Probiotic and Prebiotic Applications in Dogs and Cats

Kelly S. Swanson, PhD
Department of Animal Sciences, Division of Nutritional Sciences, and Department of Veterinary Clinical Medicine
University of Illinois at Urbana-Champaign, USA

Why Study Dogs and Cats?

• Companionship

• Pet health/nutrition a big business

• Science
  – Living environment and exposures
  – Proximity to humans
  – Disease incidence
  – Similar dietary composition, but unique metabolism
Public Health Risk?

Dogs and Cats

- Simple non-ruminants
- High genetic variability (dog)
  - Disease susceptibility
- Common disease states
  - Obesity and comorbidities
  - Oral cavity
  - Gastrointestinal tract
  - Skin
  - Urinary tract
Role of Microbiome in Disease?

• Microbiomes recently characterized
  – Obesity and comorbidities
  – Oral cavity
  – Gastrointestinal tract
  – Skin
  – Urinary tract

Primary Focus on Gut

Hand et al., 2013

Deng et al., 2014
Dietary Options

• Wide variety
  – Diet form
  – Macronutrient composition
  – Micronutrients and phytochemicals

  – Dietary fibers, prebiotics, and probiotics
    • Common in complete foods
    • Dietary supplements
    • Doses highly variable
    • Individual sources/strains or blends

Dog/Cat Prebiotics and Probiotics

• Main focus on gut health
  – Most data based on culture/qPCR/FISH

  – Prebiotics:  
    • Commonly tested
      – Fructo-, galacto-, manno-, or glucooligosaccharides
    • Traditional targets
      – Bifidobacteria; Lactobacillus
    • Doses vary widely (<0.2% to >1% diet)

  – Probiotics:  
    • Commonly tested
      – Bifidobacterium; Lactobacillus; Enterococcus; Bacillus
      – Commonly $10^6$ to $10^9$ cfu/dose
    • Poor quality control of commercial products (Weese and Martin, 2011)

Gibson and Roberfroid, 1995
Prebiotics in Dogs and Cats

• *In vitro* cultures:
  – Pure or batch
    • Microbial utilization/growth
    • Pathogen inhibition
  • Substrate disappearance
  • Organic acid production
  • Gas production

Ogué-Bon et al., 2010; Panasevich et al., 2013

Prebiotics in Dogs and Cats

• *In vivo* testing:
  – Most data in healthy research animals
    • Tightly-controlled studies, but small animal #
  – Outcome variables:
    • Fecal characteristics (consistency scores; DM%; pH)
    • Fecal microbiota and metabolites
    • Intestinal immunity, histomorphology, or gene expression (few studies)
Prebiotics in Dogs and Cats

- Effects depend on type and dose
- Microbial activity often altered
  - ↑ fecal SCFA and ↓ fecal pH
  - ↓ fecal protein catabolites
  - Moderate shifts in microbiome

Barry et al., 2012; Beloshapka et al., 2014

Prebiotics in Dogs and Cats

- Inulin and scFOS protective against *Salmonella typhimurium* DT104 infection
  - Reduced fever
  - Reduced enterocyte sloughing

Apanavicius et al., 2007
Probiotics in Dogs and Cats

• Probiotics:
  – *In vitro* cultures (most pure)
    • *Bifidobacterium; Lactobacillus*
    • *Enterococcus; Bacillus*
  – Analyses
    • Growth
    • Resistance to acidity/bile
    • Adhesion properties
    • Pathogen inhibition
    • Antibiotic susceptibility

Perelmuter et al., 2008

Probiotics in Dogs and Cats

• *In vivo* data:
  – Healthy research animals or free-living pets
  – Free-living diseased populations
    • IBD; hemorrhagic diarrhea; food-responsive enteropathies
    • Often tested against drug therapies
  – Outcomes:
    – Clinical disease activity index (Jergens et al., 2003)
    – Mucosal, digesta, or fecal microbiota
    – Intestinal histology
    – Immune cell number/function
    – Gut inflammatory/permeability markers

Table: Composite (CRU) Score

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<thead>
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<th>A. Attitude/activity</th>
<th>B. Appetite</th>
<th>C. Licking</th>
<th>D. Stool consistency</th>
<th>E. Stool frequency</th>
<th>F. Weight loss</th>
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Satisfaction of 3 variables

Tests Composite (CRU) Score

CRU: Composite (CRU) Score

Cruelly-induced control

Note: CRU = Mucosal, BI, Enteric, IBD.
Probiotics in Dogs and Cats

- Common results:
  - ↑ in probiotic bacteria in feces
  - No or minor shift in microbiome
  - Improved clinical and histological scores?
  - ↑ tight junction proteins?

Probiotics in Dogs and Cats

- Recent evidence: dogs with idiopathic IBD
  - VSL#3: 112 to 225 x 10^9 cfu/10 kg BW for 60 d
  - Drug therapy: metronidazole + prednisone

Garcia-Mazcorro et al., 2011

Rossi et al., 2014
Summary Points

• Dogs and cats useful for microbiome research

• Pre-/probiotics have many potential applications for canine and feline health
  – Gastrointestinal disease
  – Obesity; urinary tract; skin; oral

• Current evidence (gut)
  – Canine/feline microbiota highly active
  – Prebiotics alter microbial activity/populations, but not adequately tested in clinical setting
  – Probiotic use controversial, but possible benefits

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