Purina® PRO PLAN® Symposium 2026
Navigating Microbiota Dynamics
Applicable to Pet Nutrition

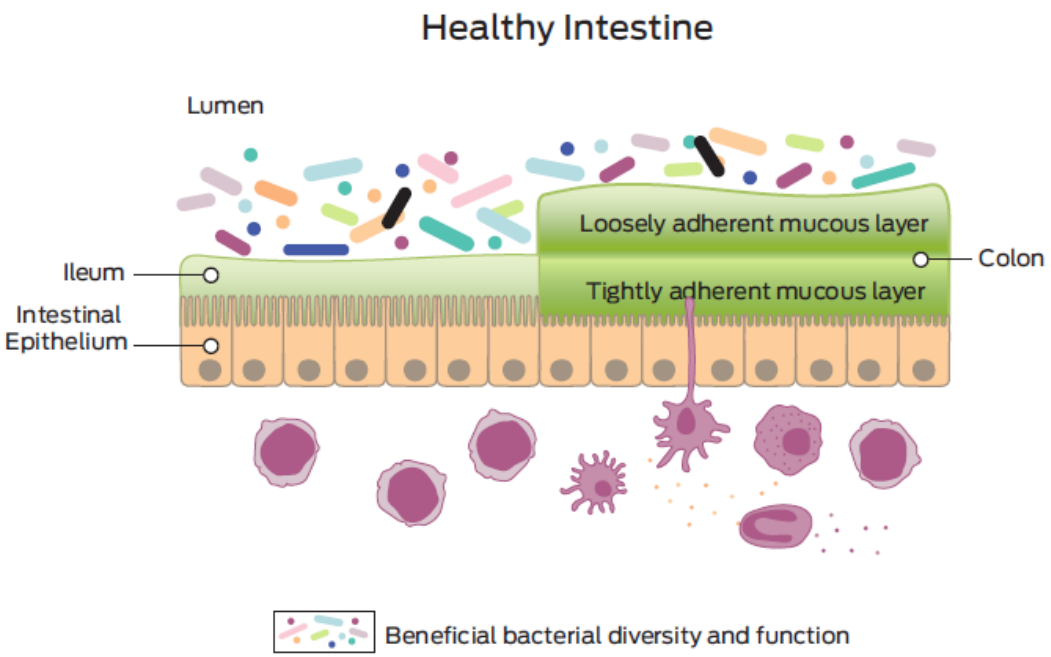
PURINA
PRO PLAN
symposium

Influence of Feeding Practices on Gut Health in Dogs and Cats

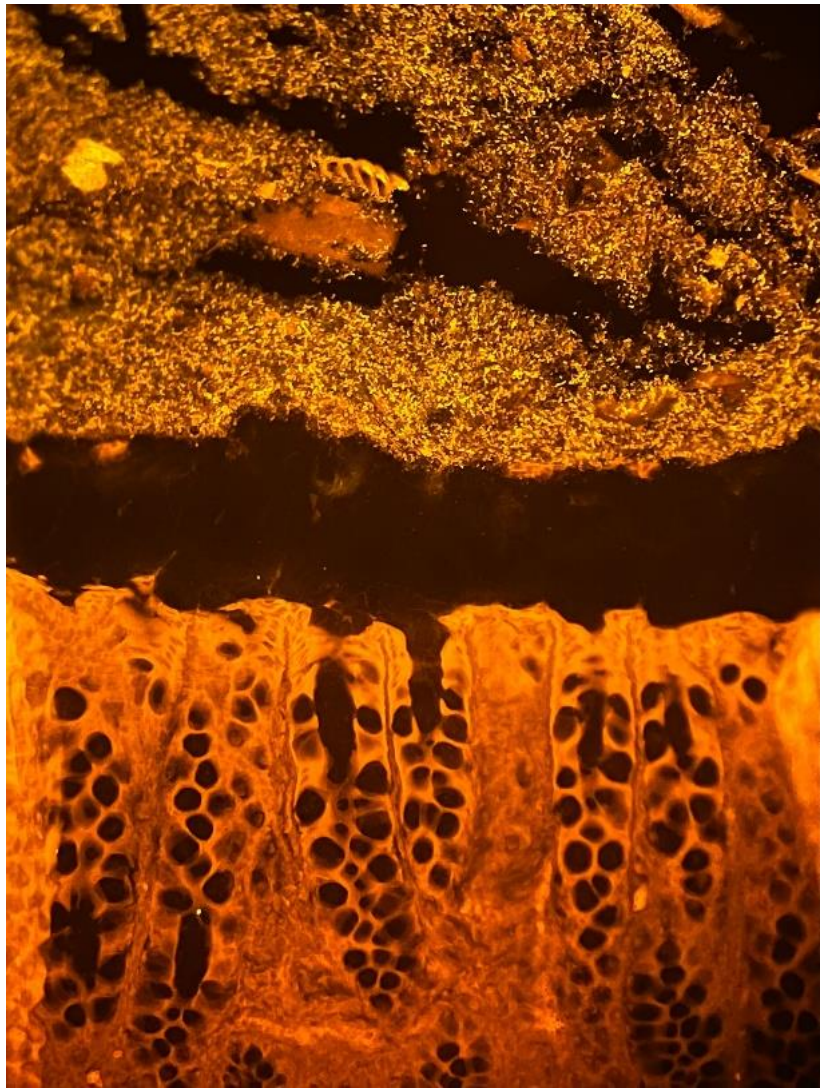
ESCG
European Society of Comparative Gastroenterology

Jan S. Suchodolski
Kelly S. Swanson

COLON IN A HEALTHY CAT



Suchodolski JS - Assessing and Managing the Gut Microbiome in Canine and Feline Practice.
In "Purina Institute - Canine and Feline Clinical Nutrition Handbook, 2023 edition"



Live bacteria (what we see as feces)

Mucus layer

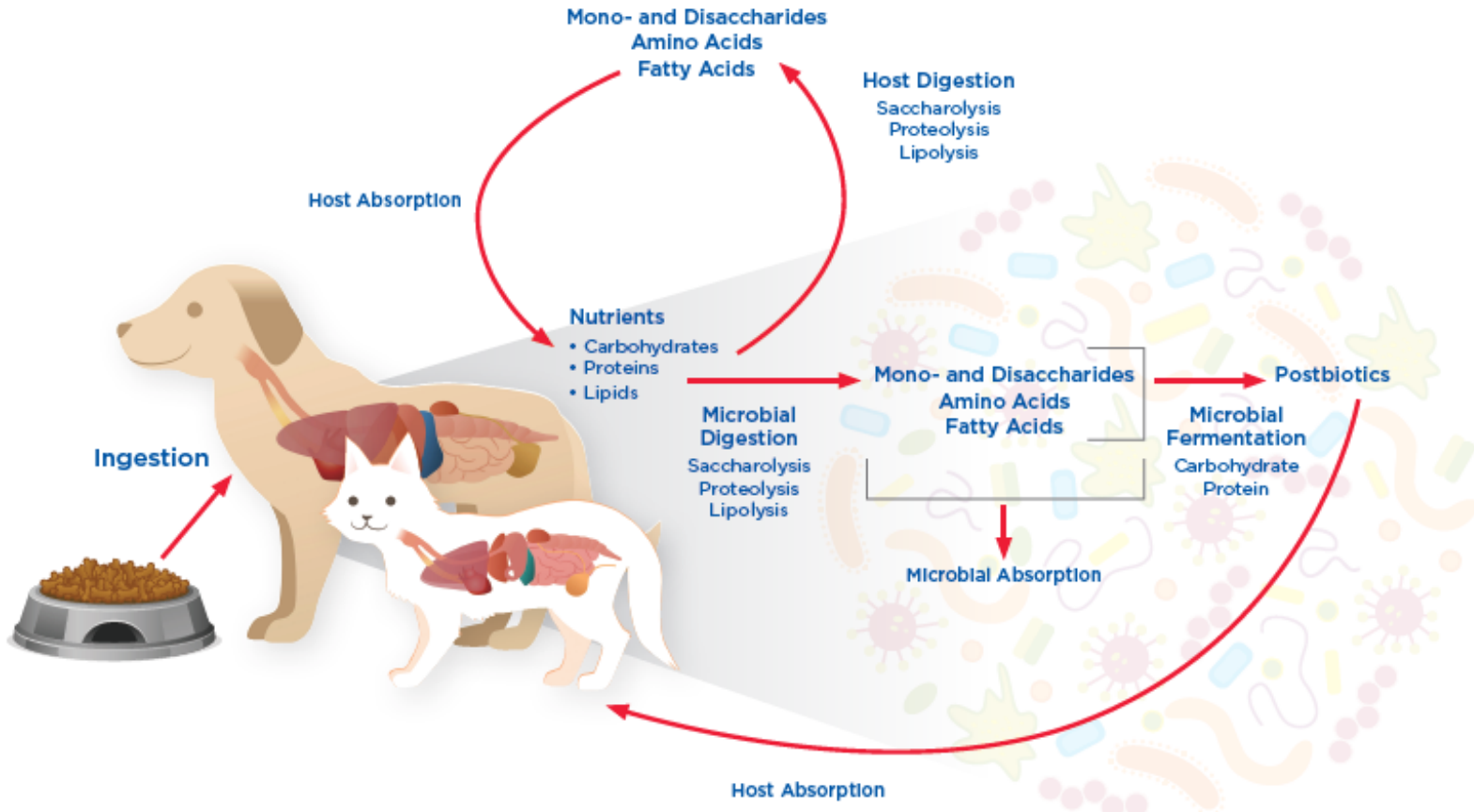
Epithelium

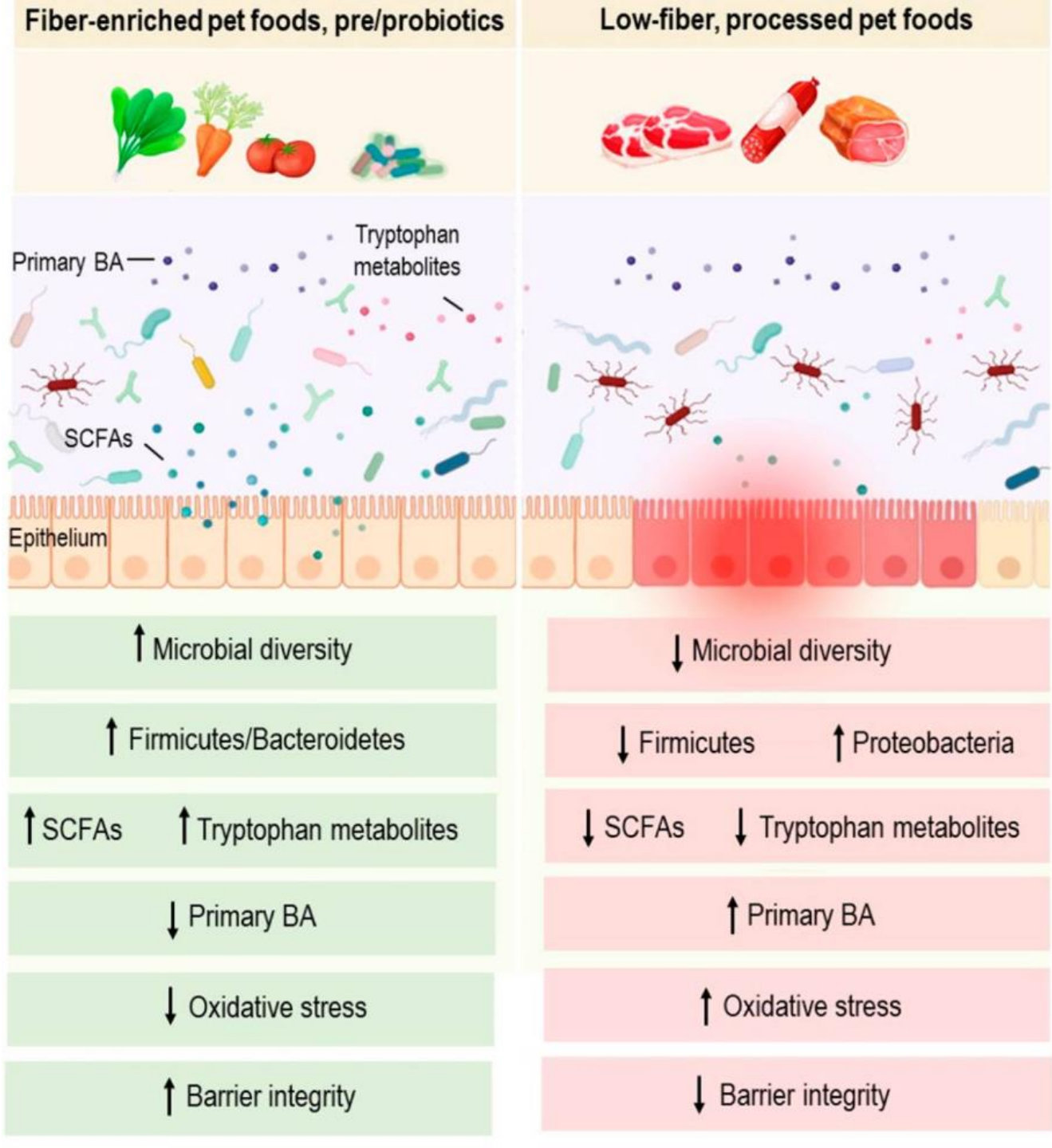
Dr. Suchodolski JS, Sung CH, GI LAB, TAMU

▸ Front Microbiol. 2020 Jun 25;11:1266. doi: 10.3389/fmicb.2020.01266

The Effects of Nutrition on the Gastrointestinal Microbiome of Cats and Dogs: Impact on Health and Disease

Susan M Wernimont [1,*], Jennifer Radosevich [1], Matthew I Jackson [1], Eden Ephraim [1], Dayakar V Badri [1], Jennifer M MacLeay [1], Dennis E Jewell [2], Jan S Suchodolski [3]





▸ Metabolites. 2022 Nov 25;12(12):1176. doi: 10.3390/metabo12121176

The Nexus of Diet, Gut Microbiota and Inflammatory Bowel Diseases in Dogs

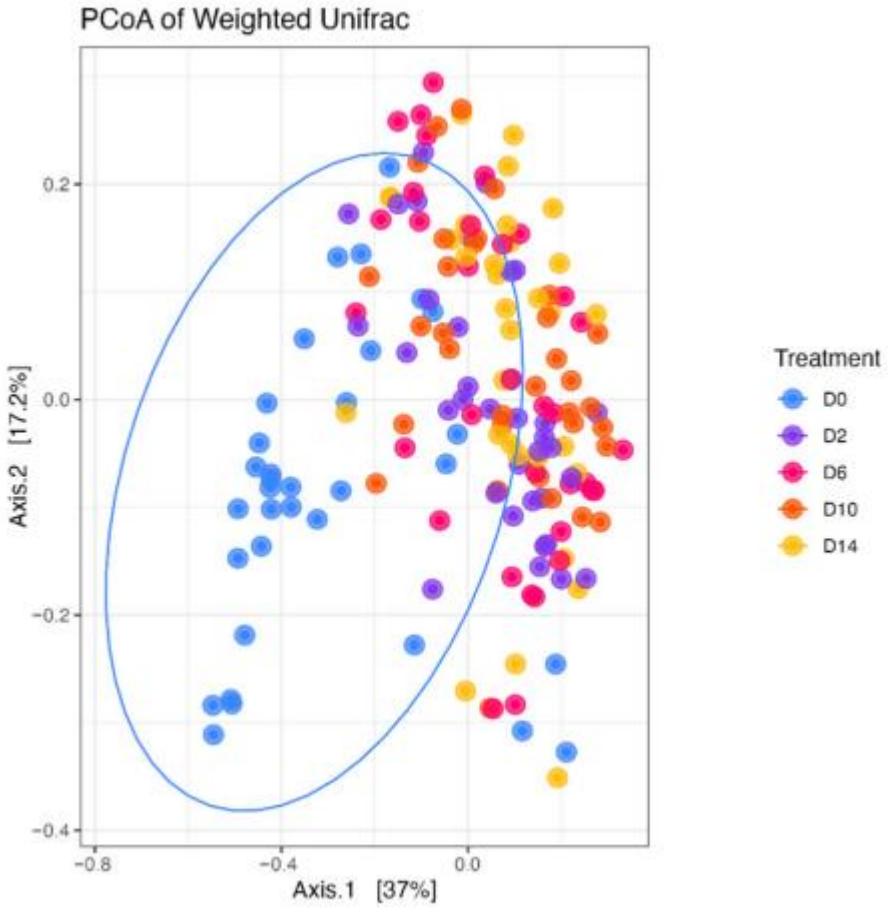
Soufien Rhimi [1], Aicha Kriaa [1], Vincent Mariaule [1], Amel Saidi [1], Amandine Drut [1,2], Amin Jablaoui [1], Nizar Akermi [1], Emmanuelle Maguin [1], Juan Hernandez [1,2], Moez Rhimi [1,*]

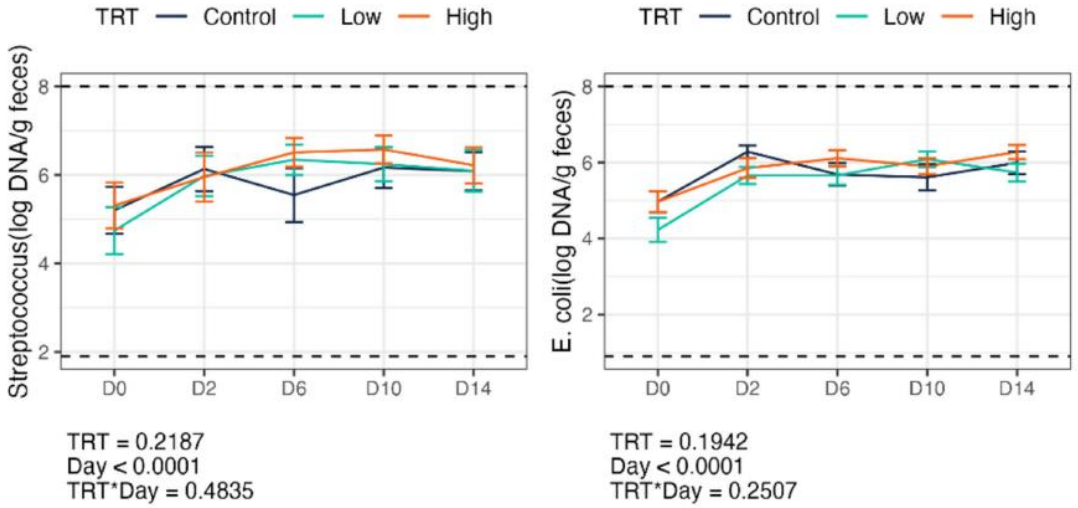
Editors: Lian Li, Baichuan Deng, Giulia Pignataro

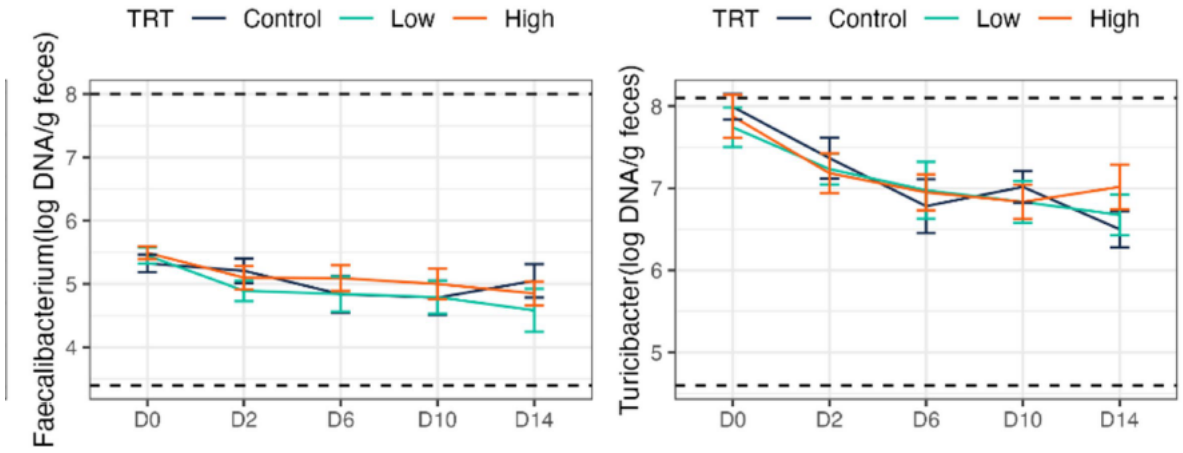
Evaluation of *Bacillus subtilis* ATCC PTA-122264 on the fecal characteristics and microbiota of healthy adult dogs subjected to an abrupt diet change

Patrícia M. Oba[1], Olivia R. Swanson[1], Yifei Kang[2], Julio C. Mioto[1], John F. Menton[3], Elena Vinay[3], Mathieu Millette[4], Melissa R. Kelly[5] and Kelly S. Swanson[1,6,7]*

- dogs fed a high-fiber kibble diet for 28 d
- then abruptly transitioned to a high-protein, high-fat canned diet and fed for 14 d







Evaluation of *Bacillus subtilis* ATCC PTA-122264 on the fecal characteristics and microbiota of healthy adult dogs subjected to an abrupt diet change

Patrícia M. Oba[1], Olivia R. Swanson[1], Yifei Kang[2], Julio C. Mioto[1], John F. Menton[3], Elena Vinay[3], Mathieu Millette[4], Melissa R. Kelly[5] and Kelly S. Swanson[1,6,7]*

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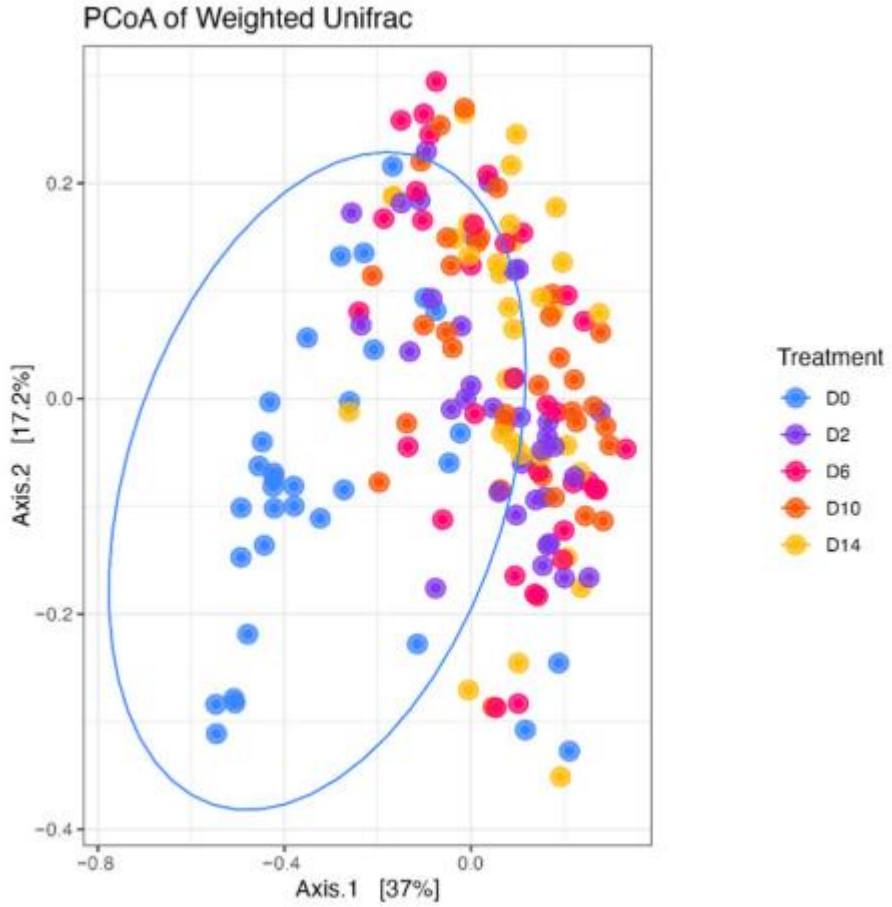
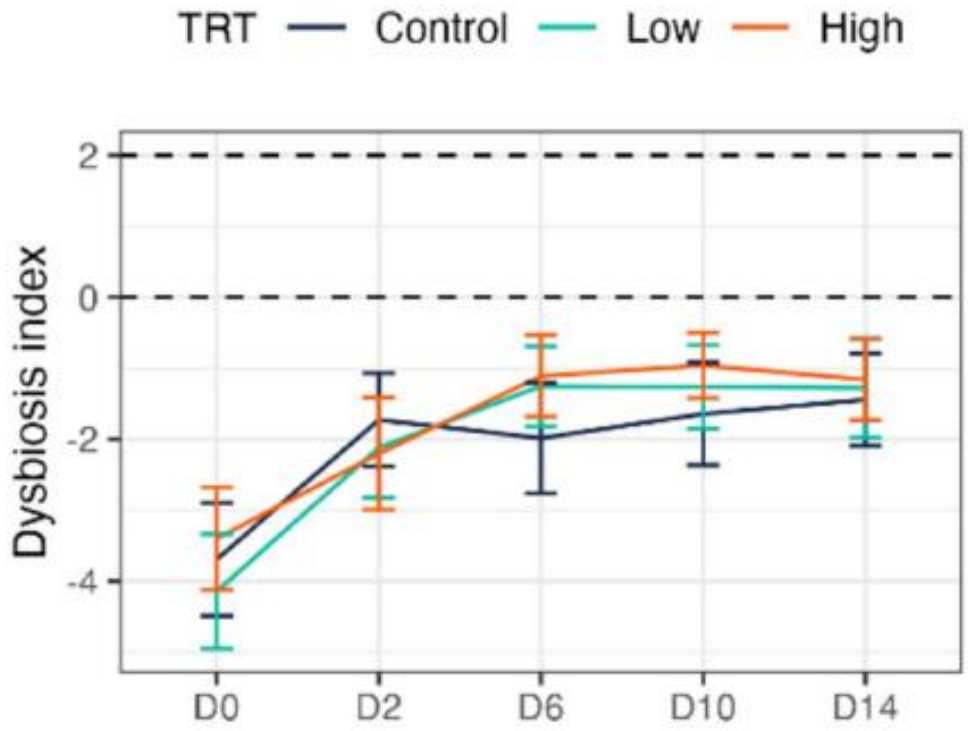


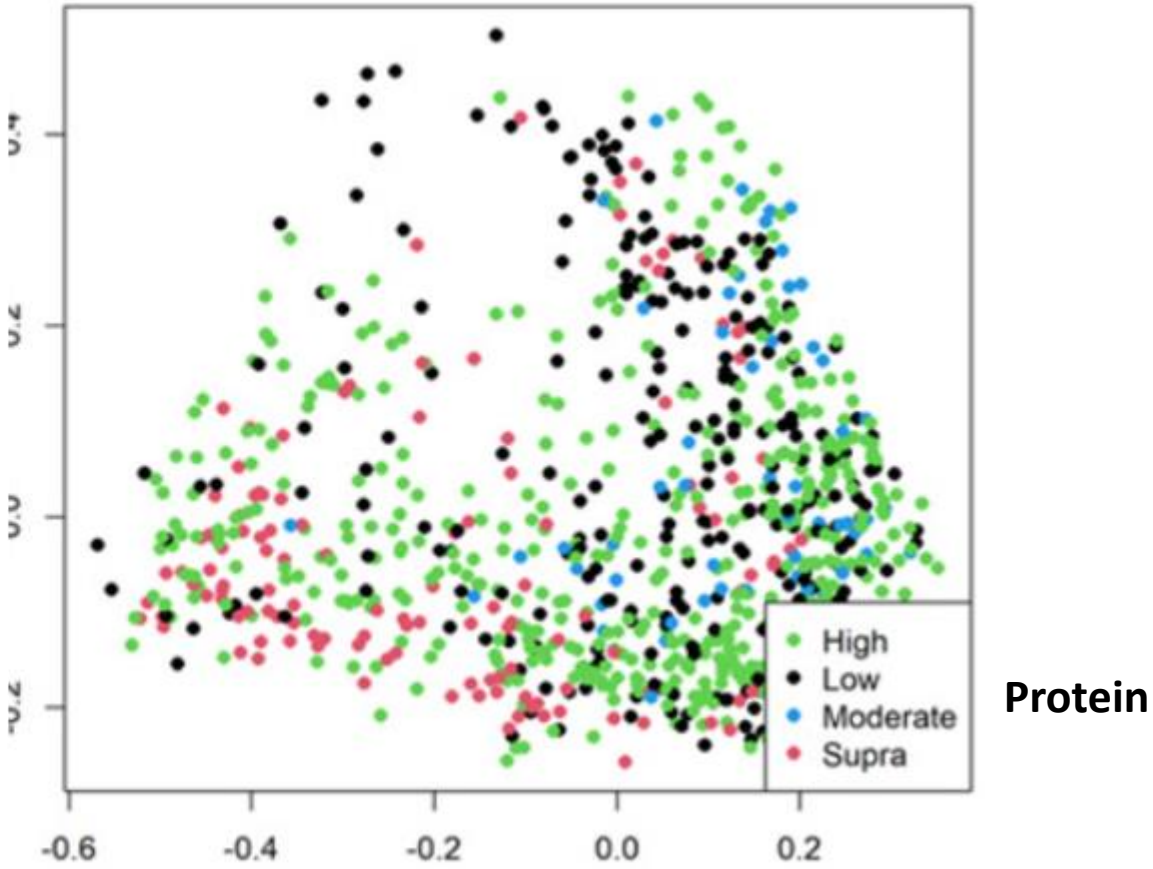


TRT = 0.4297
Day < 0.0001
TRT*Day = 0.7838

ORIGINAL ARTICLE | Open Access

Using meta-analysis to understand the impacts of dietary protein and fat content on the composition of fecal microbiota of domestic dogs (*Canis lupus familiaris*): A pilot study

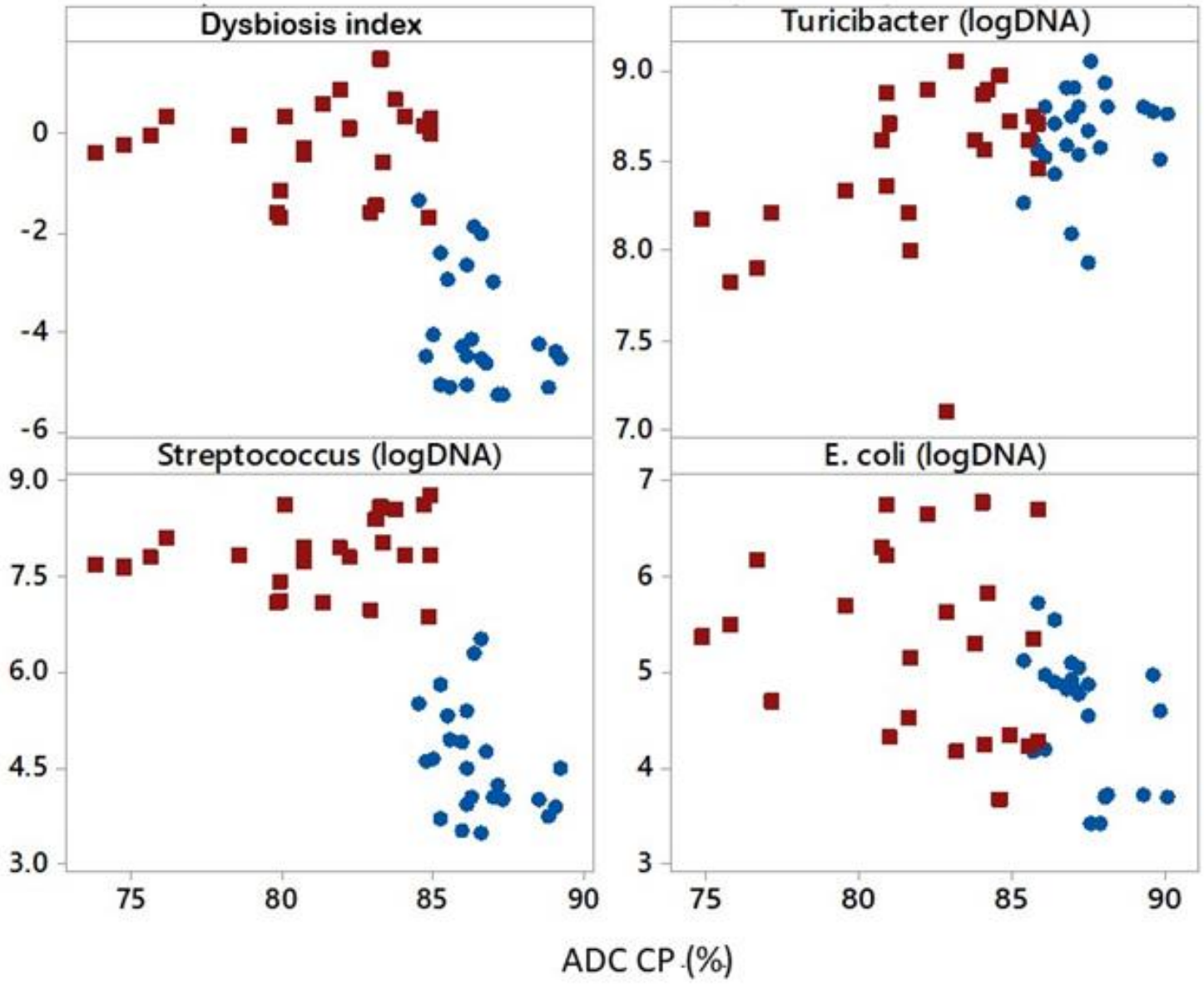
Francis D. Phimister, Rachel C. Anderson, David G. Thomas, Michelle J. Farquhar, Paul Maclean, Ruy Jauregui, Wayne Young, Christina F. Butowski, Emma N. Bermingham



Protein

- Identified changes in fecal microbiota composition at a more individual taxonomic level, corresponding to the levels of protein or fat
- However, **small effect size** and overlap between protein and fat levels at the overall community level

Lower Protein digestibility leads to shifts in the microbiome - higher Streptococcus and E. coli



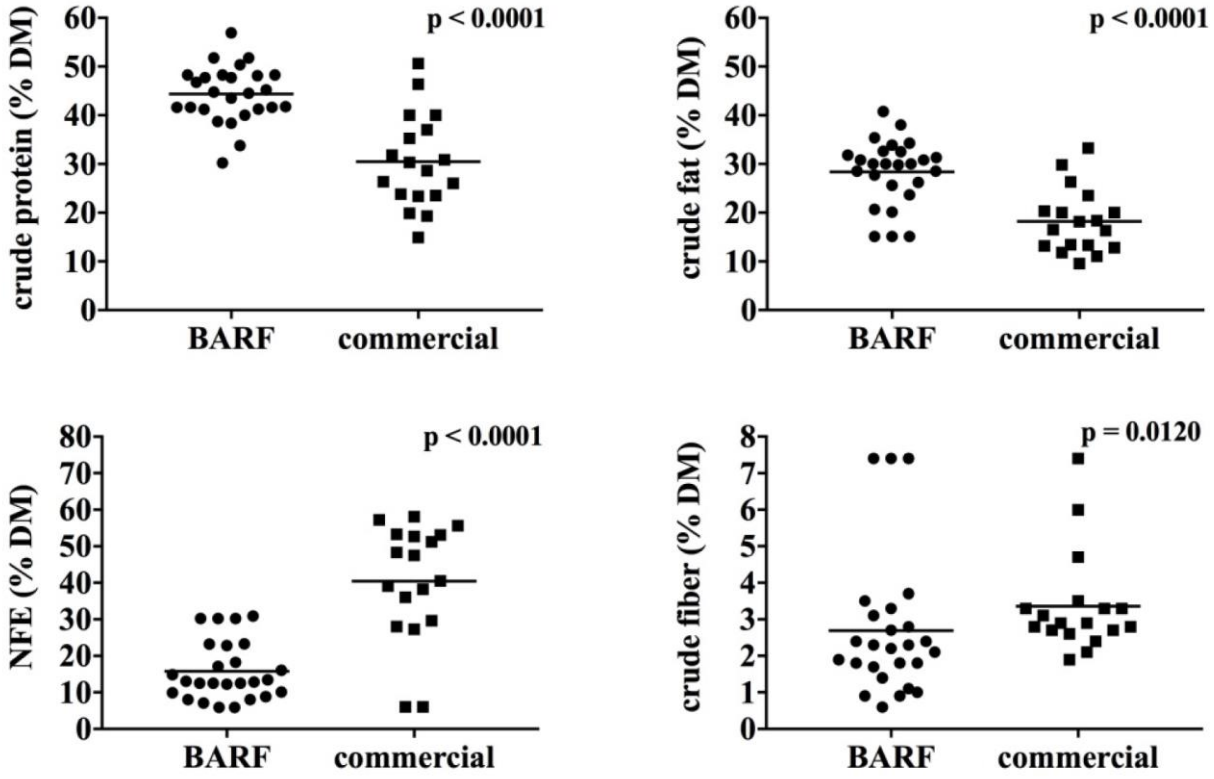
ADC CP = 80.43 ± 2.02%

ADC CP = 86.8 ± 0.59%

The fecal microbiome and metabolome differs between dogs fed Bones and Raw Food (BARF) diets and dogs fed commercial diets

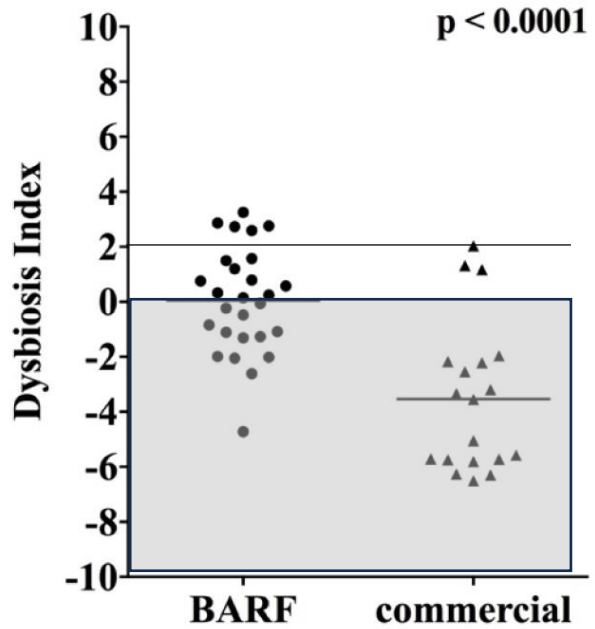
Milena Schmidt, Stefan Unterer, Jan S. Suchodolski, Julia B. Honneffer, Blake C. Guard, Jonathan A. Lidbury, Jörg M. Steiner, Julia Fritz, Petra Kölle

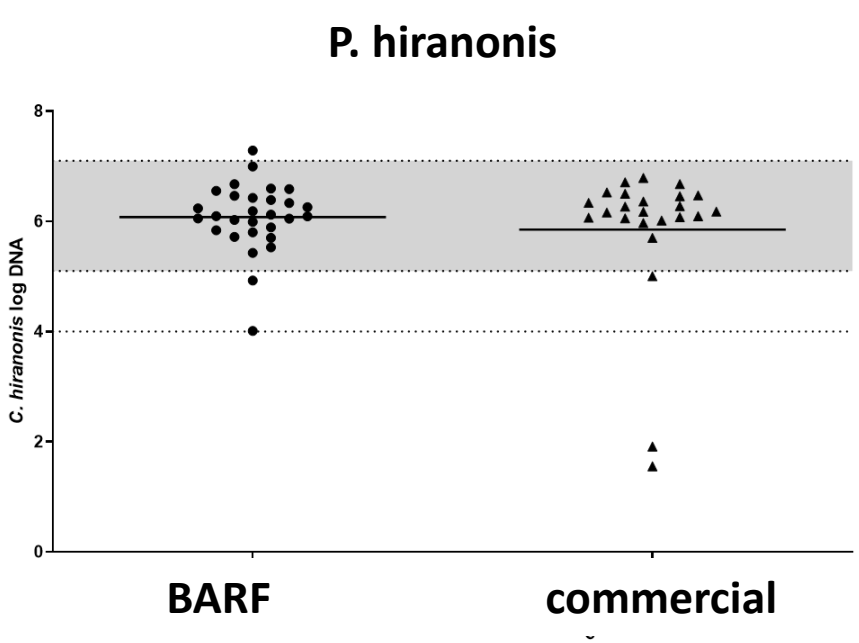
- Uncontrolled home-made diets with high fat and undigestible protein, low fiber

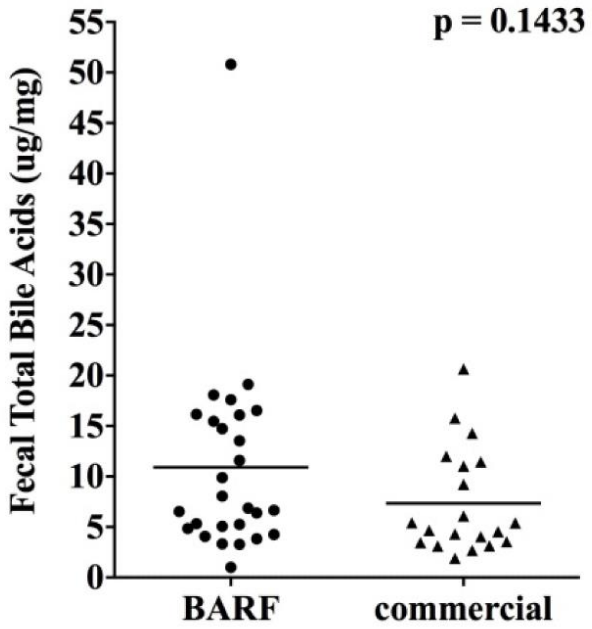


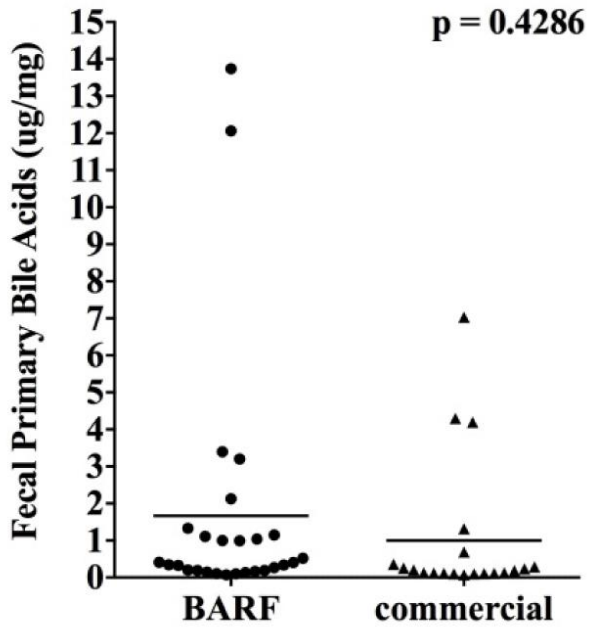
Category	Dog 1
Daily Ration	
Meat	80% (5×/week beef; 2×/week goat, lamb, chicken, fish)
Muscle meat	80%
Organs	20% (heart, esophagus, udder, liver)
Vegetables & Fruit	20%
Oil	20 g
Carbs	2×/week (pasta, rice, oats, potatoes ~175 g)
Dairy / Milk	2–3×/week ~200 g
Treats	50 g dried meat/week
Bread + Liver Sausage	—
Raw Egg	—
Bones	
Marrow bone	1×/week
Chicken parts	~400 g every 2 weeks

Category	Dog 2
Daily Ration	
Meat	150–200 g (tripe, esophagus, omasum, udder, lung)
Muscle meat	—
Organs	Included in meat
Vegetables & Fruit	50–100 g
Oil	10 g
Carbs	50 g flakes (corn, wheat, carrots, spinach, etc.)
Dairy / Milk	~150 ml milk
Treats	~20 g (dog biscuits with grains)
Bread + Liver Sausage	2×/week
Raw Egg	1×/week (no shell)
Bones	—
Marrow bone	—
Chicken parts	—


p < 0.0001
Dysbiosis Index
10
8
6
4
2
0
-2
-4
-6
-8
-10
BARF
commercial


P. hiranonis
C. hiranonis log DNA
8
6
4
2
0
BARF
commercial


p = 0.1433
Fecal Total Bile Acids (ug/mg)
55
50
45
40
35
30
25
20
15
10
5
0
BARF
commercial


p = 0.4286
Fecal Primary Bile Acids (ug/mg)
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
BARF
commercial

Effect of Raw or Kibble Diets on Fecal Microbial and Metabolic Biomarkers in Healthy Dogs

Wenyi Huang[1]; Susan Wynn[2]; M. Katherine Tolbert[1]; Ashley L. Self[1]; Floris C. Dröes[1]; Jan S. Suchodolski[1]

AAVN 2025

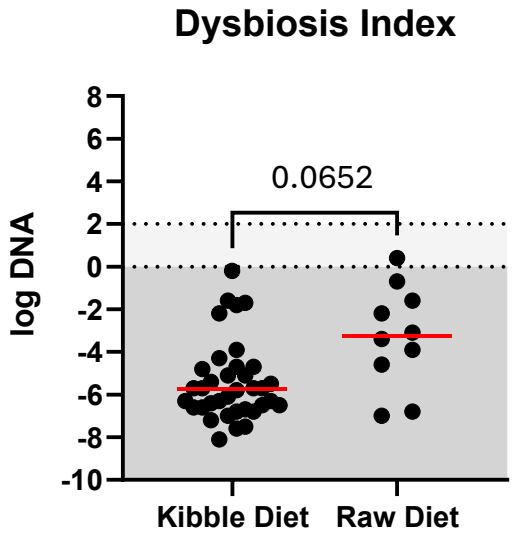
Study Population:

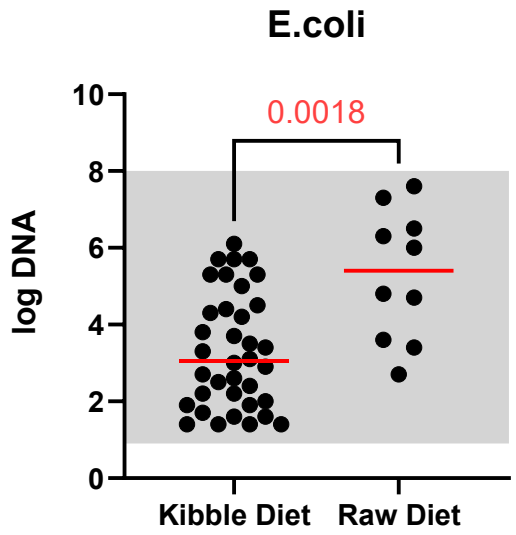
- Fecal samples collected from clinically healthy dogs fed for at least 1 month:

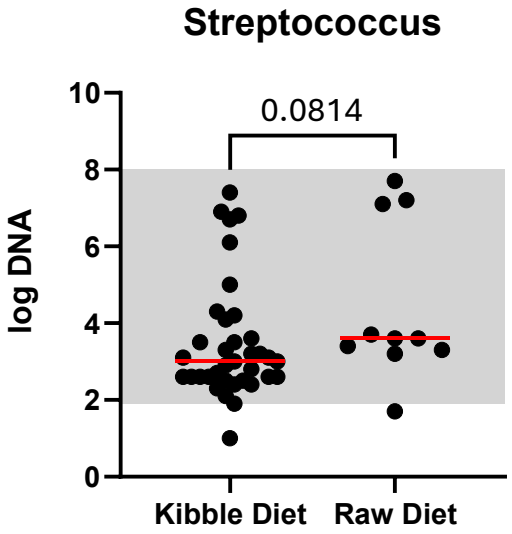
  - Various **Commercial** Raw Diets (n=10)

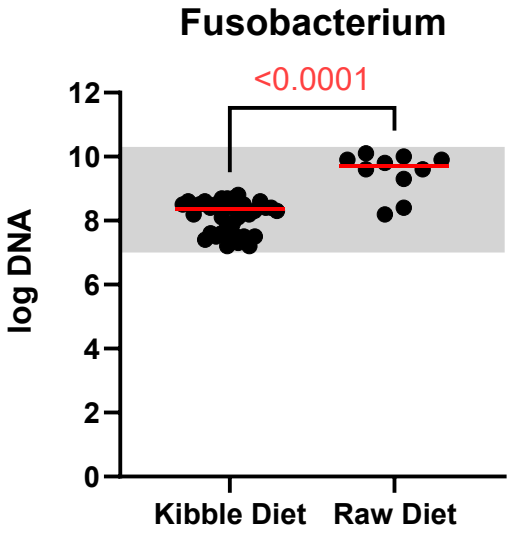
  - Various Commercial Kibble Diets (n=36)

Core Bacteria

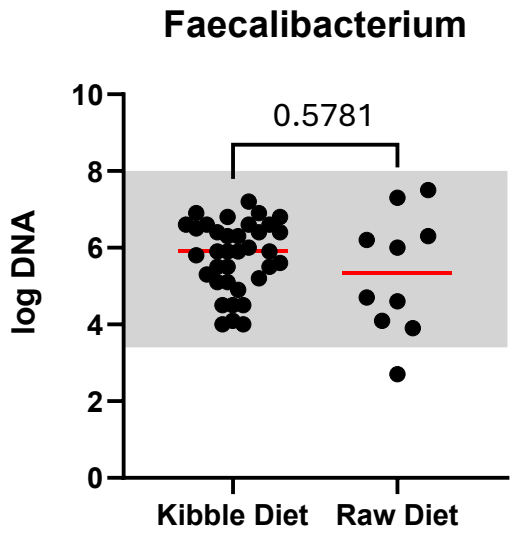


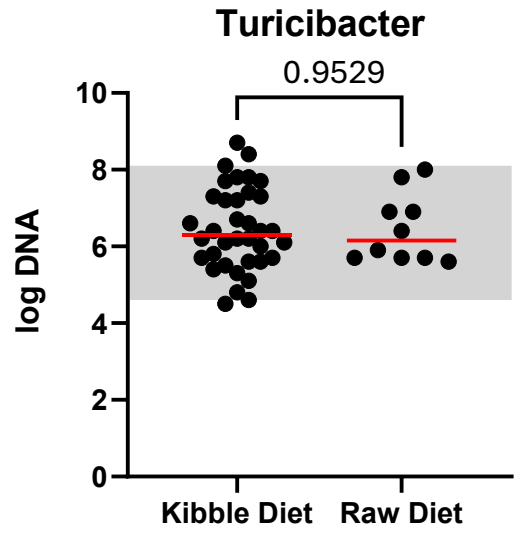


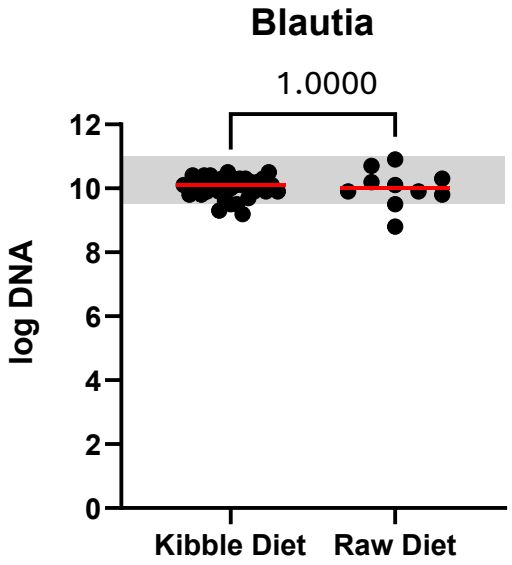


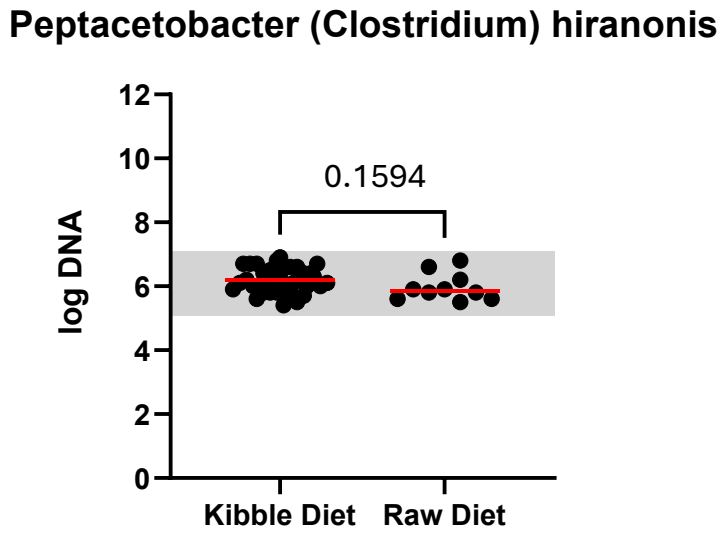


Core Bacteria

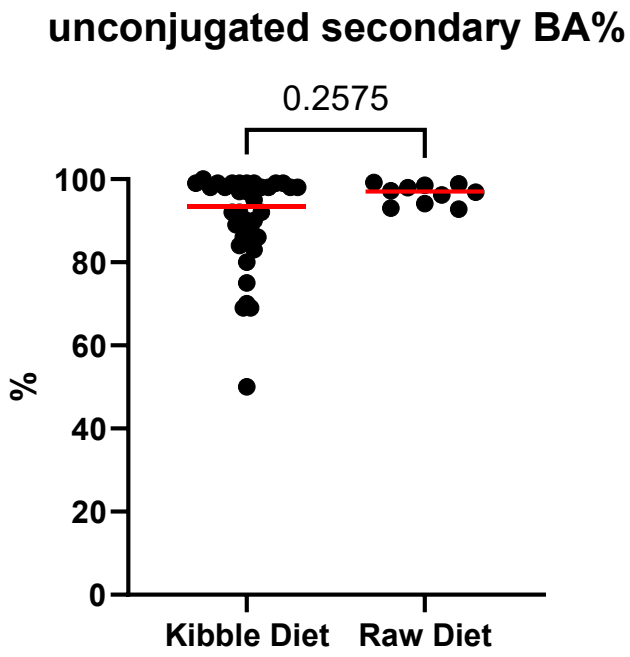


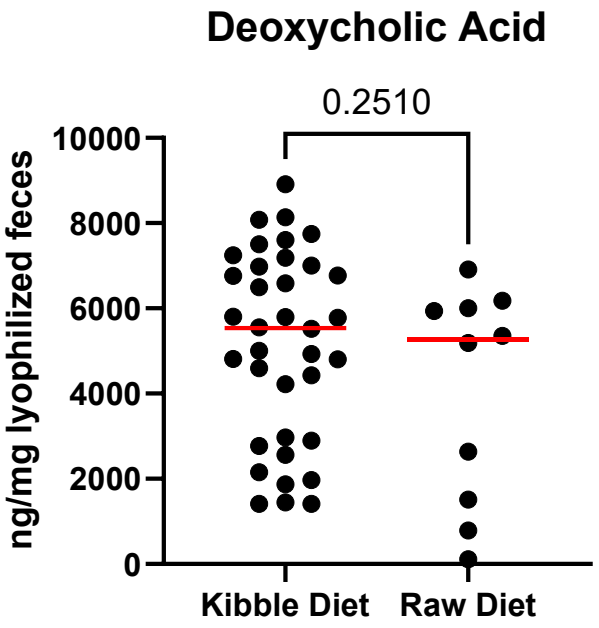


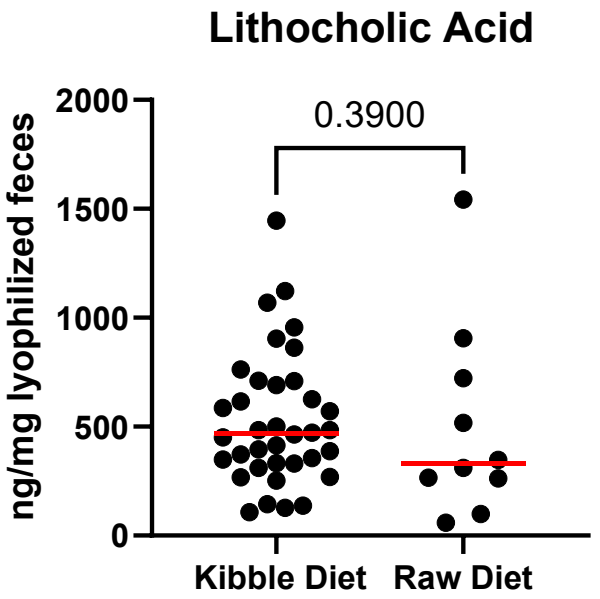




Fecal Bile Acid



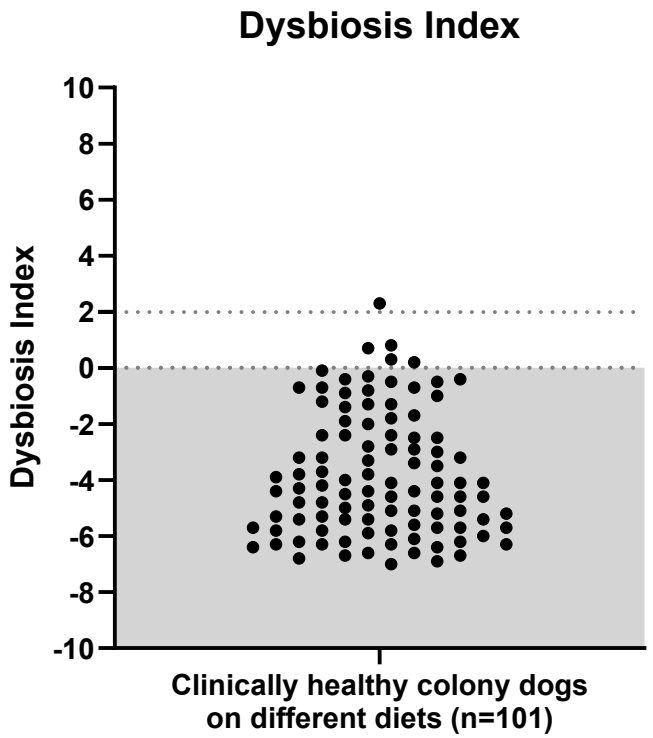


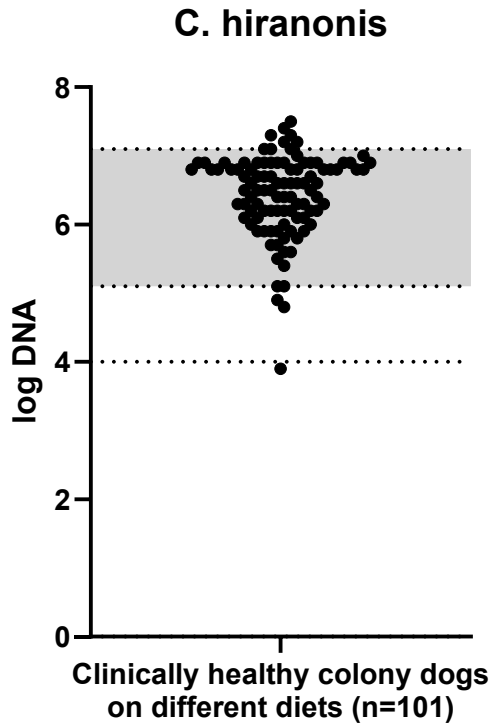


Effects of diet type on the core fecal bacterial taxa and the dysbiosis index of healthy adult dogs

Patrícia M. Oba[1], Leah J. Roberts[1], Elizabeth L. Geary[1], Jan S. Suchodolski[2], Kelly S. Swanson[1*]

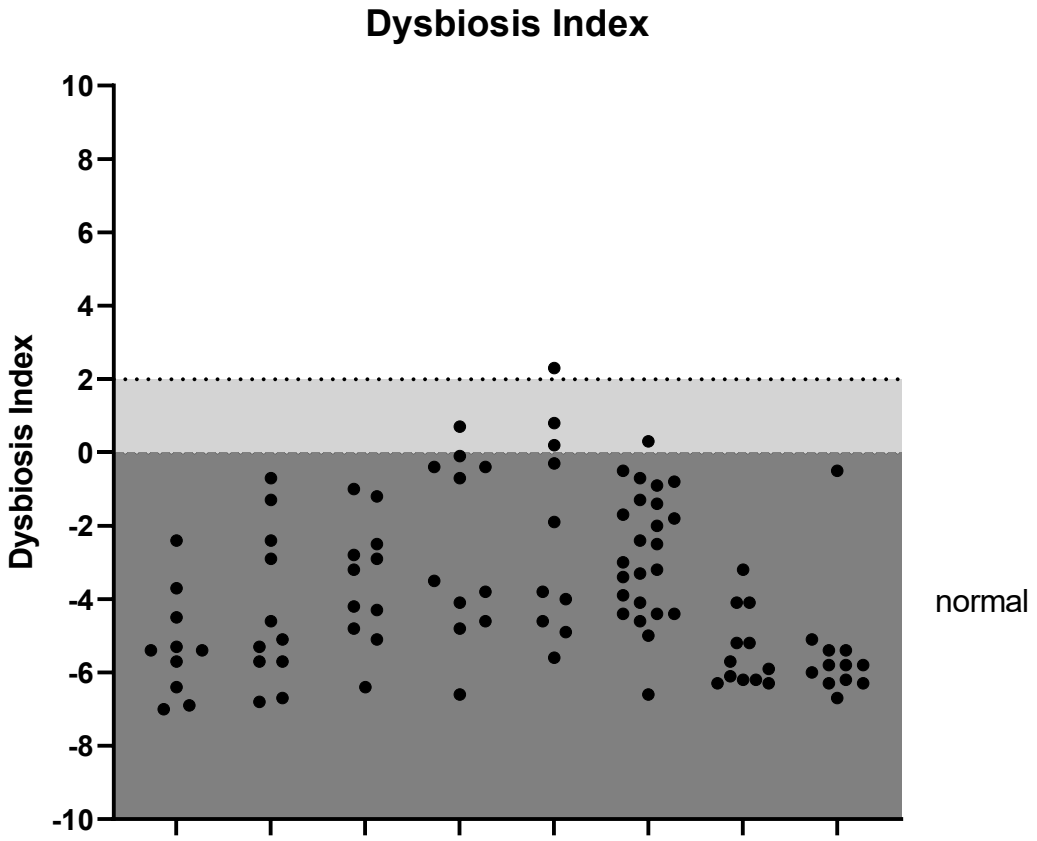
[1]University of Illinois at Urbana-Champaign, United States, [2]Department of Small Animal Clinical Sciences, College of Veterinary Medicine & Biomedical Sciences, Texas A&M University, United States

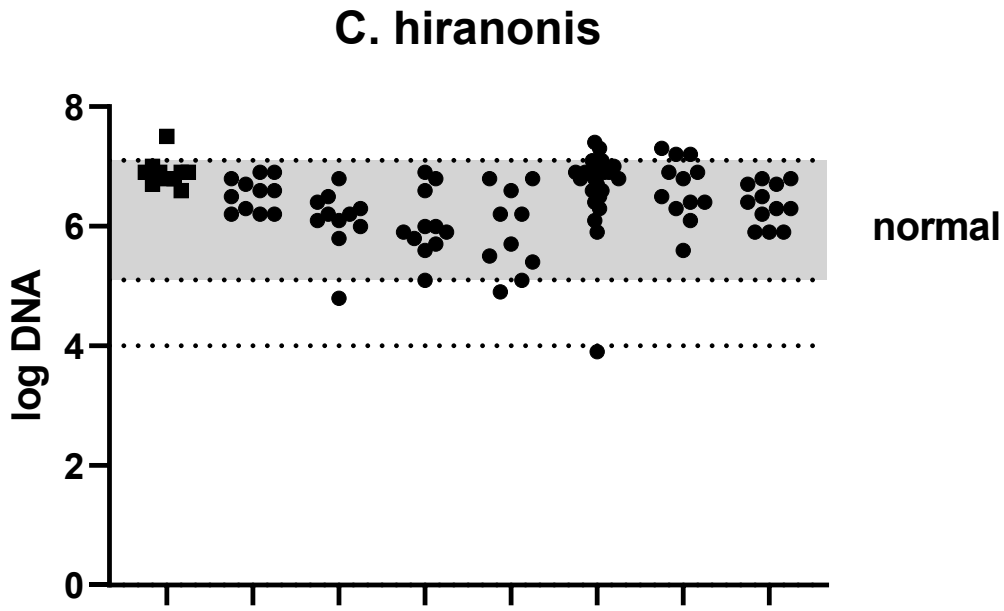


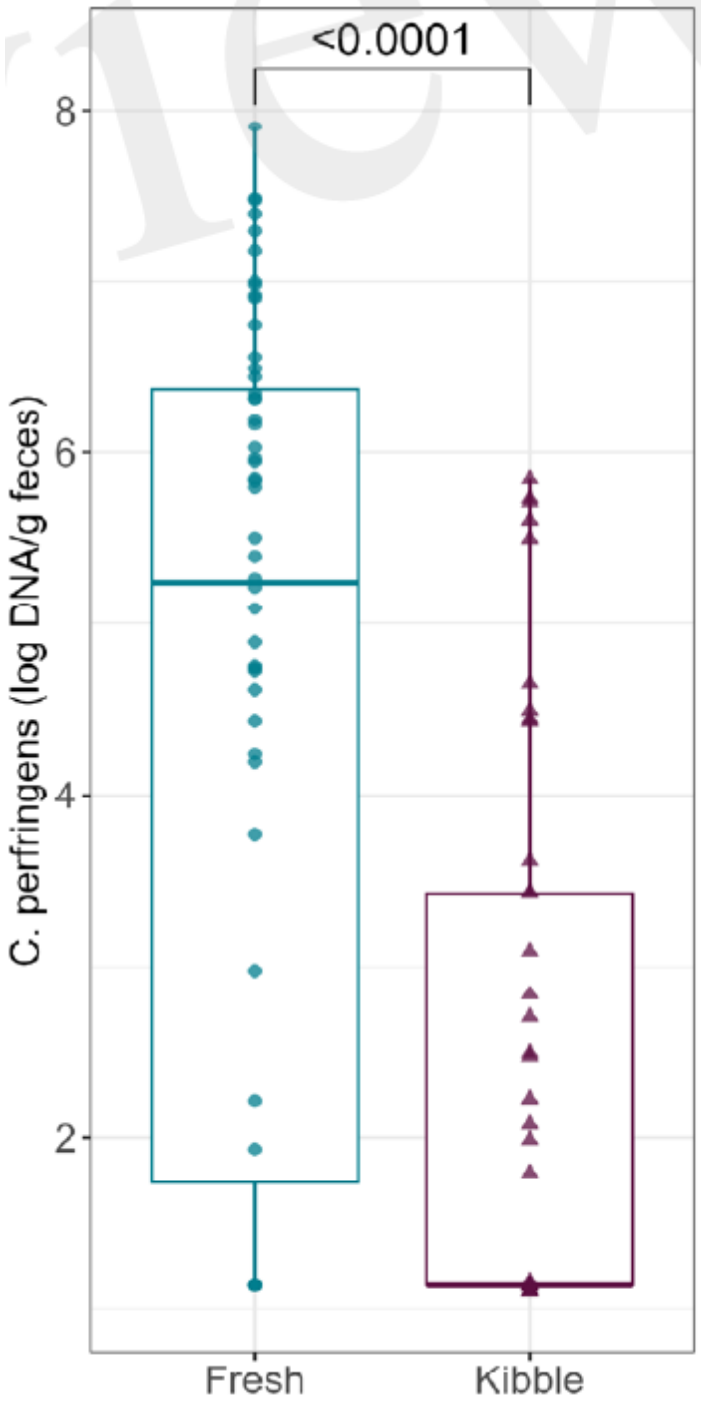


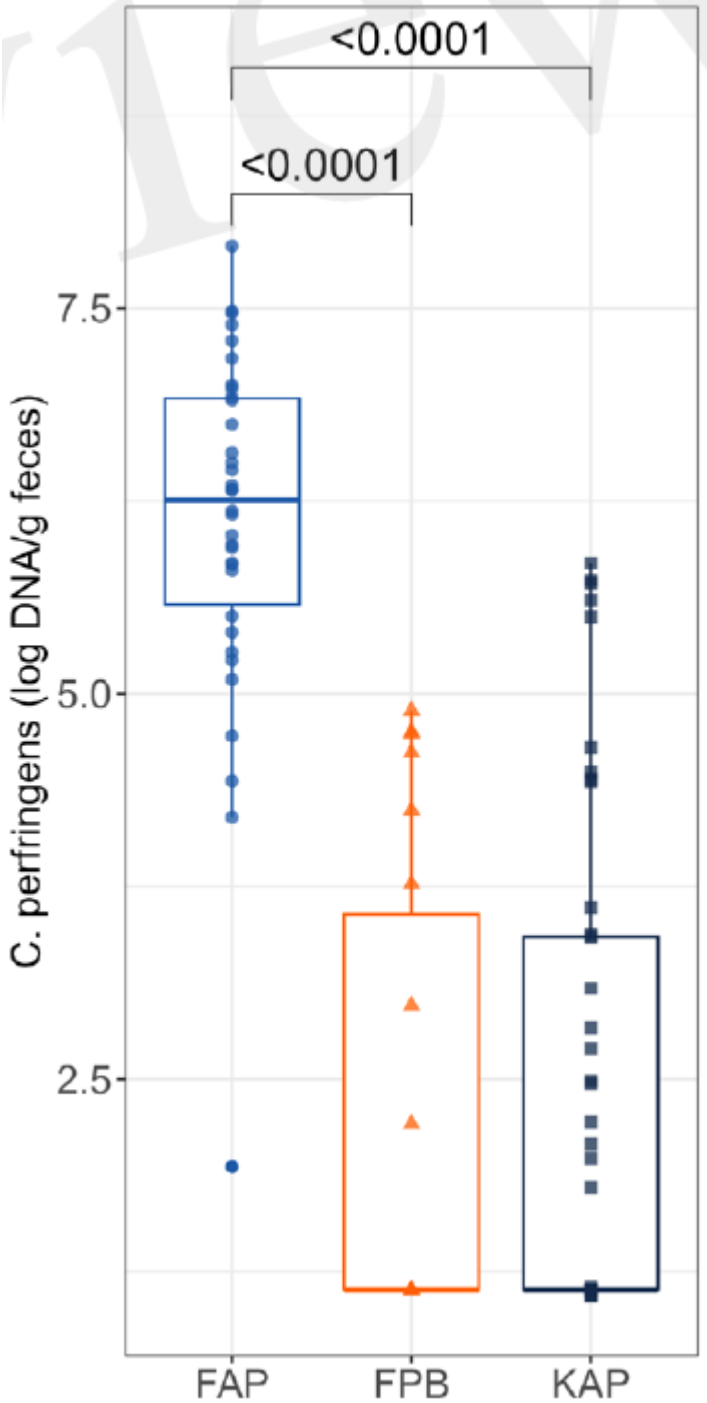
- 101 healthy dogs on various balanced diet types
  - kibble, plant protein, fresh food, raw-based

- While there is variation, the Dysbiosis Index stays typically within normal
  - 1% of dogs had DI > 2









- fresh animal protein-based diets (FAP)
- fresh plant protein-based diets (FPB)
- kibble animal protein-based diets (KAP)

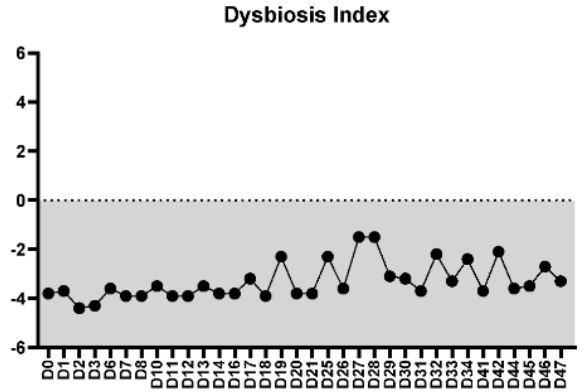
Temporal Variability of the Dominant Fecal Microbiota in Healthy Adult Cats

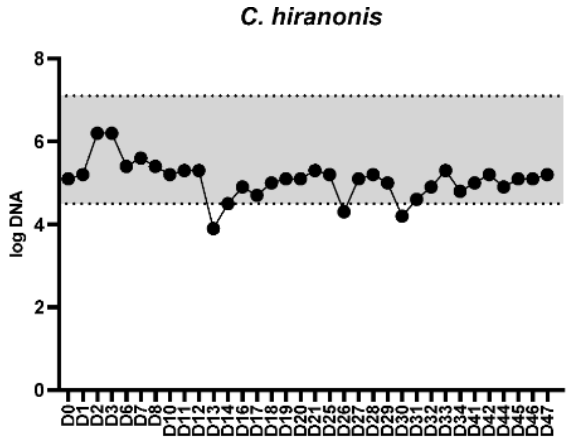
by Chi-Hsuan Sung [1], Sina Marsilio [2], Rachel Pilla [1], Yu-An Wu [1], Joao Pedro Cava
Min-Pyo Hong [1] and Jan S. Suchodolski [1,*]

Clinically healthy cats

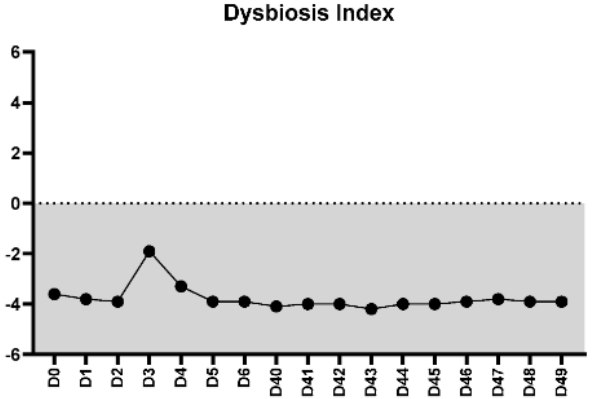
- Some have very stable microbiome
- Some vary a lot, but within normal

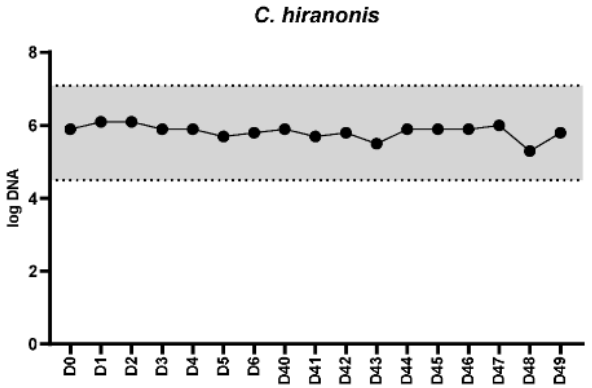
Cat 01



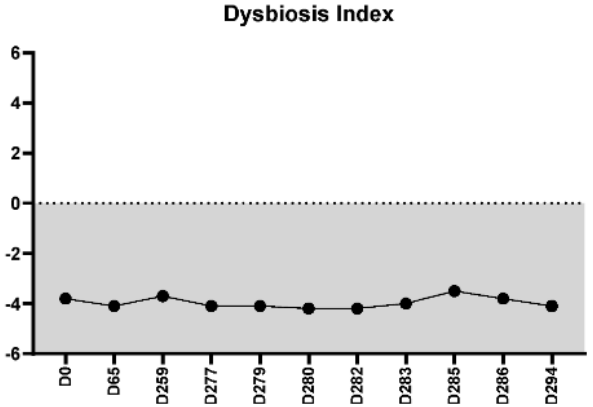


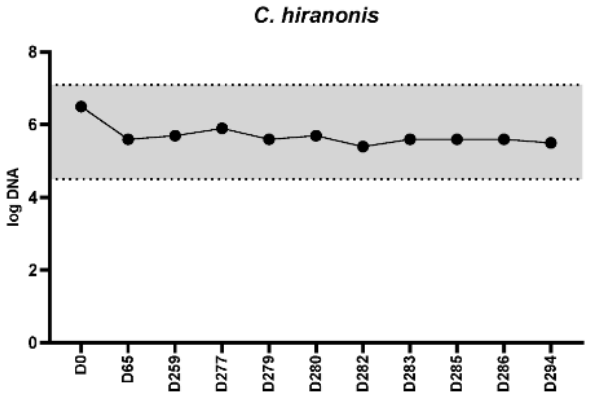
Cat 03





Cat 05



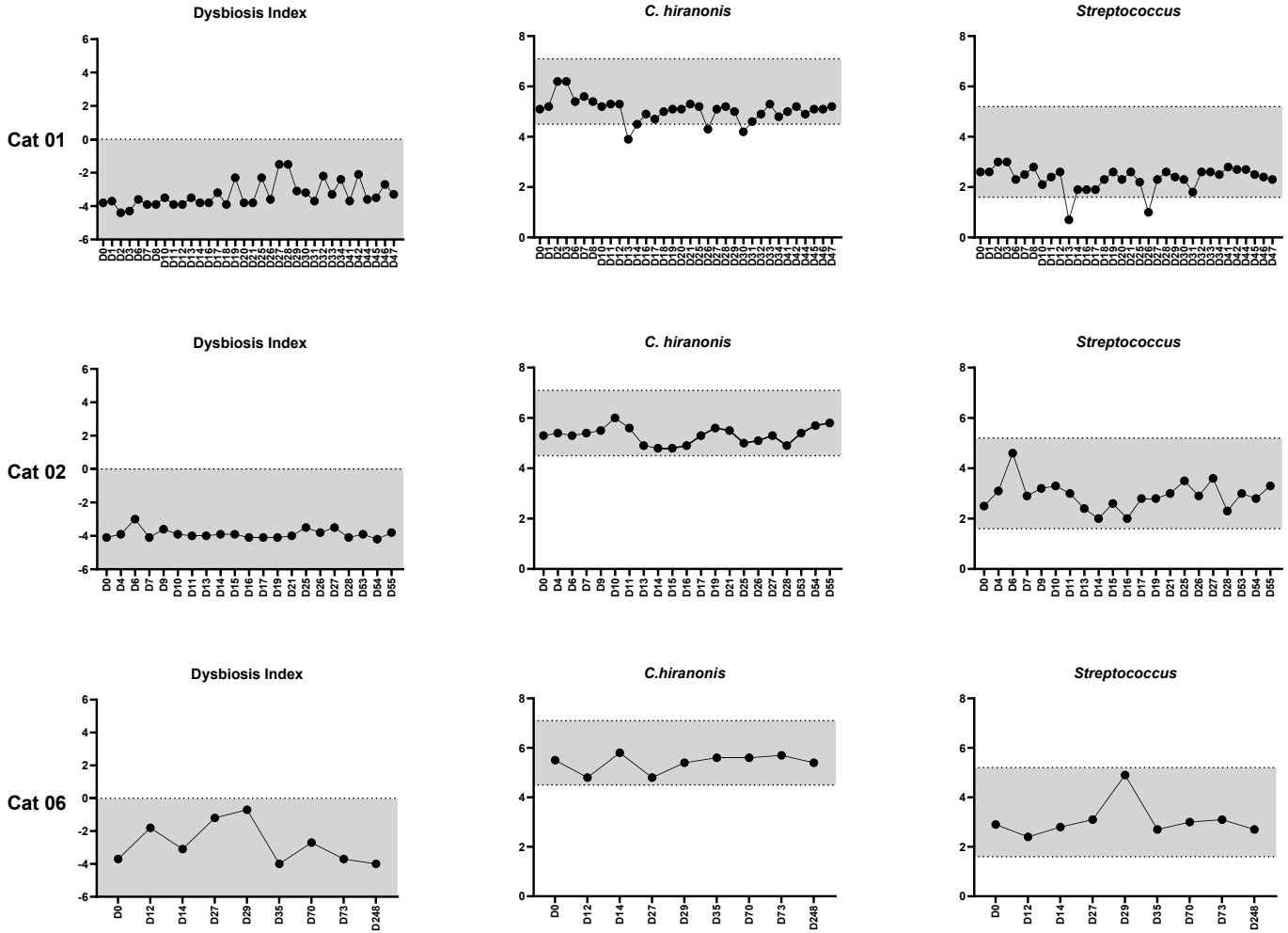


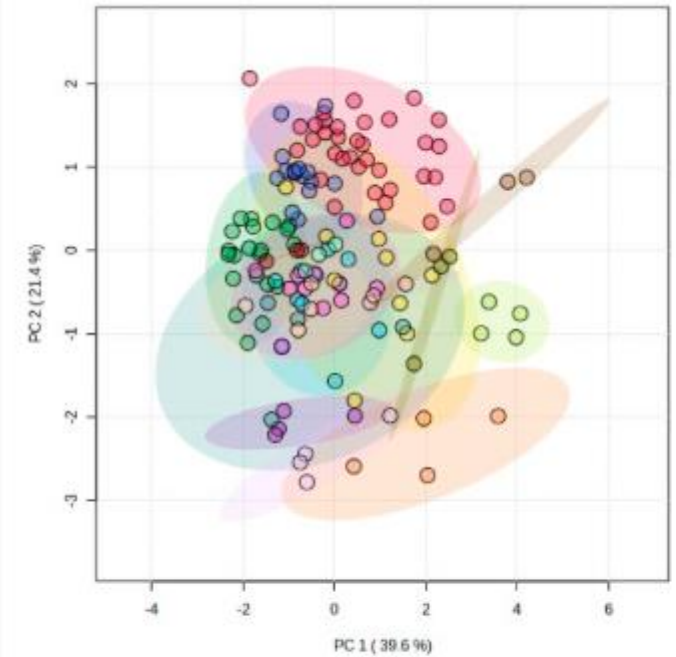
Temporal Variability of the Dominant Fecal Microbiota in Healthy Adult Cats

by Chi-Hsuan Sung [1], Sina Marsilio [2], Rachel Pilla [1], Yu-An Wu [1], Joao Pedro Cavasin [1], Min-Pyo Hong [1] and Jan S. Suchodolski [1,*]

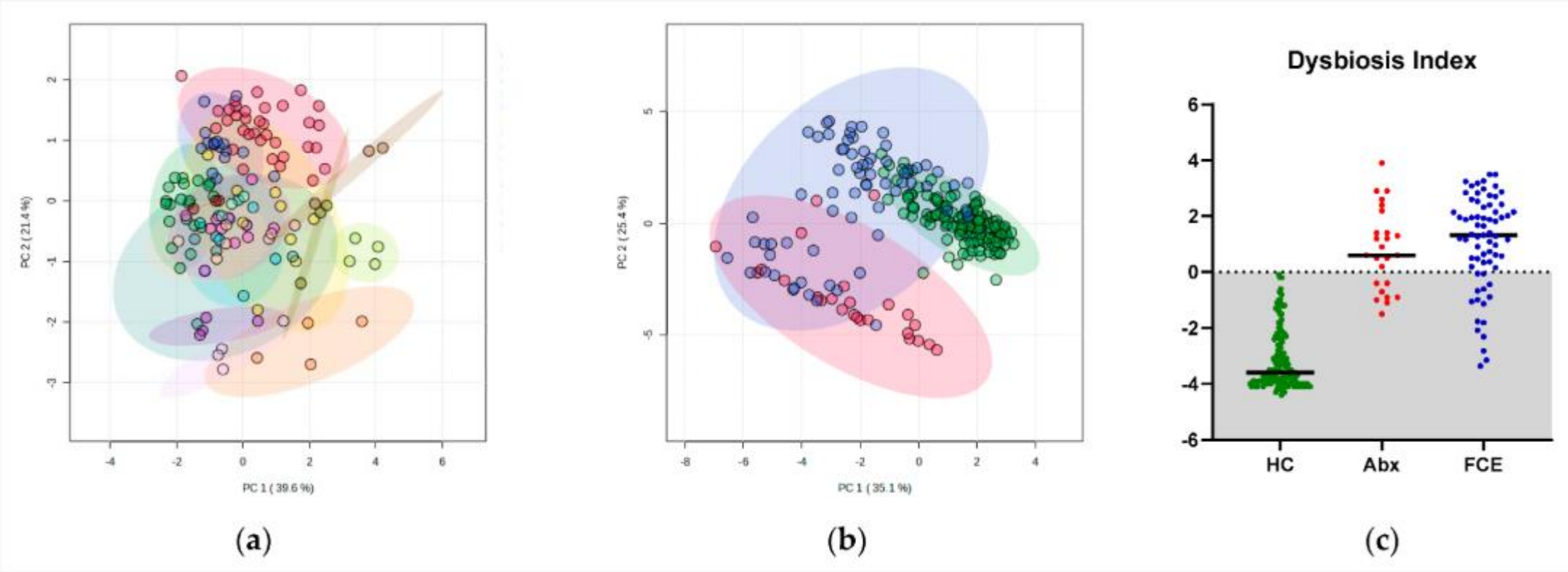
Streptococcus seems most variable group

- Quicker transit time – more undigested food reaches colon where lactic acid bacteria can overgrow because of lower pH?
- Cats receive treats?





(a) qPCR results in 17 healthy cats across multiple time points. Each cat's microbiota at a given time point had higher similarity to its own at other time points.



- Cats show inter-individual variation when healthy
- But this inter-individual variation is much smaller than the dysbiosis observed in CE or antibiotics

Abrupt Diet Change

- Diet change is common
- Gradual transition recommended
- What if change is abrupt?
- Considerations
  - Nutrient (protein; fiber)
  - Moisture content (gut fill)
  - Diet format (nutrients; gut fill)

Abrupt Diet Change

RESEARCH Open Access

Longitudinal fecal microbiome and metabolite data demonstrate rapid shifts and subsequent stabilization after an abrupt dietary change in healthy adult dogs

Ching-Yen Lin[1], Aashish R. Jha[2,3], Patrícia M. Oba[4], Sofia M. Yotis[4], Justin Shmalberg[2,5], Ryan W. Honaker[2] and Kelly S. Swanson[1,4,6*]

- Diet format (nutrients, gut fill)

Abrupt Diet Change

- Healthy adult dogs
  - Diet fed kibble 14 days, then changed to:
    - Kibble diet + soluble corn fiber (top dress)
    - Canned diet
  - Fecal sampling (before and 2, 6, 10, and 13 days after)

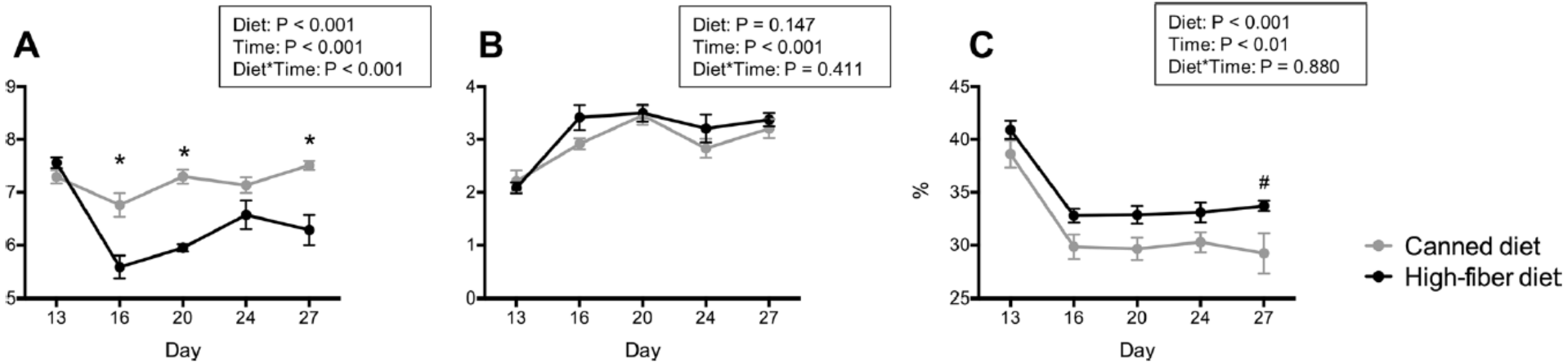
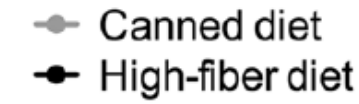


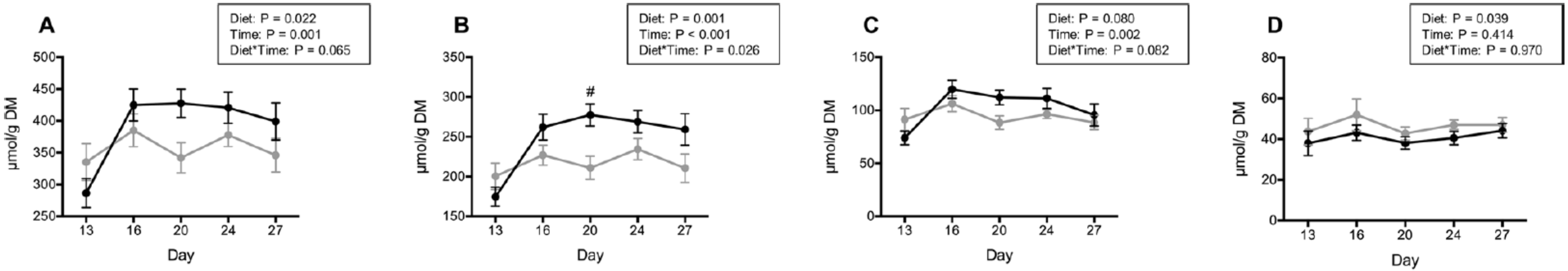
Fig. 1 Fecal characteristics, including fecal pH (**A**), fecal scores (**B**), and fecal dry matter (**C**) of dogs fed a high-fiber diet or protein-rich canned diet.

Lin et al., 2022

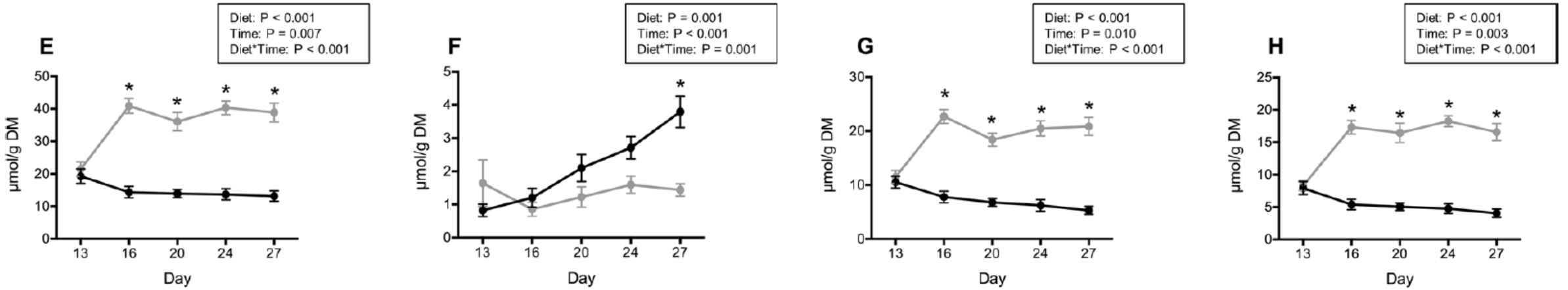
Most Fecal Metabolites Shifted in 2 Days



- Fecal total SCFA, acetate, propionate, and butyrate



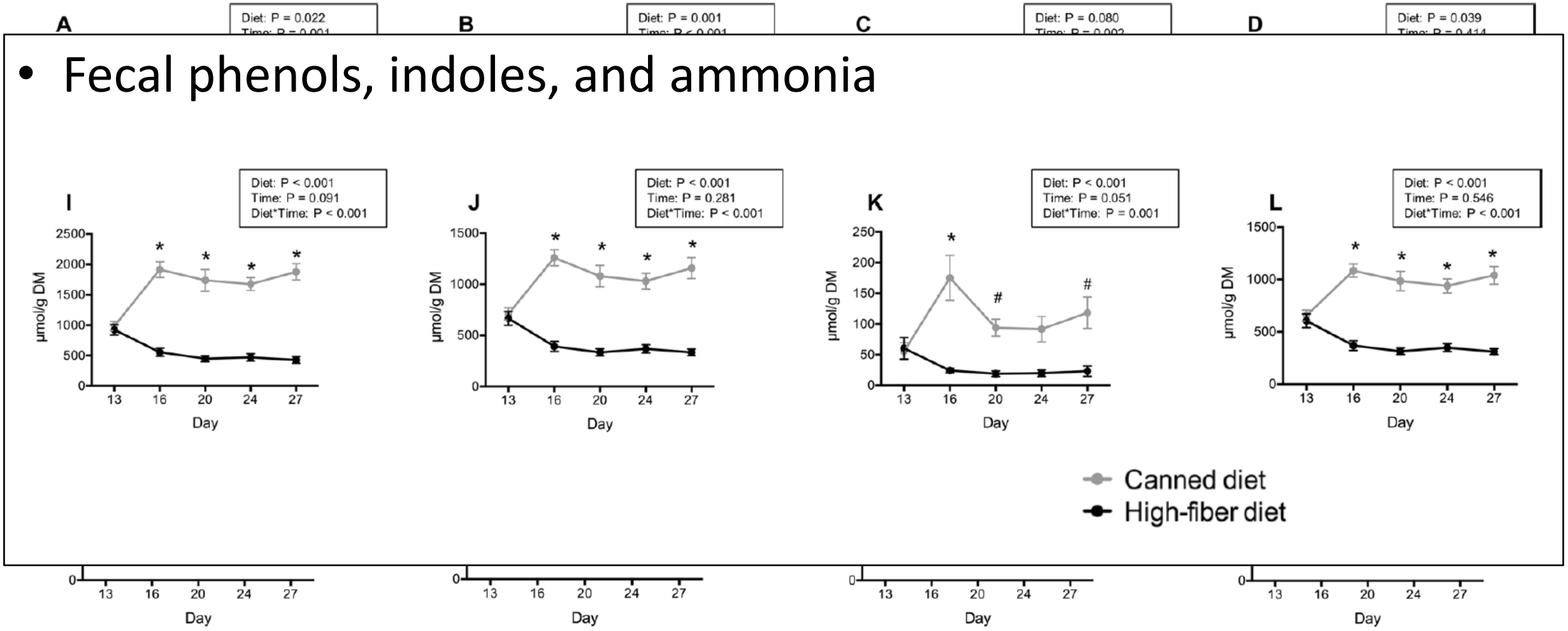
- Fecal total BCFA, valerate, isovalerate, and isobutyrate



Lin et al., 2022

Most Fecal Metabolites Shifted in 2 Days

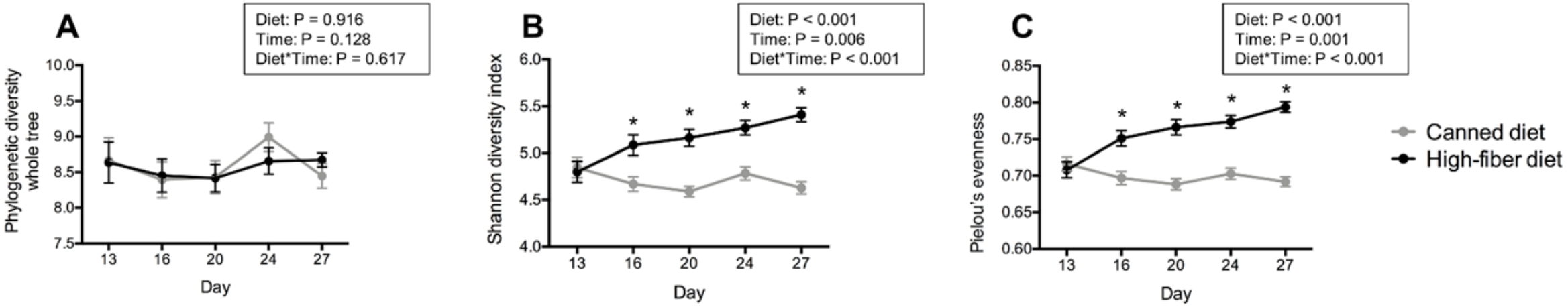
- Fecal total SCFA, acetate, propionate, and butyrate
- Fecal phenols, indoles, and ammonia



Lin et al., 2022

Most Fecal Microbiota Shifted in 6 Days

- Alpha and beta diversity



Lin et al., 2022

Most Fecal Microbiota Shifted in 6 Days

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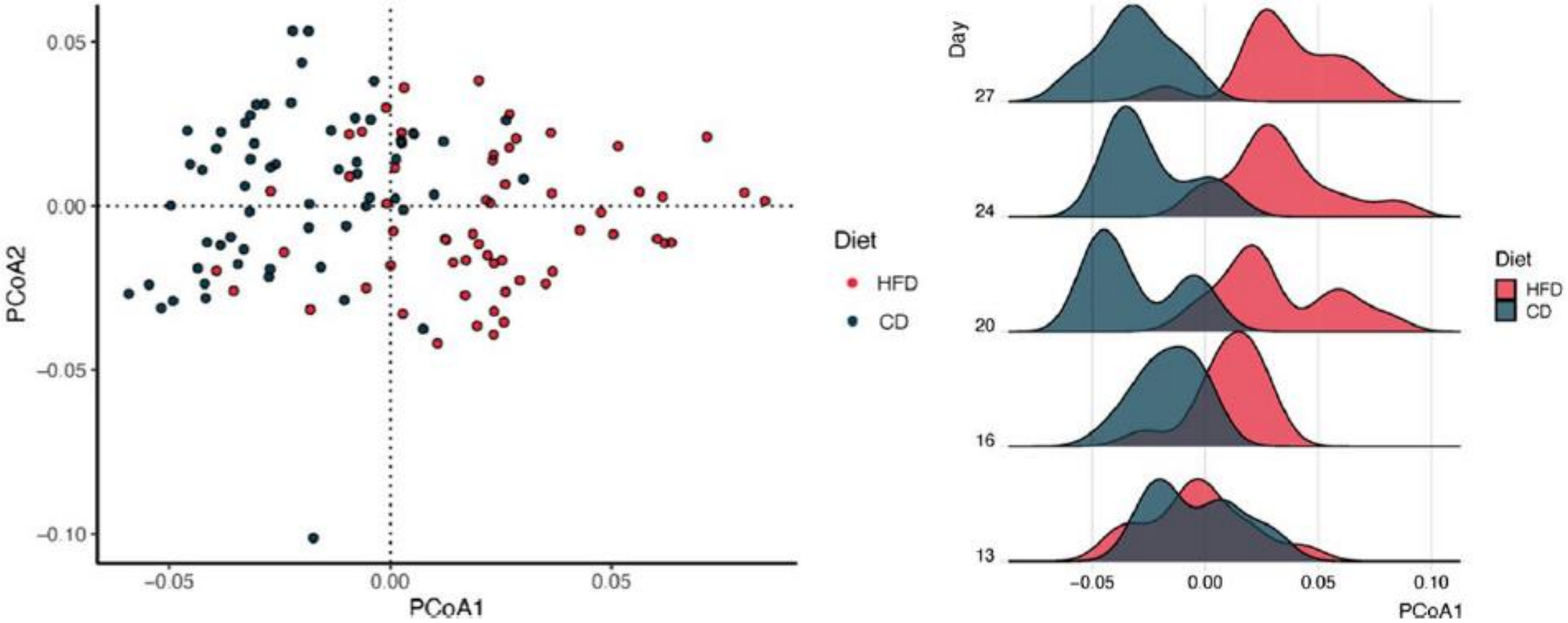

Lin et al., 2022

Most Fecal Microbiota Shifted in 6 Days

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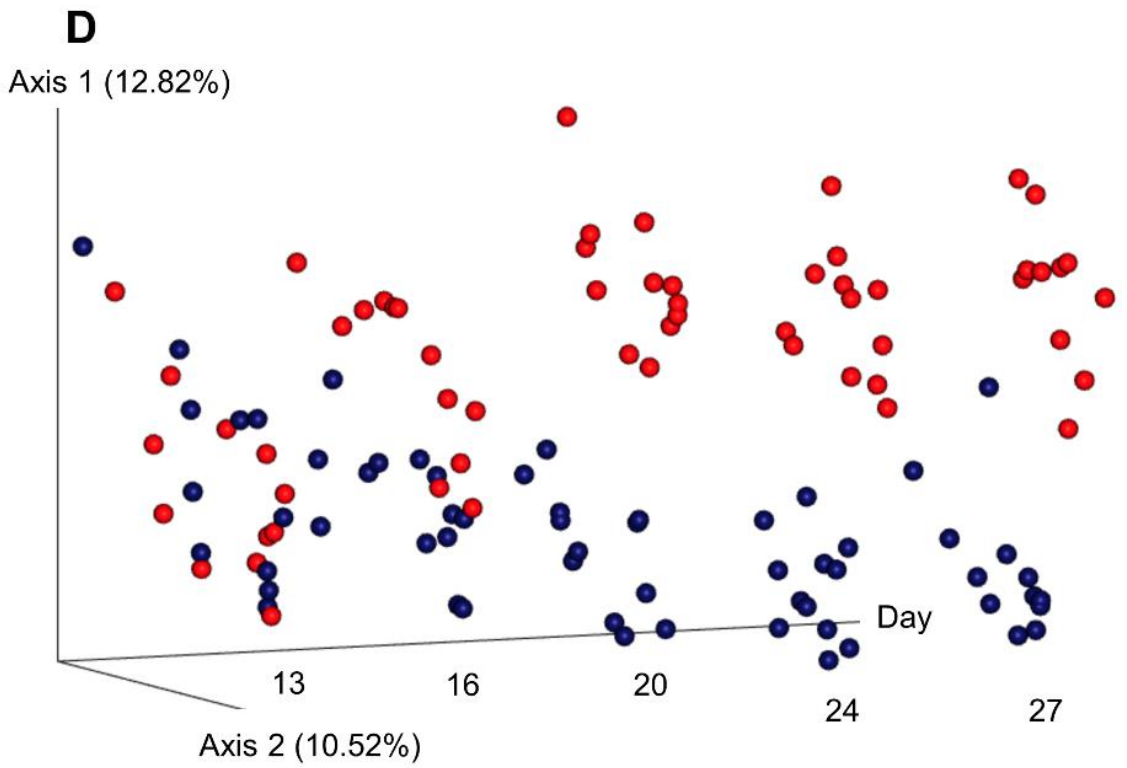
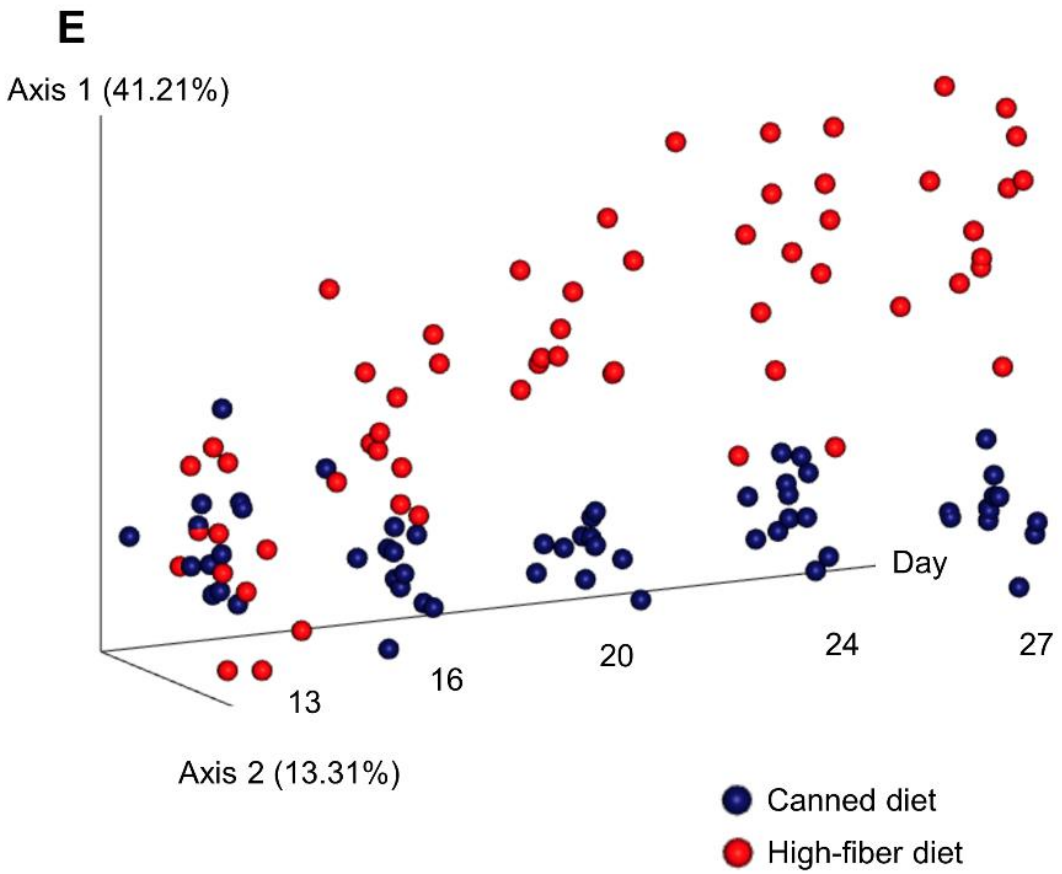
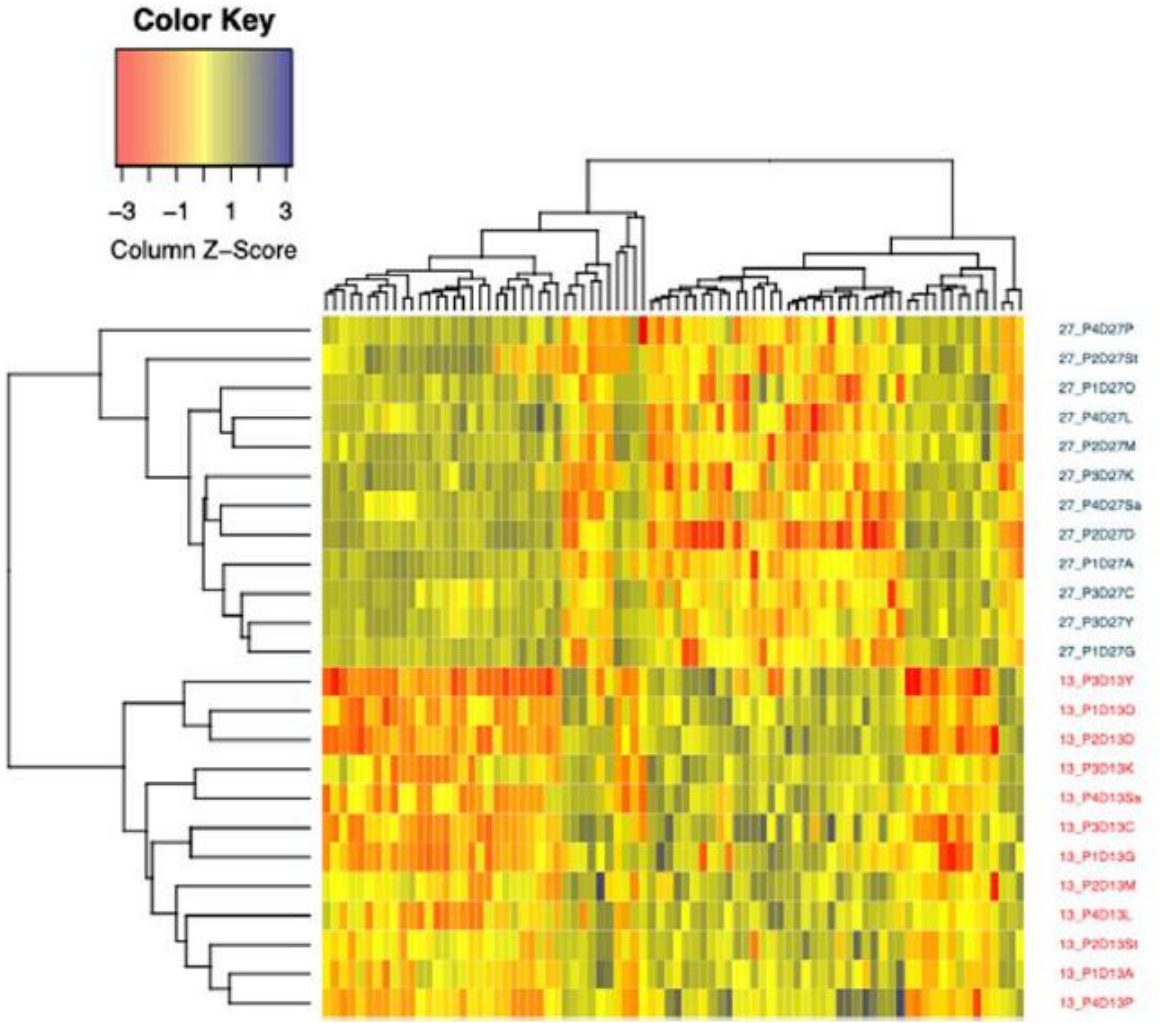


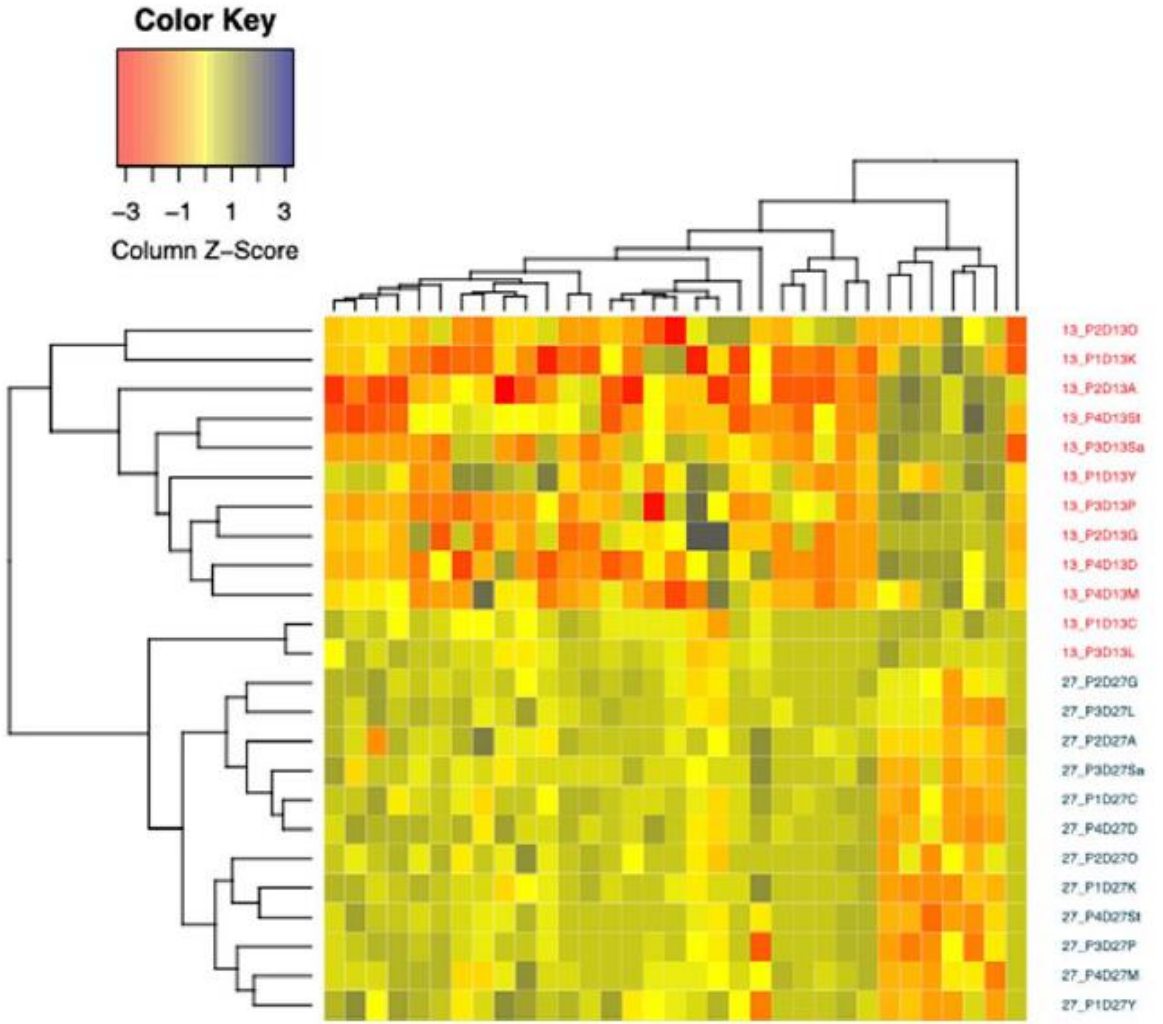


Lin et al., 2022

Fecal Microbial Functional Capacity

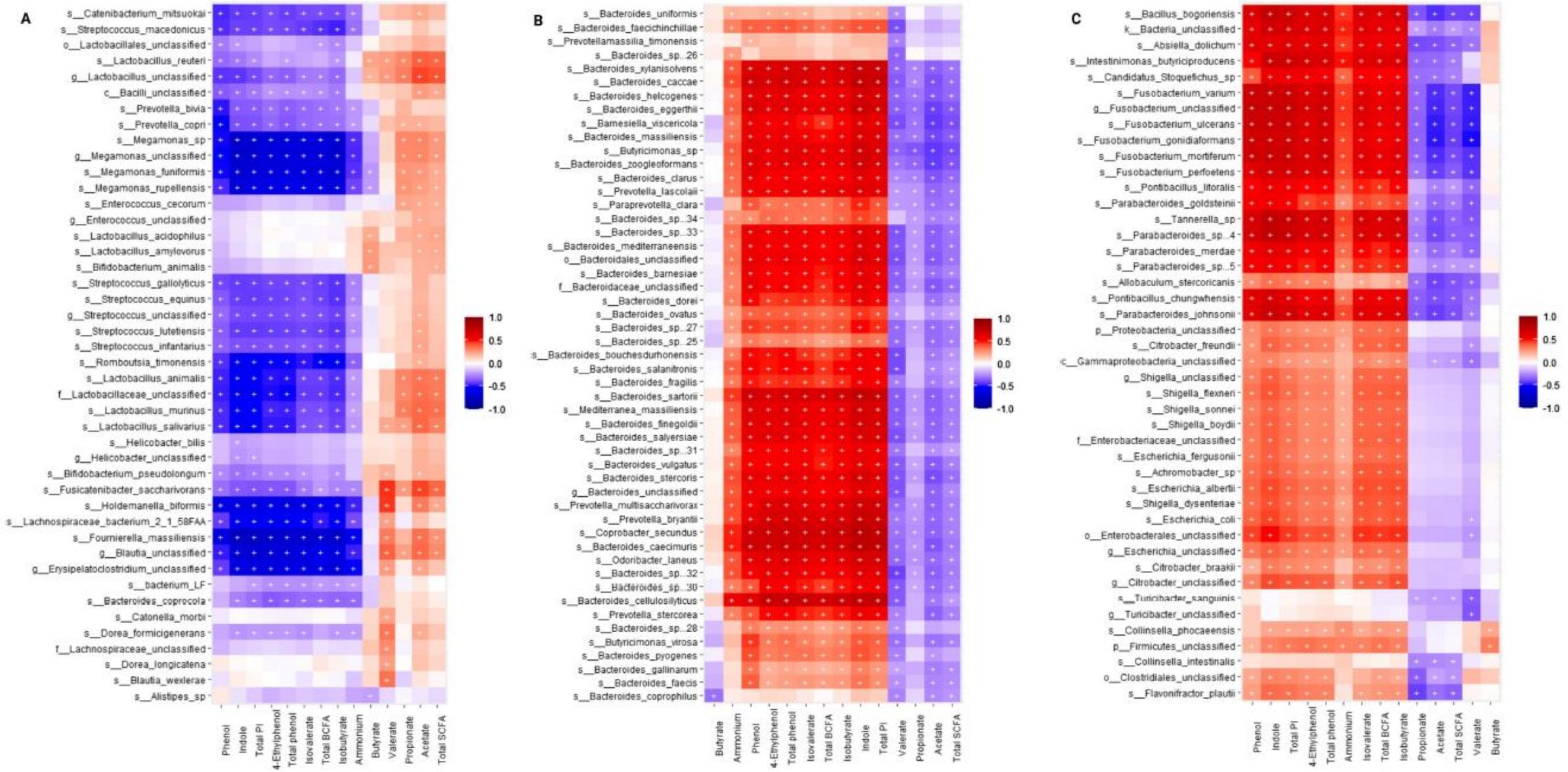
- Clear differences and dependent on diet





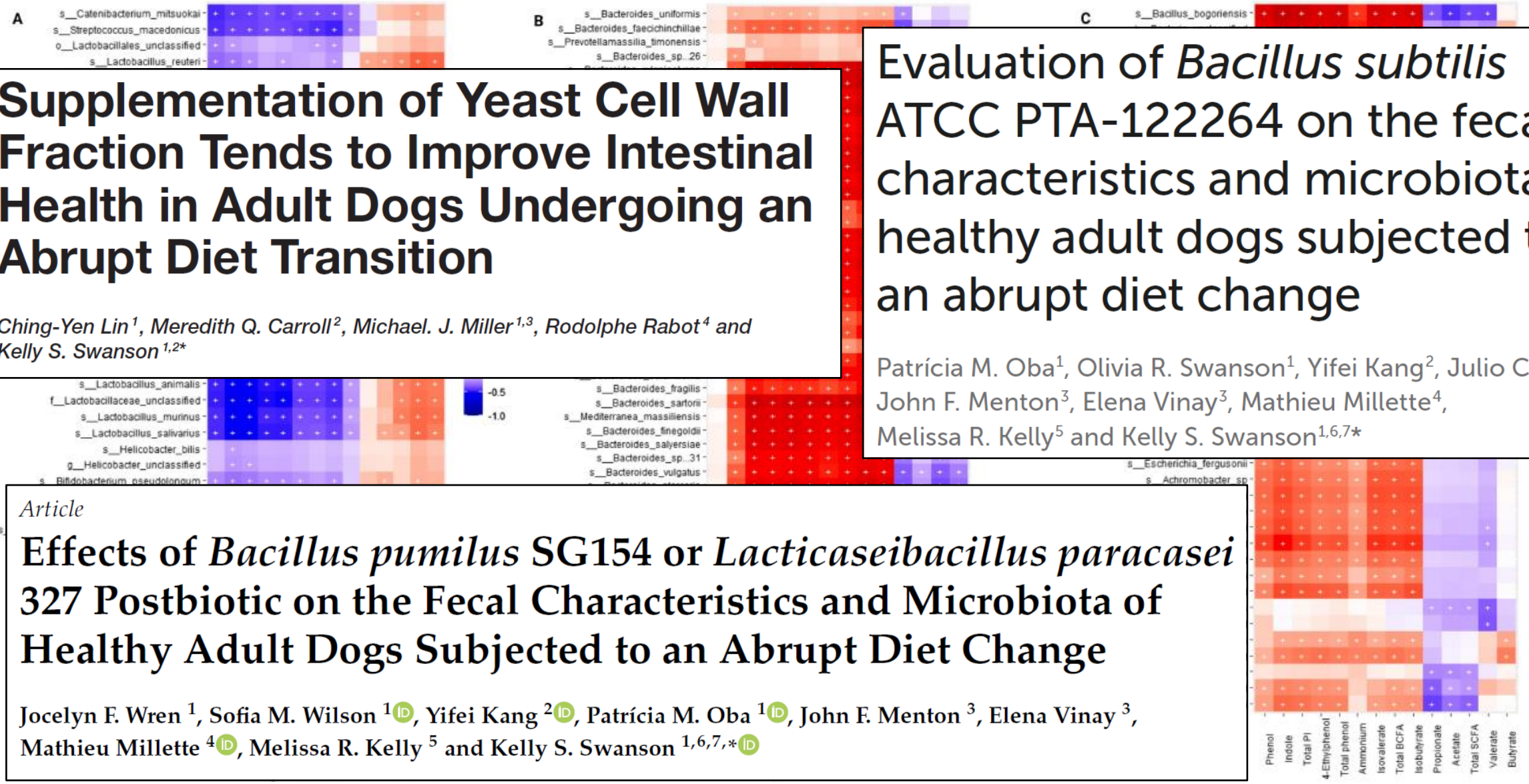
Lin et al., 2022

Strong Microbiota-Metabolite Relationships



Lin et al., 2022

Similar Results with Other Studies



Supplementation of Yeast Cell Wall Fraction Tends to Improve Intestinal Health in Adult Dogs Undergoing an Abrupt Diet Transition

Ching-Yen Lin[1], Meredith Q. Carroll[2], Michael. J. Miller[1,3], Rodolphe Rabot[4] and Kelly S. Swanson[1,2]*

Evaluation of *Bacillus subtilis* ATCC PTA-122264 on the fecal characteristics and microbiota of healthy adult dogs subjected to an abrupt diet change

Patrícia M. Oba[1], Olivia R. Swanson[1], Yifei Kang[2], Julio C. Mioto[1], John F. Menton[3], Elena Vinay[3], Mathieu Millette[4], Melissa R. Kelly[5] and Kelly S. Swanson[1,6,7]*

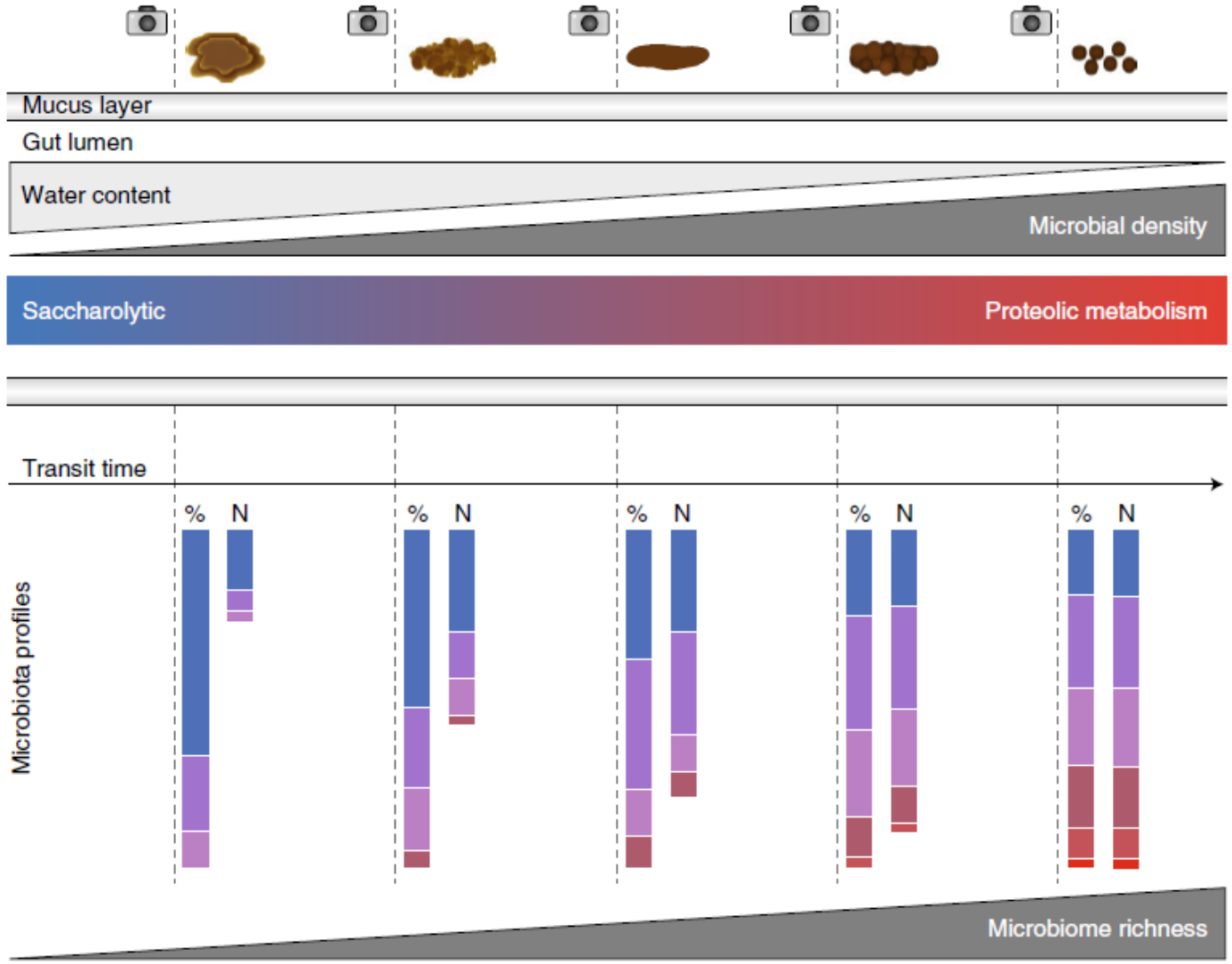
Article

Effects of *Bacillus pumilus* SG154 or *Lacticaseibacillus paracasei* 327 Postbiotic on the Fecal Characteristics and Microbiota of Healthy Adult Dogs Subjected to an Abrupt Diet Change

Jocelyn F. Wren [1], Sofia M. Wilson [1], Yifei Kang [2], Patrícia M. Oba [1], John F. Menton [3], Elena Vinay [3], Mathieu Millette [4], Melissa R. Kelly [5] and Kelly S. Swanson [1,6,7,*]

Altered Transit Time

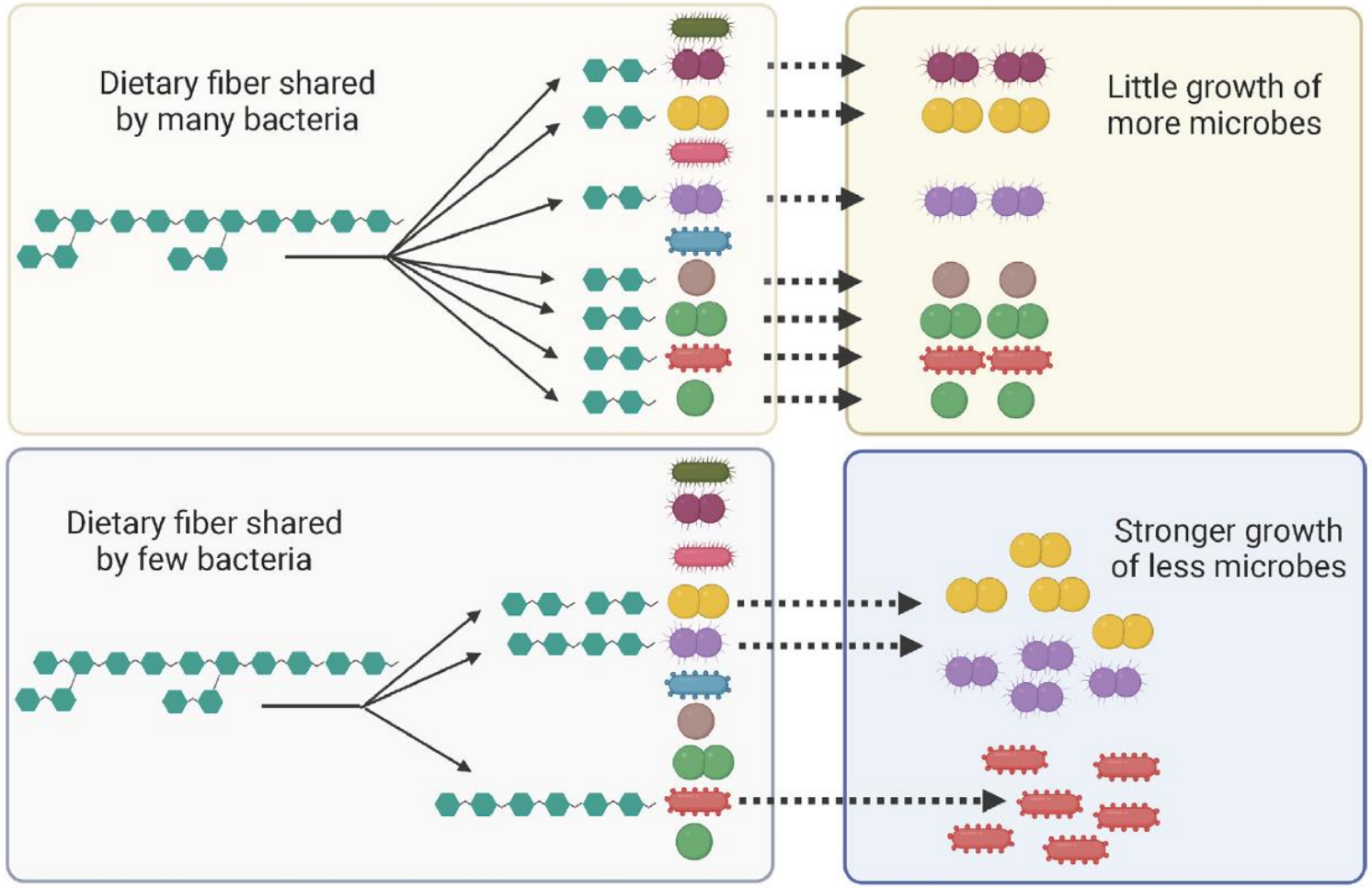
- Outcomes affected
  - Water absorption
  - Stool firmness
  - Microbial density
  - Microbial richness
  - Microbial metabolism



Falony et al., 2018

Diet May Alter Transit Time

- Dietary fiber
  - Insoluble ↓ time
  - Soluble ↑ time
- May affect
  - Fecal scores
  - Microbial diversity
  - Microbial metabolism



Cantu-Jungles and Hamaker, 2023

Diet May Alter Transit Time

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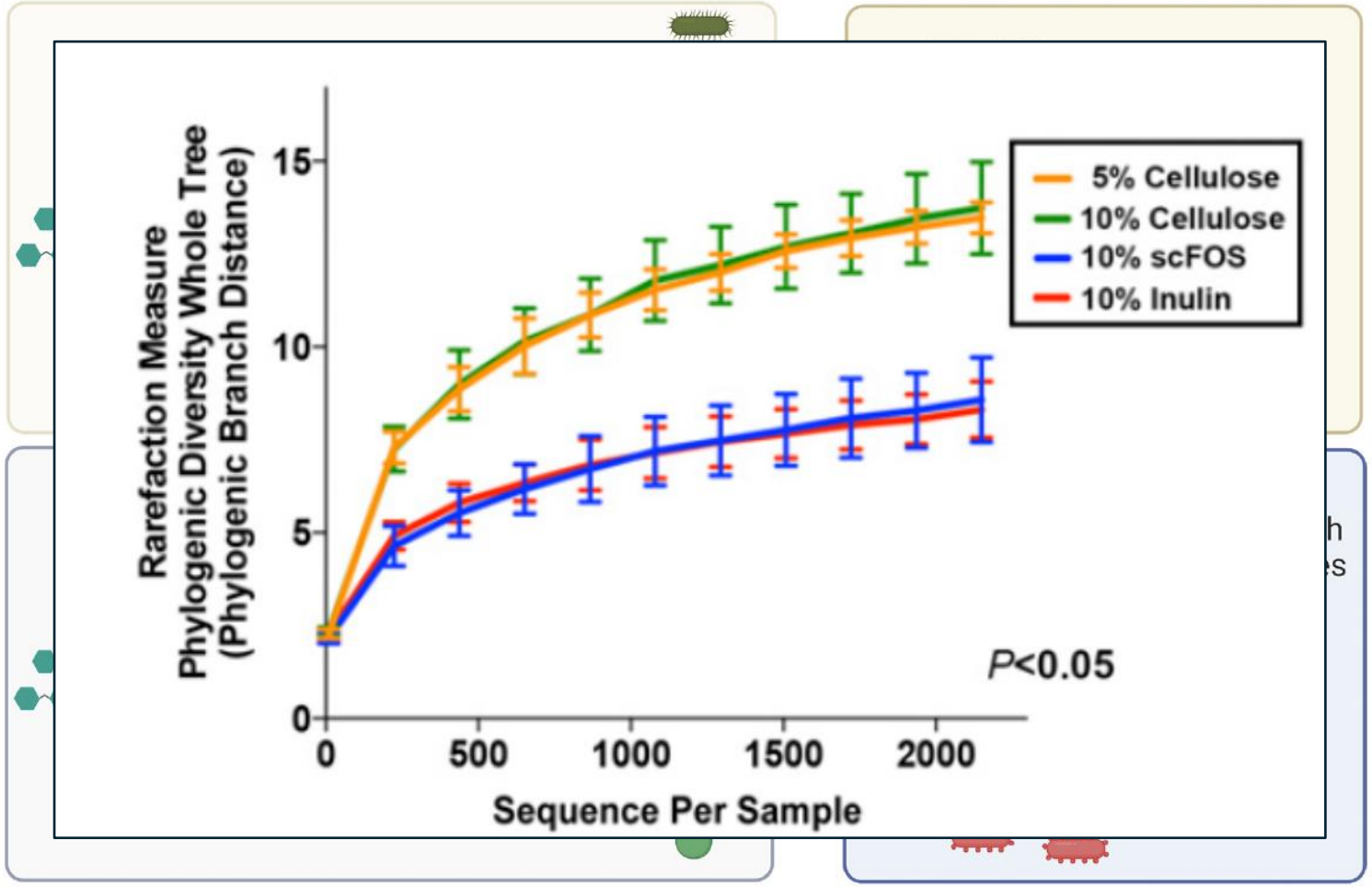


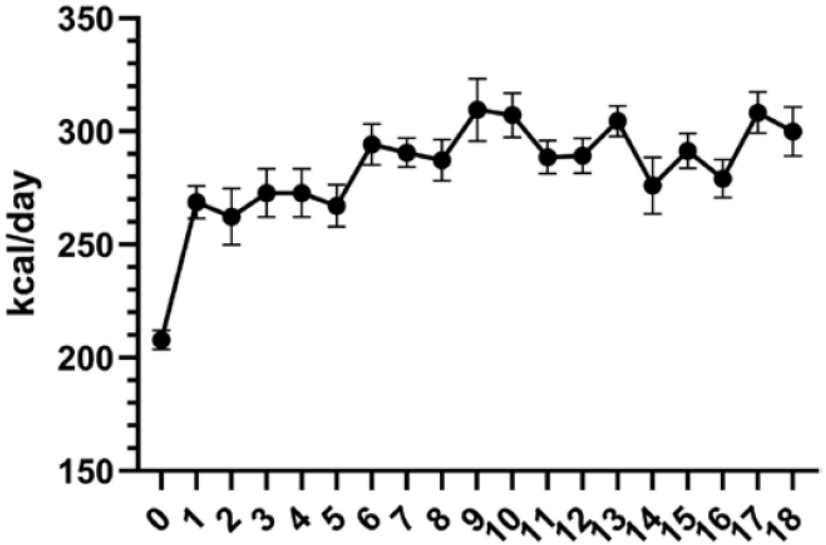
Liu et al., 2016; Cantu-Jungles and Hamaker, 2023

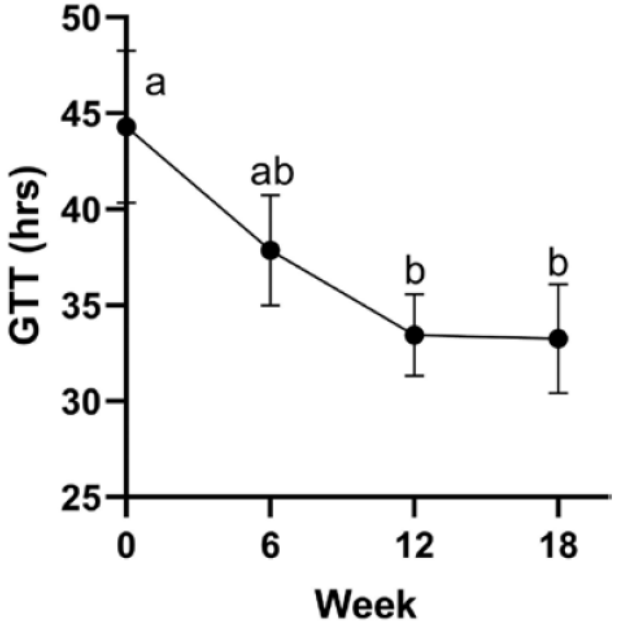
Diet May Alter Transit Time

- Greater/lower food consumption

Effects of overfeeding on the digestive efficiency, voluntary physical activity levels, and fecal characteristics and microbiota of adult cats

Danielle L. Opetz,[†] Patricia M. Oba,[‡] and Kelly S. Swanson[†,‡,‖,1,]





↓ nutrient digestibility

↓ fecal pH

>15 genera altered

Opetz et al., 2023

Physical Activity

- Activity affect motility and transit time?
  - Intensity
  - Duration
  - Frequency
  - Environmental conditions

- Implications
  - Nutrient digestibility
  - Stool quality
  - Microbiota populations

Mailing et al., 2019

Physical Activity

- Activity affect motility and transit time?
  - Intensity
  - Duration
  - Frequency
  - Environmental conditions
- Implications
  - Nutrient digestibility
  - Stool quality
  - Microbiota populations

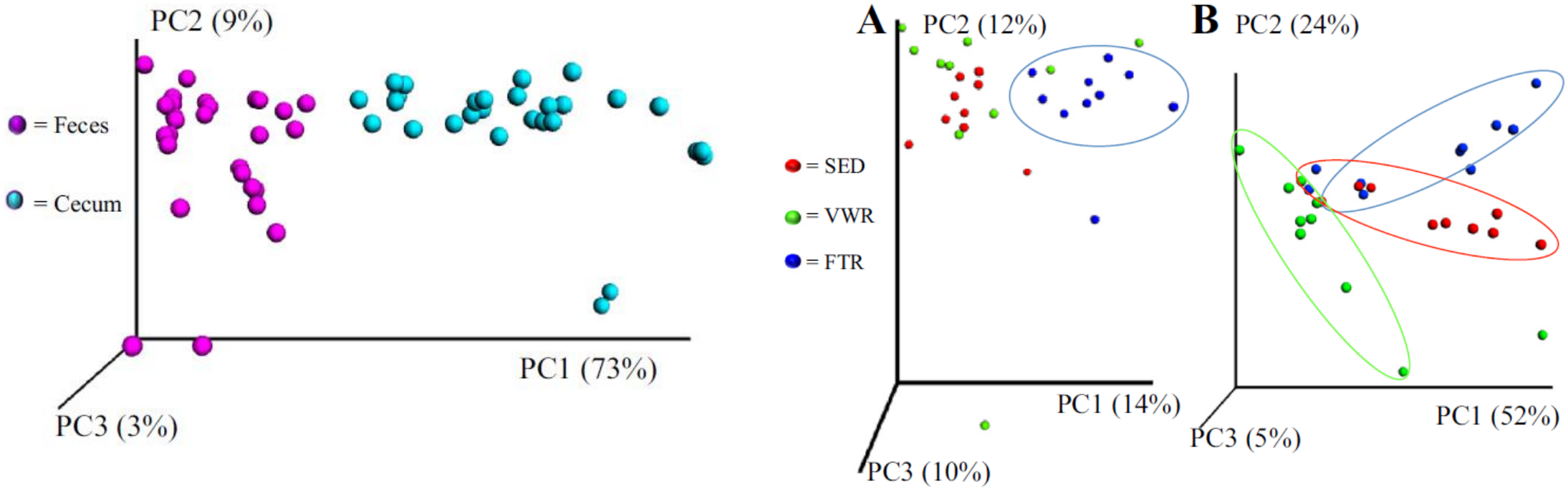
Potential mechanisms?

- Ischemia
- Heat stress
- Metabolic flux
- Gut barrier
- Mucus layer
- Gut motility, mechanical forces
- Vagus nerve / enteric NS
- Hormones / myokines
- Bile acids

Mailing et al., 2019

Voluntary vs. Forced Exercise (Mice)

- 6-week intervention; same diet
  - Sedentary (no running wheel)
  - Voluntary (access to running wheel)
  - Forced (40 min/day on treadmill)



Allen et al., 2015

Issues in Racing Sled Dogs?

- Diarrhea a common issue in sled dog racing

- What about other outcomes?
  - Greater pathogen activity
    C. perfringens enterotoxin (CPE)
  - Greater *C. difficile* antigen
    (glutamate dehydrogenase; GDH)

Table 1. Fecal scores recorded in sled dogs before and during the 2008 Iditarod trail race.

Fecal Score	1	2	3	4
Before racing (n = 49)	0	6 (12.2%)	13 (26.5%)	30 (61.2%)
During racing (n = 80)	7 (8.8%)	22 (27.5%)	35 (43.7%)	16 (20%)

Racing was significantly associated with diarrhea (fecal score of ≤ 2) ($P = .021$).

Table 2. Culture and ELISA results for *Clostridium perfringens* and *Clostridium difficile* in sled dogs before and during the 2008 Iditarod trail race.

	C. perfringens Culture	CPE ELISA	*C. difficile* Culture	GDH ELISA[a]	*C. difficile* Toxin A/B ELISA
Before racing (n = 55)	55 (100%)	3 (5.5%)	32 (58.2%)	43 (81.1%)	0
During racing (n = 80)	76 (95%)	15 (18.8%)	29 (36.3%)	66 (84.6%)	0

McKenzie et al., 2010

What About Moderate Exercise?

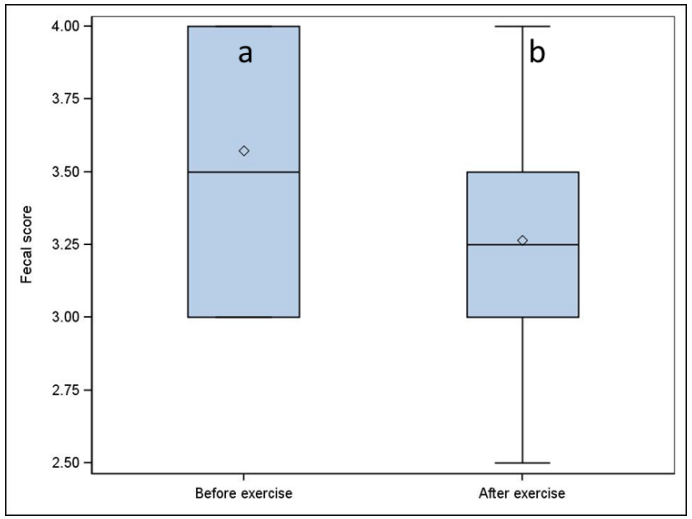
- Exercise challenge in labrador retrievers
  - 7 wk of training
    - 2 runs/wk escalating every 2 wk (6.4 km/run → 9.7 km/run → 12.9 km/run)
  - Challenge (16 km run)
  - Fresh feces before and after challenge

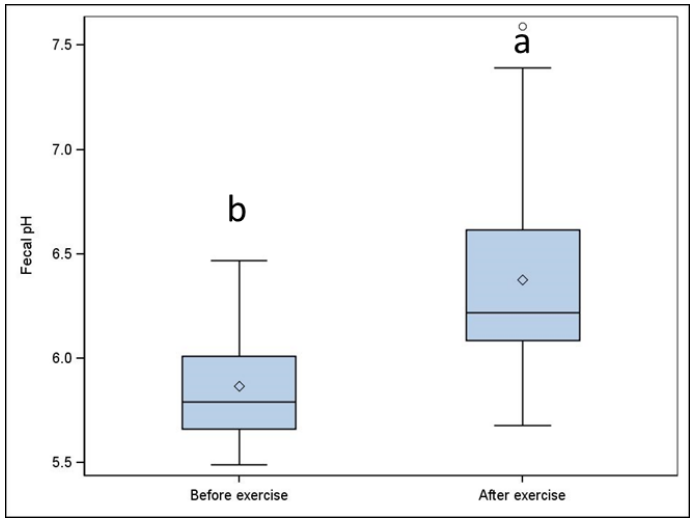
FOUR RIVERS
KENNEL & CANINE SENIOR CENTER

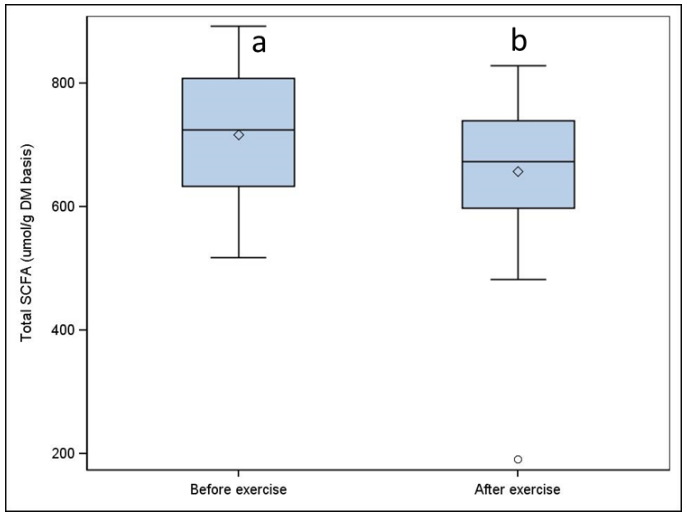
Oba et al., 2023

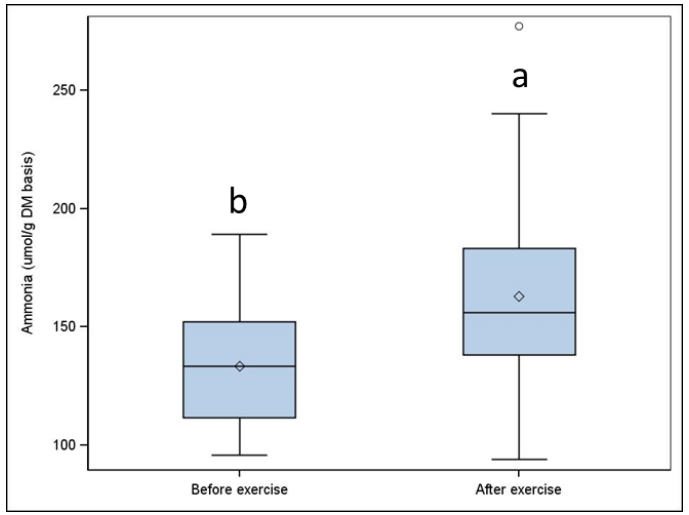
What About Moderate Exercise?

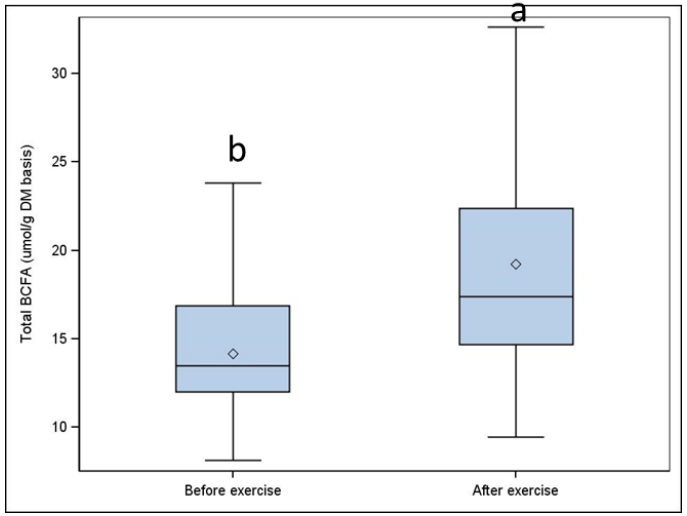
- Exercise challenge in labrador retrievers







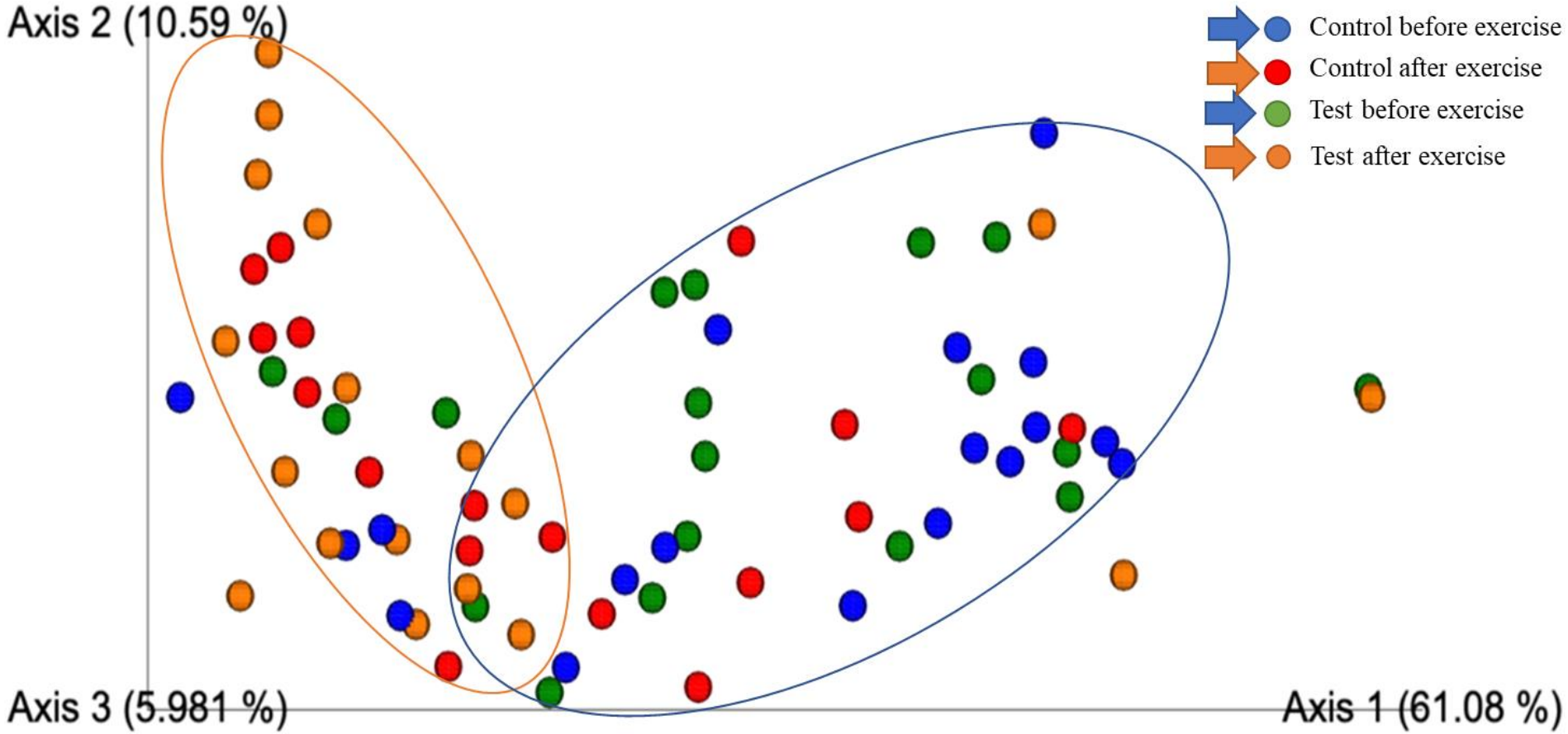




Oba et al., 2023

What About Moderate Exercise?

- Exercise challenge in labrador retrievers



Oba et al., 2023

Environmental Stressors

- Workforce: military, police, search-and-rescue
- Common issues: increased defecation; loose stools; gut microbiota?
- Microbiota affect olfactory capabilities?

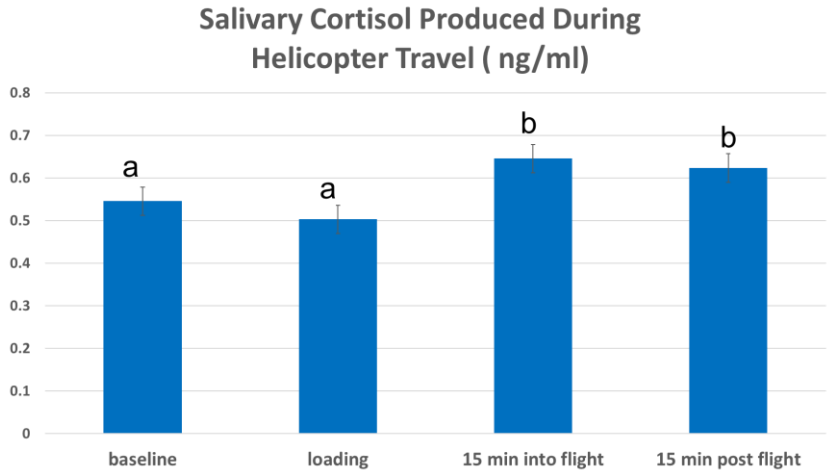
Effects of oral administration of metronidazole and doxycycline on olfactory capabilities of explosives detection dogs

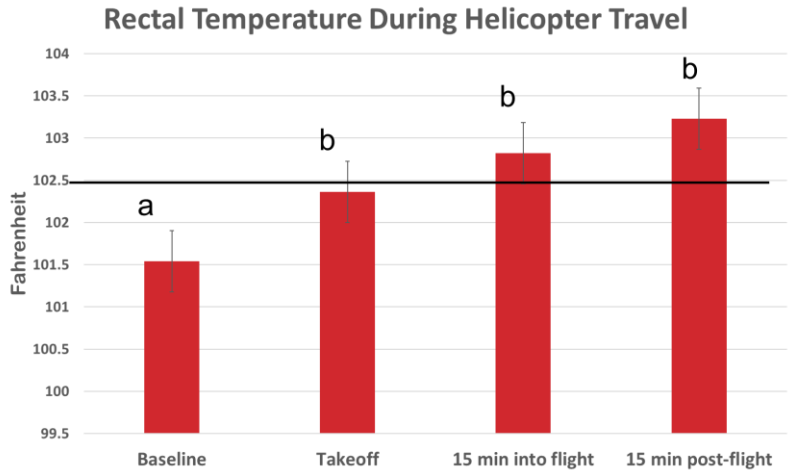
Eileen K. Jenkins DVM, MS
Tekla M. Lee-Fowler DVM, MS
T. Craig Angle PhD
Ellen N. Behrend VMD, PhD
George E. Moore DVM, PhD

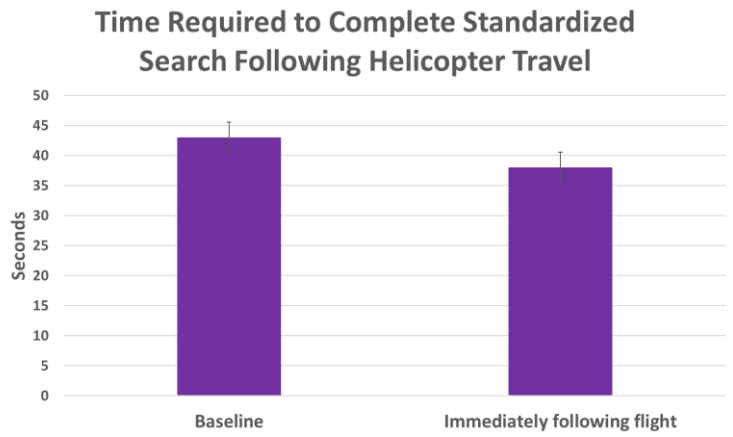
Jenkins et al., 2016

Environmental Stressors

- Pilot testing
  - Federal Emergency Management Agency (FEMA) search-and-rescue dogs
  - Helicopter travel
    - 30 minutes travel
    - Standardized search exercise immediately post-flight
    - Collections 15 min post-travel







Venable et al., 2016; Perry et al., 2017

Environmental Stressors

- Work ongoing…

ARTICLE OPEN

Phenotypic correlates of the working dog microbiome

Hillary A. Craddock[1,4], Anastasia Godneva[2,4], Daphna Rothschild[2], Yair Motro[1], Dan Grinstein[1], Yuval Lotem-Michaeli[1], Tamar Narkiss[3], Eran Segal[2] and Jacob Moran-Gilad[1]

Effects of fecal microbial transplantation on police performance and transportation stress in Kunming police dogs

Qiu-Ye Lin[1] · Jin-Jing Du[2] · Hu Xu[3] · Ming-Kui Lv[2] · Le Xu[2] · Jie Li[3] · Zhen-Hui Cao[2,4]

Craddock et al., 2022; Lin et al., 2024

Summary

- Diet influences gut microbiome composition but mostly within a normal range
- Gut microbiomes vary across animals, generally within normal range, but some more stable than others. Why?
  - Lactic acid bacteria have high variability
  - Due to changes in transit time?
- Abrupt diet change can elicit negative outcomes
- Factors affecting transit time also important
  - High fiber intake or increased food consumption
  - Physical activity
  - Environmental stressors

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Thank you!

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European Society of Comparative Gastroenterology