The effect of a commercial high-fibre diet and an iso-malto-oligosaccharide-supplemented diet on post-prandial glucose concentrations in dogs

By M. HESTA, J. DEBRAEKELEER, G. P. J. JANSSENS and R. DE WILDE

Summary
In order to evaluate the effect of insoluble and soluble fibre on the levels of post-prandial glycaemia, six healthy dogs were fed three different diets: a low-fibre control diet, a high-fibre diet (HF; mainly insoluble fibre) and the control diet with 10% iso-malto-oligosaccharides (IMO) added. The diets were fed for 2 days before the blood collections were started on the third day. Serial blood samples were taken 20, 60, 90, 150, 180, 240 and 360 min after feeding and one sample was taken just before the feeding after a fasting period of at least 20 h. There were no problems concerning the faecal consistency. The post-prandial glycaemia curve was significantly lower in the HF and IMO group in comparison with the control group. At 20 and 60 min the glucose concentration was significantly lower in the HF and IMO groups. At 90 and 150 min only the IMO group had a significantly lower glucose concentration. At 360 min there was a trend for a lower glucose concentration in the IMO group. The results show that both the HF and the IMO diets had a beneficial effect on post-prandial hyperglycaemia. Substitution of IMO may have the same or a slightly better effect, but this has to be confirmed in diabetic dogs and the effect may depend on the composition of the basal diet.

Introduction
The ingestion of food results in a post-prandial increase in blood glucose followed by a blood insulin increase. Glucose metabolism is impaired in diabetes mellitus, and may also be impaired in obesity, gestation and ageing (SUNVOLD and BOUCHARD 1998). The reported incidence of diabetes mellitus varies from 0.2 to 1% of dogs and cats presented to veterinary hospitals. (MARMOR et al. 1982; MATTHEEUWS et al. 1984; PANCIERA et al. 1990).

The objectives of the dietary treatment of patients with diabetes mellitus are to establish and maintain an optimal body weight, to integrate the meals with the insulin therapy and to optimize glycaemic control through diet composition (MICHEL 2000). The latter, in particular, can be influenced by dietary fibre (NELSON 2000). The effect of fibre depends on the meal size, the type of fibre, other nutrients (quantity and source of complex carbohydrates) and how the fibre is divided into the feed (WOLEVER et al. 1979; BLAXTER et al. 1990). Two types of fibre are often distinguished according to their physical properties: soluble fibre and insoluble fibre. Soluble fibre has a greater water-holding capacity, is more fermentable, and is generally considered to form more viscous solutions than insoluble fibre. The terms soluble and insoluble indicate that the fibre is more or less dispersible in water rather than referring to true chemical solubility. (GALLAHER and SCHNEEMAN 1996).
In diabetic people, the more viscous soluble fibre sources are believed to have a greater effect on glycaemic response than less viscous insoluble fibres, although others have found both fibre types to be beneficial (Anderson et al. 1979; Nuttall 1993; Nelson and Sunvold 1998). In dogs with alloxan-induced diabetes mellitus Nelson et al. (1991) obtained a similar effect on glycaemic control when feeding a diet that was high in insoluble (cellulose) to that obtained with a diet that was rich in soluble fibre (pectin).

In another study, the addition of guar (soluble fibre) abolished the post-prandial hyperglycaemia in four normal dogs and reduced it in two other dogs (Baxter et al. 1996). Wheat bran had the same effect but to a lesser extent. Diabetic dogs responded similarly although the differences were not significantly different because of the small number of dogs. Normal dogs consuming 1% carboxymethylcellulose (high viscosity) (soluble fibre) diet showed the best glycaemic response in comparison with the control or higher concentrations (Nelson and Sunvold 1998).

Soluble fibre is thought to have an effect on glucose metabolism through slower gastric emptying, slower glucose absorption and enhanced insulin sensitivity. Insoluble fibre is assumed to have a bulking effect, leading to decreased contact with gastrointestinal enzymes, a slower starch hydrolysis and a delayed absorption of glucose (Nelson 1992; Anderson and Akanji 1991).

In the present study, the post-prandial glucose concentrations in healthy dogs were evaluated after feeding a high-fibre diet (1) in comparison with a control food (2). In addition, an investigation to evaluate whether or not the supplementation of a commercial food (control food) with isomalto-oligosaccharides (IMO) had an effect similar to fibre was also carried out.

In the present study, a commercially available diet which is high in insoluble fibre (cellulose) and suggested for use in diabetic dogs, was compared with a diet supplemented with isomalto-oligosaccharides (IMO). IMO consist of $\alpha$-D-glucose residues linked by $\alpha$(1–6) glycosidic bonds (Crittenden and Playne 1996). IMO is not completely indigestible but is partially digested by intestinal enzymes. In humans IMO increases the number of faecal bifidobacteria (Kaneko et al. 1994).

**Material and methods**

Six adult healthy beagle dogs were fed three different diets: a low-fibre diet (control; 2.7% crude fibre; Royal Canin RCCI (Royal Canin Benelux, Brussels, Belgium) Size: medium adult 1); a high-fibre diet (HF; 15.3% crude fibre; mainly insoluble fibre; Hill’s prescription diet (Hill’s Pet Nutrition, Breda, the Netherlands) canine w/d dry); and the control diet with 10% isomalto-oligosaccharide (IMO; Cerestar (Cerestar, Vilvoorde, Belgium): IMO (C 019T0); added (at the expense of the basal diet). The IMO mixture was composed of a variety of isomalto-oligosaccharides with a different degree of polymerization (DP) (Table 1). The diets were ground and by adding 50% lukewarm water, the diet became a palatable porridge. The dogs in the HF and control groups were fed individually according to their energy requirements (480 kJ ME/kg$^{0.75}$). In the IMO group the same amount of feed was given as in the control group. The diets were fed for 3 days. First the HF diet was fed for 3 days, followed by the control diet and finally the

**Table 1. IMO (CO19T) composition (information from the company)**

<table>
<thead>
<tr>
<th>Glucose</th>
<th>21%</th>
<th>isodP 4</th>
<th>11%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maltose</td>
<td>14%</td>
<td>isodP 2-4</td>
<td>54%</td>
</tr>
<tr>
<td>isodP 2</td>
<td>12%</td>
<td>isodP n</td>
<td>11%</td>
</tr>
<tr>
<td>isodP 3</td>
<td>31%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

DP, degree of polymerization
IMO diet. In this way the control diet served as a short wash out period. Before the start of the experiment all dogs consumed the control diet for several weeks. A blood sample was taken after a fasting period of at least 20 h just before the meal on the third day. The ration was eaten within 5 min. Serial post-prandial blood samples were taken 20, 60, 90, 150, 180, 240 and 360 min after feeding. Tubes with sodiumfluoride (NaF) were used for the collection. A commercial available testkit (D-glucose; Boehringer, Mannheim, Germany) was used for the determination of plasma glucose concentrations.

A proximate analysis was performed on the different diets (Table 2). Starch was determined by the method of Ewers. The total dietary fibre (TDF) as well as soluble and insoluble dietary fibre (SDF, IDF) were determined according to the method of PROSKY et al. (1985).

Results

The post-prandial glycaemia curve (Fig. 1) was significantly lower in the HF and IMO group in comparison with the control group (p < 0.002) (repeated measures). At 20 and 60 min the glucose concentration was significantly lower in the HF and IMO groups compared with the control (p = 0.000 and 0.001, respectively). At 90 and 150 min only the IMO group had a significantly lower glucose concentration (p = 0.01 and 0.027, respectively). At 360 min there was a trend for a lower glucose concentration in the IMO group (p = 0.055; one-way analysis of variance) in comparison with the control group.

The analyses of the different products are presented in Table 2. In the IMO-supplemented product almost no TDF was detected (0.2% TDF; 0.11% insoluble). No problems with faecal consistency were seen in the IMO-supplemented group.

Discussion

First, the fact that the control and the HF diet were not comparable as to ingredients and nutrients has to be stressed. Second, the experimental design did not exclude possible time and sequence effects. The commercial high-fibre diet significantly decreased the post-prandial glycaemia curve in healthy dogs. This effect was even more pronounced and lasted longer in the 10% IMO group. Soluble fibre is often thought to have a greater effect than
The dogs in the IMO group consumed slightly less calories, which also might have had a minor influence. The 21% glucose and 14% maltose in the commercial IMO product apparently did not influence the post-prandial glucose concentrations. Whether or not they would influence the results in diabetic dogs is not yet clarified.

The level of TDF found in the IMO product was only 0.2%. The AOAC method (Prosky et al. 1985), which was used to determine TDF, was not appropriate for the detection of some other oligo-saccharides (oligofructose and inulin) (Quemener et al. 1994). In addition, the dilution due to supplementation with IMO resulted in a lower level of TDF in the IMO-supplemented product than in the control diet (see Table 2). Nevertheless, the hypoglycaemic effect is remarkable and indicates that other criteria than soluble or insoluble TDF may influence the post-prandial glycaemia.

Dietary fibre is most effective if the diet is also high in complex carbohydrate (Nelson et al. 1991). The high-fibre diet contained more complex carbohydrates than the control or the IMO diet (59.8% of energy in the HF vs. 41.6% in the control diet and 47% in the IMO diet) and could therefore not explain the differences between the HF and IMO diet.

Not only the quantity of complex carbohydrates consumed plays a role in the post-prandial glycaemia but also the source of complex carbohydrates. Sunvold and Bouchard (1998) found that a sorghum diet had the lowest and a rice diet had the highest area under the curve (AUC) of post-prandial glucose. Corn, wheat and barley diets had intermediate responses. For post-prandial insulin, rice had again the largest response (AUC) and barley the lowest. It was noted that different results can be possible with other rice sources due to variation in amylose content.

In both the control and the HF diet, maize was the only cereal and quantitatively the most important ingredient on the ingredient list, suggesting that the source of carbohydrates will probably not have played a role in the differences in post-prandial glycaemia.

The addition of 10% of IMO to the diet did not cause any of the problems with faecal consistency, which have been noted in dogs or cats after inclusion of similar levels of fructo-oligosaccharides (Diez et al. 1997; Hësta et al. 2001). However, the commercial IMO product also contained 21% glucose and 14% maltose and only 65% of IMO (Table 1). Moreover IMO is only partly indigestible (Kaneko et al. 1994) which could explain why 10% of the IMO mixture was well tolerated.
Conclusions
The results suggest that feeding the commercial high-fibre diet could be beneficial in diabetic dogs; an effect that has already been shown by Nelson et al. (1991) with a similar diet. Substitution of IMO for 10% of a diet for adult maintenance may have the same or a slightly better effect, but this has to be confirmed in diabetic dogs and the effect may depend on the composition of the basal diet.

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References

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