As published in: *Veterinary Clinical Nutrition 1997;4:130-134.*

Effects of Dietary Fiber Content on Satiety in Dogs

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Abstract

Numerous studies have indicated that human subjects consuming high fiber, low calorie diets were satiated after consuming fewer calories than those consuming low fiber diets. However, data in dogs are conflicting. The objective of this experiment was to evaluate the effect of dietary fiber on satiety as measured by voluntary food consumption.

Thirty dogs were fed a commercial dry dog food (2 % crude fiber) for a 7 day acclimation phase. The commercial dry dog food was fed twice a day in unrestricted quantities. Average total daily food and calorie intakes were determined. After the acclimation phase, dogs were split into two treatment groups for an 8 day treatment phase. In the morning, Group 1 dogs were fed a low fiber food (2 % crude fiber) and Group 2 dogs were fed a high fiber food (9 % crude fiber); in the afternoon all dogs were allowed an unrestricted quantity of the same commercial dry dog food. Food provided at each morning feeding was 50% of the individual dog's average total daily intake determined during the acclimation phase. Total food intake per feeding was recorded daily.

Morning food intake was slightly less than afternoon food intake during the acclimation phase, reaching significance in Group 2 dogs. During the treatment phase, morning food intake was significantly less than afternoon food intake for both groups, however, total daily food intake (grams) was not significantly different between treatment groups. Dogs were consuming similar amounts of food in the afternoon, regardless of diet fed in the morning feeding. Dogs fed the high fiber diet consumed fewer total calories throughout the day than those dogs fed the low fiber diet (65.3 vs 79.4 Kcal/kg body

weight/day, respectively; $p < 0.001$). These results indicate that high fiber diets may provide a satiety effect when fed to dogs and can help reduce caloric intake.

Introduction

Dietary fiber is proposed to promote satiety and reduce voluntary food intake, making it a potentially valuable tool in obesity management. Satiety is a complex physiologic state in which hunger is inhibited and the desire to eat is at a minimum. Many factors are involved in satiety, including both peripheral and central stimuli.[1-3] Peripheral satiety signals include those which derive from the gastrointestinal tract in response to gastric distention, osmolality of gastrointestinal tract contents, and amino acids, fats or other nutrients; plus signals from adipose tissue and liver; and responses to circulating concentrations of amino acids, glucose, and various hormones. Central satiety signals have a direct effect on the central nervous system and include alterations in the concentration of neurotransmitters, glucose, insulin, amino acids and certain hormones.

Numerous studies have indicated that human subjects consuming high fiber, low calorie diets were satiated after consuming fewer calories than those consuming low fiber diets.[3-5] It is proposed that high fiber diets may induce satiety more quickly or for a longer period due to greater gastric distention from energy dilution and greater water absorption capacity of fiber-rich foods, alterations of postprandial glycemia and insulinemia due to reduced rate of carbohydrate digestion and absorption, slowed gastric emptying, or other mechanisms.[3]

Subjectively, human subjects describe a greater feeling of "fullness" following consumption of high fiber foods.[5] Canine subjects cannot describe their feelings of hunger or satiety. However, voluntary food consumption provides an objective measurement that may serve as an indirect measurement of satiety. One methodology successfully used in humans involves providing the subject with a "preload" to induce satiety, followed later by a test meal. Decreased consumption of the test meal, or decreased total calorie intake, are taken as evidence of the satiety effects from the preload.[5] This method has also been applied to dogs.[6,7] The objective of this experiment was to evaluate the effect of dietary fiber on satiety in dogs as measured by voluntary food consumption following a high fiber meal.

Materials and Methods

Animals: Thirty small breed dogs (Miniature Schnauzers and Toy Poodles) were used. Dogs were housed in groups of two to four dogs, in indoor/outdoor runs. Dogs were individually fed twice a day and allowed 15-20 minutes/feeding to consume their food. Feeding periods were approximately 6 hours apart. Water was available *ad libitum*.

Diets: Three diets were fed during this study: a commercial dry dog food[a] (Control); a low fiber dog food (Diet 1); and a high fiber dog food (Diet 2). Diets were formulated with similar ingredients, except that either a blend of vegetable fibers or added corn were used to create differences in dietary crude

fiber (Table 1). The test diets were formulated to be similar in nutrient content except for fat, fiber and calories (Table 2).

Experimental design: The study included a seven day acclimation phase followed by an eight day treatment phase. Total food intake was recorded throughout both periods. All dogs were fed the Control diet during the acclimation phase. Dogs were offered an excess of food during both the morning and afternoon feeding periods and allowed to eat to appetite. Following the acclimation phase, dogs were divided into two groups that were similar in terms of breed, body weight, age and previous food intake. Groups were randomly assigned to receive either Diet 1 or Diet 2 for the morning feeding. Food provided at each morning feeding was 50% by weight of the individual dog's average total daily food intake during the acclimation phase. All dogs were offered the Control diet in unrestricted quantities for the afternoon feeding. Food intake was recorded for each feeding period. Morning, afternoon and total daily caloric intake were determined using calculated metabolizable energy. Body weight was recorded at the beginning and end of each phase.

Statistical analysis: Paired t-tests were used to test for differences between morning and afternoon feedings, within treatment group. Unpaired t-tests were used to test for differences between treatment groups. Differences were considered significant if p was less than 0.05.

Results

There was no difference in body weight between the two groups of dogs. Body weights did not change measurably during either phase of the study.

Total food intake during the acclimation phase did not differ between groups. Food consumption was slightly greater during the afternoon feeding for both groups in the acclimation phase, however, this achieved statistical significance only for Group 2 (Fig 1).

During the treatment phase, average morning food intake was significantly less ($p<.001$) than afternoon intake for both groups, and was less for Group 2 than Group 1 (Fig 2). Total daily food intake was not significantly different between treatment groups, yet calorie intake was significantly lower for Group 2 dogs (Table 3) since Diet 2 contained fewer calories than Diet 1 (Table 2).

Discussion

Is is widely accepted that animals eat to meet their energy needs, thus calorie intake and calorie needs are the primary controllers over food intake. In this study, despite having consumed fewer calories in the morning relative to dogs fed the low fiber diet, dog fed the high fiber diet did not increase their afternoon intake to compensate. Thus they voluntarily consumed fewer calories per day. This suggests that the fiber preload may have provided a prolonged feeling of fullness that helped to compensate for decreased calorie intake.

Our findings are consistent with recently published data regarding the impact of dietary fiber on voluntary food intake in dogs.[7] These results, however, differed from another study in calorie restricted dogs.[6] Differences in experimental design are the most likely explanation for the divergent results. Because satiety is such a complex phenomenon and the effects of fiber provide only one portion of the total control over the desire to eat, experimental design is critical in demonstrating the effects of fiber.[3] The major aspect of food which induces satiation is the energy content. Therefore, the effects of dietary fiber on satiety would likely be masked if the fiber were incorporated into a high-energy, high-protein meal that maximizes fullness sensations regardless of fiber[3] or if the energy intake were so severely restricted that the effects of fiber would be inadequate to satiate the subject given the physiologic drive to meet energy needs.

In the current study, daily calorie intake was not restricted. Under these conditions, fiber was associated with significantly lower total calorie intake. The implications of this are that dietary fiber does provide a satiety effect and can help reduce voluntary calorie intake.

High fiber diets may induce satiety more quickly or for a longer period due to greater gastric distention from energy dilution and greater water absorption capacity of fiber-rich foods, alterations of nutrient digestion and absorption, slowed gastric emptying, or other mechanisms.[3] Gastric distention is an effective means of inhibiting food intake in dogs.[8] Other means of diluting calories that could induce satiation through gastric distention include the addition of water. However, when water is the diluent, inhibition of food intake occured only when an unusually large volume was rapidly consumed.[1]

In addition to satiety, a high fiber, low fat diet may be beneficial in terms of the composition of weight loss. In one study, dogs fed a high fiber, low fat diet lost a greater percentage of body fat than dogs fed a low fiber, high fat diet at the same calorie intake.[9] The ability of high fiber diets to reduce voluntary food intake and to influence the composition of weight lost suggests that using high fiber diets in canine weight management programs could be beneficial.

Conclusion

This study was designed to determine the effect of consumption of a high fiber diet on dogs' desire to eat at a subsequent meal. In this study, with no enforced limits on consumption of the afternoon meal, dogs fed the high fiber food consumed fewer calories each day than dogs fed the low fiber food. This suggests that fiber does provide a satiety effect in dogs, and that high fiber diets should be useful in controlling calorie intake, such as in the management or prevention of obesity.

References

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Table 1. Ingredient Composition of Experimental Diets

Ingredient	Low Fiber, Diet 1	High Fiber, Diet 2
Corn	63	37
Poultry Byproduct Meal	10	10
Soybean Meal	10	7
Corn Gluten Meal	6	6
Beef and Bone Meal	4	4
Beef Tallow	5	2
Vegetable fiber blend	0	29
Vitamins and minerals	2	5

Table 2. Nutrient Composition of Diets (as fed)

	Commercial Dry Dog Food*	Low Fiber Diet 1	High Fiber Diet 2
Crude Protein,%	21.5	22.6	23.3
Crude Fat, %	11.4	10.3	7.19
Crude Fiber %	2.13	1.99	9.49
Total Dietary Fiber %	14.67	14.14	29.04
Insoluble Fiber %	12.35	12.32	26.37
Soluble Fiber %	2.32	1.81	2.67
Metabolizable Energy, kcal/g	3.414	3.615	3.138

* Purina Dog Chow Little Bites™, Ralston Purina Company, St. Louis, MO

Table 3. Average Food Intake in Dogs as Influenced by Dietary Fiber and Caloric Density

		Group 1			Group 2		
		A.M.	P.M.	Total	A.M.	P.M.	Total
Grams, as fed[a]	mean	65.0	98.1	162.5	53.3[b]	94.4	147.7
	s. d.	18.5	34.3	44.4	31.4	55.9	73.1
Kcal, Metabolizable Energy[a]	mean	232.9	335.1	568.0	167.2[b]	322.5	489.7[c]
	s. d.	70.1	117.2	154.4	98.4	191.2	243.9
Kcal/ kg body weight[a]	mean	32.2	47.2	79.4	22.1[b]	43.2	65.3[b]
	s. d.	8.0	16.4	19.4	12.5	27.0	33.4

[a] Within Groups, AM and PM differed ($p < 0.001$)

[b] Means differed between groups for same time period ($p < 0.001$)

[c] Means differed between groups for same time period ($p < 0.01$)

Figure 1. Average calorie intake during the acclimation phase. Both groups were fed the same diet, to appetite, during two 15 to 20 minute feeding periods. Group 2 dogs consumed significantly more food during the afternoon feeding than during the morning feeding, but total consumption did not differ between the two groups.

Figure 2. Average calorie intake during the treatment phase. Dogs were fed either a low fiber diet (Group 1) or a high fiber diet (Group 2) during the morning feeding. Both groups were fed a common Control diet, to appetite, during the afternoon feeding period. Calorie intake was significantly lower for Group 2 dogs, compared to Group 1 dogs, for both the morning feeding and total day.

1. Endnotes:

[a]Purina Dog Chow Little Bites™, Ralston Purina Company, St. Louis, MO.