacterial populations compared to feeding a whole prey diet. Shifts in microbial populations may affect the functional capacities of the microbiota and its interaction with the host. Further research is warranted to determine the impacts of these shifts on long term health of domestic cats.
P49) FECAL MICROBIOTA OF DOMESTIC CATS FED WHOLE OR GROUND RAW CHICK DIETS

Kerr, K.R., Dowd, S.E., Swanson, K.

1University of Illinois, Champaign, Illinois, USA; 2MR DNA (Molecular Research LP)

Introduction
There has been a recent increase feeding unconventional diets, including whole prey diets, to cats. Our objective in this study was to evaluate fecal microbial populations of domestic cats fed whole and ground (6.35 mm grind) raw 1-3-d old chicks [dry matter: 25%, crude protein: 70% DM basis, fat: 21% DM basis; My Pet Carnivore, Indianapolis, IN].

Materials and methods
Fecal samples were collected from neutered male domestic cats (mean age=5.7 y). A crossover design was utilized. Fecal bacterial DNA was isolated and amplicons of the 16S rRNA V4-V6 region generated and analyzed by 454 titanium pyrosequencing. Data were analyzed utilizing the Mixed Models Procedure (SAS Inst., Cary, NC). During the study, three cats presented with symptoms of infection (anorexia, or diarrhea) and tested clinically positive for a group B Salmonella species. The remaining cats tested negative. Data were analyzed post hoc to test for differences in microbial populations due to clinical status.

Results
The predominant genera were Clostridium (nine to 30%), unidentified Lachnospiraceae genera (10 to 28%), Blautia (four to 19%) and Peptococcus (two to 19%). No differences due to dietary treatment were observed. Feces of cats which tested clinically positive for Salmonella had higher (P<0.05) proportions of the genera Coprococcus (5.6 vs 0.4%) and Escherichia (sub-genera Shigella; 1.1 vs 0.3%), and tended (P<0.10) to have lower proportions of the genera Anaerotruncus (1.4 vs 2.3%).

Discussion and conclusions
There are many potential risks to feeding products containing raw meat, including health concerns from potentially pathogenic bacteria. Although the pyrosequencing technique utilized herein did not detect Salmonella, a shift in microbial populations due to clinical status was detected. Further investigations to determine the relationship between clinical status and microbial shifts may be of interest.
Introduction
We investigated metabolizable energy (ME) intake of privately-owned puppies, whose owners had asked for a check of their puppies’ diet for nutritional adequacy.

Materials and methods
Data on 163 puppies were available. A standardized questionnaire was used; the owners weighed food and puppy. Expected mature weight was estimated according to breed standards and the body weight (BW) of the parent of the same sex. The actual weight was calculated in % of expected mature weight and compared with recommendations (Meyer and Zentek 2010, NRC 2006). Data were evaluated for deviation from recommended weight by more than 10%, age and mature weight.

Results
Thirty-six percent of puppies were growing according to recommendations, another 36% of them were above and 28% were below recommendations. On a metabolic BW basis the ME intake of the puppies growing according to recommendations showed a significant effect of age, but little effect of expected mature BW (table). ME intake of these puppies amounted to 84% of current requirements (NRC 2006). Puppies growing slower than recommended ate only 77% of the requirements and puppies growing faster ate 92%.

Discussion
Results suggest that activity of pet puppies is lower than in kennel puppies. Presumably in the restricted space of private homes the reduction of activity is over-proportional for larger breeds, levelling out size differences.

Conclusion
Puppies in private homes have a lower ME intake than current recommendations.

Table: Energy intake of pet puppies

<table>
<thead>
<tr>
<th>Mature BW</th>
<th>2-4 months</th>
<th>5-6 months</th>
<th>7-12 months</th>
</tr>
</thead>
<tbody>
<tr>
<td>kg</td>
<td>ME intake</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>MJ/kg BW^0.75 (n)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;15</td>
<td>0.80±0.06 (3)</td>
<td>0.72±0.09 (2)</td>
<td>0.61±0.06 (3)</td>
</tr>
<tr>
<td>15-&lt;27.5</td>
<td>0.83±0.02 (9)</td>
<td>0.74±0.04 (5)</td>
<td>0.55±0.03 (7)</td>
</tr>
<tr>
<td>27.5-&lt;47.5</td>
<td>0.99±0.02 (11)</td>
<td>0.84±0.04 (5)</td>
<td>0.67±0.09 (2)</td>
</tr>
<tr>
<td>&gt;47.5</td>
<td>1.02±0.04 (5)</td>
<td>0.67±0.06 (3)</td>
<td>0.62±0.06 (3)</td>
</tr>
</tbody>
</table>

Reference
Meyer and Zentek 2010; Ernährung des Hundes, Enke
Introduction
There are few data on the energy requirements of pet dogs. Therefore we evaluated data on metabolizable energy (ME) intake of pet dogs whose owners reported their dog’s diet for a check on nutritional adequacy.

Materials and methods
Reports (standardized questionnaire, dog and food weighed by owners, estimate of ideal weight by owner, breed standard and weight with ~ one year, definition of over- or underweight 10% deviation) on 586 adult dogs with and without chronic diseases were evaluated. ME of the food was estimated according to NRC (2006).

Results
The mean ME intake of all dogs was 0.41±0.12 MJ/kg body weight (BW)0.75. Obesity decreased ME intake per kg metabolic BW to 0.34±0.11 MJ (n=21). Underweight dogs had a higher ME intake (0.49±0.16 MJ ME/kg BW0.75). There was no effect of disease or size. Dogs < 8 years ate 0.42±0.12 MJ/kg BW0.75 whereas older dogs ate 0.39±0.11 MJ/kg BW0.75. Intact males were above average ME intake. Breeds with above average energy intake included Jack Russells, many hunting dogs and Boxers, breeds with below average intake included Dachshunds, several terriers and Golden Retrievers.

Discussion
The mean maintenance energy requirements of pet dogs are similar to that of kennel dogs who do not exercise very much. Presumably opportunity and stimulus to exercise are lower for pet dogs than for kennel dogs. Low physical activity of pet dogs may level out part of effects described in kennel dogs.

Conclusion
Feeding guidelines on pet food should reflect the ME intake of pet dogs.
P52) RENAL ENERGY EXCRETION IN HORSES DEPENDS ON RENAL HIPPURIC ACID AND NITROGEN EXCRETION

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1LMU München, Oberschleißheim, Bayern, Germany; 2University of Bonn

Introduction
Phenolic acids from forage cell walls are metabolized to hippuric acid and excreted via urine. This causes high renal energy losses in horses. We investigated the relationship between N, hippuric acid and energy excretion in equine urine.

Materials and methods
Four adult ponies (250-390kg body weight) were fed eight different diets (predominantly fresh grass, alfalfa hay, grass silage, straw, extruded straw, grass cobs, soybean meal in two doses). Urine was collected quantitatively (non-invasive), and analysed for energy (bomb calorimetry), N (Kjeldahl-method), urea (enzymatically) and hippuric acid (HPLC).

Results
Renal energy excretion increased with increasing renal N excretion and with increasing renal hippuric acid excretion. The ratio of hippuric acid to N and of energy excretion to N decreased with increasing N excretion (table).

Table: Renal excretion of hippuric acid, N and energy

<table>
<thead>
<tr>
<th>Diet</th>
<th>Hippuric acid mg/kg BW0.75</th>
<th>N g/kg BW0.75</th>
<th>Energy kJ/kg BW0.75 (kcal)</th>
<th>Energy kJ/g N (kcal)</th>
<th>Hippuric acid mg/g N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fresh grass</td>
<td>558±78a</td>
<td>1.2±0.1a</td>
<td>60±6 (14±1)ac</td>
<td>48±2 (11±0)a</td>
<td>448±49a</td>
</tr>
<tr>
<td>Grass cobs</td>
<td>313±86b</td>
<td>0.5±0.1b</td>
<td>41±9 (10±2)b</td>
<td>80±9 (19±2)b</td>
<td>620±146b</td>
</tr>
<tr>
<td>Grass silage</td>
<td>268±65bc</td>
<td>0.8±0.0c</td>
<td>54±2 (13±0)a</td>
<td>66±2 (16±0)c</td>
<td>333±82a</td>
</tr>
<tr>
<td>Soy1</td>
<td>265±21bc</td>
<td>1.6±0.1d</td>
<td>65±4 (16±1)c</td>
<td>41±1 (10±0)a</td>
<td>166±9c</td>
</tr>
<tr>
<td>Alfalfa hay</td>
<td>206±12cd</td>
<td>1.2±0.1a</td>
<td>55±10 (13±2)ac</td>
<td>47±6 (11±1)a</td>
<td>175±14c</td>
</tr>
<tr>
<td>Extruded straw</td>
<td>178±51d</td>
<td>0.4±0.0e</td>
<td>27±2 (6±0)d</td>
<td>65±3 (16±1)c</td>
<td>428±101a</td>
</tr>
<tr>
<td>Straw</td>
<td>167±48d</td>
<td>0.3±0.1c</td>
<td>21±3 (5±1)d</td>
<td>84±10 (20±2)b</td>
<td>649±171b</td>
</tr>
<tr>
<td>Soy2</td>
<td>133±29d</td>
<td>1.9±0.1f</td>
<td>76±0 (18±0)e</td>
<td>39±1 (9±0)d</td>
<td>69±17c</td>
</tr>
</tbody>
</table>

Means not sharing a superscript letter are significantly different (ANOVA, Holm-Sidak-test, p<0.05)

Discussion and conclusions
Grass and feed stuff made of grass appear to increase hippuric acid excretion, and thus increase renal energy excretion. The ratio of energy/N in the urine depends on hippuric acid and nitrogen excretion.

References
P53) BASAL ACID-BASE AND MINERAL STATUS OF EXERCISED HORSES FED DIFFERENT DOSES OF SODIUM CHLORIDE

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Introduction
Previously it has been demonstrated that providing additional NaCl to horses in moderate work, according to current recommendations, can induce immediate postprandial acidosis. The aim of the current study was to clarify whether this NaCl induced acidosis i) persists beyond the immediate postprandial period, and ii) is still present after a two week adaptation period.

Material and methods
Six adult warmblood mares in moderate work received 1.00kg hay and 0.64kg concentrates/100kg bwt.d. Using a 3x3 Latin Square, either 0 (NaCl-0), 50 (NaCl-50) or 100 (NaCl-100) g NaCl/d were fed together with the concentrates in two equal doses (07.30, 16.30h), over three weeks. Mineral digestibility was determined in the last week of each period. Morning (7.00am) urine and venous blood samples were collected on days 0, 1-4, 8, and 15, and analysed for pH, acid-base status, creatinine and electrolyte concentrations. Fractional electrolyte clearances (FC) were determined.

Results
Mean digestibility of sodium ranged between 60-62% whereas chloride digestibility was consistently above 94%. Supplemental NaCl decreased urine density and potassium concentration, but increased urine sodium concentration and FC of sodium and chloride ($P<0.05$). 100g but not 50g of NaCl decreased blood pH (0:7.414, 50:7.412, 100:7.406), base excess, urine pH (0:7.42, 50:7.46 100:7.12) and urine acid excretion ($P<0.01$). Interestingly 50 g but not 100g increased ionisation of blood calcium suggesting calcium mobilization for buffering. This was accompanied by a numerically increased FC of calcium. The NaCl effects persisted throughout the trial.

Discussion and conclusions
The addition of 100g NaCl to horses in moderate work resulted in acidosis, whereas feeding 50g resulted in compensated acidosis. Renal excretion of both electrolytes was increased with both doses suggesting that the supplemented NaCl is not primarily used to replace electrolyte losses by sweat.
**P54) METABOLIZABLE ENERGY INTAKE OF ADULT PET CATS**

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**Introduction**
The aim of the present study was to check whether there is a systematic difference between energy requirements of pet and laboratory cats. Therefore we evaluated data on metabolizable energy (ME) intake of pet cats whose owners reported their cat’s diet for a check on nutritional adequacy.

**Materials and methods**
Data on 80 adult cats (majority neutered) were evaluated. A standardized questionnaire was used; the cat owners weighed food and cat. Body weight (BW) of the cats was compared to data from Kienzle and Moik¹ (2011) on ideal BW of cats. Over- or underweight were defined as ≥15% deviation from ideal weight. ME of the food was estimated according to NRC (2006).

**Results**
Twenty-six percent of the pet cats were normal weight, 64% overweight and 10% underweight. The mean ME intake of all adult cats amounted to 0.35±0.13 MJ/kg actual BW⁰.⁶⁷ (n=80). When the data were evaluated according to normal, overweight and underweight there was a significant effect with normal weight cats eating 0.47 MJ/kg BW⁰.⁶⁷ (n=21), underweight cats eating 0.49±0.18 MJ/kg BW⁰.⁶⁷ (n=8) and overweight cats eating 0.36±0.12 MJ/kg BW⁰.⁶⁷ (n=51). Based on BW⁰.⁴ overweight cats ate 0.58 MJ. The majority of owners of overweight cats did not perceive their cats as overweight.

**Discussion**
Our results suggest that there is little difference between current recommendations (NRC 2006) and ME intake of pet cats, as long as deviations from ideal BW are strictly assessed by comparing BW to recent standards. Categorizing moderately overweight animals as normal may lead to errors in assessing ME requirements.

**Conclusion**
Feeding recommendations need to take into account the incidence of overweight in cat populations, the lack of perception of this condition in cat owners, and the effect of overweight on ME requirements on a metabolic BW basis.

**Reference**
¹Kienzle, Moik (2011) *British Journal of Nutrition* 106, S113-S115
P55) WHY DO SMALL ANIMAL VETS RARELY INCLUDE NUTRITION CONSULTATION IN THEIR WORK?
Kienzle, E.1, Wechsung, S.2, Dobenecker, B.1, Hoff, T.3, Bergler, R.2
1LMU München, Oberschleißheim, Bayern, Germany; 2Psychologisches Institut der Universität Bonn; 3Katholische Fachhochschule NRW. Abtlg. Köln

Introduction
We investigated the perception of nutrition consultation in small animal practices by veterinarians.

Materials and methods
A standardized questionnaire based on a pilot study with 15 vets was answered by 214 vets. Besides descriptive statistics a cluster analysis was carried out to identify different approaches of veterinarians to nutrition consultation.

Results and discussion
Ninety percent of veterinarians believe that questions by owners on nutrition are increasing. More than 50% estimate the percentage of nutrition associated diseases in their practice to be above 20%, the majority related to obesity. Vets estimate that only 30% of owners are compliant to feeding recommendations. More than 80% of vets believe that owners do not tell the truth about feeding. Interestingly the percentage of vets who think that their clients lie about other problems such as their financial or family situation is below 60%. About one-half of the vets admit to not feeling very competent in nutrition. Less than 50% charge for nutrition consultation, they would rather give a quick free feeding tip than a thorough consultation for a fee. Continuing education in nutrition has low priority: 82% of vets never or rarely took part in a specialized training.

We identified five types of vets by cluster analysis:

- **Type “nutrition referrer”** (7%): Little interest in nutrition, refers to specialists
- **Type “pet food referrer”** (28%): Little interest in nutrition, works with representatives of the pet food industry
- **Type “quick tips”** (23%): Moderate interest in nutrition, perceives himself as competent, little relevant continuing education, gives quick tips in standard situations (puppies, nutrition associated diseases)
- **Type “budding nutritionist”** (28%): Strong interest in nutrition, practices some nutrition consultation, wants to improve knowledge in nutrition and communicative skills
- **Type “nutrition ignorant”** (13%): Little interest in nutrition, perceives himself as competent, lack of relevant continuing education, nutrition is discussed exclusively in context with nutrition associated diseases, no consideration of preventive nutrition, ignorance of the owner's role.

Conclusion
The “budding nutritionists” are the most promising target group for detailed continuing education in nutrition.
P56) LITERATURE META-ANALYSIS SUGGESTS NEW PROTEIN EVALUATION SYSTEM FOR HORSE FEED
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Introduction
In horses, amino acids (AA) can only be absorbed from the small intestine. Thus, praecaecal digestible (pcd), crude protein (CP) and AA should be the basis of protein evaluation of horse feed. However, only little data from horse studies are available. Nevertheless it is unlikely that protein bound in cell walls can be digested in the small intestine. The ‘Cornell Net Carbohydrate and Protein System’ for cattle, makes an analytical distinction into neutral detergent insoluble CP (NDICP) and the remaining neutral detergent soluble CP (NDSCP=CP-NDICP). The aim was to investigate whether a concept of protein evaluation on the basis of soluble and insoluble protein is applicable to horse feed.

Materials and methods
Available literature (see German recommendations for requirement standards for horses 2013, in preparation) was monitored for i) pcdCP and pcdAA from digestibility trials with horses, ii) contents of NDSCP and NDICP in feedstuffs of interest, and iii) the distribution of individual AA onto either NDSCP or NDICP.

Results
Evaluable data on pcdCP were available for meadow grass, hay (grass, alfalfa), cereal grains (oats, barley, corn) and mixed rations with concentrate-forage-ratios of 1:0, 3:2 and 1:4. NDICP was positively correlated with the experimentally determined praecaecal undigested protein in the feed (R=0.719, P<0.001). The strong linear dependency of pcdCP from NDSCP intake (R=0.832, P<0.003) revealed a praecaecal digestibility of NDSCP of 90% (b=0.898). Furthermore, literature indicates a fairly equal distribution of AA onto NDSCP and NDICP. Thus, pcdCP and pcdAA in horse feed can be estimated as follows: pcdCP=0.9*NDSCP and pcdAA=0.9*AANDSCP, where AANDSCP represents AA in the NDSCP fraction.

Discussion and conclusions
Results indicate that the analytical fraction NDICP can be used indirectly to estimate the part of CP that is available for auto-enzymatic digestion. Because of the equal distribution of AA profiles in NDSCP and NDICP the proposed concept can even be used on AA basis.
P57) DEVELOPMENT AND VALIDATION OF A FELINE FECAL CONSISTENCY SCALE

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Introduction
Scales based on owners’ visual perception of a condition and the language they use to describe clinical signs are important for successful outcomes for studies relying on owner assessments. We have undertaken development and validation of an owner-based fecal scoring scale for utilization in clinical studies with diarrheic cats.

Materials and methods
Initially, interviews were conducted with owners whose cats had recently experienced diarrhea. They were shown a series of five photographs of feline fecal matter obtained from the Iams Pet Care Health and Nutrition Center to place in order of “most” to “least” like diarrhea. Owners were also asked to identify “in litter photos” corresponding to photos without litter and for descriptors for each photo set. Based on the interviews, a draft scale (5-point scale, 1=most like diarrhea and 5=least like diarrhea) was developed. A second round of cognitive debriefing interviews was conducted to demonstrate face and content validity and the owner’s ability to classify 5-7 random photos of fecal matter.

Results
Participants agreed that the photographs accurately and adequately represented the spectrum of fecal consistencies they had observed with their cats. The language used to describe the photos and the participants’ placement of the photos in order of fecal consistency was highly reproducible ($P<0.0001$). Participants stated that having photos “in litter” and “without litter” as well as descriptors was optimal for classifying samples. A series of five photo pairs optimally described the range of consistencies. Second round participants had no difficulty using the scale to classify additional photos of fecal samples and concurred with the descriptors, order, and range of photos.

Discussion and conclusions
The new fecal scale was developed with owners similar to those who would be making the assessment of stool consistency in clinical studies, and demonstrated good face and content validity and qualitative discriminability.
P58) EFFECTS OF SODIUM-RESTRICTED DIET ON CARDIOVASCULAR PARAMETERS OF DOGS WITH MYXOMATOUS MITRAL VALVE DISEASE

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Introduction
Low-sodium diets for dogs with cardiac diseases can be associated to pharmacologic therapy. However, no consensus exists about the real benefits and the desirable level of sodium restriction. This study evaluated the effects of a low-sodium diet on electrolytes, neurohormonal and cardiovascular parameters of dogs with hemodynamically significant valvular regurgitation.

Materials and methods
Fourteen dogs with myxomatous mitral valve disease on stages functional class II or Ib (International Small Animal Cardiac Hearth Council) were randomly assigned to two groups: restricted sodium (RNa; n=5), fed a kibble diet with 29mgNa/100kcal of metabolizable energy; control (n=9), remained on the original diet (commercial kibble diets; 75 to 207mgNa/100kcal). Pharmacologic therapy for dogs on Ib stage was enalapril maleate and for dogs on II stage enalapril maleate and furosemide. Serum electrolytes and echocardiographic parameters were monitored at start and after 60 days. Aldosterone and plasmatic renin activity were evaluated only for RNa group. Mixed linear regression was performed to compare groups ($P<0.05$).

Results
Potassium (in both groups) and aldosterone and renin activity in RNa group did not change, but serum Na increased (although within normal range) for both groups ($P<0.05$). All dogs presented a reduction in the mitral valve regurgitation (mmHg and m/s; $P<0.05$), but for RNa a greater reduction was verified ($P<0.05$). An increase in the size of the left atrium was observed in both groups ($P<0.05$). There were no significant changes on left ventricular dimensions, although a difference on left atrium/aorta ratio was verified, with higher values for RNa ($P<0.05$).

Discussion and conclusions
No apparent activation of neurohormonal compensatory mechanisms or adverse effects of sodium restriction was observed. Although there were changes on mitral regurgitation, left ventricular dimensions did not reduce significantly and it was not possible to conclude if sodium-restricted diet promotes additional benefits over the medical therapy.
P59) EFFECT OF DIET ON BLOOD GLUCOSE AND LACTATE IN EXERCISING SLED DOGS

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Introduction
Feeding dogs performing hard physical work, like sled dogs, can be challenging in order to obtain optimal health and performance. The aim of the present study was to investigate if there was any effect on blood glucose and lactate in exercising dogs when fed two different diets.

Materials and methods
Eight Alaskan huskies were divided into two groups and fed the two diets in a crossover experiment. The protein:fat:carbohydrate ratio was 24:60:16% of metabolisable energy (ME) in diet A, and 22:77:1% of ME in diet B, and each diet was fed for three weeks. The dogs were exercised, running 12km per day, four days per week during the whole experimental period. Blood samples were collected for glucose and lactate analysis before (0km), at 6km and after the exercise session (12km) in the third week of both periods. Data were statistically analysed using the mixed procedure in SAS, with diet, distance, period and their interactions as fixed effects and dog as random effect.

Results, discussion and conclusion
There were no effects on blood glucose. Blood lactate increased with exercise in both periods. However, higher concentrations were measured in the first period compared to the second, and there was an effect ($P<0.05$) of the interaction diet distance period. It is likely that the dogs may have come into better shape in the second period explaining the lower lactate concentrations. Additional contributing factors as changed weather conditions (i.e. decreased temperature and snow) from period one to period two might have influenced the results. In conclusion, feeding a diet based on only protein and fat or a diet also containing carbohydrates did not show any clear effects on blood glucose and lactate in exercising dogs.
P60) ENERGY REQUIREMENTS FOR RACING ENDURANCE SLED DOGS
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Introduction
Endurance sled dogs have unique dietary energy requirements. Currently, there is a disparity in the literature regarding energy expenditure with calculated energy requirements of these dogs, which we sought to clarify.

Materials and methods
Three sled dog teams (total of 28 dogs) completing the 2011 Yukon Quest volunteered to provide diet history. Nutritional content of a mock meal and all snacks used on the trail were analyzed (protein, fat, NFE) for each team. Average kilocalorie consumption of metabolizable energy per team based on Atwater equation was divided by the average number of dogs in the team during both the first and second half of the race. Dogs were weighed at the start of the race Whitehorse Yukon (WH), a mid-way checkpoint in Dawson (DS) and at the finish in Fairbanks (FB). Linear regression compared average weight loss to estimated average kcal/dog/team consumed daily.

Results
Terrain was less rigorous and ambient temperature ranged from -23°C to -12°C for leg one, while mountainous terrain and lower temperatures (-40°C to -25°C) characterized leg two. During the first half of the race (average BW=23.6kg), Team 1 gained weight (average=1.95kg/dog), while the other two teams experienced weight loss (Team 2=0.81kg/dog, Team 3=0.09kg/dog). Linear regression revealed 8,800kcals/day were required for weight maintenance (r²=0.82). During leg two (average BW=22.7kg), weights decreased for all three teams (average per dog; Team 1=0.4kg, Team 2=2.1kg, Team 3=1.0kg). The extrapolated kcal requirement was approximately 13,400kcals/day (r²=0.95). Metabolizable energy from substrates ranged from 47-51% fat; 33-38% protein and 15-17% carbohydrate for all three teams.

Discussion and conclusions
Our data suggest that endurance sled dogs have an exercising energy requirement similar to that described by Hinchliff and colleagues. Energy requirements appear to vary substantially due to terrain and ambient temperature, and overall metabolizable energy from fat is less than expected.
Introduction
Hair ingested by licking during cat grooming can eventually coalesce into solid masses in cat stomach or intestines. It is believed that dietary fiber influences on formation of these trichobezoars. We evaluated the effect of two insoluble fiber sources on kibble diet on trichobezoars fecal excretion in cats.

Materials and methods
Thirty-two cats and four diets were used: control (CO), without fiber addition; inclusion of 10% sugarcane fiber (SF10) on CO diet; 20% sugarcane fiber (SF20) and 10% purified cellulose (CEL10). Animals were fed for 42 days and into three study periods (days 15-17, 25-27 and 40-42) they were housed in individual cages for total feces collection. The fecal pool of each period was put under a sieve (0.6mm) and exposed to running water until all fecal material were liquefied and had passed through the sieve, being retained only the trichobezoars. These were dried (55°C), washed with ether and classified into small (<1cm), medium (from 1 to 2cm) and large (>2cm). Means were evaluated by repeated measures ANOVA and polynomial contrasts (P<0.05).

Results
Cats fed sugarcane fiber presented a linear reduction on small and medium trichobezoar excretion (number/cat/day; P=0.004) and on trichobezoar mass excretion (mg/g of fecal dry matter; P=0.008). Although CO group showed increased excretion of large trichobezoars (P=0.003), SF20 reduced it from 0.35 (number/cat/day) to zero (P=0.006).

Discussion and conclusions
Although not measured, it was observed that cats supplemented with sugarcane fiber exhibited a higher excretion of hair of untangled shape in the stool. There was no effect of cellulose on any evaluated trait. Differences on fiber size (sugarcane-190µm and cellulose-110µm) may have been responsible for this effect, whereas long fibers appear to cause greater peristaltic stimulation changing the dynamic of swallowed hair propulsion. In conclusion, sugarcane fiber reduced the trichobezoar formation in cats, which may have clinical applications in cats predisposed to obstruction by trichobezoars.
P62) SOLUBLE AND INSOLUBLE FIBER AND PROTEIN LEVEL ON SATIETY AND HORMONAL RESPONSES IN CATS
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Introduction
Dietary fiber and protein can interfere on satiety modifying hormonal responses and food intake through central and neuroendocrine mechanisms. The effects of soluble and insoluble fiber in diets with high and low protein on postprandial blood glucose, insulin and serum levels of glucagon like peptide 1 (GLP-1) and ghrelin were evaluated in cats.

Materials and methods
Forty cats and five kibble diets were used: control, with low dietary fiber (8%) and low protein (30%; LFLP); high soluble fiber (8% soluble [carboximethylcellulose]; 12% insoluble [sugarcane fiber]) and high protein (38%; HSFHP); high soluble fiber and low protein (HSFLP); high insoluble fiber (3% soluble; 17% insoluble) and high protein (HIFHP) and high insoluble fiber and low protein (HIFLP). Animals were fed ad libitum for 34 days and daily food intake, ingestion pattern and blood glucose, insulin, GLP-1 and ghrelin postprandial responses were evaluated (34th day) during 12hr. Means were evaluated by repeated measures ANOVA and contrasts ($P<0.05$).

Results
The ingestion pattern (g/kg/hr) and DM intake (mean of 14.7g/kg/d) did not differ between diets, but energy intake was limited by fiber (91 x 67kcal/kg0.67/d; $P=0.03$). Post-prandial maximum glucose and glucose increment concentrations were lower for diets with high fiber comparing to the control, and inside insoluble fiber lower for high protein ($P<0.05$). The GLP-1 basal levels did not differ among treatments, but the high fiber diets induced a rise in average and maximum levels and GLP-1 area under the curve ($P<0.02$). No clear effect of food intake on postprandial ghrelin was verified, although the consumption of fiber supplemented diets resulted in lower maximum values of this hormone ($P<0.05$).

Discussion and conclusions
The inclusion of fiber reduced glucose maximum concentration. The GLP-1 plasma concentration can be modulated by the inclusion of fiber in the food, especially by soluble fiber. However, no clear changes in the animals feeding pattern was verified.
Introduction
Copper associated chronic hepatitis is a disease found in several dog breeds with an estimated heritability between 40% and 80%. This study was intended to identify causative mutations linked to copper disease in Labrador Retrievers.

Materials and methods
A genome wide association study was carried out between Labradors with high and low levels of hepatic copper; by using a mapping technique correcting for population structure several linked regions were identified. Candidate genes in the regions were then sequenced, identifying a coding mutation in the ATP7A gene. The mutation’s effect was investigated by measuring the uptake and efflux of radioactive copper assay in dermal fibroblasts of different genotypes. The effect was further investigated by visually tracking the movement of ATP7A within the cell with the use of immunocytochemistry.

Results
A mutation was identified in the ATP7A gene (T328I). The low-copper mutant allele is common; it was found to exist in 41 dog breeds at up to 80% allele frequency. The mutation is situated at a phosphorylation site with very high conservation across mammalian species. The radioactive copper assay identified a clear difference in copper trafficking in the mutant cells. Visual tracking ATP7A further confirmed the effect of the mutation in increasing cellular copper accumulation.

Discussion and conclusions
The accumulation of copper in the intestinal cells could result in a reduction in the whole-body copper accumulation in the dog producing some level of protection from the disease as observed on the macro level. The mutant allele’s frequency across breeds suggests it is not a recent mutation. Copper is important in female reproduction. We hypothesize that evolutionary pressure on early dogs lead to an increase in copper accumulation. The identified ATP7A mutation appears provide a level of immunity from CACH in males where the copper accumulation may have less utility.
P64) GENOTYPING BY WHOLE GENOME SEQUENCING FOR USE IN CANINE MAPPING STUDIES

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Introduction
Whole genome sequencing was compared to genotyping by SNP array to measure genotype quality and efficacy of both methods in capturing the genomic variation in a set of samples.

Materials and methods
To investigate the increased utility of whole genome sequence data in 89 samples from the Yorkshire Terrier breed as well as seven from four other breeds were sequenced at target coverage of 13X. SNPs were identified and genotyped from the sequencing data. To assess the quality of genotype cells genotypes were compared against reference genotypes measured by Illumina GoldenGate. SNPs that are part of the CanineHD 170K SNP genotyping panels were then compared to the genotyping from the whole genome sequencing.

Results
More than nine million putative SNPs were identified and genotyped. Average concordance was measured at 93% (homozygotes, 95%; heterozygotes, 86%). Analysis of the genomic variation estimates that the current 170k SNP array captures 90% of the variation of a target mutation 30% of the time, and 70% of the variation 50% of the time. Utilizing a more complex linear modeling approach allowed 90% of the variation to be captured 77% of the time. To match the efficacy of the current best-in-class 170K SNP array, around 100,000 random SNPs from whole genome sequencing were required.

Discussion and conclusions
The results indicate that whole genome sequencing captures a larger portion of the genomic variation than SNP arrays. It also benefits from capturing coding variation. Typically we would target around 30X coverage for genotyping on a diploid organism. This lower level of coverage meant that genotype calls were less accurate. This could be solved with more sequencing as technologies get cheaper. The increased informativeness of random SNPs in capturing the genomic variation indicates that emerging sequencing methods such as RAD sequencing may have applications in canine genetics.
P65) EFFECT OF SIMULTANEOUS OMEGA 3 PUFA AND CURCUMIN SUPPLEMENTATION ON INSULIN SENSITIVITY AND PLASMA LIPIDS IN OBESE DOGS

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Introduction
Omega-3 polyunsaturated fatty acids (w3-PUFA) may prevent dyslipidemia associated with dietary-induced obesity in dogs as well as humans. In most studies, w3-PUFA were protected by antioxidants. However, some studies have suggested that the beneficial effects of w3-PUFA would be abolished by antioxidants. Our objective was to investigate whether an addition of the antioxidant curcumin altered the effects of w3-PUFA supplementation on insulin sensitivity ([IS]) and plasma lipids in obese dogs.

Materials and methods
Adult obese beagles (n=8, BW=17.6±3.3kg, BCS=7.6/9±1.1) were fed with a high fat diet. Study 1 consisted of a 6-wk w3-PUFA supplementation period, then a 6-wk w3-PUFA+curcumin supplementation period, and study 2, a single 12-wk w3-PUFA supplementation period. BW, body composition, IS, plasma lipid concentration ([TG], [NEFA]) were assessed at T0 and at the end of each period.

Results
BW and body composition were unchanged whatever the supplementation. In study one, basal insulinemia was similar to T0 at the end of w3-PUFA supplementation period, lower at the end of w3-PUFA+curcumin supplementation period (23.38±2.32 vs. 25.98±3.45µU/mL, P>0.05 and 13.68±1.96, P<0.05 in both cases) and IS was higher than T0 at the end of w3-PUFA supplementation period (0.1±0.02 vs. 0.08±0.02, P<0.05). In study two, basal insulinemia and IS were lower compared to T0 (19.22±1.88 vs. 23.26±1.73µU/mL and 0.06±0.01 vs. 0.07±0.02, P<0.05). In study one, TG concentration was similar to T0 at the end of w3-PUFA supplementation period (0.73±0.13 vs 0.66±0.12mmol/L, P>0.05) and lower at the end of w3-PUFA+curcumin supplementation period (0.59±0.09mmol/L, P<0.05 in both cases). In study one, NEFA concentration was lower than T0 at the end of w3-PUFA supplementation period (1.17±0.1mmol/L vs 0.9±0.1mmol/L, P<0.05) and this effect was reversed at the end of w3-PUFA+curcumin supplementation period (0.99±0.08mmol/L, P<0.05). In study two, NEFA concentration was lower compared to T0 (0.99±0.09mmol/L vs. 0.71±0.07mmol/L, P<0.05).

Discussion and conclusions
These preliminary data indicate that supplementation with antioxidant curcumin could modify the w3-PUFA effects in different ways.
**P66) ASSOCIATION OF SIGNALMENT PARAMETERS WITH ACTIVITY OF PET DOGS**

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**Introduction**  
Activity monitors are increasingly being used to quantify the activity of pet dogs. The aim of this study was to investigate associations between signalment and activity of free-living pet dogs.

**Materials and methods**  
Healthy pet dogs were recruited to wear an Actical™ activity monitor on their collars continuously for two weeks in their home environment. At least 15 dogs were enrolled in each of the following weight ranges: <10kg, 10-20kg, 21-30kg, 31-40kg, >40kg and their age, gender and neuter status recorded. Each dog's intensity of activity for each minute of recording was classified using the total counts for that minute and our pre-established cut-points. The percentage of time dogs spent in sedentary, light, or moderate/vigorous activity each day was calculated. Median total daily activity counts and median percentages of time dogs spent in activities of differing intensity were used for the analysis. Associations between signalment characteristics and activity parameters were evaluated with the Mann-Whitney test, the Kruskal-Wallis test, and Spearman rank correlations.

**Results**  
Ninety-eight dogs were included in the analysis with at least 17 dogs in each weight category. Time that dogs were sedentary was positively correlated with age ($r=0.5003, P<0.0001$) while the median total daily activity count ($r=-0.4705, P<0.0001$), time spent in light ($r=-0.4587, P<0.0001$) and more vigorous activity ($r=-0.4951, P<0.0001$) were negatively associated with age. No other significant associations between signalment and activity parameters were found.

**Discussion and conclusions**  
The association of age with median total daily activity counts and time spent in activities of differing intensity were consistent with a previous finding of association between age and counts delivered by this activity monitor. The lack of differences in activity across weight categories may reflect the impact of lifestyle negating any potential behavioral differences across breeds.
P67) KINETICS OF SYSTEMIC AND INTESTINAL IMMUNITY IN PUPPIES AFTER NATURAL INFECTION BY CANINE PARVOVIRUS TYPE 2

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**Introduction**

In dogs, resistance to canine parvovirus type 2 (CPV-2) relies more on local immunity than on systemic one. Animals with high level of fecal CPV-2 antibodies have a favorable prognosis. The objective of this study was to evaluate the relationship between the systemic and local immune responses in puppies naturally infected by CPV-2.

**Material and methods**

Twenty-five puppies from one kennel experiencing CPV-2 circulation were followed between five and nine weeks of age. Blood, feces and rectal swabs were collected once per week from each puppy. Level of CPV-2 specific antibodies was measured on sera (haemagglutination inhibition test-HI) and feces (ELISA test). Seroconversion was defined by an increase in HI titer of at least four-fold. Detection of CPV-2 was performed on rectal swabs (qRT-PCR) and the animal was considered infected when more than 102 DNA copies/1mg feces were excreted. Data were analyzed with Kruskal Wallis and Mann-Whitney test (Tanagra software).

**Results**

All puppies (25/25) went through CPV-2 infection, excreting between 1.9x10³ and 1.3x10¹⁰ DNA copies (median: 9.3x10⁶). 84% (21/25) of puppies seroconverted during the week following infection diagnosis (ID) and all puppies (25/25) were seropositive at two weeks post ID. Fecal antibodies were detectable one week before ID (optical density range: 0-0.109). Their concentration, non-different one week before and one week after ID (respective medians: 0 and 0; \(P=0.577\)), increased significantly at two weeks (median: 0.101; \(P=0.006\)) and remained unchanged at three weeks (median: 0.139; \(P=0.526\)) after ID. None of the puppies died during the experiment.

**Discussion and conclusions**

This work has demonstrated the presence of fecal CPV antibodies before seroconversion and virus excretion. A delay in local immune response to CPV-2 infection has been demonstrated comparing with systemic reaction. Development of specific immunity and resistance to CPV-2 in puppies remain to be explored.
P68) PROTECTION AGAINST CANINE PARVOVIRUS TYPE 2 IN PUPPIES DEPENDING ON MATERNALLY DERIVED ANTIBODY TITERS

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Introduction
The prevalence of canine parvovirus type 2 (CPV2) in diarrheic puppies ranges between 50 and 70%. Canine neonates acquire CPV2-specific maternally derived antibodies (MDA) after birth through colostrum. Subsequently, MDA decrease to non-protective levels around 5-8 weeks of age. A higher risk of CPV2 infection is considered at antibody titer below 1:80 (Pollock and Carmichael, 1982). Variation in CPV2 specific MDA transfer and its impact on the protection against CPV2 infection has never been studied in puppies in non-experimental conditions. The aim of this study was to evaluate the kinetics of CPV2 MDA in puppies from birth till weaning.

Materials and methods
Blood was collected once per week from two until 56 days of age on 79 puppies from one multi-racial breeding kennel. CPV2 antibody titers were evaluated on sera by haemagglutination inhibition test (HI). Titers below 1:80 were considered as non-protective. Data were analyzed with Chi square and Kruskal-Wallis test (Epi Info software).

Results
Depending on CPV2 antibody titers at Day Two, puppies were classified into three groups: A (HI <1:80; n=13); B (HI 1:80-160; n=21); C (HI >1:160; n=45). Group A never presented protective MDA titer during the study. Each week, between seven and 35 days of age proportion of puppies with HI titer ≥1:80 was higher in group C than in group B (100%; 93%; 77%; 57%; 23% vs. 68%; 28%; 0%; 0%; 0%; P=0.001; P=0.001; P=0.001; P=0.03, respectively). Group C remained under non-protective antibody titer during significantly shorter period than group A (P=0.037) and B (P=0.006).

Discussion and conclusions
The level of specific CPV2 antibodies at birth differed within puppies, with 18% of neonates below the minimal protective level. Puppies with high level of CPV2 MDA at birth remained longer under protection against CPV2 infection. Attention has to be paid to the correct colostrum intake for a long-lasting passive immune protection in order to reduce the non-protective period in CPV2 infection.
P69) LOW FOOD BASE EXCESS AND URINE OVER ACIDIFICATION INCREASE URINARY SUPERSATURATION FOR CALCIUM OXALATE DUE TO REDUCED CITRATE AND INCREASED OXALATE EXCRETION BY CATS

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Introduction
Cats fed excessively acidified diets may have increased urinary relative supersaturation for calcium oxalate (RSSCaOx), effect attributed to an increased urinary Ca excretion. The effects of diet mineral manipulation based on food base excess (BE) calculation on acid-base balance, bone metabolism, and urinary RSSCaOx was studied.

Materials and methods
In a basal formulation for cat maintenance (BE = 196mEq/kg; common level for non acidified commercial diets) two dosages of a commercial mixture of anionic salts was added, resulting in diets with BE of 9 and -187mEq/kg. Eighteen cats were used, with three diets and six cats per diet. The acid-base status was studied by venous blood gas analysis, bone metabolism by body composition (dual-energy X-ray absorptiometry [DEXA]) and the serum markers carboxy terminal telopeptide type 1 (CTX-1) and bone alkaline phosphatase (BAP). Urine was totally collected during 5-d and analyzed for pH, Ca, citrate, oxalate and RSSCaOx (Equil-93 software). Means were compared by polynomial contrasts ($P<0.05$).

Results and discussion
A linear reduction on urine pH (from 7.31 to 5.85) and blood pH, base excess, and bicarbonate, with a linear increase on serum chlorine was verified ($P<0.05$). The diet with lowest BE (-187mEq/kg) induced metabolic acidosis and hyperchloremia. No changes on bone mineral content or bone mineral density were verified ($P>0.05$). No time effect was verified for BAP, but CTX-1 reduced from the start to the end of the study for cats fed the diet with higher BE ($P<0.05$), indicating a reduction on bone reabsorption. Urinary Ca (mg/dL) did not change (although urinary Ca excretion [mg/kg/d] reduced for higher BE food), but oxalate and RSSCaOx showed a linear increase, and citrate a linear decrease with the reduction of food BE ($P<0.01$).

Conclusions
Very low food BE promotes chronic metabolic acidosis and hyperchloremia, increasing urinary RSSCaOx by mechanisms other than increased calcium urinary excretion.
P70) CLINICAL EFFICACY OF A HIGHLY HYDROLYZED POULTRY FEATHER PROTEIN-BASED DIET FOR CANINE AFR DIAGNOSIS AND DIETARY MANAGEMENT: A 12 CASE PILOT STUDY
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Introduction
Diets formulated with protein hydrolysates are widely available for canine adverse food reactions (AFR) management. The aim of this study was to assess the efficacy of a diet formulated with a highly-hydrolyzed poultry feather protein for canine AFR diagnosis and clinical management.

Materials and methods
Animals showing dermatological signs compatible with AFR were fed exclusively with the test diet over eight weeks. Then, they all went through a dietary challenge with their former diet. If dogs relapsed, they were returned to the test diet for two more months. The study design integrated four evaluations: day 0, day 56 (±2 days), day 70 (±2 days), day 126. At examination, the severity of the lesions (CADESI-3 score) and pruritus score were recorded by board-certified dermatologists. Initial CADESI score had to be ≥100 and initial pruritus score had to be ≥1. Neither anti-inflammatory nor immune-modulatory treatments were allowed during the trial. Twelve adult dogs with suspected AFR were included in the study. The group included eight males (one castrated) and four spayed females, age mean 5±3 years. Results are expressed as a median and range.

Results
3/12 dogs were excluded for non-compliance. 9/12 dogs completed the trial. CADESI [median (range): day 0, 142 (99-200) and day 56, 78 (36-128); P=0.0177] and pruritus [day 0, 3 (2-4) to day 56, 2 (0-4); P=0.0264 and day 70, 4 (1-4) to day 126, 2 (1-4); P=0.026] scores significantly decreased throughout the trial (Wilcoxon paired test). Six of the 9 dogs (67%) were diagnosed with adverse food reaction. One dog (11%) did not improve when fed the test diet. Two dogs (22%) improved during the test period, but their clinical signs remained mild to moderate.

Discussion and conclusions
The data suggest that a highly hydrolyzed feather based protein diet might be relevant to diagnose and manage canine AFR.
P71) DIETS OR FOOD ITEMS FED TO DOGS AT YOUNG AGE AND THEIR ASSOCIATION WITH CANINE ATOPY/ALLERGY TYPE OF DERMATOLOGICAL DISEASE: EVIDENCE FROM A CASE CONTROL STUDY IN FINLAND

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Introduction
In Finland where we have no fleas, atopy/allergy type of dermatological problems are common. The etiology is unknown but there are several theories, e.g., abnormal immunity due to “too good hygiene”, deranged microbiota, abnormal absorption, or lack of key nutrients in the food. As symptoms often are helped by changing the diet to raw food, we hypothesized that raw food intake at a young age might decrease the incidence of atopy/allergy in dogs.

Materials and methods
The large DOGRISK owner questionnaire was used for data gathering (www.ruokintakysely.fi). It includes questions about the owner’s dog’s descriptives, diseases, environmental factors and nutrition at different life stages. Dogs, where owners reported that their dogs had been diagnosed as suffering from atopy/allergy, were chosen as the case group (n=150) whereas healthy dogs were randomly chosen as a control group (n=300) in a 1:2 ratio. Associations between diseases and 54 food items served at ages 2-6 months as well as at 6-18 months were analyzed using cross-tabulation and Pearson Chi-square test.

Results
The sample was not significantly different from the whole data (n=3475). The diet at 2-6 months of age showed a significant association between the following raw food items and being free from atopy/allergy: raw diets, -offal, -meat, -bone, -cartilage, -tripe, -fish, -egg, -vegetables, -berries and drinking from outdoor puddles (P=<0.001-0.013) whereas dry dog food and skin chewing bones significantly associated with an increase in atopy/allergy (P=0.004-0.033). There were no other significant associations between food items and owner-reported atopy/allergy. Similar associations were found for food items served at 6-18 months. Significantly more males, white coated animals and dogs that had spent less time outside also suffered from the disease.

Discussion and conclusions
This is the first report from this data and now 6,000 more cases have been gathered. More complex analyses should be performed, looking for confounding variables. If the results still stand, clinical studies should be performed to verify these results.
P72) ASSOCIATION BETWEEN RAW EGGS IN PUPPY NUTRITION AND OWNER REPORTED CHRONIC INTESTINAL SYMPTOMS

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Introduction
Avian eggs have been reported to have antimicrobial activities and antioxidant properties, functional lipids and protease inhibitors. Data from the DOGRISK-survey (on the internet since 2009) were used to establish associations between feeding eggs and chronic digestive tract symptoms. Significant associations were found between raw eggs and owner evaluated chronic digestive tract symptoms.

Materials and methods
Owners reported on the dog’s diseases and on what they were feeding and frequency of giving it (1=never to 5=daily). In this study we wanted to know if overall puppyhood (~2-6 months) diets with or without avian eggs increased adult dogs’ chronic digestive tract symptoms. Data were analyzed using the Chi-square test. From altogether 9,375 answers we selected all cases that had information about giving eggs or not (n=6805 in the raw egg group and n=6798 in the cooked egg group) wherefrom n=973 and n=969, respectively, suffered from chronic digestive tract symptoms.

Results
In all dogs, regardless of diet, additional feeding of raw eggs was significantly associated with fewer cases of chronic digestive tract symptoms with p-values of <0.005. Additional feeding of cooked eggs did not associate significantly with the disease. Associations between raw eggs and chronic digestive tract symptoms were also significant (P<0.005) in dogs that did not get any or only little (less than a couple of times per month) dry food, excluding the possible positive effect of dried egg in dry foods.

Discussion and conclusions
Eggs might have great potential as a conveniently packaged “nutriceutical” as they seem to have a sparing-effect on chronic digestive tract disease in dogs. An egg bought for human consumption should pose no salmonella threat to owners. Prospective clinical trials are needed to verify a true cause-effect relationship.
P73) STARCH HAS MORE EFFECT THAN FIBER ON POSTPRANDIAL GLUCOSE RESPONSE OF DOGS

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Introduction
The effect of starch and fiber on postprandial glucose response, and fiber and energy intake on satiety were studied in non-obese dogs.

Materials and methods
Cellulose (CEL), carboximetilcellulose (CMC), pea fiber (PE) and sugarcane fiber (SCF) were combined in six extruded diets (poultry meal; broken rice; maize; poultry fat; starch to 100%) with 32-42% of starch: SCF+CEL and PE+CEL with high insoluble fiber (IF=22%) and low soluble fiber (SF=2.5%); SCF+CMC and PE+CMC with high SF (4.5%; IF=19%); CMC and CEL with low fiber (14%). For glucose response, diets were fed in two amounts: intake of 9.5g or 12.5g of starch/kg0.75/day (6x2 factorial arrangement with six diets and two dosages, totaling 12 treatments). Diets were evaluated in six dogs conditioned to consume all daily food in 10min, after 5-d of adaptation. Plasma glucose was measured before and after 5, 10, 15, 45, 60, 90, 120, 180, 240, 300, 360, 420 and 480min of total food intake. Satiety was evaluated in a 3x2 factorial arrangement (three diets [SCF+CEL; SCF+CMC; CEL] and two amounts of energy [95 and 130kcal/kg0.75/day]) in two repetitions (after 10 and 20 days of adaptation): after 90min of food intake, dogs were exposed during 45min to a challenge commercial food. Results were compared by repeated measures ANOVA and Tukey test (P<0.05).

Results
Fiber did not change glucose postprandial responses (P>0.05). The high dose of starch intake, however, induced higher glycaemia (180 and 240min), greater maximum glycaemia and area under glucose curve (P<0.05). In satiety study dogs fed 95kcal or 130kcal lost and gained weight, respectively. Dogs fed 95kcal intaked higher the challenge diet (P<0.05). Although at the Pearson’s correlations IF (P=0.04) and SF (P=0.002) reduced the intake of the challenge meal, these effects were not evidenced by Tukey test (P>0.05).

Discussion and conclusions
Like in humans, for dogs starch intake is more important than fiber for postprandial glucose response. Under restricted energy intake, fibers do not modulate dog satiety.
P74) EFFECTS OF SOLUBLE FIBER ON THE FECAL MICROBIOME OF HEALTHY ADULT DOGS

Panasevich, M.R.1, Kerr, K.R.1, Dilger, R N.1, Fabey, G.C. Jr.1, Guérin-Deremaux, L.2, Lynch, G.L.3, Dowd, S.E.4, Swanson, K.S.1

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Introduction
Prebiotics are fermentable carbohydrates that elicit an increase in beneficial hindgut bacteria and a decrease in potentially pathogenic hindgut bacteria. NUTRIOSE® FM10 (NU) is a soluble fiber that could be a potential prebiotic source in dog foods. The objective of this study was to evaluate the effect of increasing dietary NU concentrations on the fecal microbiome of healthy adult dogs.

Materials and methods
Fresh fecal samples were collected from 10 female dogs with hound bloodlines (6.36 ± 0.17yr; 22 ± 2.1kg) fed five test diets containing graded levels of NU (0.0, 0.5, 0.75, 1.0, or 1.25% as-is; Roquette Frères, Lestrem, France) in a replicated 5x5 Latin square design. Each dog received a diet for a total of 14 days; 10 days to adapt to the test diet and four days of fecal collection. DNA was extracted followed by amplification of the V4-V6 variable region of the 16S rRNA gene using barcoded primers. Sequences were taxonomically classified using BLASTn against a curated GreenGenes database and compiled into each taxonomic level.

Results
No changes were observed at the phylum level with increasing concentrations of NU. There were, however, significant changes at the bacterial genus and species levels. Within the firmicutes phylum and Lachnospiraceae family, fecal concentrations of Lachnospira increased (P≤0.05) with increasing NU concentrations. At the species level, fecal concentrations of Eubacterium biforme increased linearly (P≤0.05) with increasing levels of NU, while Fusobacterium mortiferum was lower (P≤0.05).

Discussion and conclusions
Overall, NUTRIOSE® FM10 maintained microbial balance throughout the study. Changes in the genus Lachnospira, and the species, Eubacterium biforme and Fusobacterium mortiferum, are thought to be beneficial to the microbiome. Overall, these data suggest some microbiota modulation possibilities with NUTRIOSE® FM10.
P75) EFFECTS OF POTATO PULP ON THE FECAL MICROBIOME OF HEALTHY ADULT DOGS

Panasevich, M.R.¹, Kerr, K.R.¹, Dilger, R.N.¹, Fabey, G.C. Jr.¹, Guérin-Deremaux, L. ², Lynch, G.L.³, Dowd, S.E.⁴, Swanson, K.S.¹

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Introduction
The inclusion of dietary fibers in dog foods has become increasingly popular due to their positive effects on gut health. These positive effects often are a result of changes in the hindgut microbiome. Potato pulp (PP), a co-product of potato starch isolation, has a favorable chemical composition to be a novel fiber source in dog diets. The objective of this study was to evaluate the effect of increasing dietary PP concentrations on the fecal microbiome of healthy adult dogs.

Materials and methods
Fresh fecal samples were collected from 10 female dogs with hound bloodlines (6.13 ±0.17 yr; 22±2.1 kg) fed five test diets containing graded levels of PP (0.0, 1.5, 3.0, 4.5, or 6.0% as-is; Roquette Frères, Lestrem, France) in a replicated 5x5 Latin square design. Each dog received a diet for a total of 14 days; 10 days to adapt to the test diet and four days of fecal collection. DNA was extracted followed by amplification of the V4-V6 variable region of the 16S rRNA gene using barcoded primers. Sequences were taxonomically classified using BLASTn against a curated GreenGenes database and compiled into each taxonomic level.

Results
With the inclusion of PP, fecal concentrations of firmicutes increased ($P<0.05$) while fecal fusobacteria decreased ($P<0.05$). Similar shifts were noted at both genus and species levels. Linear increases ($P<0.05$) in Faecalibacterium and Faecalibacterium prausnitzii were observed with increasing dietary PP concentration, while Clostridium spp., and Clostridium biranonis decreased linearly ($P<0.05$) with increasing dietary PP concentration.

Discussion and conclusions
The inclusion of PP modulated the hindgut microbiome in a beneficial way at the microbial phylum, genus, and species levels. The results are consistent with previous research regarding the effects of fermentable fiber on the dog fecal microbiome. Overall, PP had a favorable effect on the hindgut microbiome by increasing beneficial bacteria and decreasing select potentially pathogenic bacteria.
P76) EFFECT OF DIETARY PROTEIN MATRIX IN HOME-COOKED DIETS ON THE RESPONSE TO PROBIOTIC SUPPLEMENTATION BY LABRADOR DOGS

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Introduction
The response to probiotic supplementation depends on several intrinsic as well as extrinsic factors related to the diet-matrix, with the food format likely to affect probiotic survival, and efficacy.

Materials and methods
The influence of dietary protein source on the response to probiotic was studied using 16 adult Labrador dogs distributed into four equal groups in a 2x2 factorial design, and fed either a vegetable-protein blend (VPB) or poultry byproduct meal (PBM) based diet, both with (pro) or without (con) Lactobacillus acidophilus (at 108 cfu/day) for nine weeks. Both the diets (pressure-cooked, semi-moist) had the same formulation except for the protein source (and necessary small adjustments), and nutritionally equivalent; adequate to meet the requirements. The experimental protocol included a digestion trial, bi-weekly assessment of erythrocytic antioxidants, and immune response studies at the end.

Results
The digestibility of carbohydrate and fat was higher ($P<0.05$) with PBM- than VPB-diets; digestibility of protein and fibre remained unaltered. Faecal DM% was higher on PBM diets. Faecal ammonia reduced ($P<0.001$) in PBM-pro compared to the PBM-corn with no such effects on VPB-diets. Faecal lactate increased upon probiotic supplementation of VPB-diet; short-chain fatty acids increased with probiotic supplementation of VPB- but not PBM-diet. Faecal lactobacilli increased in both probiotic groups with concomitant reductions in clostridia; bifidobacteria increased only in VPB-pro vs. VPB-con. Dietary intervention influenced ($P<0.05$) erythrocytic super-oxide dismutase and reduced glutathione. Delayed-type hypersensitivity response to phytohaemagglutinin-P was higher in both the probiotic groups than their respective controls indicating improved cell-mediated immune response. Antibody response to sheep-erythrocytes varied significantly ($P<0.05$) but without any particular trend ascribable to the dietary treatments.

Discussion and conclusions
Comparatively better response of VPB-diet to probiotic could be due to its high fibre content inducing thereby a synbiotic effect. Overall, the response to probiotic may be potentially altered by a varying source of dietary protein.
P77) RAW MATERIAL PARTICLE SIZE OF EXTRUDED DIETS AND NUTRIENT DIGESTIBILITY AND FECAL PARAMETERS OF BLUE-FRONTED PARROT (AMAZONA AESTIVA)

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Introduction
Raw material particle size affects the extrusion quality and appearance of kibble diets. Very fine particles are often used to produce round, stuffed and flat kibbles, with defined shapes for birds. It is not known for psittacines the consequences to gut physiology and health, and the metabolic responses induced by the consumption of foods made of small raw material particle sizes. Considering these, we studied the effects of two raw material particle sizes of extruded foods for blue-fronted parrots on nutrient and energy digestibility, food metabolizable energy, and fecal traits and volatile fatty acids (VFA).

Materials and methods
A common formula based on maize, soybean meal, and wheat bran, balanced for parrot maintenance was ground in a hammer mill fitted with two screen sizes (0.5 and 2mm), totalling two diets. Fourteen adult healthy blue-fronted parrots were used in a randomized design. Birds were fed during 7-d for diet adaptation, followed by 13-d of fecal collection for digestibility (chromic oxide as marker) and 3-d of fresh fecal collection for VFA evaluation. For digestibility calculation, uric acid was measured on feces and its mass and nitrogen discounted. Results were compared by the F test ($P<0.05$).

Results
No effect of raw material particle size was observed on food intake, nutrient or energy digestibility, fecal dry matter, score, pH or short and branched chain fatty acid concentrations. A tendency for higher VFA concentrations on feces of parrots fed fine grind particle size ($P=0.054$) was verified.

Discussion and conclusions
Probably this tendency is due to the reduced food mean retention time in the gizzard and faster passage throughout the gut, with lower VFA absorption. For parrots, a small particle size of raw material is not necessary, and this common procedure adopted for prepared extruded foods needs more studies to investigate its consequences to birds' health.
P78) PREDICTION OF PROTEIN DIGESTIBILITY OF ANIMAL BY-PRODUCTS
FOR DOGS BY THE PROTEIN SOLUBILITY IN PEPSSIN METHOD
Kawauchi. I.M.1,2, Sakomura, N.K.2, Pontieri, C.F.F1, Rebelato, A.2, Putarov, T.C.2, Malheiros, E.B.2, Castrillo, C., Carciofi, A.C.2
1Grandfood Indústria e Comércio Ltda., Dourado, São Paulo, Brazil; 2São Paulo State University (UNESP), Jaboticabal, São Paulo, Brazil; 3IUCA. Department Producción Animal y Ciencia de los Alimentos, University of Zaragoza, Spain

Introduction
Animal by-product meals have large variability on protein content and digestibility. In vivo digestibility procedures are precise but laborious, and in vitro methods could be an alternative to evaluate and classify this ingredient category. This study proposed to establish prediction equations to estimate the protein digestibility of meat and bone meal (MBM) and poultry by-product meal (PM) using the protein solubility in pepsin method (PSP).

Materials and methods
Sixteen samples, eight of MBM and eight of PM had their protein digestibility determined for dogs by the substitution method. Basal diet was formulated for dog maintenance and other 16 diets were produced by mixing 70% of basal diet and 30% of each tested meal. After mixing and grinding, all diets were extruded under similar conditions and submitted to digestibility evaluation with six dogs per diet. MBM and PM samples had their PSP evaluated with three pepsin concentrations: 0.02%, 0.002% and 0.0002%. This dataset was used to develop the prediction equations.

Results
For MBM/PM, protein concentration ranged from 39% to 46%/57% to 69% and the mean protein digestibility by dogs was 76±4.2%/85±3.7%. The pepsin level which present higher Pearson correlation coefficients with in vivo results were 0.0002% for MBM (r=0.380; P=0.008) and 0.02% for PM (r=0.482; P=0.005). The relationship between in vivo and in vitro results could be expressed by the equations: protein digestibility of MBM=61.7+(0.2644*PSP at 0.0002%; P=0.008; R2=0.126); protein digestibility of PM=54.1+(0.3833*PSP at 0.02%; P=0.005; R2=0.216).

Discussion and conclusions
Although significant, the coefficients of determination of the equations were low indicating that the models were weak and need to be used with caution. Perhaps a greater number of observations could improve the equations. More studies are necessary to establish a consistent model to predict the protein digestibility of MBM and PM by the PSP method.
P79) DETERMINATION OF TYPICAL URINE MINERAL CONCENTRATIONS IN HEALTHY CATS FED VARIOUS COMMERCIAL DIETS

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Introduction
Feline urolithiasis can develop when the concentration of key precursors in the urine reach supersaturation. There is a paucity of data on typical urinary ion concentrations in domestic cats. The goal of this study is to report the range of concentrations of the ions most commonly involved in stone formation in the urines of healthy adult cats fed a variety of commercial diets.

Materials and methods
Data from feeding trials conducted in groups of seven healthy adult cats over a 10-year period were retrieved. Trials consisted of a 9-day adaptation period to a complete and balanced diet (dry with moisture <10% or canned with moisture >70%) fed to weight maintenance, followed by five days of individual urine collections. Urine samples from these five days were pooled. Urinary pH and total volume were recorded. After acidification to pH=2, calcium, magnesium, sodium, potassium, phosphate, oxalate, ammonium and creatinine concentrations were determined by ionic chromatography with within- and between-sample quality controls. Descriptive statistics were performed with ExcelTM.

Results
Urines from 142 male and female cats fed 255 dry expanded diets and 27 canned diets (seven cats/diets) were analyzed. Results for urinary volume (mL/kg/day), pH and concentrations (mmol/L) are reported in tables one and two.

Table 1: Urinary parameters obtained with dry diets

<table>
<thead>
<tr>
<th></th>
<th>Volume</th>
<th>pH</th>
<th>Creatinine</th>
<th>Ca</th>
<th>Mg</th>
<th>Na</th>
<th>K</th>
<th>Phos</th>
<th>Oxalate</th>
<th>NH4+</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median</td>
<td>12.9</td>
<td>6.28</td>
<td>25.5</td>
<td>0.77</td>
<td>3.88</td>
<td>231</td>
<td>192</td>
<td>72.7</td>
<td>1.71</td>
<td>195</td>
</tr>
<tr>
<td>Range</td>
<td>2.1-55.8</td>
<td>5.70-8.19</td>
<td>4.7-68.4</td>
<td>0.10-6.33</td>
<td>0.12-12.88</td>
<td>12-567</td>
<td>35-452</td>
<td>5.0-308.9</td>
<td>0.35-5.22</td>
<td>47-517</td>
</tr>
</tbody>
</table>

Table 2: Urinary parameters obtained with moist diets

<table>
<thead>
<tr>
<th></th>
<th>Volume</th>
<th>pH</th>
<th>Creatinine</th>
<th>Ca</th>
<th>Mg</th>
<th>Na</th>
<th>K</th>
<th>Phos</th>
<th>Oxalate</th>
<th>NH4+</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median</td>
<td>28.8</td>
<td>6.77</td>
<td>12.8</td>
<td>0.26</td>
<td>1.42</td>
<td>80</td>
<td>72</td>
<td>37.1</td>
<td>0.85</td>
<td>68</td>
</tr>
<tr>
<td>Range</td>
<td>6.7-60.0</td>
<td>5.73-8.22</td>
<td>5.9-42.8</td>
<td>0.10-1.78</td>
<td>0.13-5.04</td>
<td>13-257</td>
<td>32-274</td>
<td>11.5-107.0</td>
<td>0.29-2.35</td>
<td>22-237</td>
</tr>
</tbody>
</table>

Discussion and conclusions
This is the first report of the urinary ion concentrations in a large number of adult cats fed a wide variety of commercial maintenance diets and showing important variation between cats and diets.
P80) EFFECT OF FEEDING DIETS CONTAINING DIFFERENT PROPORTIONS OF DIETARY MACRONUTRIENTS ON IMMUNITY IN WORKING DOGS

*Canis familiaris*

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¹LWT Animal Nutrition; ²Massey University, North Shore City, Auckland, New Zealand

**Introduction**

The majority of studies on immune function in dogs have focused on the impact of nutraceuticals and aging, with little work specifically relating to effects of diet on immunity, particularly in working dogs. This study aimed to compare the effects of feeding exercising working dogs diets differing in macronutrient proportions on immune function parameters.

**Materials and methods**

Twelve healthy adult Harrier Hounds were fed a control diet (commercial AAFCO formulated dry diet; 63.1% carbohydrate (CHO); 19.5% protein (PRO); DM basis) they were trained to run on a treadmill (twice weekly; 6.3degree slope, 3.5-3.7m/s,30min, 15min) for four weeks prior to the start of and during the study. On day 0, dogs were randomly assigned to an experimental test diet (medium CHO dry diet; 34.6% CHO; 48.1% PRO; similar fat, fibre and gross energy levels to control diet), or remained on the control diet for the remainder of the eight-week study. Jugular blood samples were taken prior to a 60min submaximal exercise test on days 0, 14, 28 and 56 for assessment of immune cell responses (lymphocyte proliferation (Con A, PHA), expression of cell surface markers (CD4, CD8, B cells, CD14), phagocyte function).

**Results**

There were no significant differences ($P>0.05$) between or within the groups of dogs fed the two diets for the majority of immune parameters measured during the study. Statistically significant differences were observed in CD14 expression and phagocytosis, although these changes are unlikely to be biologically significant. There was a significant time dependent increase in lymphocyte proliferation to PHA in the test group, but no change was observed in dogs fed the control diet.

**Discussion and conclusions**

Neither the proportions of macronutrients fed to the dogs, nor the exercise regime caused any deleterious changes in immune function over the duration of the trial. However, the intensity of exercise performed by the dogs may not have been high enough to modulate immune function.
P81) DIGESTIBILITY AND PALATABILITY OF FOODS FOR DOGS AND CATS EXTRUDED WITH DIFFERENT AMOUNTS OF MECHANICAL AND THERMAL ENERGY
Sa, F.C.1, Souza, E.M.2, Rokey, G.2, Venturini, K.S.1, Werneck, J.N.3, Goncalves, K.N.V.1, Carciofi, A.C.1
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Introduction
Greater thermal energy implementation (water steam) can be compensated by reduced mechanical energy transference, reducing electric energy consumption and equipment wear. However, changes in the relationship between these energies can alter nutrients' digestibility, kibble structure and hardness, and odor compounds formation adding higher or lower palatability to diet.

Materials and methods
This study evaluated the implementation of three amounts of mechanical (dog/cat: 8/7.3, 20/21 and 28/29kWhr/t) and thermal energy (98/86, 61/90 and 47/81kWhr/t) during the processing of a stand formulation for dogs or cats (maize, poultry-by product meal, poultry fat, and beet pulp), totaling three diets for each species.Digestibility was determined through total collection of feces in six dogs/cats per diet. Palatability was evaluated in two different sites, using at least 35 animals. Kibble analysis included hardness in a texturometer, starch gelatinization by the amylo-glucosidase method, and electron microscopy.

Results
The reduced mechanical energy was compensated by higher applications of thermal energy, so starch gelatinization did not differ among diets (dogs=76%; cats=79%; P>0.05). Nutrient digestibility, fecal traits, production, and short chain fatty acid were also similar among food processing (P>0.05). Dogs preferred the food extruded with 20 over the sample processed with eight and 30kW/h/ton, and the food processed with 8 over 30kW/h/ton (P<0.01). Cats preferred the foods extruded with eight and 20 over the sample processed with 30kW/h/ton (P<0.01), without preference among eight or 20kW/h/ton. Kibble analysis showed similar densities (g/L) and hardness (kgf to rupture). Electron microscopy analysis showed similar internal changes in treatment 20kW/h/ton.

Discussion and conclusions
Provided that similar and adequate cooking level (gelatinization index) was accomplished, different ratios of mechanical and thermal energy implementations can be adequate for the digestibility of extruded dog and cat foods. However, it results in important differences on food palatability, and both dogs and cats prefer food processed under moderate or low mechanical energy.

Keywords: Extrusion, palatability, processing.
P82) CREATING CANINE GROWTH CURVES FROM A PRIMARY CARE PRACTICE POPULATION
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¹WALTHAM Centre for Pet Nutrition, Melton Mowbray, Leicestershire, UK; ²Banfield Pet Hospital

Introduction
Using growth curves to understand optimal growth of dogs can help promote healthy development, as over or under feeding of puppies has been linked to developmental orthopaedic disorders. Curves based on data from a primary care population should be more representative of the pet population than most published curves which are usually based on research colony animals. This study aimed to create growth curves for popular breeds using data collected during primary care consultations in Banfield Pet Hospitals across the USA.

Materials and methods
The observational nature of these data mean careful data cleaning and choice of study population is necessary. As it is known that the pet population contains many overweight dogs, the dataset was restricted to puppies that achieved a healthy body condition score by young adulthood. As only a small proportion of visits included a directly assessed body condition score, body condition (‘thin’, ‘normal’, or ‘heavy’) was predicted using a linear discriminant analysis based on actual weight, recommended weight and demographic variables. This increased the data available for analysis, and enabled a comparison with curves constructed from the general population. Curves were based on visits where the puppy had no reported signs of illness, and were constructed using an extension of the LMS method of Cole (1988), which is related to the technique used by the World Health Organisation to create child growth standard curves.

Results
Curves generated from puppies ultimately attaining a healthy body condition are markedly different from those constructed from the general population.

Discussion and conclusions
We demonstrate that it is possible to create growth curves from data collected during routine veterinary consultations and that careful choice of study population is essential.

Reference
P83) CHANGES IN WEIGHT AND BODY CONDITION SCORES OF CATS DURING THEIR FIRST TWO WEEKS OF RESIDENCE IN AN ANIMAL SHELTER IN UPSTATE NEW YORK

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Introduction
Cats entering animal shelters are stressed by relocation to an unfamiliar environment, pre-existing disease, and/or prior mistreatment. In light of these stressors, cats are often hypophagic in the first 1-2 weeks of residence. Inadequate nutrition may contribute to risk of upper respiratory tract infections, which can lead to euthanasia in shelters. Additionally, excessive starvation has been linked to hepatic lipidosis in cats. Because rapid weight loss could put these animals at risk, it is important for shelters to understand the risks. The primary objective was to measure changes in body weight and body condition scores (BCS) among cats during their first two weeks of residence in an animal shelter.

Materials and methods
The weight and BCS of 160 cats one year of age or older entering an animal shelter in upstate New York were assessed during the period April-October 2010. Cats that were too fractious to handle, pregnant, ill, or injured were excluded. Each cat’s weight and BCS (1-9) were recorded on days one, four, seven, 10 and 14 of their residence in the shelter. Potential risk factors for weight change such as gender, age, neuter surgery, source (e.g., owner-surrendered, stray), and shelter acquired illness were examined.

Results
More than 40% of the 122 cats with data through day 14 experienced at least a 2% decrease in body weight by day 14 in the shelter. Female cats and those neutered in the shelter were significantly ($P<0.05$) more likely to experience this weight loss compared to males and cats entering pre-altered, respectively. Age, source and illness were not associated with weight loss in this study.

Discussion and conclusions
Shelters should weigh cats daily to identify weight changes and intervene when necessary to maximize the health of their cats. Identification of complete anorexia in cats, particularly female cats, should be done due to the propensity for weight loss.
P84) ENERGY INTAKE OF PET DOGS COMPARED TO ENERGY EXPENDITURE AT REST, SITTING AND STANDING

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Introduction
The relationship of energy expenditure (EE) under different resting conditions to maintenance metabolizable energy intake (EI) in pet dogs is unknown.

Materials and methods
EE was measured using indirect calorimetry in 41 healthy pet dogs (six Dachshunds, four Corgis, four Basset hounds, six Jack Russell terriers, five Beagles, four huskies, one Australian Shepherd, five Italian greyhounds and six medium to large sight-hounds) of normal body condition, habituated to wear a mask while laterally recumbent (basal EE), laying upright, sitting or standing for >10 minutes on multiple days. Average EI was calculated using National Research Council (2006) methodology by analyzing representative food samples and weighing all food consumed for one month while dogs maintained body weight.

Results
The regression slopes of logarithm of body weight against logarithms of EI or EE were 0.72-0.79 for dogs weighing 4-26kg. Mean (±SD) EI was 88±18 kcal.kg\(^{-0.75}\).d\(^{-1}\); EE while laying laterally, laying upright, sitting or standing was equivalent to 69±16, 79±22, 91±29 and 101±29 kcal.kg\(^{-0.75}\).d\(^{-1}\), respectively; the ratio of EI to basal EE was 1.3±0.3. There was no evidence of a difference in EI or its ratio to basal EE among breeds but EE for each resting condition differed among breeds (p<0.05) with Corgis, Jack Russell terriers and huskies having the lowest and sight hounds the highest kcal.kg\(^{-0.75}\).d\(^{-1}\).

Discussion and conclusions
EE increases on average 14% when a dog raises its head, 30% when it sits up, and 46% when it stands, however, EI is only 30% more than basal EE on average.
P85) CHANGING THE ENERGY DENSITY OF THE DIET USING AIR: A POSSIBLE STRATEGY FOR WEIGHT MANAGEMENT

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Introduction
Major challenges with weight management using weight loss diets include hunger and rapid consumption of food, both of which lead to poor owner compliance. Low-energy-dense diets, incorporating water or dietary fibre decrease energy intake without reducing food volume, and can slow food intake. However, they can also cause diarrhea. The aim of this study was to assess the effect of low energy density-high volume diets on food intake in dogs fed their maintenance energy requirement (MER).

Materials and methods
Before the study, 17 adult female dogs were fed at MER, ensuring that they were in an ideal body condition. However, their whole daily allowance was consumed rapidly. Dogs were then successively fed four different dry diets differing in energy density (e.g., 800kcal/L, 683kcal/L, 567kcal/L and 450kcal/L). Each diet was fed for five consecutive days, using a Latin square design. Measurements included duration of food intake, amount of food remaining, body weight and faecal score. Data were analysed by two-way non-parametric ANOVA, using the mixed procedure of SAS, with diet and week included as fixed effects and dog included as a random term.

Results
Throughout the study, faecal score remained optimal, and BW remained stable. As energy density decreased, the duration of food intake increased significantly (Table).

Discussion and conclusions
This study has demonstrated that using air to increase the volume of a diet, and thereby decreasing energy density, can decrease speed of food intake. This might be a useful strategy for weight management.

<table>
<thead>
<tr>
<th>Diets</th>
<th>800kcal/L</th>
<th>683kcal/L</th>
<th>567kcal/L</th>
<th>450kcal/L</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duration of the meal (seconds)</td>
<td>171(55-900)a</td>
<td>185(77-900)b</td>
<td>268(80-900)c</td>
<td>374(136-900)d</td>
</tr>
<tr>
<td>Food intake (kcal/kg0.75)</td>
<td>103(67-185)</td>
<td>101(154-182)</td>
<td>102(65-185)</td>
<td>101(68-166)</td>
</tr>
</tbody>
</table>

Results are express as a median (min-max). P<0.001 between different letters
P86) COMPARISON OF THE DIGESTIVE EFFICIENCY OF FERRET (*MUSTELA PUTORIUS FURO*), DOG (*CANSIS FAMILIARIS*) AND CAT (*FELIS CATUSS*) FED EXTRUDED DIETS

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**Introduction**

The digestive tract of ferrets is anatomically simple, with no cecum, ileocolic valve and external difference between the transition of the ileum and colon. The species has a short large intestine that provides minor contributions to the digestive process. This study compared the digestibility of the three species, fed extruded diets with different amounts of carbohydrates.

**Materials and methods**

Three formulations (broken rice, poultry by-product meal, maize gluten, poultry fat and beet pulp) for cat maintenance with different amounts of nitrogen-free extract (NFE) were used: high carbohydrate (HC; NFE=54%, CP=30%, Fat=7%); moderate carbohydrate (MC; NFE=36%, CP=41%, Fat=10%); low carbohydrate (LC; NFE=18%, CP=45%, Fat=23%). The experiment followed a 3x3 factorial design (three species and three diets), totaling nine treatments and six repetitions per diet. Digestibility (DM, CP, Fat and NFE) was determined from feces total collection and analyzed. Results were submitted to ANOVA, considering the effects of diet, species and their interaction (P<0.05).

**Results**

Dogs and cats presented higher similarity for food intake, but ferrets consumed almost two times more. Species x diet interaction was verified for dry matter (DM) and NFE digestibility. Ferrets presented lower DM digestibility than dogs and cats for all three diets (P<0.05), lower NFE digestibility than dogs for the three diets, and also lower NFE digestibility than cats for the HC and LC foods (P<0.05). For protein, ferrets also presented lower digestibility than dogs and cats (P<0.05), whereas for fat, dogs and ferrets presented similar digestibility, and both higher than the presented by cats (P<0.05). In general, for all three species, apparent digestibility increased with the increase in the nutrient amount in the diet (P<0.05).

**Discussion and conclusions**

Ferrets fed kibble diets present lower digestibility of DM, protein, and NFE than dogs and cats, and similar fat digestibility than dogs with higher values than cats.
A NOVEL VIDEO DETECTION SYSTEM FOR FELINE FEEDING AND DRINKING BEHAVIOURAL ASSESSMENT

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Introduction  
Cats demonstrate complex feeding and drinking patterns; consuming small meals and drinking at irregular intervals during a day. These types of behaviours make it impractical for an analyser to undertake direct observations because they would have to observe the animals for the entire test session. In addition, a single person cannot track multiple cats simultaneously. Therefore, to facilitate these types of studies, a real time video-based monitoring system was developed.

Materials and methods  
A camera was installed in front of each test cage, and a PC was used to run Lab View software that performed a background subtraction algorithm to each cage simultaneously at 25-30 frames per second to detect whether the cat was in close contact with the food bowl/water bowl or not. At the same time the program recorded the real time weight of each bowl and associated each weight reading with its corresponding frame while recording. The monitoring system required a motion detection algorithm that was computationally inexpensive, while working for cats of various colours and keeping the number of false alarms to a minimum. The background subtraction algorithm was modified to account for slight changes in lighting, while not detecting small changes in background, such as a cat’s tail swinging in the feeding area.

Results  
The system was tested for 20 hours, and showed an extremely accurate performance, where a single i5 Processor was able to monitor and record videos of four cages at 25-30 fps simultaneously. In addition, the algorithm was able to provide a successful detection rate of 94%, with a 5% false acceptance rate and a 1% false rejection rate in cats of different colours.

Discussion and conclusions  
The system has allowed us to investigate feeding and drinking bouts and also the role of olfaction in meal choice.
P88) ASSOCIATION BETWEEN DIET COMPOSITION AND IN VITRO SELENIUM BIOACCESSIBILITY IN PET FOODS

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Introduction
Variable Se levels in raw materials complicate the formulation of pet foods meeting the European recommended allowance of 75 µg/1000 kcal ME, and stay below the legal maximum of 142 µg/1000 kcal ME (FEDIAF, 2012). Since many factors influence Se availability in other species (e.g., protein type, fat content) and information on pets is scarce, a recommendation based on total Se may not be accurate enough. Therefore, the aim was to identify dietary factors associated with in vitro bioaccessibility (BAiv) of Se in pet foods.

Materials and Methods
Sixty-two diets (cat, n=10; dog, n=52) of which 54 commercially available (kibble, n=20; pellet, n=8; canned, n=17; raw meat, n=6; steamed meat, n=3) and eight unprocessed (kibble, n=4; canned, n=4) from the same batch as corresponding processed diets, were analysed for DM, ash, N, Cfat, S, AA, TDF, GE, and Se. After in vitro digestion (adapted from Hervers et al., 2007), undigested fractions were analysed for DM, ash, and N, and digested fractions for Se. Data were analysed using the GLM and REG procedures of SAS.

Results
In the complete dataset only a significant difference was found in Se BAiv for processing type (P=0.0002). Canned and steamed meat diets had a significantly lower Se BAiv than pellets and raw meat diets. For extruded diets (n=19) Se BAiv correlated positively to N digestibility (R²=0.2921, P=0.0169). The opposite was found for canned diets (n=16; R²=-0.3731, P=0.0120). Moreover, the canning process decreased Se BAiv (P=0.0010), whereas extrusion did not affect Se BAiv (P<0.05).

Discussion and Conclusions
The contrasting effect of N digestibility in canned vs. kibble diets may be caused by differences in heat damage of S-containing amino acids. These findings warrant in vivo validation to clarify if recommendations on Se levels in pet foods need to take processing type into account.
P89) NUTRITIONAL EVALUATION OF PROTEIN SOURCES FOR DOG FOODS

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Introduction

Compared with farm animals, little information is available about the digestibility values of protein sources used to produce commercial diets for dogs. This lack of information does not allow an informed decision on their nutritional value. Considering this, the digestibility of high-ash poultry by-product meal (HAPM), soybean meal (SBM), corn gluten meal (CGM) and micronized whole soybeans (MWS) was determined for dogs by the substitution method.

Materials and methods

Thirty-five Beagle dogs were used in the digestibility trials. A basal diet (BD) was formulated for dog maintenance, and four test diets obtained by mixing 70% of BD with 30% of the test ingredient. After mixing and grind, all diets were extruded under similar conditions and submitted to digestibility evaluation (total collection of feces) using seven dogs per diet. The apparent digestibility of the protein sources was calculated by the substitution method, considering the digestibility of the BD, test diet and the substitution level of the ingredient.

Results and discussion

CGM and MWS presented higher digestibility of dry matter (88.4%, 75.6%), organic matter (88.8%, 79.5%), gross energy (88.6%, 83.2%), and metabolizable energy content (5.16kcal/g, 4.95kcal/g). Crude protein digestibility was higher than 85% for all ingredients. SBM and HAPM showed the lowest dry matter digestibility (67.8% and 5.7%) and metabolizable energy content (3.54kcal/g, 3.51kcal/g). Little data about ingredient digestibility (not diet digestibility) was found to compare to the obtained results.

Conclusions

Studied ingredients are good protein sources for dog food, but HAPM and SBM should be used with more attention due to their moderate to low dry matter digestibility and energy content.
P90) MODIFIED ATWATER AND NRC 2006 EQUATIONS CAN PREDICT METABOLIZABLE ENERGY IN CANNED CANINE DIET

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Introduction
Metabolizable energy (ME) of petfoods can be determined by animal trials or predicted using published equations. To date, the most commonly used equation is the modified Atwater equation (3.5 kcal/g of protein and carbohydrates, 8.5 kcal/g of fat) proposed by the National Research Council (NRC) in 1985. This equation is still recommended by the Association of American Feed Control Officials (AAFCO). In 2006, however, the NRC has recommended newer predictive equations of ME based on digestible energy estimated as a function of total dietary fiber (TDF). Our objective was to compare ME determined by those equations versus ME determined by animal trials (gold standard) in canned canine diets.

Materials and methods
A dataset containing 30 canned canine diets was included in the study. For each dietary trial, proximate analysis, gross energy of the diet and feces and digestibility trials on six dogs were available. ME was predicted by modified Atwater and NRC2006 (TDF) equations, and compared with the experimentally determined ME by linear regression analysis. The mean absolute difference between measured and predicted ME was also calculated as an index of error of prediction. The mean (±SD) measured ME of diets was 1027±242 kcal/kg as fed (range: 535-1703 kcal/kg). High correlations were found between ME measured and predicted by modified Atwater (R²=0.954) or NRC2006 (R²=0.937) equations. Mean error of prediction was slightly higher for modified Atwater (82±50 kcal/kg, 8.0%) than for NRC2006 (59±34 kcal/kg, 6.1%).

Results
Modified Atwater equation gave a general underestimation of ME (-8%) whereas NRC2006 was very close to the measured ME, especially for diets with an energy density ≥900 kcal/kg (+3%).

Discussion and conclusions
Our results suggest that modified Atwater and NRC2006(TDF) equations can be used to predict ME in canned canine diets. Although slightly less accurate, the modified Atwater equation presents the advantage of being easier to use.
The Global Nutrition Committee (GNC) of the World Small Animal Veterinary Association (WSAVA) aims to help ensure that pets around the world receive nutrition which enables them to live longer, healthier and happier lives. It also leads the WSAVA’s campaign to have a nutritional assessment confirmed as the ‘Fifth Vital Assessment’ in a standard physical examination and for the veterinary healthcare team to provide nutritional recommendations for every animal as an integral component of optimal patient care.

In working toward its goal, the GNC delivered a set of ‘Global Nutrition Guidelines’ for veterinary professionals and pet owners in 2011. They are now available in ten languages, have been endorsed by 27 WSAVA member associations and have been published in more than 15 journals. Earlier this year, it added a downloadable ‘Nutrition Toolkit’, containing a set of practical, non-branded tools for veterinary staff and owners. They include:

- Body condition score charts
- A body condition video
- Muscle condition score charts

Dr Marge Chandler, Co-Chair of the GNC, explains: “Feedback from veterinarians so far confirms that they are using them to provide better care for patients; to feel more confident in answering questions about pet food and to suggest useful and accurate nutrition websites to owners. We will continue to add further tools and to translate them into additional languages for the benefit of veterinarians and pet owners around the world.”

The Nutrition Toolkit is available for download at http://wsava.org/nutrition-toolkit.

The GNC would like to thank its sponsors, without whose generous support it could not deliver its work. They are Hill’s Pet Nutrition, Nestlé Purina, P&G and Royal Canin/Mars Petcare. WSAVA is an umbrella organization representing 180,000 veterinarians globally through 94 member associations. For more information on the WSAVA visit www.wsava.org.
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To become a diplomate of the ECVCN, candidates have to be veterinarians who have completed an internship (1-1.5 years) and a residency program (2.5-3 years) which is certified by the annual reports during the residency and by the supervisor. The candidates must have experience in practical nutrition with healthy and sick animals, documented and written three clinical cases with at least one published; attend the ECVCN resident class for two days' duration prior to the ESVCN Annual Conference; and completed research project(s) with two published papers in nutrition, at least one as first author.

The certifying exam consists of three parts: two written; one on general veterinary nutrition, and another on the sub-specialty, either companion or food animals (resident's choice); and an oral exam featuring clinical case discussions based on either companion or food animals. Currently in 2013, there are 13 residency programs in nine European countries, with a total of 23 residents (seven alternative and 15 standard).

Every five years, each residency program is resubmitted for evaluation, in order to be recertified. Every five years, ECVCN diplomates have to submit their track record of publications and evidence of being active at a specialist level in nutrition to be recertified as a diplomate. ECVCN diplomates work as academics, in the petfood industry, as private consultants, and as private clinical nutritionists.
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