Petfood Forum Europe

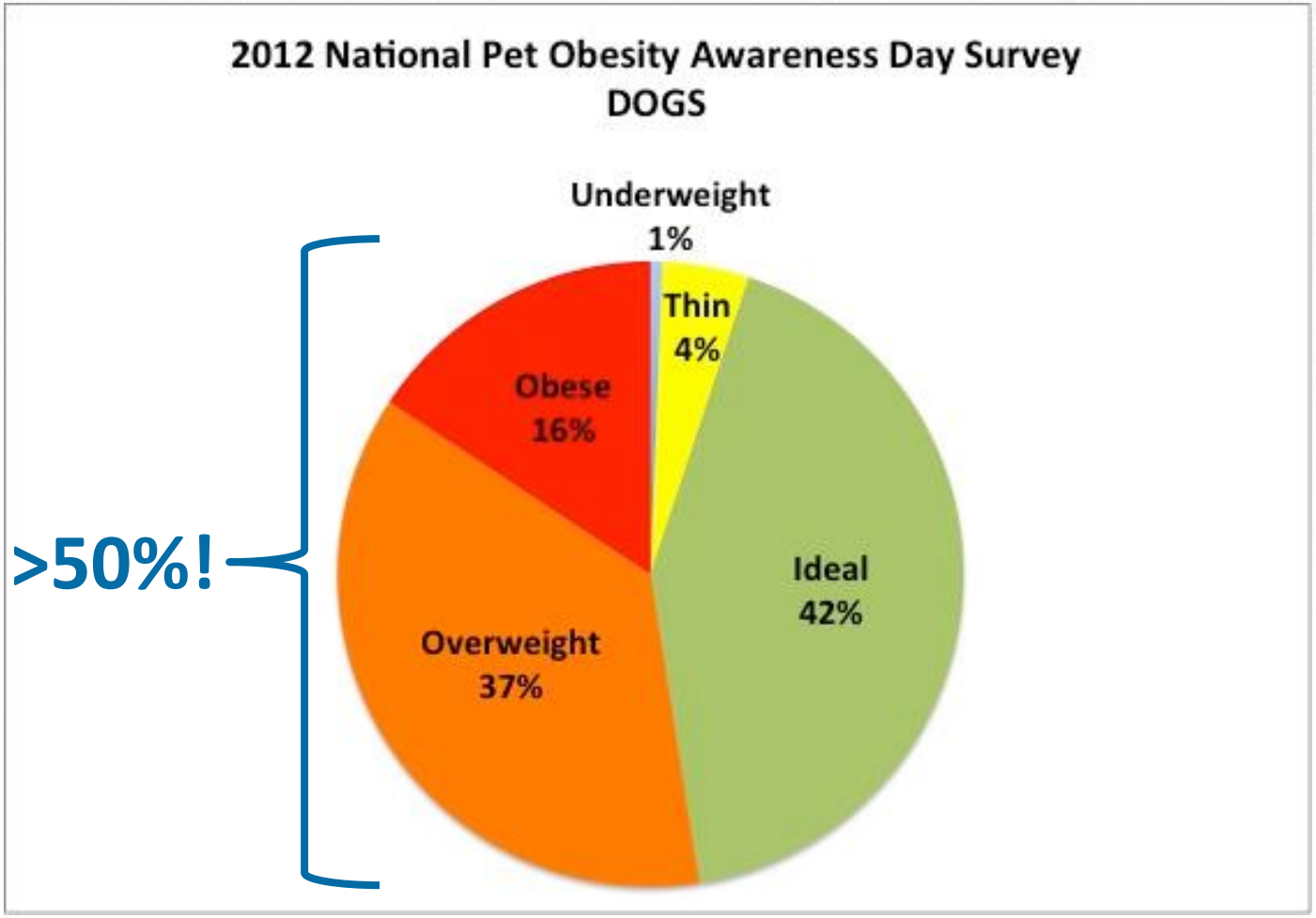
Effects of prebiotic inulin-type fructans in overweight dogs

Dr. Franka Neumer

Beneo-Institute

Petfood Industry

Background


2012 National Pet Obesity Awareness Day Survey
DOGS
Underweight
1%
Thin
4%
Obese
16%
Ideal
42%
Overweight
37%
>50%!

Background

- 53 % of dogs are overweight or obese
- In dogs, obesity leads to altered
  - **blood lipids**
  - **glucose intolerance**
  - **insulin resistance**

…. similar to humans!

American Veterinary Medical Association (2012), Deng et al. (2013)

Background

- Many human + canine studies have highlighted the benefits of dietary fiber, especially fermentable fiber, which results in:
  - **decreased postprandial hyperglycaemia**
  - **greater insulin sensitivity**
  - **altered gastrointestinal peptide release**

e.g. Deng et al. (2013), Respondek et al. (2008), Massimino et al. (1998)

Fermentable fiber effects: blood glucose, hormones

Nutrient Requirements and Interactions

Fermentable Dietary Fiber Increases GLP-1 Secretion and Improves Glucose Homeostasis Despite Increased Intestinal Glucose Transport Capacity in Healthy Dogs[1,2,3]

Stefan
Monika

Nutrition
[7]Medici
The IAM

The Journal of Nutrition
Nutritional Toxicology

Short-Chain Fructooligosaccharides Influence Insulin Sensitivity and Gene Expression of Fat Tissue in Obese Dogs[1,2]

Frédérique Respondek,[3]* Kelly S. Swanson,[4,5] Kathe
Louis Istasse,[6] and Marianne Diez[6]

[3]Beghin-Meiji, 67390 Marckolsheim, France; [4]Department of Ani
Illinois, Urbana, IL 61801; and [6]Faculty of Veterinary Medicine, U

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The effects of dietary fibre type on satiety-related hormones and voluntary food intake in dogs

Guido Bosch[1]*, Adronie Verbrugghe[2], Myriam Hesta[2], Jens J. Holst[3], Antonius F.B. van der Poel[1], Geert P.J. Janssens[2] and Wouter H. Hendriks[1]

[1]*Animal Nutrition Group, Department of Animal Sciences, Wageningen University, PO Box 338, 6700 AH Wageningen, The Netherlands*
[2]*Laboratory of Animal Nutrition, Faculty of Veterinary Medicine, Ghent University, Heidestraat 19, B-9820 Merelbeke, Belgium*
[3]*Department of Biomedical Sciences, The Panum Institute, University of Copenhagen, Blegdamsvej 3, DK-2200 Copenhagen, Denmark*

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Fiber diet with inulin increases SCFA

Study design: 2-arm, 7 weeks, IN + sugar beet pulp (10.5 %) vs. control (8.5% cellulose)

	LFF		HFF		
	Mean	SEM	Mean	SEM	*P*
Total SCFA (mmol/g DM)	0·26	0·02	0·54	0·04	<0·001
Acetate (mmol/g DM)	0·14	0·02	0·32	0·03	<0·001
Propionate (mmol/g DM)	0·06	0·01	0·14	0·01	<0·001
Butyrate (mmol/g DM)	0·03	0·00	0·05	0·01	0·060

→ Significant increase in faecal total SCFA

→ Significant increase in faecal acetate + propionate, trend for ↑ butyrate

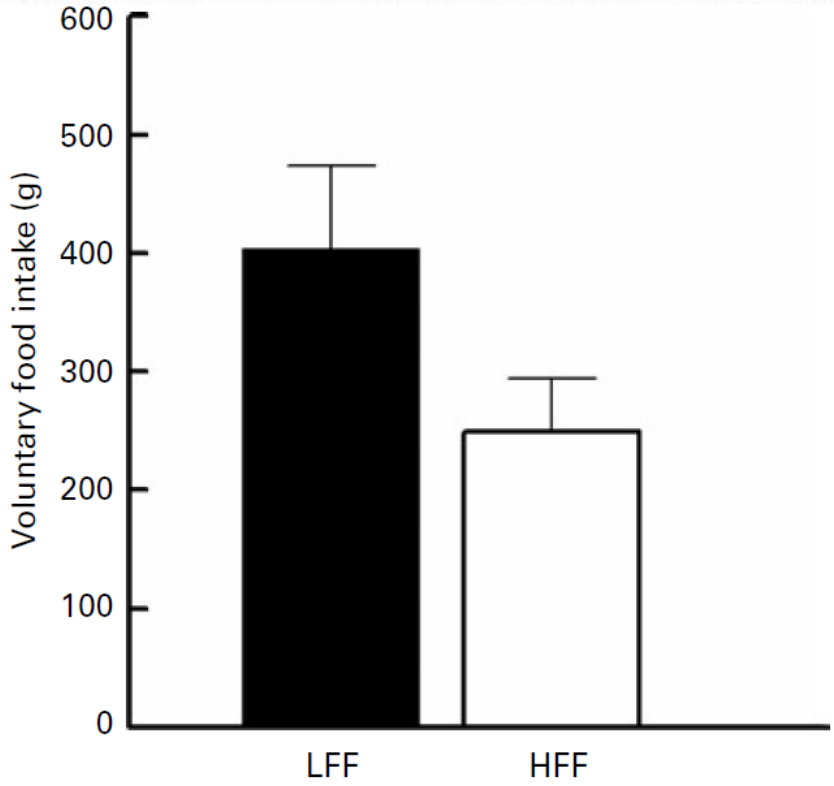
… when dogs consumed inulin containing fiber diet

HFF = high fermentable fiber, LFF = low fermentable fiber, SCFA = short chain fatty acids, IN = inulin

Bosch et al. (2009)

Fiber diet with inulin decreases food intake

Study design: 2-arm, 7 weeks, IN + sugar beet pulp (10.5 %) vs. control (8.5% cellulose)

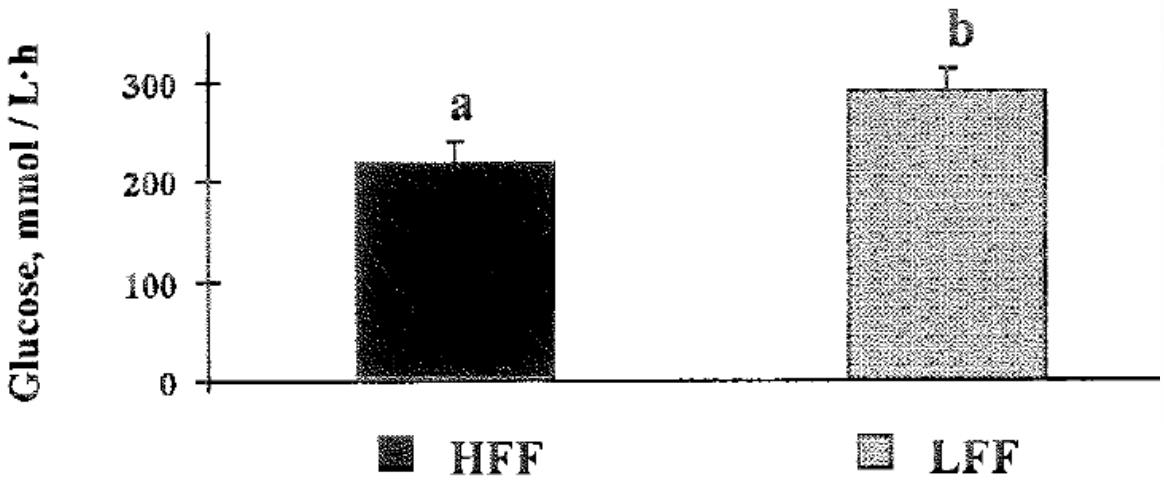


→ Trend for lower voluntary food intake when dogs consumed inulin containing fiber diet ($p<0.058$)

HFF = high fermentable fiber, LFF = low fermentable fiber, SCFA = short chain fatty acids, IN = inulin
Bosch et al. (2009)

Fiber diet with FOS improves glucose homeostasis

Study design: 2-arm, 2 weeks, FOS + gum arabic + sugar beet pulp (9.5%) vs. control (7% cellulose)

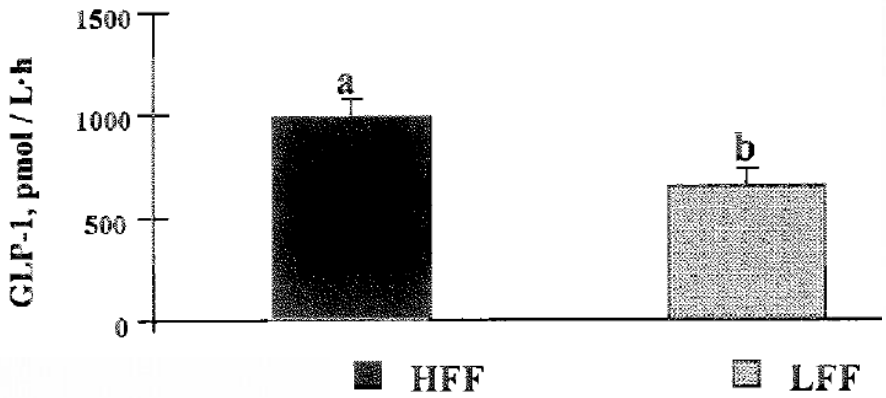


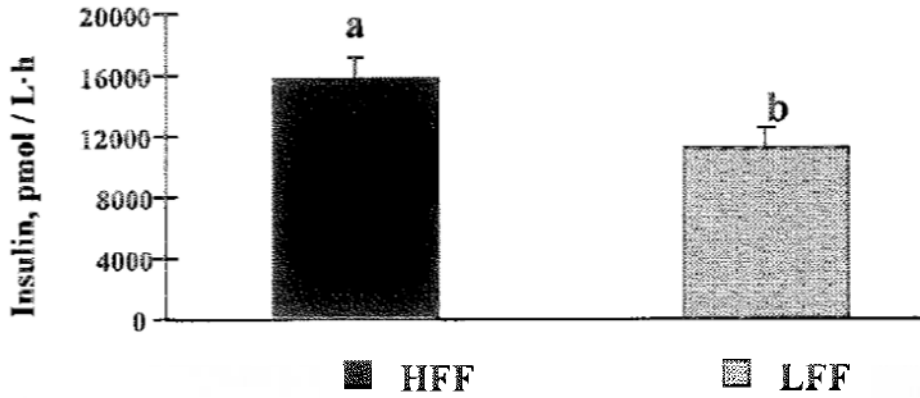
→ **Significantly lower iAUC $_{0\text{-}120min}$ for glucose when dogs consumed fructan containing fiber diet ($p<0.05$)**

HFF = high fermentable fiber, LFF = low fermentable fiber, FOS = Fructooligosaccharides, iAUC = incremental area under the curve
Massimino et al. (1998)

Fiber diet with FOS improves glucose homeostasis + increases GLP-1 + insulin secretion

Study design: 2-arm, 2 weeks, FOS + gum arabic + sugar beet pulp (9.5%) vs. control (7% cellulose)





→ Significantly higher iAUC $_{0\text{-}120min}$ for GLP-1 + insulin when dogs consumed the fructan containing fiber diet ($p<0.05$)

→ Similar effects for inulin-type fructans confirmed also in other studies (e.g. Respondek et al. (2008))

HFF = high fermentable fiber, LFF = low fermentable fiber, FOS = Fructooligosaccharides, iAUC = incremental area under the curve
Massimino et al. (1998)

Which additional benefits of fermentable inulin-type fructans could be expected in dogs?

- In addition to the **immediate** postprandial effect, certain dietary fibers have also been shown to alter the glycaemic response several **hours later** in a subsequent meal, effect is termed

  “<u>second-meal effect</u>”

- Situation in dogs?

HFF = high fermentable fibers
e.g. Brighenti et al. (2006), Priebe et al. (2010)

Second-meal effect

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Dietary fibre fermentability but not viscosity elicited the 'second-meal effect' in healthy adult dogs

Ping Deng[1], Alison N. Beloshapka[1], Brittany M. Vester Boler[1] and Kelly S. Swanson[1,2,3]*
[1]*Department of Animal Sciences, University of Illinois, 1207 West Gregory Drive, Urbana, IL 61801, USA*
[2]*Division of Nutritional Sciences, University of Illinois, 1207 West Gregory Drive, Urbana, IL 61801, USA*
[3]*Department of Veterinary Clinical Medicine, University of Illinois, 1207 West Gregory Drive, Urbana, IL 61801, USA*

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Second-meal effect study

- 3-arm parallel, duplicated 3x3 Latin square design
- N = 6 healthy female dogs
  - Low fiber (LF, 2%) vs.
  - Low fermentable fiber (LFF, 8%) vs.
  - High fermentable fiber (HFF, 8%)

    → 5% pectin + 3% inulin-type fructans

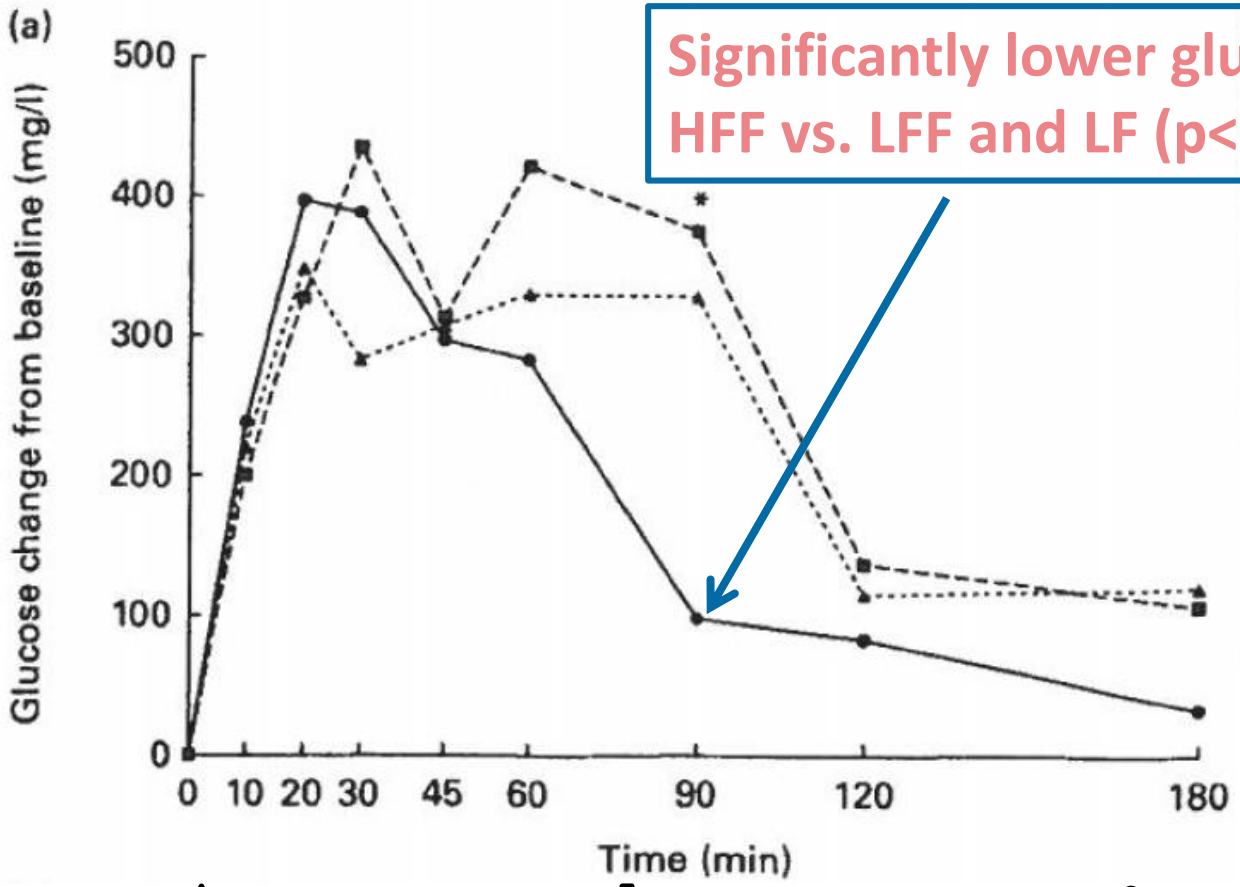
Deng et al. (2013)

Second-meal effect study

- Objective:
  Effect of **fiber source** in a morning meal on metabolic responses to a glucose challenge later in the day
- Outcome measures:
  Serum glucose, serum insulin, plasma GLP-1

Deng et al. (2013)

Second-meal effect study



Significantly lower glucose iAUC (0-180 min) of HFF vs. LFF and LF ($p<0.05$)

Low fiber (LF)

Low fermentable fiber (LFF)

High fermentable fiber (HFF)

Deng et al. (2013)

Second-meal effect study

- Results:
  Glucose $_{iAUC\ 0\text{-}180\ min}$ significantly lower in dogs fed HFF vs. HF and LF diets ($p<0.05$)
  Insulin + GLP-1 $_{iAUC\ 0\text{-}180\ min}$ not affected
- Conclusion:
  Fermentable fiber have the potential to decrease blood glucose response in a consequent meal, fed hours later

HFF = high fermentable fiber, LFF = low fermentable fiber
Deng et al. (2013)

Postulated mechanisms on glucose metabolism

Fermentable fiber

↓

Fermentation (colon)

↓

↑ SCFA

↑ Secretion of **GLP-1** (and related peptides) **to delay gastric emptying + stimulate insulin secretion**

↑ **Insulin sensitivity** by influencing adipocyte metabolism + ↓ lipolysis

Butyrate may modulate **glucose-associated inflammation**

Propionate effects on hepatic carbohydrate metabolism **to increase glucose use + decrease glucose production**

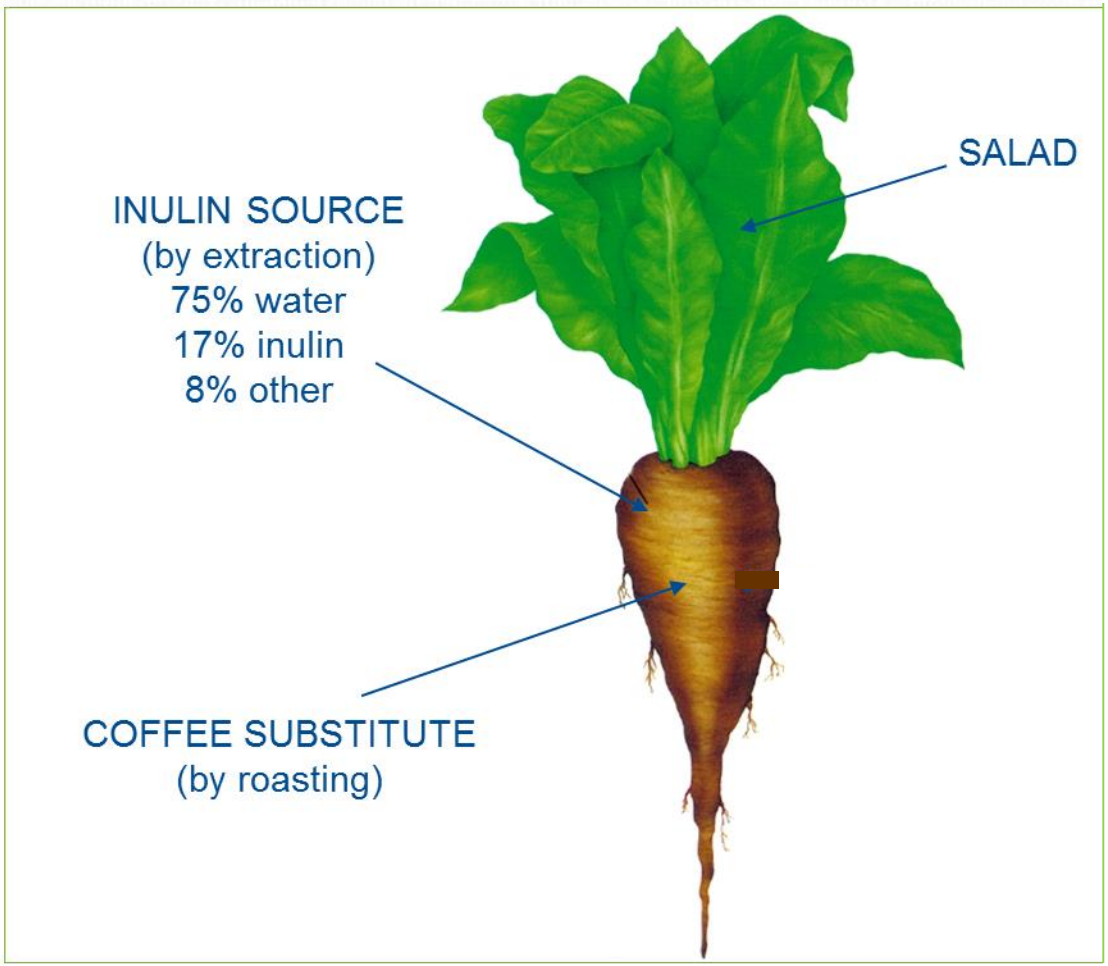
SCFA = short chain fatty acids, GLP-1 = glucagon-like peptide-1,
e.g. Robertson et al. (2007), Segain et al. (2000), Kinoshita et al. (2000), Anderson et al. (1984)

BENEO study with overweight dogs to investigate the effects of Orafti®SIPX inulin on:

- **Second-meal effect**, i.e. glucose and endocrine (insulin, GLP-1) responses after an oral glucose challenge
- **Fecal microbiota populations** (high-throughput DNA sequencing)
- **Fermentative end-products** (e.g. SCFA, BCFA, secondary BA)

SCFA = short chain fatty acids, BCFA = branched chain fatty acids, BA = bile acids

Inulin-type fructans from chicory root



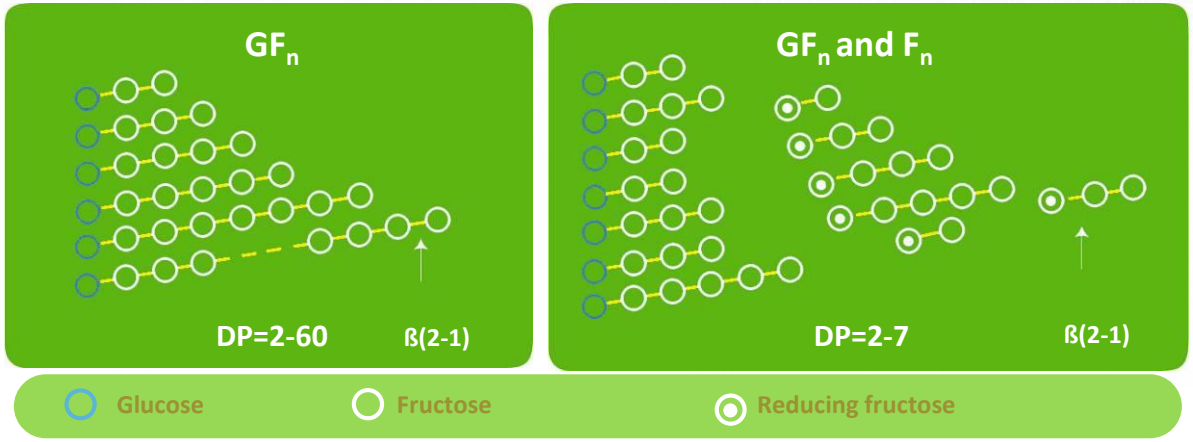
Inulin-type fructans from chicory root

Chicory roots

15-17% inulin

Extraction (hot water) → **Inulin**

Partial hydrolysis (enzymatic) → **Oligofructose**



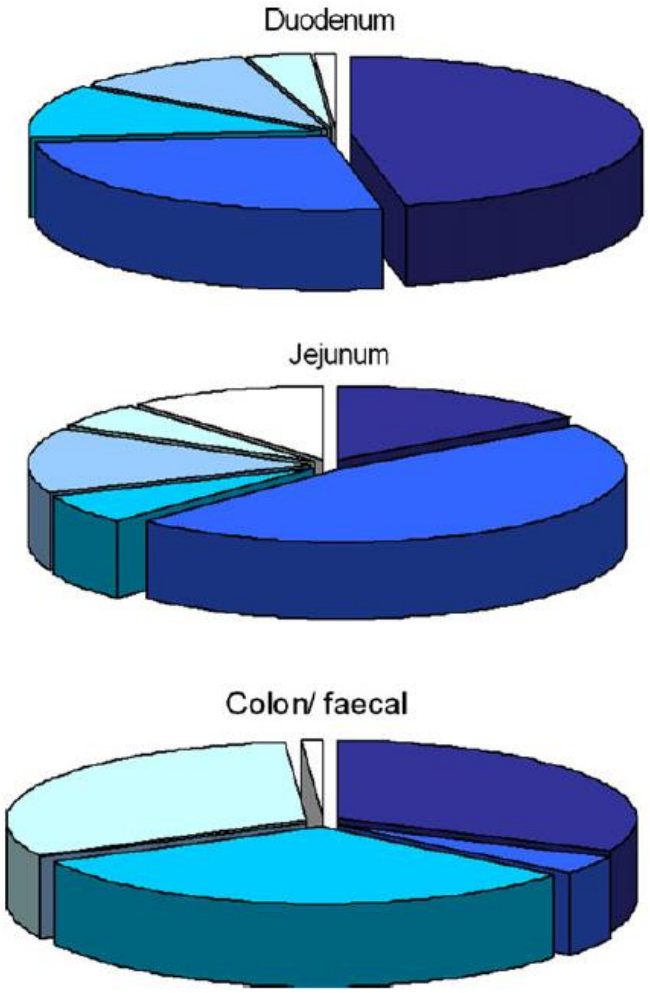
DP= Degree of Polymerisation

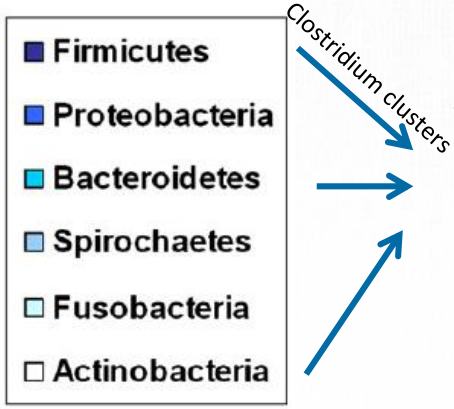
Inulin and Oligofructose

- Non-digestible by intestinal enzymes
- No glucose supply (non-glycemic)
- Selected fermentation by the colon microbiota, stimulation in particular of microbes considered as representative of a healthy microbiota
  → key feature to be termed “prebiotic”
- Increase of SCFA

SCFA = short chain fatty acids

Dog microbiota: typical bacterial phyla





„important producers of metabolites (e.g. SCFA) that have direct beneficial impact on host health“

„comparable to the human gut“

„colonic microbes of dogs are capable of fermenting fibers such as fructans“

Schmitz & Suchodolski (2016), Deng & Swanson (2015), Honneffer et al. (2014), Barry et al. (2010)

Design Beneo Study

- Orafti®SIPX inclusion at 2 dosages: **0.5 + 1%**
- Replicated 3 x 3 Latin square design
- 3 14-day treatment periods

Day 1-14: **Baseline**
Basal diet
(2-3% fibre)

Day 15-28: **Intervention**
Placebo (0.25%) or
Orafti®SIPX (**0.5 / 1%**)
with basal diet

Day 29-43: **Wash-Out**

Day 1-12: **Adaption**	Days 13: **Stool sample**	Day 14: **Glc challenge, blood samples**

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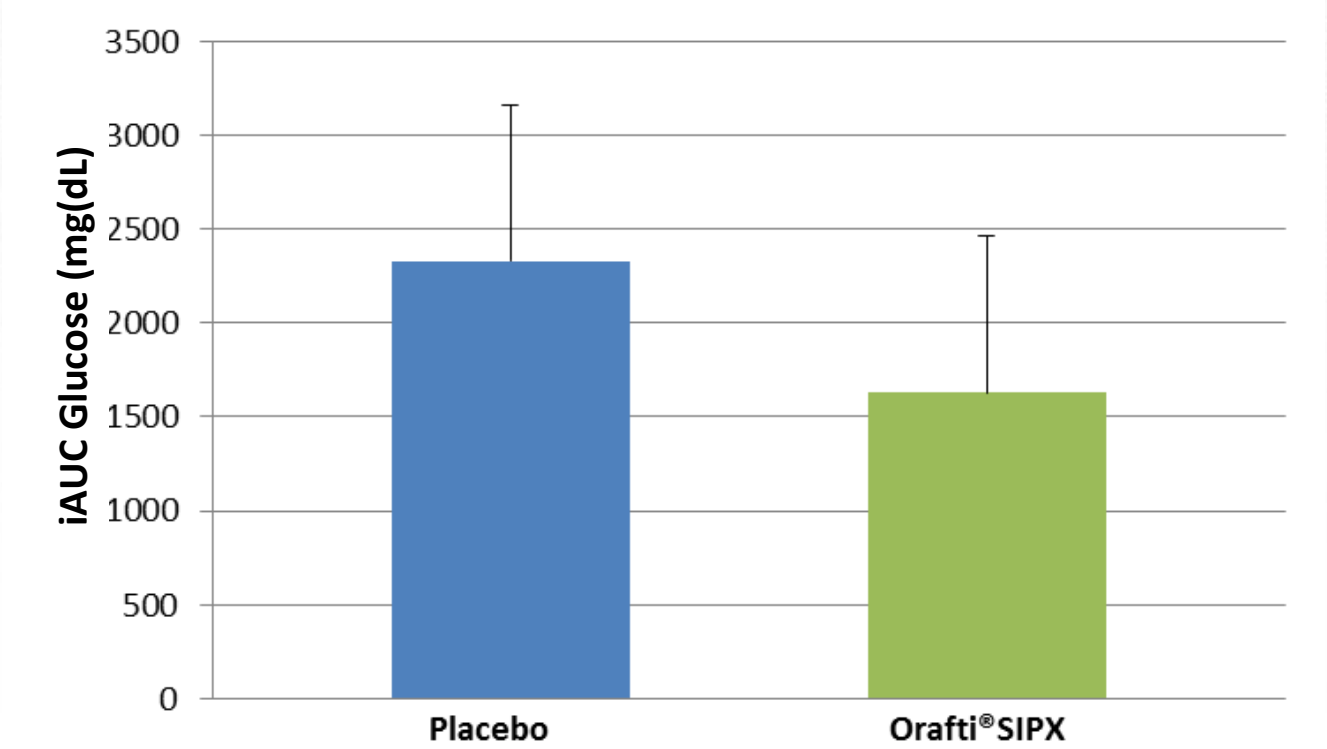
ITF = inulin-type fructans

First results from the study

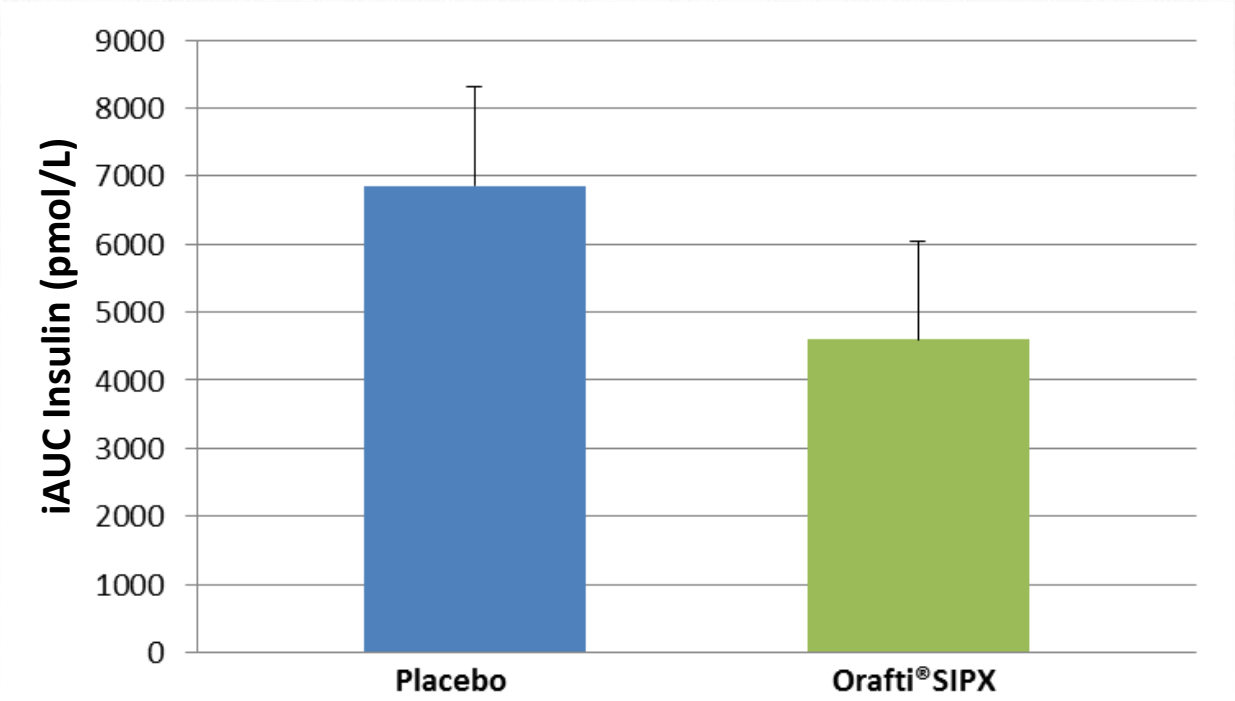
- Second-meal effect / blood glucose + insulin data
- SCFA
- Selected microbiota populations

Second-meal effect – blood glucose



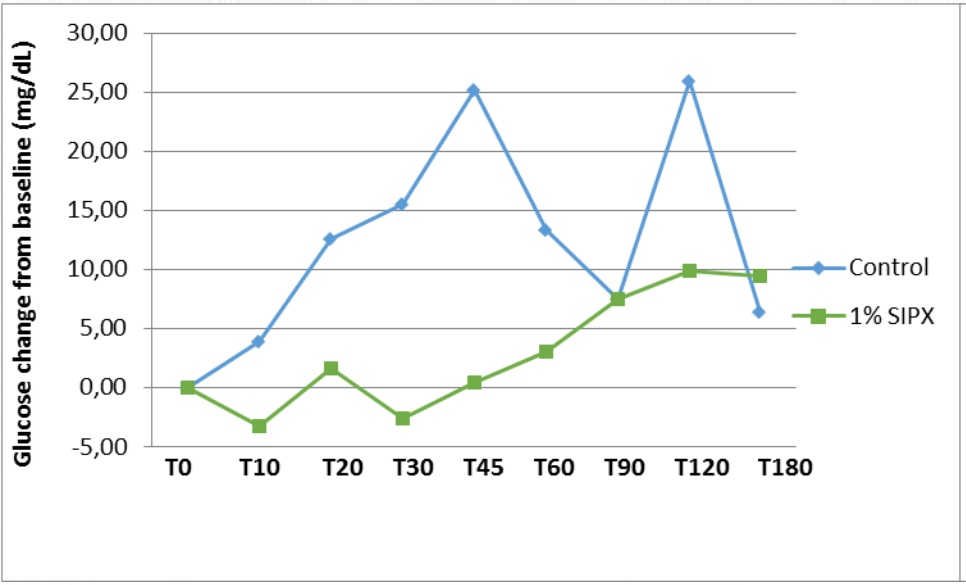
→ Lower iAUC 0-180 min for glucose when dogs consumed Orafti®SIPX at 1% vs. placebo
→ Indicative for a second-meal effect

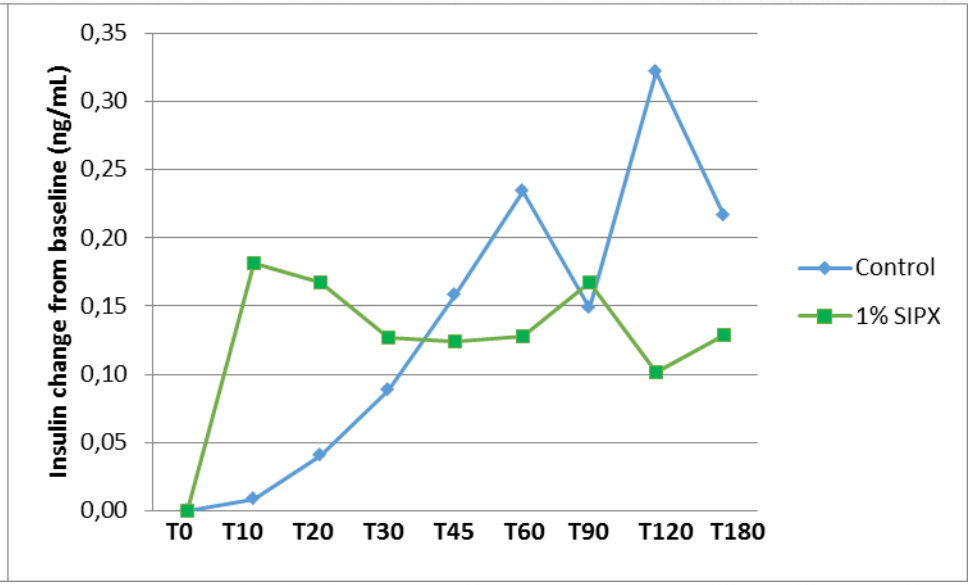
Blood insulin



→ Lower iAUC 0-180 min for insulin when dogs consumed Orafti®SIPX at 1% vs. placebo
→ Suggesting a lower insulin demand (fits with numerically lower iAUC for glucose)

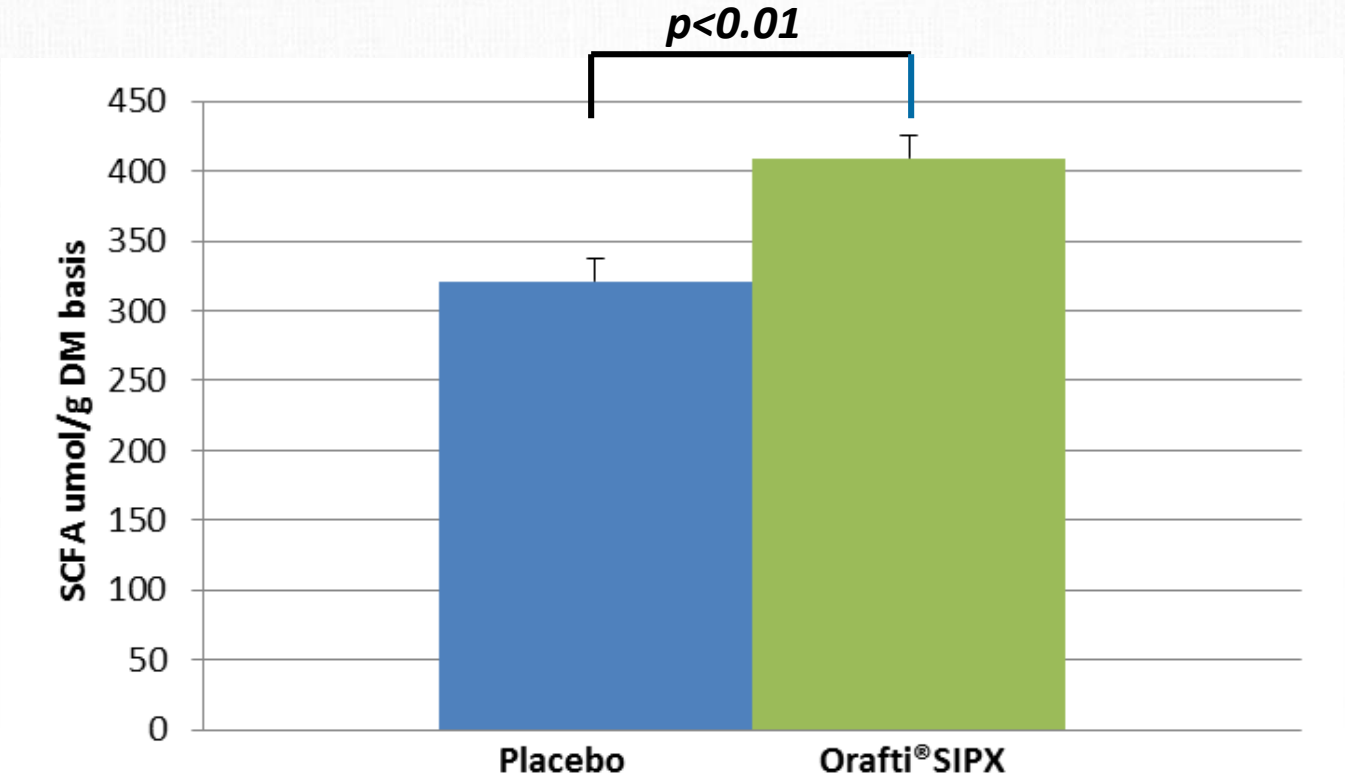
Glucose and Insulin curves





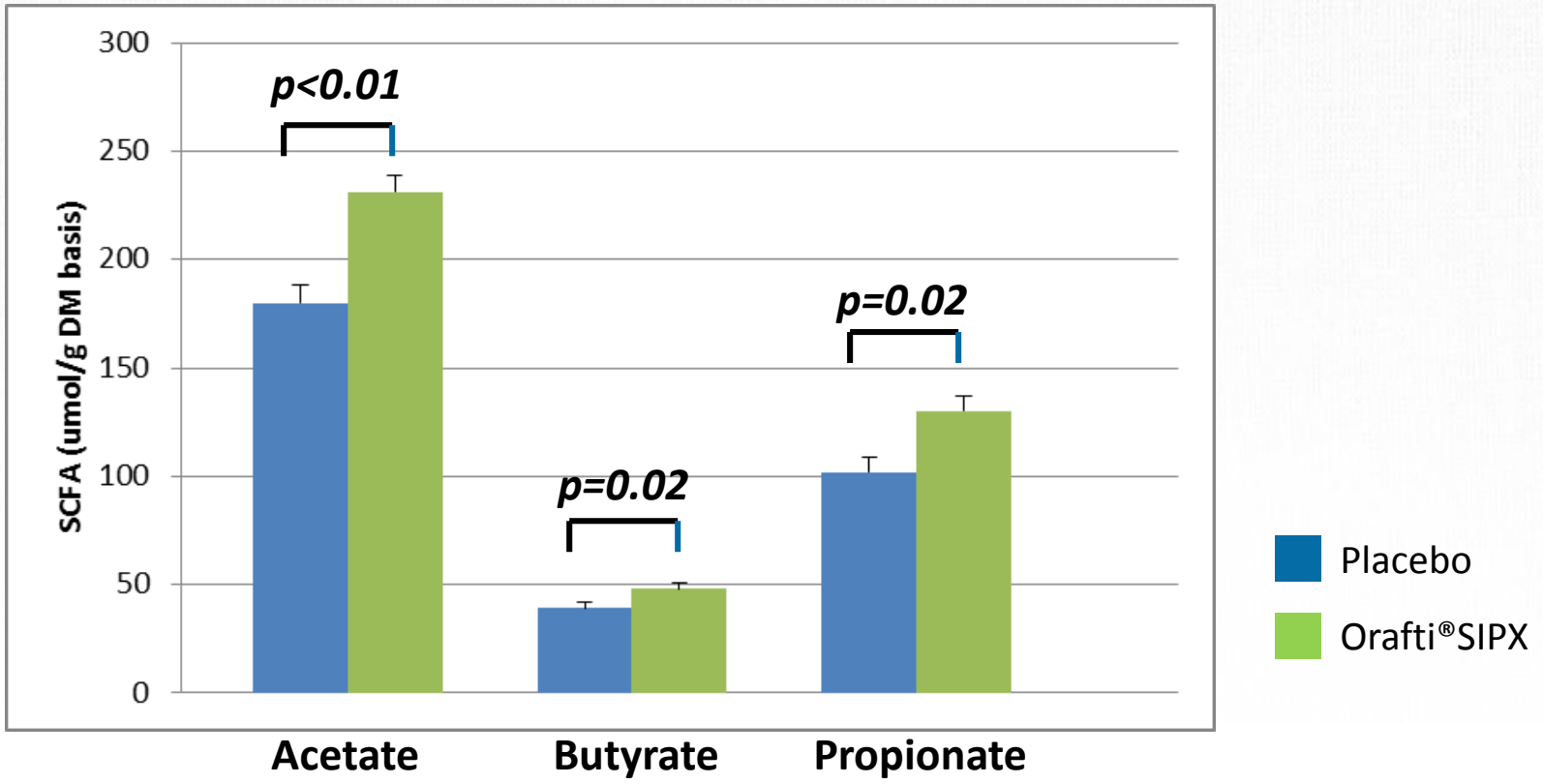
→ Generally smoother and more stable curves with 1% Orafti®SIPX

Total SCFA (Acetate, Butyrate, Propionate)



→ Significantly higher total SCFA when dogs consumed Orafti®SIPX at 1% vs. placebo
→ Indicative for increased gastrointestinal fermentation

SCFA



→ Significantly higher levels for Acetate, Butyrate and Propionate when dogs consumed Orafti®SIPX at 1% vs. placebo

→ Indicative for increased fermentation

Microbiota

- Inulin-type fructans modified the microbiota composition in particular with 1% Orafti®SIPX
- Key saccharolytic species such as *Bifidobacterium, L. Ruminococcus, Blautia* were numerically higher compared to the placebo group

Conclusion

- > 50% of dogs are overweight or obese
- Obesity is often associated with altered blood glucose and hormone concentrations
- Inulin-type fructans increase SCFA concentrations and selectively modify the gut bacteria in overweight dogs
- Data from recent study on the „second-meal effect“ indicate further benefits for blood glucose control in overweight dogs