

Waltham International Symposium: Pet Nutrition Coming of Age

Weight Loss in Obese Dogs: Evaluation of a High-Protein, Low-Carbohydrate Diet^{1,2}

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EXPANDED ABSTRACT

KEY WORDS: • dog • obesity • high-protein diet • body composition

Obesity and excess body weight are estimated to affect approximately 25% of dogs receiving veterinary care in Western countries (1,2). They are recognized as the most common nutritional diseases in companion animals (3). Energy restriction both during and after weight loss is the cornerstone to achieve and maintain optimal body condition. An important concern with energy restricted diet, however, is to cover all the requirements for essential nutrients, especially protein. In obese humans and animals, increasing dietary protein during weight loss programs has been shown to maintain lean body mass (4,5). The purpose of this study was therefore to assess the effect of a high-protein low-starch weight-reduction diet in the management of canine obesity.

In a preliminary study of client-owned dogs nine overweight or obese dogs (8 females and 1 male) with mean ages, body weights and body condition scores (BCS⁴) of 8 y (range 3–10), 30 kg (13.5–48) and 4.6/5 (4.5–5 in a 5-point scale), respectively were recruited. Mean excess body weight was 30% (11–58). History and clinical examination revealed inactivity or lethargy ($n = 5$), impaired breathing ($n = 3$) and locomotion problems ($n = 2$) but all other variables were within normal limits.

Treatment consisted of feeding a high-protein, low-starch diet at 40–55% of maintenance energy requirements (MER) for the dog's estimated optimal body weight until it reached

optimum body condition. Dogs were fed twice daily and sessions of exercise of at least 20 min/d were recommended to prevent excess protein catabolism and to minimize losses of fat-free mass (FFM).

The time necessary to reach the target weight and a BCS of 3 ranged from 4 to 38 wk (mean \pm SEM: 18.3 \pm 3.8). The rate of weight loss varied from 0.8 to 3.1% (1.9 \pm 0.3) per wk. Weight loss improved or suppressed the inactivity, lethargy, impaired breathing and locomotion problems initially reported by the owners.

MATERIALS AND METHODS

Experimental study

Experimental diets. Two high-fiber dry expanded diets were used: a high-protein and low-starch diet [Test,⁵ %DM: crude protein, 47.5%; starch, 5.3%; total dietary fiber (TDF), 30.8%; ash, 7% and metabolizable energy (ME), 11.6 kJ/g as fed] formulated for the study and a commercially available control weight reduction diet (Control,⁶ %DM: crude protein, 23.8%; starch, 23.9%; TDF, 38.6%; ash, 5.2% and ME, 9.8 kJ/g as fed). Energy content was measured using dogs at the research center of Royal Canin.

Animals: feeding protocol. Eight adult obese Beagle dogs, 4 neutered males and 4 intact females, 6 \pm 0.4 (mean \pm SEM) y of age at the beginning of the study, at least 30% (30–72) overweight for at least 1 y, and belonging to the Animal Nutrition Unit of the Veterinary Faculty, were used. Optimal weight and thus target body

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⁴ Abbreviations used: BCS, body condition score; FFM, fat-free mass; ME, metabolizable energy; MER, maintenance energy requirements; TDF, total dietary fiber.

⁵ High-protein experimental diet. Ingredient list: poultry meal, corn gluten, rice gluten, purified cellulose, barley, beet pulp, poultry fat, poultry liver hydrolysate, minerals, psyllium seeds, brewer's yeasts, fructooligosaccharides, chelated trace elements, L-carnitine, vitamins.

⁶ Hill's Prescription Diet, Canine R/D dry, Hill's Pet Nutrition, Topeka, KS. Ingredient list: maize meal, peanut hulls, chicken and turkey meal, soy hulls, poultry hydrolysate, vegetable oil, linseeds, cellulose powder, salt, choline chloride, L-carnitine, zinc oxide, iron sulfate, manganese oxide, copper sulfate, calcium iodine, sodium selenite, vitamin A, pro-vitamin D, vitamin E, niacin, thiamin, pantothenic acid, pyridoxine hydrochloride, riboflavin, folic acid, biotin, vitamin B₁₂, antioxidants.

TABLE 1

Age, sex and weight of the dogs used in the experimental study¹

Animals	Age <i>y</i>	Initial BCS ²	Weight			Time to reach target weight <i>d</i>	Average body weight loss %/wk
			Initial <i>kg</i>	Target <i>kg</i>	Initial/target %		
High protein	5.5 ± 0.6	4.3 ± 0.3	20.0 ± 1.4	13.7 ± 0.6	145.3 ± 5.3	164.5 ± 7.3	1.95 ± 0.2
Control	6.5 ± 0.5	4.3 ± 0.1	19.5 ± 0.7	13.8 ± 0.3	140.8 ± 2.5	127.8 ± 17.7	2.35 ± 0.2

¹ Values are means ± SEM.² BCS, body condition score.

weights for those dogs were known from historical colony data and corresponded to a BCS of 3 using a scale from 1 to 5. Obesity was also assessed by BCS using the same scale. Table 1 summarizes data about the dogs. As a baseline before inducing weight loss, all dogs were fed for 3 mo a commercial dry dog food (crude protein 24.0%, fat 16.1%, 15.9 MJ/kg) and individual intake was recorded daily. The dogs were then allotted to two similar groups based on sex and body weight and fed either the high-protein (Test) or the control diets. To adapt dogs of the Test group to their new diet, they were fed equal amounts of the baseline and the Test diet during wk 1. During wk 2 they were given the Test diets exclusively. Over this 2-wk period, the amounts of food given were identical to the amounts eaten spontaneously during the baseline period. During wk 3, daily food allowance was reduced by 10%. The same protocol was used with the group fed the control diet, with some adjustments, to ensure similar energy intake with those fed the high-protein (Test) diet because the control diet was less energy dense than the test diet. For the rest of the study, to ensure a weekly weight loss rate of around 2%, food allowance was decreased by increments of 10% when no change of body weight was observed over a consecutive 2-wk period until dogs reached their target body weight as previously defined (Table 1). Individual food consumption was recorded daily. Water was provided ad libitum. During the whole study, dogs were maintained in their usual kennel, by groups of two or three. The protocol was approved by the Animal Use and Care Advisory Committee of the University of Liège.

Measurements

Biometrics. Body weights and BCS were recorded weekly. Average weekly body weight loss rate was calculated (Table 1).

Hematology and blood biochemistry. Before inclusion in the study, dogs were determined to be healthy on the basis of a physical examination, complete blood count, serum biochemistry panel and urinalysis. During a baseline period, dogs underwent hormonal evaluation (serum insulin, T3, T4, cortisol) to rule out any primary hormonal disorder. The hormonal evaluation included a thyroid function test. Serum thyroxine was determined at baseline and after a thyroid stimulation to ensure that thyroid-related disorders would not confuse response to the weight-reduction program.

Body composition. Body composition was determined before and after the weight-loss program as reported elsewhere (6). Total body water was measured using the isotopic dilution of D₂O. On the day of the measurement, 20-h food-deprived dogs were placed in individual cages for water restriction and body water equilibration from 2 h before to 4 h after the tracer injection. Dogs were injected with ²H₂O (99.9% ²H/H, Leman, Saint-Quentin-en-Yvelines, France) subcutaneously (1.5 g kg⁻¹ body weight). Blood samples (5 mL) were collected from the jugular vein before and 4 h after the tracer injection. Deuterium was assayed by Fourier transform infrared spectroscopy. Total body water (in kg) was estimated from the deuterium pool value. FFM was obtained from total body water divided by 0.744 (7). The body fat content was further calculated from body weight and FFM.

Statistical analysis. Linear regression of percentage excess body weight by time (body weight measured each wk/target body weight) was used to analyze the differences between the two diets. The effects

of diet and sex were assessed separately by one-way ANOVA performed on the difference for each parameter at initial and final status and by a two-way ANOVA to test the interaction. Simple linear regressions were calculated to test for correlation among biometrics parameters. The statistical tests, unless otherwise stated, were carried out at the 5% significance level. Results are expressed as means ± SEM.

RESULTS

Weight loss

Initial and target body weight and BCS are reported in Table 1. Body fat content was 37.3 ± 2.0% and 35.8 ± 1.3% for the high-protein (Test) and the control group, respectively. Final body fat content was 17.0 ± 3.0% for the high-protein group and 17.7 ± 2.0% for the control group. Mean body weight loss was 43.1 ± 2.8% of initial body weight (45.3 ± 5.3% vs. 40.8 ± 2.5% in high-protein and control group, respectively). A linear relationship was found between time and excess weight ($r^2 = 0.98$). The BCS and both thoracic and pelvic circumferences (data not shown) were significantly ($P < 0.001$; r ranging from 0.73 to 0.93) and positively correlated with excess body weight for both groups. The BCS was also significantly and positively correlated with thoracic and pelvic circumferences ($P < 0.001$; r ranging from 0.72 to 0.79).

Composition of weight loss

Body composition assessed by the deuterium oxide dilution method allowed calculation of the composition of the body weight loss. Total body weight loss was 6.3 ± 0.9 and 5.7 ± 0.4 kg and its fat content 80.4 ± 3.1% and 70.0 ± 3.1% ($P = 0.056$) for the high-protein and the control groups, respectively.

Food consumption and energy allowance

During the pretest period food consumption of the baseline commercial diet was 310 ± 13 and 296 ± 8 g d⁻¹ in dogs assigned to the high-protein and control diets, respectively. These amounts correspond to an energy allowance of 694 ± 13 kJ/kg target body weight^(0.75) d⁻¹ and 659 ± 10 kJ/kg target body weight^(0.75) d⁻¹. By feeding similar amounts of less energy dense diets than the baseline diet, the energy allowance was automatically reduced and weight loss was observed with both diets. The energy levels that induced weight loss were, respectively, 419 ± 19 and 374 ± 32 kJ/kg target body weight^(0.75) d⁻¹ for the high-protein and the control group. These amounts correspond, respectively, to 76.2 and 68.0% of the MER for optimal body weight, on the assumption that 550

$\text{kJ kg}^{(0.75)} \text{d}^{-1}$ can be considered as an adequate equation to estimate MER in medium-sized adult dogs (8).

More severe food restriction was necessary to induce weight loss in female than in male dogs: 356 ± 24 (64.8% MER) vs. 437 ± 10 (79.4% MER) $\text{kJ/kg target body weight}^{(0.75)} \text{d}^{-1}$ ($P = 0.02$), respectively. The level of energy that induced initial weight loss did not allow dogs of either sex to reach target weights. To reach target weight, energy allowance was gradually decreased to reach $66.2 \pm 7.7\%$ and $61.6 \pm 5.2\%$ MER for the high-protein and the control groups, respectively, and $74.0 \pm 4.1\%$ and $53.9 \pm 2.5\%$ MER ($P = 0.006$), respectively, for males and females.

DISCUSSION

In dogs most nutritional studies on obesity are conducted on recently induced excess weight by ad libitum feeding of a high-fat diet (9,10). By contrast, we chose to use chronically (>1 y) grossly obese Beagles, in the static phase of obesity (11), to be as close as possible to field conditions. In veterinary practices, as shown in our field study, weight loss programs are generally set up for overweight or obese dogs (BCS of 4 and 5) in the static phase of obesity. Additionally, in our two studies, the mean age of the dogs was similar to the age for peak prevalence of obesity in the canine species (2). At baseline and except for their weight, all the dogs were healthy as assessed by clinical, serum chemistry and hormonal evaluation.

Traditionally, high-fiber low-energy diets have been promoted for weight management. The content of TDF in those diets typically range from 20 to 40% on a DM basis, as in the two diets used in this study. Dietary fibers are used to dilute energy density of the food and to provide a feeling of satiety by causing gastric distension. This latter effect remains controversial in dogs. A concern with feeding weight-reduction diets is that reduced energy intake is associated with suboptimal intake of essential nutrients, especially protein (12). Feeding a high-protein diet in obese dogs resulted in a better conservation of lean body mass (4).

As expected, dogs of both groups lost their excess body weight and reached their predetermined target body weight over a period ranging from wk 12 to wk 26. Although the weight loss was more rapid in the control group than in the high-protein group, the differences were not significant between the diets for the duration ($P = 0.11$) nor for the rate of weight loss ($P = 0.22$).

Although the difference in the loss of lean body mass only approached significance ($P = 0.056$), and the test diet had a slower rate of weight loss than that of the control, the results tend to support the hypothesis that higher levels of dietary protein in weight-reduction diets for dogs result in a greater conservation of lean body mass. However, a slower rate of weight loss over a longer period with the control diet might have resulted in a better conservation of FFM. A larger study with more dogs needs to be performed to test this hypothesis.

During wk 2 of the study, the average energy allowance was

decreased to reach 73.4% of the energy given at baseline. This was achieved by progressively replacing the baseline diet by both reducing diets. This level of energy restriction and the further 10% reduction during wk 3 induced weight loss in all 4 males but in only 2 out of 4 females. The energy restriction to maintain a 1–2% weekly weight loss rate had to be more severe in females than in males: $53.9 \pm 2.5\%$ vs. $74.0 \pm 4.1\%$. These preliminary observations suggest that energy restriction could be more severe in females to induce and maintain weight loss. To our knowledge, this has not been reported previously, probably because others did not adjust energy intake to the rate of weight loss from the beginning of the study.

One common figure proposed to estimate energy allowance during a weight-loss program is 60% of MER for optimal body weight (13,14). Our data suggest that this degree of energy restriction might not be sufficient to induce and maintain weight loss in obese female dogs. This should be taken into account when setting up a weight-loss program.

In conclusion, in the experimental study, although rates of weight loss slightly differed between reducing diets, our data suggest that higher protein intake might reduce lean body mass losses. Energy restriction should be higher in female dogs and validated over time to ensure regular weight loss. From our field study, it appears that our test diet allowed safe and efficient weight loss.

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