Reducing pet obesity with fibres in the diet

NOWADAYS, OBESITY IS THE MOST COMMON NUTRITIONAL DISORDER IN COMPANION ANIMALS AND MAINLY CAUSED BY OVEREATING AND LITTLE EXERCISE. DEPENDING ON TYPE AND INCLUSION LEVEL, DIETARY FIBRE MAY INCREASE AND MAINTAIN SATIETY AND POSTPONE THE ONSET OF HUNGER. IN THIS ARTICLE WE SHARE SOME OF THE CURRENT DATA.

Studies conducted in different countries (e.g. England, Australia, USA) have estimated that the incidence of overweight and obesity among dogs is between 22 and 40%. The cause of overweight and obesity is a chronic energy intake that exceeds energy expenditure. Dietary fibre may aid in the mitigation and prevention of obesity as it may increase and maintain satiety and prevent the feeling of hunger in the dogs. The feeling of hunger may result in an increase in begging and scavenging behaviour[1], which may in turn encourage the owners to feed their pet more than the animal's physiological energy requirement[2]. The study presented here looked at the effect of fibre fermentability on physiological satiety-related metabolites and voluntary food intake in dogs.

PREVIOUS STUDIES

Several studies in the past have evaluated the effect of dietary fibre on satiety in dogs. Jewell & Toll[3] and Jackson et al. [4] showed a reduced daily energy intake when the dogs were fed high-fibre diets. In addition, voluntary food intake (VFI) of an additional meal 75 min after consumption of the morning meal was lower in the dogs fed high-fibre diets[5]. No effect of dietary fibre on VFI in the dogs was found by Butterwick & Markwell[6]. However, the dogs in the latter study were overweight and supplied with approximately 45% of calculated maintenance energy requirements at target body weight (BW) to induce weight loss. This restriction in daily energy intake may have resulted in an increased feeding motivation to a level that nullified possible effects of dietary fibre on satiety[7].

EFFECT OF FIBRES

Several physical and chemical properties of dietary fibres may influence the duration of postprandial satiety. Fibre fermentability yielding short chain fatty acids (SCFA) may affect satiety through its actions on the production and secretion of gastrointestinal satiety hormones. Infusion of SCFA in the colon of rats[8] and oleic acid in the colon of dogs[9] increased peripheral peptide tyrosine–tyrosine (PYY) concentrations. PYY can cross the blood–brain barrier and act on the arcuate nucleus of the hypothalamus, stimulating neurons that create a sensation of satiety and inhibiting neurons that stimulate feeding behaviour[10]. Stimulation of the secretion of glucagon-like peptide-1 (GLP-1), a proglucagon-derived peptide secreted by the enteroendocrine L-cells present in the distal part of the gastrointestinal tract[11], was increased by the inclusion of fermentable fibres in the diets of dogs during an oral glucose tolerance test[12]. Both PYY and GLP-1 contribute to the ileal brake and increase gastric emptying time and small intestinal transit time[13]. This may prolong gastric distension and signals of satiation[14] and prolong the contact between nutrients and small intestinal receptors involved in maintaining satiety[15]. A delay in gastric emptying will also delay starch digestion and subsequent absorption of glucose[16], thereby maintaining more stable postprandial glucose and insulin concentrations in the blood[17].
Sows fed a diet high in sugarbeet pulp had more stable postprandial glucose concentrations compared with those fed a low-fibre diet that showed a drop in glucose concentration below basal levels. This was associated with an increase in physical activity possibly caused by the feelings of hunger[18].

TABLE 1 - COMPOSITION OF THE LOW-FERMENTABLE FIBRE (LFF) AND HIGH-FERMENTABLE FIBRE (HFF) DIETS

	LFF	HFF
Ingredient composition (g/kg as is)*		
Wheat starch (pre-gelatinised)	468.75	463.00
Poultry meat meal (low ash)	285.00	275.00
Poultry fat	135.00	135.00
Cellulose	85.00	2.00
Sugarbeet pulp (molassed)	2.00	85.00
Inulin	2.00	20.00
Premix†	10.00	10.00
Digest	10.00	10.00
Molasses	4.25	2.00
Titanium(IV) oxide	2.00	2.00
Nutrient composition (g/kg DM)		
Ash	37.5	42.0
Starch	372.4	367.5
Sugar	13.6	41.6
Crude protein	274.1	262.2
Crude fat	191.4	191.2
TDF	123.7	93.9
IDF	110.9	74.7
SDF‡	12.8	19.2
NDF	139.4	99.5
ADF	93.9	41.7
ADL	11.1	10.8
NSP§	111.0	95.1
Energy content (kJ/100 g DM)		
Gross energy	2,294	2,300

*TDF, total dietary fibre; IDF, insoluble dietary fibre; SDF, soluble dietary fibre; NDF, neutral-detergent fibre; ADF, acid-detergent fibre; ADL, acid-detergent lignin. * Wheat starch, Pregel Wheat Alpha (Meneba, Weert, The Netherlands); poultry meat meal, Meat Meal 63 (Sonac, Lingen, Germany); poultry fat (Sonac, Lingen, Germany); cellulose, Arbocel BWW40 (J. Rettenmaier Benelux, Zutphen, The Netherlands); sugarbeet pulp, molasses (Research Diet Services, Wijk bij Duurstede, The Netherlands); inulin, Beneo IPS (Orafti, Tienen, Belgium); premix (Twilmij B.V., Stroe, The Netherlands); digest, Luxus Digest N8008 (AFB International, Nuland, The Netherlands); titanium(IV) oxide (Sigma-Aldrich Chemie B.V., Zwijndrecht, The Netherlands). † The premix provided per kilo gram of diet: Ca, 0.41 g; P, 0.07 g; Mg, 0.05 g; K, 0.1 g; Na, 0.01 g; Cl, 0.09 g; linoleic acid, 0.15 g; PUFA, 0.17 g; lysine, 0.05 g; methionine, 0.02 g; methionine þ cysteine, 0.04; threonine, 0.04 g; tryptophan, 0.02 g; retinol, 5.25 mg; vitamin D3, 50mg; vitamin E, 100 mg; vitamin K3, 2 mg; vitamin B1, 10 mg; vitamin B2, 10 mg; niacin, 50 mg; pantothenic acid, 25 mg; vitamin B6, 7.5 mg; vitamin B12, 50mg; biotin, 300mg; choline chloride, 475 mg; folic acid, 1.25 mg; vitamin C, 100 mg; Fe, 75 mg; Mn, 35 mg; Cu, 5 mg; Zn, 75 mg; I, 1.75 mg; Co, 2 mg; and Se, 0.2 mg. ‡ Calculated by subtracting the IDF content from the TDF content. § Derived by subtracting the crude protein, crude fat, starch and sugar content from the organic matter content). As inulin was included in the analysed sugar content, the NSP content of the HFF diet is underestimated with approximately 18 g/kg DM (20 g/kg included in the diet with 90% pure inulin).*

HUNGER HORMONE

Fermentable fibres have also been found to affect peripheral ghrelin concentrations, a hormone correlated with hunger or appetite[19]. Rats fed diets supplemented with a short-chain oligofructose showed lower active ghrelin plasma concentrations 8 h after the last meal compared with those fed the diet without fructan supplementation[20]. There is still little information available regarding the potency of various fermentable fibres to affect the satiety in dogs. The aim of the present study was therefore to investigate whether an increase in dietary fibre fermentability prolongs the duration of postprandial satiety as measured by VFI and physiological satiety metabolites when included in the diets of dogs.

EXPERIMENTAL SET UP

Sixteen (eight males and eight females) healthy adult beagle dogs aged between 2-6 years with an initial BW between 7.2 and 11.4kg were individually housed in indoor pens at the Laboratory of Animal Nutrition of Ghent University (Merelbeke, Belgium). Dietary treatments were equally distributed among pens. The dogs were assigned to one of two dietary treatments (low-fermentable fibre (LFF) or high-fermentable fibre (HFF)) according to BW and sex (blocking factors) resulting in a mean BW of 9.7 (SEM 0.5) and 9.7 (SEM 0.4) kg for the LFF and the HFF groups respectively.
The dogs were fed one of the two experimental diets formulated to be iso-nitrogenous and iso-energetic on a metabolisable energy basis, and iso-fibrous on a total dietary fibre (TDF) basis. Ingredient composition of both diets is shown in *Table 1*. The LFF diet contained cellulose as a fibre source, whereas the HFF diet contained a combination of sugarbeet pulp and inulin. Differences in fermentability between fibre sources used were based on the in vitro studies[21,22]. The content of molasses in the sugarbeet pulp was estimated to be 5% and an identical amount of molasses was added to the LFF diet. $TiO2$ (2g/kg diet) was included as an inert digestibility marker[23]. Faecal and blood samples were taken during the study period. At the end of the study (week 7), each dog was offered
1kg of the dry extruded control diet that dogs previously experienced as palatable (Hill's Science Plan Canine Adult with Beef, Hill's Pet Nutrition Inc., Topeka, KS, USA). The dogs were allowed to eat for 20 min, after which food intake was recorded.
The diet was offered to each dog at precisely 6 h after the morning feeding (14.30 hours).

RESULTS

All dogs remained healthy throughout the study although a general decrease in the BW was observed for both groups (approximately 5% BW loss for each dietary treatment). No significant differences were found between the dietary treatments in the BW at the start and end of the experiment and BW loss (P=0.906, 0.909 and 0.927, respectively; data not shown). One dog in the LFF treatment group lost substantial BW during the trial and showed very high concentrations of ghrelin compared with the other dogs. The obtained physiological and VFI data from this dog were therefore excluded from the statistical analyses. The dogs fed the HFF diet showed higher ADC for DM and organic matter (P<0.001), whereas the LFF-fed dogs had a higher ADC for crude fat (P<0.001) and tended to have a higher crude protein digestibility (P=0.099; *Table 2*). The NSP digestibility was higher for the HFF diet compared with the LFF diet (P<0.001). In addition, the dogs fed the HFF diet showed higher ADC for NDF (P<0.001) and ADF (P=0.002) and tended to have a lower ADC for acid-detergent lignin (P=0.082) compared with the dogs fed the LFF diet. Finally, the ADC for energy was higher for the HFF-fed dogs compared with the LFF-fed dogs (P<0.001).

TABLE 2 - APPARENT DIGESTIBILITY COEFFICIENT (ADC; %) FOR NUTRIENTS AND ENERGY IN THE LOW-FERMENTABLE FIBRE DIET (LFF) OR THE HIGH-FERMENTABLE DIET (HFF) FED TO DOGS (MEAN VALUES WITH THEIR STANDARD ERRORS FOR EIGHT LFF-FED DOGS AND EIGHT HFF-FED DOGS)

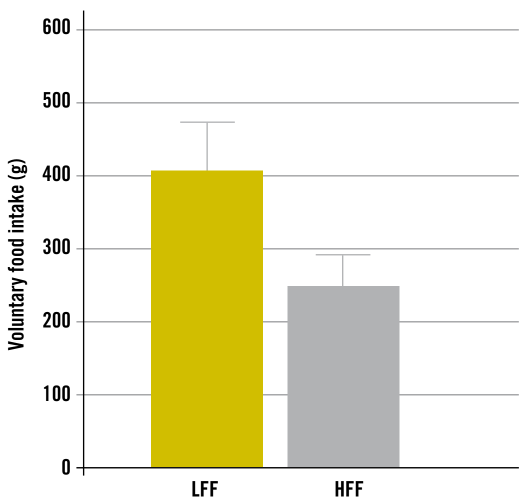
	LFF		HFF		
	Mean	**SEM**	**Mean**	**SEM**	**P**
DM	77.9	0.28	80.9	0.56	<0.001
OM	80.6	0.25	84.1	0.57	<0.001
Crude protein	77.3	0.81	75.4	0.68	0.099
Crude fat*	94.5	0.19	92.3	0.18	<0.001
NDF	37.0	0.59	62.3	2.14	<0.001
ADF	3.3	0.96	22.3	5.00	0.002
ADL	43.7	4.13	34.9	2.26	0.082
NSP	22.8	0.69	20.6	4.96	<0.001
Gross energy	82.7	0.25	84.9	0.43	<0.001

OM, organic matter; NDF, neutral-detergent fibre; ADF, acid-detergent fibre; ADL, acid-detergent lignin.
* Due to the limited amount of faecal material available for the analysis, the values presented were based on seven dogs for the LFF treatment and six dogs for the HFF treatment.

FAECAL, BLOOD AND VFI

Significant differences in the faecal characteristics between the treatment groups were observed. The faecal DM content was lower for the dogs fed the HFF than the LFF (P<0.001) diet. Compared with the dogs fed the LFF diet, higher total SCFA, acetate and propionate concentrations were found for the dogs fed the HFF diet (P<0.001). Moreover, butyrate concentrations tended to be higher in the HFF dogs (P=0.060). The dogs fed the LFF diet showed a higher branched-chain ratio and NH3

FIGURE 1 - VOLUNTARY FOOD INTAKE OF THE LOW-FERMENTABLE FIBRE (LFF) AND HIGH-FERMENTABLE FIBRE (HFF) -FED DOGS. DOGS HAD AD LIBITUM ACCESS FOR 20MIN TO THE CONTROL DIET THAT WAS PRESENTED 6 H FOLLOWING THEIR MORNING MEAL (EXPERIMENTAL DIET). VALUES ARE MEANS FOR SEVEN DOGS FED THE LFF AND EIGHT DOGS FED THE HFF, WITH THEIR STANDARD ERRORS REPRESENTED BY VERTICAL BARS (P =0.058)



concentration in the faeces compared with the dogs fed the HFF diet (P=0.002 and 0.009, respectively).

No treatment effect was found for faecal consistency score (P=0.590). The basal concentrations of plasma glucose, insulin, PYY, GLP-1 and ghrelin were not different between the treatments groups (P>0.05). For all the measured metabolites, postprandial concentrations changed after the meal (P<0.01), but the concentrations were not affected by the dietary treatment (P>0.10 for diet and diet:time interaction, data not shown). For each dog, the amount of food consumed at the end of the study was lower than the amount of food offered. The dogs fed the HFF diet tended to show a lower VFI compared with the dogs fed the LFF diet (P=0.058, *Figure 1*). No significant correlations were found between VFI and glucose, insulin, PYY, GLP-1 or ghrelin concentration in plasma at 6 h after the meal (P>0.05, data not shown).

CONCLUSION

Inclusion of fermentable fibre in canine diets may contribute to the prevention or mitigation of obesity through its effects on satiety. The present study showed that the dogs fed the HFF diet had an increased large intestinal fibre degradation and the production of SCFA than the dogs fed the LFF diet. Concerning the feelings of satiety and appetite, the dogs in the HFF treatment group tended to have a lower VFI compared with the LFF-fed dogs. This suggests that dogs fed the HFF diet were less motivated to consume food when freely available. Postprandial plasma PYY, GLP-1, ghrelin and glucose responses did not differ between the treatment groups and could not be linked to the observed lowered voluntary food consumption of the HFF diet group.

It is likely that other satiety-related hormones and/or mechanisms controlling the feelings of satiety or hunger may have been involved in the observed decrease in VFI in the present study. <-

References 1-23 are available on request.