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Effect of soybean hulls on blood biochemical profiles and body condition of dogs

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ABSTRACT - The objective of this study was to evaluate the alterations in blood biochemical profiles and body condition of dogs after intake of the diet without soybean hull (0%SH) and with soybean hull (16%SH) replacing corn. Twelve Beagle dogs with ideal body condition score (BCS) (average: 5) were distributed in a completely randomized design (six animals per treatment) and received the daily amount of food according to the energy needs for maintenance (g/kg weight$^{0.75}$). The animals were evaluated on days 0 and 28 in relation to the blood biochemical profiles and body measurements, such as: total cholesterol, high-density lipoprotein (HDL), low-density lipoprotein (LDL), very-low density lipoprotein (VLDL), triglyceride (TAG), glucose, body weight (BW), body fat percentage (%BF), nape, rib, tail base (TB), chest, and abdomen with plicometer, and BCS (scale of 1, thin and 9, obese), canine body mass index (CBMI), and thickness of the adipose tissue of the seventh lumbar vertebra (L7) with ultrasonography. The data were analyzed by Student's t test. The variation (final – initial, mg/dL) of cholesterol (16.33 vs. 15.55), HDL (17.56 vs. 10.05), LDL (22.78 vs. 14.57), VLDL (–4.01 vs. –1.92), TAG (–20.11 vs. –11.66), and glucose (–16.77 vs. –20.31) of dogs fed 0%SH and 16%SH, respectively, showed no difference. The body measurement variation (cm) of TB (1.00 vs. –0.60) obtained a significant difference. The addition of soybean hull in the diet does not alter the blood biochemical profiles; however, it does decrease the deposition of lipids in subcutaneous tissue.

Key Words: animal nutrition, digestive physiology, fiber

Introduction

Currently, fibers are widely used in the feeding of dogs. Dry commercial foods for companion animals contain significant amounts of carbohydrates and these are mostly digestible, like starch. The part that is not digestible, denominated non-starch polysaccharides, is usually classified as dietary fiber (De-Oliveira, 2011). Physiologically, fibers are conceptualized as corresponding to food components that resist degradation by mammalian enzymes (Fischer, 2011).

Soybean is the most produced leguminous plant in the world and Brazil is one of the biggest producers. Soybean hulls (SH), co-product previously obtained by separation during the process of extracting the oil from the grain, represents the thin layer that covers the seed. It has been studied as an alternative fiber source, in particular due to the beneficial results in animal health and, as a fibrous food, to its little energetic contribution in the diet (Andrade et al., 2012; Medeiros, 2004).

Diets with fibers are inserted into the animal feed according to their beneficial actions, such as control of various biochemical parameters in serum, i.e., glucose, triglycerides, and cholesterol (De-Oliveira, 2011). Studies show that dogs and cats that have their diet supplemented with different sources of fiber reduce postprandial blood glucose and cholesterol levels, and lose weight. However, the authors emphasize that the chemical and physical characteristics of the fiber source should be well established to achieve these goals (Pinto, 2007; Pinhão, 2010).

Furthermore, diets rich in fiber can alter the body condition of dogs, particularly by diluting the calories and reducing the diet digestibility (Medeiros, 2004; Weber, 2007). The body composition can be determined using different techniques with different degrees of precision, accuracy, and costs (Rivera, 2011). Weight is the most commonly used measure to estimate the body

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and nutritional status of small animals. However, since it is a dynamic factor, it is subject to physiological changes (Rodrigues, 2011). Therefore, other techniques have been increasingly used for the purpose of a more complete assessment of the animal, for example, body condition score (BCS) (Laflamme, 1997), canine body mass index (CBMI) (Mueller et al., 2008), measurement of the adipose tissue in the seventh lumbar vertebra (L7) by ultrasound (Morooka, 2001), and body fat percentage (%BF) (Burkholder & Toll, 2000). These assessments allow the body composition to be divided into a finite number of categories, because they are easy and quick to perform (German et al., 2010).

Thus, the objective of this study was to evaluate the blood biochemical profiles and the body condition of dogs after the ingestion of a diet with soybean hulls replacing corn.

Material and Methods

Twelve Beagle dogs (six males and six females) with 11.3±1.6 kg average body weight (BW) and four years of age, were distributed in a completely randomized design and divided into two treatments, 0%SH and 16%SH. The dogs underwent clinical evaluations, which attested to good health, were vaccinated, dewormed, and housed in concrete kennels with solariums (5 m long × 5 m wide). The study was approved by the Ethics Committee on Animal Use of the sector of Agrarian Sciences of the Federal University of Parana, Curitiba, PR, Brazil, under case no. 019/2012.

Two extruded diets were evaluated: control, 0%SH and test, 16%SH. The soybean hull was included replacing corn (Table 1). The diets were given to the dogs for 28 days at fixed schedules, at 08.00 and 04.00 h. The 0%SH diet was offered in sufficient quantity to meet the needs of the metabolic energy (ME) of dogs in maintenance, according to the NRC (2006): kcal/day = 130 × weight (kg)$^{0.75}$. The provision of the 16%SH diet was calculated as a function of the value of the 0%SH ME diet. This calculation was used to restrict only energy, allowing the dogs to ingest the same volume of food in grams, of the 0%SBH diet. Water was provided *ad libitum*.

Prior to collecting blood, the dogs remained fasting for 12 h and water was offered *ad libitum*. Two blood samples were collected from the jugular vein with the animal in right lateral decubitus, on day 1 and day 28 of the experiment, a total of six samples of blood per treatment in each period. The samples were stored in vials without EDTA and the analyses were performed on the same day of the collection. Biochemical glucose profiles (enzymatic colorimetric test, Kovalent®), total cholesterol, high-density lipoprotein (HDL), low-density lipoprotein (LDL), very-low density lipoprotein (VLDL) (enzymatic photometric test Kovalent®), and triglyceride (enzymatic colorimetric test using glycerol 3-phosphate oxidase, Kovalent®) were evaluated.

Body composition was determined with the dogs fasting on days 1 and 28. The evaluations included body weight (BW) and body condition score (BCS) according to Laflamme (1997), on a scale from 1 to 9 (1, thin and 9, obese). The CBMI was calculated according to Mueller et al. (2008), using the equation: CBMI = body weight/height^2, with the height being measured from the atlanto-occipital joint to hind leg limit with the animal in a steady position. Thickness values (cm) of the nape, rib, tail base (TB), chest, and abdomen were measured with a plicometer device. The thickness of the adipose tissue (mm) of the L7 was evaluated with ultrasound, on a transverse plane, and a 7.5-MHz linear transducer (Morooka et al. 2001); and %BF,

Table 1 - Ingredients and chemical composition of the experimental diets

Ingredient (%)	0% soybean hulls	16% soybean hulls
Corn	56.3	40.5
Bird fat	3.0	3.0
Protenose	6.0	6.0
Meal of poultry viscera	30.0	30.0
Common white salt	0.5	0.5
Dog Flavouring 8005	2.0	2.0
Butylated hydroxyanisole	0.015	0.015
Butylated hydroxytolune	0.015	0.015
Citric acid	0.05	0.05
Calcium propionate	0.4	0.4
Choline chloride	0.4	0.4
Mineral-vitamin supplement[1]	0.5	0.5
Calcium carbonate	0.303	0.00
Potassium chloride	0.514	0.577
Soybean hulls	0.0	16.0
Total	100	100
Chemical composition (% in DM)		
Dry matter	93.44	93.38
Crude protein	28.05	29.33
Ether extract in acid hidrolysis	14.84	12.8
Crude fiber	2.99	7.42
Total dietary fiber	14.4	24.98
Insoluble fiber	14.16	18.73
Soluble fiber	0.24	6.25
IF:SF ratio	59:1	3.0:1
Mineral matter	7.69	7.96
Calcium	1.01	0.73
Total phosphorus	1.14	1.09
Metabolizable energy (kcal/kg)	4273	3786

[1] Mineral-vitamin supplement, enrichment per feed kg: vitamin A, 20,000 IU; vitamin D3, 2000 IU; vitamin E, 480 IU; vitamin K3, 48 mg; vitamin B1, 4 mg; vitamin B2, 32 mg; vitamin B12, 0.2 mg; pantothenic acid, 16 mg; niacin, 56 mg; choline, 800 mg; zinc, 150 mg; iron, 100 mg; copper, 15 mg; iodine, 1.5 mg; manganese, 30 mg; selenium, 0.2 mg; antioxidant, 240 mg.
DM - dry matter; IF:SF - insoluble to soluble fiber ratio.

proposed by Burkholder and Toll (2000), was calculated according to the following equations:

BF in males (%) = –1.4 (LRH cm) + 0.77 (WC cm) + 4;

BF in females (%) = –1.7 (LRH cm) + 0.93 (WC cm) + 5,

in which LRH is the length of the right posterior limb from the tuberosity of the calcaneus to the medium patellar ligament and WC is the waist circumference (from the middle point between the iliac crest and the last thoracic vertebra, measured with the dog in standing position).

The twelve dogs were distributed in a completely randomized design. Each animal was considered an experimental unit, totaling six repetitions per treatment. The data were subjected to the normality test and, right after, we performed Student's t-test at 5% probability by the Statistix 8 program.

Results

Total cholesterol, HDL, LDL, VLDL, triglycerides, and glucose levels did not differ among diets (P>0.05) (Table 2). The animals that received the diet with 16%SH had lower values of TB (P<0.05) compared with animals fed 0%SH and the other body parameters did not differentiate with the addition of the soybean hull in the diet (P>0.05) (Table 3). Feed intake (in grams) did not differ between the two treatments either.

Table 2 - Average biochemical profiles (mg/dL) of days 0 and 28 observed in dogs fed diets without soybean hull (0%SH) and with soybean hull (16%SH)

	Glucose	Total cholesterol	HDL	LDL	VLDL	TAG
Day 0						
0%SH	100.86	238.33	118.32	102.37	17.650	88.200
16%SH	99.972	246.60	133.82	98.325	14.450	89.717
P*	0.7826	0.7271	0.1119	0.7920	0.2161	0.9226
SEM	1.5001	11.050	4.8427	7.1395	1.2520	7.2575
Day 28						
0%SH	84.583	254.67	135.88	105.15	13.633	68.083
16%SH	79.658	262.15	143.88	112.90	12.525	83.240
P*	0.3894	0.8496	0.3560	0.7783	0.6677	0.2746
SEM	2.7131	18.370	4.1171	12.829	1.2061	6.6558
Difference						
0%SH	–16.277	16.333	17.567	22.783	–4.016	–20.117
16%SH	–20.313	15.550	10.050	14.575	–1.925	–11.660
P*	0.3281	0.9724	0.1595	0.5209	0.1269	0.2239
SEM	1.9680	10.515	2.6161	8.6352	0.6769	3.3608

HDL - high-density lipoprotein; LDL - low-density lipoprotein; VLDL - very low-density lipoprotein; TAG - triglycerides; SEM - standard error of the mean.
Difference: final – initial values.
P* - significant differences if P<0.05 among the means by Student's t-test.

Table 3 - Average of body measurements on days 0 and 28 observed in dogs fed diets without soybean hull (0%SH) and with soybean hull (16%SH)

	Weight	CBMI	BCS	Nape	Rib	TB	Chest	AB	BF	L7
Day 0										
0%SH	11.13	16.17	4.33	9.50	4.50	9.66	5.83	4.33	24.62	22.06
16%SH	11.46	18.06	5.00	9.00	4.40	8.40	6.20	4.40	26.81	20.45
P*	0.63	0.007	0.07	0.43	0.74	0.11	0.59	0.86	0.40	0.42
SEM	0.32	0.39	0.18	0.30	0.14	0.40	0.32	0.18	1.24	0.95
Day 28										
0%SH	10.88	15.79	4.16	9.66	5.00	10.66	6.33	5.33	19.92	20.88
16%SH	11.22	17.71	5.20	8.80	5.20	7.80	5.60	5.00	23.01	20.19
P*	0.61	0.006	0.01	0.08	0.52	0.01	0.19	0.51	0.18	0.48
SEM	0.31	0.39	0.22	0.25	0.14	0.62	0.27	0.24	1.12	0.46
Difference										
0%SH	–0.25	–0.38	–1.33	0.16	0.50	1.00	0.50	1.00	–4.57	–1.18
16%SH	–0.24	–0.23	–1.30	–0.20	0.80	–0.60	–0.60	0.60	–4.43	–0.26
P*	0.96	0.39	0.95	0.53	0.52	0.01	0.09	0.48	0.83	0.56
SEM	0.07	0.08	0.29	0.27	0.22	0.35	0.32	0.27	0.29	0.75

CBMI - canine body mass indicator; BCS - body condition score; TB - tail base; AB - abdomen; BF - body Fat; L7 - seventh lumbar vertebrae; SEM - standard error of the mean.
Difference: final – initial values.
P* - significant differences if P<0.05 among the means by Student's t-test.

Discussion

With the strengthening of the relationship between people and companion animals, care with the feeding of pets is fundamental for health maintenance and longevity of their lives. In recent years, fiber has become a mainstay of the human diet, mainly due to its benefits in helping to prevent or control degenerative diseases (Fahey Jr et al., 1990).

The addition of fiber in the diet formulated for dogs can affect the viscosity of the intake, gastrointestinal motility, satiety, nutrient digestibility, and metabolic responses to feeding, as well as bacterial population of the colon. Thus, supplementation with fibers can be useful in the prevention and treatment of diseases such as diabetes mellitus and obesity (Farcas et al., 2015). Fibers can be classified according to the way they react with water (soluble or insoluble) or according to the fermentability (high, medium, and low), which is related to the degradation of substrates by anaerobic bacteria (Ferreira, 2013). Soybean hulls are a source of insoluble fiber, which promotes the consistency of stool, accelerating digesta passage rates in the gastrointestinal tract, reducing constipation and the absorption of nutrients (Cole et al., 1999).

In this study, after the inclusion of the SH as a source of fiber, there was no significant difference in biochemical profiles of total cholesterol, VLDL, HDL, LDL, triglycerides, and glucose. Cole et al. (1999), while studying various sources of SH, found insoluble:soluble fiber ratios between 15.4:1 and 5.0:1, data similar to those found in the fiber source that was used in this study (9.0:1). In the animal organism, soluble and insoluble fibers have, when ingested, different physiological effects. Corroborating with Fischer (2011), in humans, soluble fiber is potentially effective in regulating plasma levels of glucose, cholesterol, and triglyceride levels and the viscosity is considered the most common feature of all fibers that have this effect. When studying the effects of fiber in dogs, Murray et al. (1999) and Jewel et al. (2000), in different studies, concluded that the soluble and viscous dietary fiber has a significant effect on glucose absorption, attributing to this result, the ability of the viscous fiber to delay the glucose absorption rate in the intestine through the formation of a gel that prevents the absorption of cholesterol and glucose derived from the diet.

Obese and overweight dogs are more predisposed to various diseases such as metabolic disorders and decreased life longevity (Weber et al., 2007). The most important factor for the increase of serum triglycerides and cholesterol is excess feed intake. Therefore, obese individuals are more predisposed to hyperlipidemia (Pinhão, 2010). The variation in glucose levels (hyperglycemia or hypoglycemia) also results in various metabolic abnormalities and when chronic, may be a predisposing factor for the development of diseases such as diabetes (Pinto, 2007).

The fiber diet can also be used to reduce adipose tissue in dogs, preventing obesity, which has adverse effects on physiological function and contributes to the development of different diseases. These diseases occur in proportion to the deposition of fat, which may be distributed throughout the body or in certain parts. It is therefore desirable to estimate the amount of fat deposition in various locations to clarify these relationships (Morroka, 2001). The use of techniques such as measuring BCS and skinfolds by plicometer device (neck, chest, rib cage, abdomen, and base of the tail) and anthropometric tape (waist circumference and thorax) are the most used evaluation methods for measuring body fat due to the easy usage and low cost (Gonçalves and Mourão, 2008).

In this study, the dogs showed ideal BCS (median: 5 in the range of Laflamme (1997)) and only the measure of the TB with plicometer decreased in dogs that were fed the diet with 16%SH. The other parameters evaluated, such as BW, %BF, neck, rib, chest, and abdomen with plicometer device, BCS, CBMI, and L7 did not have significant changes. In a recent study, Sabchuk et al. (2014) assessed the body condition of dogs with ideal BCS for eight weeks. The authors found no differences in the parameters evaluated with the inclusion of SH in the diet. Nevertheless, several other factors can influence the evaluation of body condition in dogs, such as evaluation time and dog nutrition status, if they are obese or overweight, and age. Fritsch et al. (2010), while studying body condition in dogs with high-fiber diet, observed that overweight or obese dogs lose weight more easily than dogs with ideal BCS, because they have more %BF to mobilize to compensate the energy intake deficits.

However, more studies to assess the body condition of dogs should be performed. Thus, the fiber source used for research in modulation of glucose, cholesterol, and triglycerides should be widely studied and carefully selected according to their physicochemical characteristics of solubility and fermentation, because they may cause different physiological effects on the animal body. In other words, agreeing with Sunvold et al. (1995), the challenge is to formulate diets containing the correct amount of fermentable and non-fermentable fibers that will result in a great body condition and health of the gastrointestinal tract.

Conclusions

The addition of soybean hulls in the diet replacing corn promotes maintenance of the blood biochemical profiles in dogs that are healthy and with ideal body condition score and also reduces fat deposition on the tail base of adult dogs, thus being a sensitive measure able to detect bodily changes.

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