Revista Brasileira de Zootecnia
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ISSN 1806-9290
www.sbz.org.br

R. Bras. Zootec., v.41, n.1, p.118-122, 2012

Digestibility and behavior of dogs housed in kennels or metabolic cages

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ABSTRACT - The objective of the present study was to compare the apparent digestibility coefficients of a commercial dog food, fecal consistency and behavior of dogs housed in kennels and metabolic cages. Six adult Beagle dogs were distributed in cross-over experimental design, with six replicates per treatment. Dogs were housed in two environments: metabolic cages and in masonry kennels with solarium. Dogs were fed for a five-day adaptation period, and the five following days were used for total feces collection. Dogs behavior was recorded during a 48-h period, with 10-min intervals. Apparent digestibility coefficients were not different between treatments. However, dogs housed in metabolic cages produced lower weight and more consistent feces as compared with dogs housed in kennels. Dogs spent most of the time sleeping in both housing systems; however, dogs housed in the metabolic cages slept more than those in kennels. Stress-related behaviors (barking, whimpering, stereotypies, etc) were observed for no longer than 15 minutes per day, and were not different between dogs in kennels or in cages. There is no difference in food digestibility evaluated in dogs housed in metabolic cages or kennels; however, dogs kept in metabolic cages eliminate drier feces and spend more time inactive than those kept in kennels.

Key Words: animal diets, fecal consistency, metabolic trial

Introduction

Throughout the last decade, the global population of dogs has considerably increased. Accordingly, the quantity and quality of commercial pet foods have also developed, with diets with adequate nutrients for various classes of body size, stage of life, and specific breeds available in the market (Malafaia et al., 2002).

Brazil is the first market of commercial pet foods in Latin America and the third in the world, behind the United States and China. Today, 3.2 million tons of dog and cat food are produced per year.

Due to the expansion of the pet food market, more research on dog and cat nutrition has been carried out to ensure the production of balanced diets, the supply of good-quality raw materials, better use of dietary nutrients by the animals etc. In this context, metabolism and digestibility assays with pets, respecting their physiological conditions, needs and welfare, are required. According to Broom & Molento (2004), housing and management conditions, among others, are important factors involved in animal welfare.

The digestibility assay is of paramount importance in animal nutrition, as it determines the proportion of the nutrients in the food that can be absorbed in the gastrointestinal tract, and, therefore, it is essential in the assessment of dog foods (Malafaia et al., 2002).

When evaluating nutrient digestibility in dogs, animals can be housed in metabolic cages, preventing fecal contamination by environmental factors (rain, dust, etc) and allowing individualization and, therefore, better control of factors that affect the results. However, cages restrict animal movement and natural behavior, impairing their welfare. Dogs can be also housed in kennels, which allow for better animal welfare, as they provide more freedom for dogs to express their natural behavior (Spangenberg, 2007) and simulate what really happens to pet dogs in domestic environments. However, the determination of digestibility in kennels can make stools more susceptible to environmental contamination. Furthermore, the individualization of animals is more difficult, due to higher construction costs, requiring more physical space to build a higher number of kennels. Thus, the purpose of this study was to compare the digestibility and fecal characteristics and behavior of dogs housed in metabolic cages or in kennels.

Material and Methods

The experiment was carried out at the The experiment was carried out at the Laboratório de Estudos em Nutrição

Received June 24, 2010 and accepted July 6, 2011.
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Canina, located at the Setor de Ciências Agrárias of the Universidade Federal do Paraná (UFPR).

Six healthy 5-year-old adult Beagle dogs (13.2±1.2 kg body weight, mean±SD), three males and three females, were used. Dogs were housed either in metabolic cages (0.7 long × 0.6 high × 0.5 m wide) or in indoor masonry kennels (5 m long × 2 m wide). The experimental procedures were approved by the Animal Ethics Committee of the Setor de Ciências Agrárias of the Universidade Federal do Paraná.

Dogs were fed twice daily (7:30 am and 4:00 pm) with the amount of food required to supply their metabolizable energy (ME) needs, according to the formula: ME (MJ/day) = 0.54 × $BW^{0.75}$, as recommended by the NRC (2006) (Table 1). Water was provided *ad libitum*.

The digestibility trial consisted of five days of adaptation and five days of total feces collection (AAFCO, 2004) for the experimental period of 10 days. Feces were collected at least twice daily, weighed, and frozen (-14 ºC) in individual recipients, composing a pool of feces of each individual animal per collection period. The fecal characteristics evaluated were fecal score, production of fresh feces, and feces dry matter. Fecal score was assessed always by the same researcher, and consisted of a 1 to 5 scale, where score 1 = pasty and unshaped stool, 2 = soft, poorly shaped feces, 3 = soft, shaped, and humid stool, which left marks on the floor, 4 = well-shaped and consistent stool, which did not stick to the floor, 5 = well-shaped, hard, and dry stool, (Sá-Fortes et al., 2010).

Table 1 - Ingredient and chemical composition of the experimental diet

Ingredient	(g/kg)
Corn	440.0
Brewers rice	40.0
Soybean meal	150.0
Meat and bone meal	150.0
Fish meal	10.0
Poultry viscera meal	140.0
Poultry fat	30.0
Poultry hydrolysate	30.0
Vitamin and mineral premix[1]	5.0
Sodium chloride	5.0
Chemical composition	
Dry matter (g/kg)	919.3
Organic matter (g/kg DM)	900.4
Crude protein (g/kg DM)	305.9
Acid-hydrolysed fat (g/kg DM)	85.1
Crude fiber (g/kg DM)	23.4
Nitrogen-free extract (g/kg DM)[2]	486.0
Metabolizable energy (MJ/kg)[3]	14.6

[1] Mineral and vitamin premix (content/kg): vit. A - 16,900 IU, vit. D3 - 2,340 IU, vit. E - 104 ppm, vit. K - 1.3 ppm, vit. B1 - 3.9 ppm, vit. B2 - 6.5 ppm, Pantothenic acid - 19.5 ppm, Niacin - 32.5 ppm, Choline - 1,150.75 ppm, Zinc - 156 ppm, Iron - 104 ppm, Copper - 13 ppm, Iodine - 2.6 ppm, Manganese - 45.5 ppm, Selenium - 0.26 ppm, and antioxidant - 240 mg.
[2] NFE (g/kg DM) = 100 – (Moisture + Ash + CP + AHF + CF).
[3] ME (MJ/kg) = (0.01465 × CP + 0.03558 × AHF + 0.01465× NFE).

At the end of each 5-d period, feces from dogs housed in both environments were thawed, homogenized, and dried in a forced-ventilation oven (320-SE, Fanem, SP, Brazil) at 55 ºC until constant weight. Dried feces and diets were ground in a Wiley mill (Arthur H. Thomas Co., Philadelphia, PA, USA) through a 1-mm screen and analyzed for dry matter (drying at 105 ºC for 12 h in a forced-ventilation oven), crude protein (method 954.01), crude fiber (method 962.09), ashes (method 942.05), and acid ether extract (method 954.02), according to the AOAC (1995). Nitrogen-free extract (NFE) was estimated as NFE (g/kg) = 100 – (moisture + CP + CF + AEE + ash). Food and feces gross energy contents were determined by using a bomb calorimeter (Parr Instrument Co., model 1261, Moline, IL, USA). All analyses were carried out in duplicate, with a coefficient of variation below 5%. Metabolizable energy (ME) was estimated according to the AAFCO (2004). Apparent digestibility coefficients (ADC) were calculated for DM, OM (organic matter), CP, NFE and acid ether extract (AEE).

The behavior of dogs individually housed in metabolic cages or kennels was evaluated. The behavior of every dog was recorded during 48-h period using a scan-sampling technique (Martin & Bateson, 1986). At 10-min intervals, the experimenter approached the front of each subject cage/kennel and recorded dog behavior as soon as it was seen. Observations were performed concomitantly with the first two days of fecal collection of the digestibility assay, and started five days after the adaptation period of the animals to their housing (cages or kennels). Dogs were habituated to having a person watching them for separate 20-min sessions before the start of the study.

The following behaviors were recorded: standing (dog stands upright on all four legs), sitting (dog is supported by the two extended front legs and two legs flexed back), resting (dog is reclining in a ventral or lateral position with eyes open), sleeping (dog is reclining in a ventral or lateral position with eyes closed), drinking water, eating food, barking, whimpering, socializing (neighbouring dogs interacting with each other through cages/kennels grids), showing stereotypies (abnormal continuous behaviors, e.g. manipulating the barriers of the cage/kennel, running in circles, etc.), presenting coprophagy (eating feces), and grooming (scratching, licking itself).

Dogs were assigned in a cross-over experimental design to one of two treatments (metabolic cage or kennel) and two periods (ten days for the digestibility assay and 48 h for

behavioral observations). Animals were divided into two groups of three dogs each, and housed in alternating periods in cages or kennels, totaling six replicates per treatment. Digestibility and fecal characteristics means (data normally distributed) were compared by the Student t-test at 5% probability level, using SAS statistical package (Statistical Analysis System, version 8.2). Behavioral data (non-parametric) were analyzed with Kruskal-Wallis one-way ANOVA on ranks (Tukey test for pair wise comparisons) at 5% probability level.

Results and Discussion

There were no apparent digestibility coefficients (ADC), metabolizable energy or food intake differences between dogs housed in metabolic cages or kennels (P>0.05, Table 2). All dogs presented adequate food intake in both housing systems, and no episodes of vomiting, diarrhea, or development of stereotyped behavior was observed during the experiment.

Dogs housed in kennels presented higher feces volume and lower dry matter content, as well as lower fecal scores (Table 3). Coprophagy was observed neither in the dogs housed in metabolic cages nor in kennels.

Digestibility assays with dogs entail many questions as for the best facilities in which to conduct these trials. According to the NRC (2006), housing and environment may influence the digestibility of nutrients. However, also according to the NRC (2006), no difference in nutrient digestibility was verified in studies with dogs housed in metabolic cages or in kennels, as found in the present study.

Table 2 - Apparent digestibility coefficients and food intake of dogs housed in metabolic cages or stalls of masonry

Parameter	Cage	Stall	SEM
Apparent digestibility (%)			
Dry matter	68.9	67.4	0.882
Organic matter	74.0	72.7	0.771
Crude protein	74.6	71.8	1.071
Acid ether extract	84.1	84.6	0.718
Nitrogen free extract	75.8	74.4	0.654
Metabolizable energy (MJ/kg)	14.70	14.53	0.347
Food intake (g, as is/day)	253.3	253.3	12.11

[a,b] Means in the same row without a common superscript differ by Student t-test P<0.05).
SEM = standard error of the mean.

Table 3 - Fecal consistency and production of dogs housed in metabolic cages or stalls

Variables	Cage	Stall	SEM
Score	3.5a	3.0b	0.060
Dry matter (g/kg)	390.1a	343.0b	0.855
Fecal production (g)[1]	14.6b	19.8a	1.008

[a,b] Means in the same row without a common superscript differ by Student t-test (P<0.05).
[1] Production of feces (g, as is)/body weight (kg)/day.
SEM = standard error of the mean.

The AAFCO (2004) advocates that, if it is not necessary to collect urine, digestibility assays can be conducted in covered kennels, as those used in the present study, which allow more space for the animals to perform movements. According to Hubrecht et al. (2007), kennels are the ideal environment to perform experiments with dogs, because the animal can express its normal behavior, i.e., the existence of separate areas for the animal to defecate, to feed, and to sleep, improves hygiene and welfare. However, housing dogs in kennels presents some difficulties, such as the need for more space for construction as compared with metabolic cages, and it is more difficult to individualize animals, especially in experiments with a large number of experimental units. Moreover, another consideration is the possibility of environmental contamination of samples, which could negatively affect the research data.

The production of drier feces by dogs housed in kennels observed in the present study can be explained by the fact that dogs avoid defecting on the same place or very near where they eat (Broom & Molento (2004), and this will only happen when the animals do not have alternatives to express their behavior (Hubrecht et al., 2007). Therefore, dogs housed in cages retain feces longer, resulting in higher absorption of water in the large bowel, which makes the stool drier. This fact should be considered in experiments evaluating additives to improve fecal characteristics of dogs, since the results obtained in dogs housed in metabolic cages may be less representative of feces defecated in household settings.

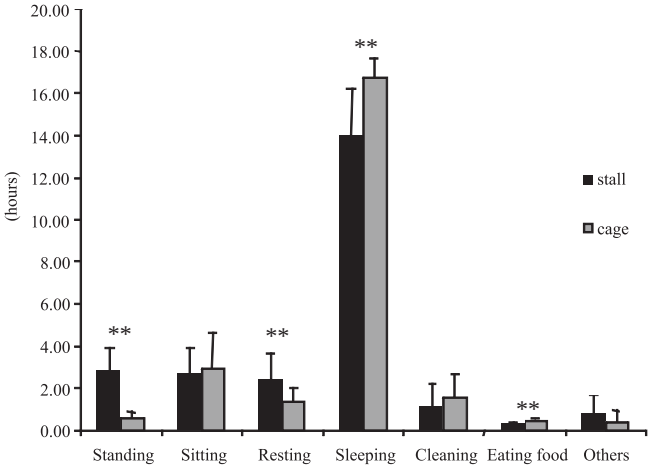
In the past, the issue of optimal environments for laboratory animals was not considered something that could interfere with the results of experimental studies, but Hubrecht et al. (1992) demonstrated that laboratory dogs may present stereotyped behaviors (abnormal repetitive behavior) during 51% of the time observed, and their nutritional requirements may be three times higher than in common dogs, which certainly interferes in experimental results.

Hubrecht et al. (2007) mention the importance of enriching the environment in which the animals are kept, providing objects safe for chewing, thereby avoiding that dogs bite other objects, such as the cage bars, for instance. According to those authors, the use of enrichment does not need to be restricted just because the animal is in testing, since this technique may help in the search for better results, provided all experimental units get the same type of enrichment.

Only findings with duration of behavior expression higher than 15 minutes were reported (Figura 1). No stress-related behavior, such as continuous barking, whimpering, pounding the cage or kennel rails, or any other stereotyped behavior, presented duration longer than 15 minutes (data not presented).

Although dogs are extremely social animals (Hetts et al., 1992; Hubrecht et al., 1992; Wells & Hepper, 1998), in the present study, the experimental dogs spent little time (less than 1% of time, data not presented) socializing with the neighbouring dogs either in cages or kennels, probably because they did not have direct contact with them.

Stereotyped behavior (11.2 min in kennels and 8.8 min in cages) and vocalization (barking: 4.8 min in kennels and 3.0 min in cages, whimpering: 7.2 min in kennels and 5.6 min in cages) were rarely observed in either housing systems, and no statistical difference was verified in the frequency of these behaviors between dogs housed in kennels or cages. This indicates that most probably the experimental dogs were not stressed. These results are different from those reported by Hetts et al. (1992), who observed that dogs housed in cages (0.71 × 0.86 × 0.69 m) spent more time grooming and in manipulation of enclosure barriers than those housed in larger spaces. As the cages and kennels in the present study were located opposite and close to each other, allowing the dogs to see and touch other dogs, this may have also contributed to the dogs welfare, as mentioned by Wells & Hepper (1998). Furthermore, the dogs of the present study are used to being housed in cages, as they are often used in digestibility trials (for at least ten consecutive days every 45 days) since they were 6 months old.



** P<0.01 by Kruskal-Wallis test.
Others: refer to the sum of other behaviors expressed in less than 15 minutes of duration.

Figure 1 - Frequency observed of the behavior of Beagle dogs housed in cages or stalls during 24-h period (n = 6).

Dogs spent more time awake (standing or resting) in outdoor kennels (Figure 1), probably due to the wider space and variety of external stimuli (smells, noises, etc) of kennels relative to the indoor cages. Other authors also reported that dogs spend most of their time inactive, i.e., about 54 to 85% of their time (Delude, 1986; Hubrecht, 1995; Yeon et al., 2001).

Defining the housing system for digestibility trials as individual kennels or metabolic cages involves issues ranging from sample contamination to the availability of physical structure. Both systems present advantages and disadvantages. Therefore, when choosing the housing environment for experimental animals, some factors, such as number of animals, infrastructure, economic viability, etc., should be considered.

Conclusions

There is no difference in food digestibility values between dogs housed in metabolic cages or kennels; however, dogs kept in metabolic cages eliminate drier and more solid feces. Dogs housed in metabolic cages spend more time inactive than those kept in kennels. Therefore, further investigation is required to compare food digestibility and fecal characteristics, as well as studying the behavior of dogs housed in different environments in order to establish environments that are reliable for conducting metabolism trials and that also provide proper animal welfare.

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