Digestive performance of dogs fed a jojoba meal supplemented diet

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Abstract

Jojoba meal, the simmondsin containing by-product of oil expelling from jojoba seeds (Simmondsia chinensis) reduces food intake in rats. In the search for diet meals for dogs, we tested the digestive effects of supplementation of jojoba meal to the diet of Beagle dogs at two different concentrations. Supplementation at a low dose (2.7%) did not reduce the body weight to lower values than control animals, and did not influence the digestibility of the food. At higher concentrations (8.1%) jojoba meal reduced body weight, which was not only due to a lower food intake, but also to a less than optimal digestibility of the jojoba supplemented food. © 2000 Elsevier Science B.V. All rights reserved.

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1. Introduction

The jojoba plant (Simmondsia chinensis) produces seeds that contain up to 50% liquid wax used as a lubricant additive and in cosmetics (Wisniak, 1987). The protein-rich residue remaining after oil extraction, referred to as jojoba meal, is hardly used at all. Valorisation of the jojoba meal could be an important marketing impulse for the jojoba industry. So far, jojoba meal has been rejected as animal feed because of the presence of the so-called simmondsins (Elliger et al., 1973). These glycosides, mostly simmondsin and simmondsin-2'-ferulate, decrease food intake in rats in a dose-dependent and persistent way due to induction of satiation and probably through interference with the cholecystokinin (CCK)-system (Cokelaere et al., 1995a,b; Flo et al., 1999).

Obesity is probably the most common form of malnutrition likely to be observed in companion...
animal practice. In the western world, ~40% of the dogs are overweight (Norris and Beaver, 1993). Obesity is the result of an extended period of positive energy balance, a state in which caloric intake exceeds energy expenditure, resulting in weight gain and expansion of adipose tissue stores, which is detrimental to the health of an animal. Pet diets based on energy restriction know little success because most owners can hardly resist their pet’s begging eyes. Jojoba meal supplementation of dog food could be a possible alternative based on the anorectic property of simmondsin.

Recent research results of our laboratory (unpublished data) have indicated that food intake reduction, observed after jojoba meal administration in dogs, might be ascribed to the same phenomenon as in rats.

However, compounds other than simmondsins are present in the meal, including polyphenols, phytic acid, trypsin inhibitors and bitter substances (Wisniak, 1987; Wiseman and Price, 1987; Vermaut, 1998), that may contribute to an impaired food intake and energy balance of jojoba fed animals.

Therefore, the aim of the following experiments was to investigate the digestibility of jojoba supplemented meals and its dose dependency in dogs.

2. Materials and methods

2.1. Animals and housing

Twelve adult (2–8 years) beagle dogs, six males and six females, were housed in pairs in a non-heated kennel. They were fed a daily ration of 250 g/animal of a commercial dry dog food (Cervo NV, Leuven) (26.9% crude protein, 17.4% fat, 6.4% ash, 7.3% moisture, 30.1% starch) approximately matching their daily maintenance needs, and had free access to water. Eight dogs were used alternately for tests and placed in a separate metabolic cage that allows minute daily recording of food intake and faeces production. These dogs were normally accustomed to the experimental procedure.

2.2. Jojoba meal

Non defatted jojoba meal (press cake) was obtained from Israel (Jojoba Israel, Kibbutz Hatzerim, Negev, Israel). The concentrations of simmondsin and simmondsin-2'-ferulate were determined by a previously described HPLC method (Van Boven et al., 1996) and were 3.6 and 1.2%, respectively. This was equivalent to a simmondsin activity of 4.43% in jojoba meal and to 0.12% (JO12) and 0.36% (JO36) respectively in the two jojoba meal supplemented test foods with 2.7 and 8.1% of jojoba meal on weight basis. The jojoba meal contained 26% crude protein and 12.3% fat.

2.3. Experimental diets

The two experimental foods (JO12 and JO36) and one control food (C) were tested. The C food was the above described commercial granulated dry food (Cervo NV, Leuven). A basic food (BF), identical to C except for fat content (10% less fat in BF than in C), was used for preparation of the experimental foods. The JO12 and JO36 foods were prepared by supplementation of the BF with an emulsion of oil and jojoba meal to obtain test diets containing 2.7 or 8.1% jojoba meal, respectively, and approximately the same crude protein and fat content as C.

2.4. Experimental design

The treatments C, JO12 and JO36 were performed in three separate experimental periods of 2 weeks, separated by 1 week at least. For each experimental period, eight different dogs were used, so that each treatment was repeated four times with a different pair of dogs. The dogs were weighed before and after treatment. An experimental period consisted of 1 week adaptation to the test food and metabolic cage and 5 days of effective faeces collection and food intake recording. The daily rations of 250 g/animal of the respective foods (C, JO12, and JO36) were offered in the morning, and remained available during 24 h. The food intake was expressed as percentage of 250 g. The collected faeces were weighed and stored at −30°C until analysis. Nitrogen and
energetic digestibility of the consumed portions of C, JO12 and JO36 were calculated by determination of dry matter (DM) content and of nitrogen (Kjeldahl) and energy content (calorimetry) on a dry matter basis of the experimental foods and the according collected faeces.

2.5. Statistical analysis

The results were expressed as the mean ± S.E.M. Statistical analysis was performed by ANOVA, followed by a Tukey multiple comparison test for the different treatments and a Pearson correlation test for analysed parameters (body weight alteration, nitrogen digestibility, energy digestibility, food intake…). Differences were considered significant when $P < 0.05$.

3. Results and discussion

3.1. Results

Results are presented in Table 1. All C treated dogs completely ate their daily offered ration of 250 g/animal. A simmondsin activity of 0.12% (JO12) did not significantly reduce food intake $(97 ± 2\%)$ below the daily portion offered $(250 g = 100\%)$, whereas supplementation of jojoba meal to a simmondsin activity of 0.36% did cause a significant decrease of food intake $(75 ± 5\%)$. Although the JO36 group ate less, the amount of excreted faeces was not reduced $(301 ± 39 g DM)$ compared to JO12 $(279 ± 11 g DM)$ and C $(280 ± 10 g DM)$. Nitrogen intake of the control animals and the JO12 group was similar and was higher than in the JO36 group. An increased nitrogen concentration of the faeces samples of the JO36 dogs, together with a decreased total food intake, resulted in a comparable N excretion in all groups. The apparent nitrogen digestibility in the JO36 group $(67.7 ± 3.1\%)$ was therefore significantly worse than in both other groups $(79.6 ± 0.9\%$ (C) and $79.0 ± 1.0\%$ (JO12)). Analogous to the nitrogen balance, the energy intake in JO36 animals was lower than in C and JO12 whereas the energy excretion was not, resulting in a significantly lower energy digestibility.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>C</th>
<th>JO12</th>
<th>JO36</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food intake (% of ration offered)</td>
<td>100$^b$ 0</td>
<td>97$^b$ 2</td>
<td>75$^b$ 5</td>
</tr>
<tr>
<td>Faeces excretion over 5 days (g DM)</td>
<td>280 ± 10</td>
<td>279 ± 11</td>
<td>301 ± 39</td>
</tr>
<tr>
<td>Nitrogen balance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N content food (%)</td>
<td>4.26 ± 0.007</td>
<td>4.26 ± 0.007</td>
<td>4.26 ± 0.007</td>
</tr>
<tr>
<td>N content faeces (%)</td>
<td>3.68$^b$ ± 0.07</td>
<td>3.78$^{bc}$ ± 0.05</td>
<td>4.1$^b$ ± 0.1</td>
</tr>
<tr>
<td>N in (g)</td>
<td>50.6 ± 0.07</td>
<td>49.4$^b$ ± 1.1</td>
<td>38.3 ± 2.9</td>
</tr>
<tr>
<td>N out (g)</td>
<td>10.3 ± 0.5</td>
<td>10.5 ± 0.4</td>
<td>12.5 ± 1.8</td>
</tr>
<tr>
<td>N digestibility (%)</td>
<td>79.6$^b$ ± 0.9</td>
<td>79.0$^b$ ± 1.0</td>
<td>67.7 ± 3.1</td>
</tr>
<tr>
<td>Energy balance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E content food (kJ/g DM)</td>
<td>21.2 ± 0.002</td>
<td>21.2 ± 0.002</td>
<td>21.2 ± 0.002</td>
</tr>
<tr>
<td>E content faeces (kJ/g DM)</td>
<td>14.7$^b$ ± 0.1</td>
<td>15.5$^{bc}$ ± 0.2</td>
<td>16.3$^b$ ± 0.3</td>
</tr>
<tr>
<td>E in (MJ)</td>
<td>25.2$^b$ ± 0</td>
<td>24.6$^b$ ± 0.5</td>
<td>19.0 ± 1.4</td>
</tr>
<tr>
<td>E out (MJ)</td>
<td>4.1 ± 0.1</td>
<td>4.3 ± 0.2</td>
<td>5.0 ± 0.7</td>
</tr>
<tr>
<td>E digestibility (%)</td>
<td>83.6$^b$ ± 0.6</td>
<td>82.2$^b$ ± 1.0</td>
<td>74.6 ± 2.3</td>
</tr>
<tr>
<td>Body weight alteration</td>
<td></td>
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<tr>
<td>Δ BW (kg)</td>
<td>−0.36$^b$ ± 0.07</td>
<td>−0.52$^{bc}$ ± 0.13</td>
<td>−1.56$^c$ ± 0.23</td>
</tr>
</tbody>
</table>

$^a$ Values are the mean of eight replicates ± S.E.M.

$^{bc}$ Values with different superscripts are significantly different $(P < 0.05)$. 

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in JO36 treated dogs (74.6 ± 2.3%) compared with JO12 (82.2 ± 1.0%) and C (83.6 ± 0.6%) animals. A significant correlation of $r = 0.98$ ($P < 0.05$) existed between the parameters nitrogen digestibility and energetic digestibility.

After 5 days of treatment, all dogs had lost weight ranking from 0.36 ± 0.07 kg (C) to 0.52 ± 0.13 kg (JO12) and 1.56 ± 0.23 kg (JO36) average body weight loss. Absolute body weight alteration is significantly correlated with nitrogen and energetic digestibility ($r = 0.71$ and 0.72, respectively, $P < 0.05$) and with food intake ($r = 0.41$, $P < 0.05$).

3.2. Discussion

At low concentrations (JO12) jojoba meal does not lower the food intake beneath the basal ration offered. However, it is not known how much these animals would eat when they had free access to food, and thus it can not be decided that jojoba meal in this concentration is not effective in reducing food intake. The JO36 treated animals did lower their food intake beneath the daily offered portion, which indicates that the food intake reducing effect of jojoba meal in this concentration was higher than the hunger drive in this case.

Absolute body weight change is the direct result of the total nitrogen and energy balance, resulting from a combination of digestibility and food intake minus the maintenance metabolism (of protein and energy).

A similar, or tendency to higher total faeces excretion as well as total nitrogen and energy excretion in JO36 treated dogs, together with a reduced intake, resulted in a less optimal digestibility in spite of the lower food intake. Thus, the additional body weight loss in these dogs compared to the C and JO12 dogs is not only the result of a lower food intake, but also of a decreased digestive efficiency and a possible influence of simmondsin or other components present in jojoba meal on the intermediate metabolism.

Cokelaere et al. (1993) recorded in growing rats receiving jojoba meal, mixed in the food at 3%, a small reduction in growth compared to pair fed animals (receiving the same amount of food, but without jojoba meal). This points to a somewhat lower digestibility caused by components present in jojoba meal. Because the apparent digestibility was measured and the relative decrease of N digestibility is higher than the decrease in E digestibility (Table 1) with JO36, this may point to a higher pancreatic enzyme secretion (N-loss) in line with the CCK-hypothesis and possible anti-enzymatic activity of jojoba compounds. Moreover, the weight loss due to a changed total N and E balance, even if this weight loss is proportional, e.g. resulting in an unchanged lean/fat ratio, can also be influenced by a changed maintenance metabolism as a direct result of interference of simmondsin or other components with factors controlling intermediary metabolism such as thyroid hormones. Cokelaere et al. (1993) indeed observed, in rapidly growing rats, that an impaired growth rate compared with paired-fed animals was accompanied by an increased level of plasma thyroid hormones, probably induced by a relative protein shortage due to jojoba meal components. These aspects have to be further elucidated in dogs.

The overall energy balance was not monitored, thus alteration of the maintenance level in JO36 treated dogs remains merely hypothetical. Nevertheless, Flo et al. (1999) showed that heat production in simmondsin-treated rats was somewhat lower compared to free-eating rats but higher than in the pair-fed animals (although never significantly).

The small weight loss of the JO12 and C animals lays within an acceptable range and can be considered in the circumstances as normal for animals receiving a ration limited to approximately their daily needs.

4. Conclusions

It can be concluded that supplementation of jojoba meal at a concentration of 8.1% results in a reduction of body weight in dogs within five days. However, since the digestibility of the food supplemented with high doses of jojoba meal is also lower than that of control food or food with low jojoba meal concentrations, the body weight loss can not be merely ascribed to the reduced
food intake. From this study it cannot as yet be concluded whether the weight loss by jojoba feeding is proportional or differential compared to animals that lose a similar amount of body weight under restricted conditions or whether the body weight changes are influenced also by differences in heat production in the jojoba treated dogs.

For quantitative conclusions on the food intake reducing effect of jojoba meal and simmondsin, supplemental research is needed.

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References


