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The Use of Sorghum and Corn as Alternatives to Rice in Dog Foods^{1,2}

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EXPANDED ABSTRACT

KEY WORDS: • dog • cereal • rice • sorghum • corn

Rice is commonly used in premium Australian dog foods because of its highly digestible and hypoallergenic nature (1). Sorghum and corn are grains available in Australia that are considerably less expensive than rice. Sorghum and corn are known to contain starch that is less digestible in the intestinal tract because of a strong starch-protein matrix (2); however, the extrusion process involved in the manufacture of dog food is likely to gelatinize the starch and make it more digestible (3). The purpose of this study was to evaluate fecal nutrient digestibility of diets containing rice, sorghum and corn, and to determine the effect these diets had on fecal quality through evaluation of fecal score.

MATERIALS AND METHODS

Animals and diets

Eighteen mixed-breed dogs aged between 1 and 6 y were divided into three balanced groups and fed extruded dry dog foods containing either rice, sorghum or corn. The other dietary ingredients included sugar beet pulp, maize gluten, vitamin and mineral mix, poultry meal, beef tallow, sunflower oil and celite (ingredient inclusion levels withheld by the manufacturer). The chemical analyses of the experimental diets are summarized in Table 1. The diets contained the digestibility marker celite (Celite Corp., Lompoc, CA) included at a level of 2%, which was determined as acid-insoluble ash using the technique described by Choct and Annison (4). The maintenance energy requirement was calculated as $(kJ) = 460 \times (\text{body weight in kg})^{0.75}$ (5). This amount was increased by 20% to ensure the dogs maintained their body weight, and then used to calculate the amount

of food offered daily using the metabolizable energy concentration of the diets (6).

Testing procedures

The University of New England Animal Ethics Committee approved all procedures conducted during the trial. The trial was conducted over 12 d, following an adaptation period on a commercial dry dog food of 4 wk. The diets were introduced over the first 4 d, and fecal samples were collected on the final 5 d of the trial period. Fecal scores were measured with a score of 1 (indicating hard dry feces) and a score of 5 (indicating diarrhea), using the Waltham Feces Scoring System (Waltham Center for Pet Nutrition, Leicestershire, UK).

Chemical analyses

The fresh fecal samples were dried at 80°C until constant weight was achieved, then the samples from the 5-d collection period for each dog were pooled and ground through a 1-mm mill screen. The total starch of the feed and feces was determined enzymatically using the Megazyme Total Starch Assay Kit (Megazyme Australia Pty., Warriewood, NSW, Australia). The gross energy content of the diets and fecal samples was determined using a DDS isoperibol calorimeter (Digital Data Systems, Johannesburg, South Africa). The nitrogen of the feed and fecal samples was determined using a Leco Nitrogen Analyzer (FP-2000, Castle Hill, NSW, Australia). The crude protein content was calculated as $N \times 6.25$. The fat content of the fecal samples was analyzed by the Soxhlet extraction procedure using AOAC Official Method 991.36 (7). The fat content of the feed was analyzed after acid hydrolysis by the Soxhlet extraction procedure using the AOAC Official Method 954.02 (7). Soluble and insoluble nonstarch polysaccharides and free sugars were determined by a combination of the methods of Englyst and Hudson (8) and Theander and Westerlund (9). Nutrient digestibilities were determined using the ratio of marker to nutrient in the feed and feces.

Statistical analysis

The data were analyzed using the statistical package StatView 5.0 for Windows (AddSoft Pty., Woodend, Vic, Australia). A one-way ANOVA measure of the mean values of the 5-d collection period was performed for each group ($n = 6$ per group), followed by a Bonferroni/

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TABLE 1

Cereal and chemical composition of the diets¹

	Rice	Corn	Sorghum
	g		
Rice	49.0	0	0
Corn	0	51.0	0
Sorghum	0	0	46.1
Total NSP ²	30.5	31.2	52.5
Insoluble NSP ²	26.4	26.4	47.6
Soluble NSP ²	4.1	4.8	4.9
Starch	389.1	381.3	397.7
Protein	264.6	276.2	265.7
Fat	143.8	149.6	146.6
	MJ		
Gross energy	20.2	20.3	20.4
ME (calculated) ³	16.6	16.6	16.5
	%		
Moisture	6.1	6.4	5.8

¹ Values are expressed as g/kg DM or MJ/kg DM.

² NSP, nonstarch polysaccharides.

³ ME, metabolizable energy.

Dunn test to compare treatment means. Differences were considered significant at values of $P < 0.05$.

RESULTS AND DISCUSSION

There was a significant effect ($P < 0.05$) of treatment group on the mean fecal scores (Fig. 1). The rice diet caused a higher mean fecal score compared to that of the sorghum and corn diets, indicating that the feces of the dogs in the rice group were looser. However, the mean fecal scores were all within the ideal range according to the Waltham Fecal Scoring System, and therefore the inclusion of corn or sorghum as the major cereal grain in the food did not negatively affect fecal quality.

The fecal starch digestibility was not different among treatment groups ($P > 0.05$), with each diet having 100% fecal starch digestibility (Table 2). This indicates that the extrusion process used in the manufacture of the diets gelatinized the starch in the sorghum and corn diets and made it readily



FIGURE 1 Mean fecal score for each treatment group. Values are means \pm SEM, $n = 6$, $P < 0.05$ from ANOVA.

TABLE 2

Nutrient digestibility coefficients and digestible energy content of the experiment diets¹

	Rice	Corn	Sorghum
Starch	$1.00 \pm 4 \times 10^{-3}$	$1.00 \pm 3 \times 10^{-6}$	$1.00 \pm 2 \times 10^{-5}$
Protein	0.87 ± 0.003^a	0.83 ± 0.004^b	0.85 ± 0.003^c
Gross energy	0.90 ± 0.003^a	0.85 ± 0.005^b	0.87 ± 0.003^c
Fat	0.97 ± 0.001^a	0.97 ± 0.001^b	0.96 ± 0.002^b
Digestible energy (MJ/kg DM)	18.07 ± 0.05^a	17.32 ± 0.10^b	17.73 ± 0.06^c

¹ Data are means \pm SEM, $n = 6$. a,b,c Different superscripts in the same row indicate a significant difference ($P < 0.05$). Significance of treatments: starch digestibility ($P > 0.05$), protein and gross energy digestibility ($P < 0.0001$), fat digestibility ($P < 0.01$), digestible energy ($P < 0.0001$).

digestible (3). The fecal protein and gross energy digestibility coefficients were different for each treatment group ($P < 0.01$). The fecal protein and gross energy digestibility coefficients were highest with the rice diet, followed by the sorghum and corn diets, suggesting that the rice diet was the most digestible (1). The higher gross energy digestibility of the rice diet resulted in the increased digestible energy content of the rice diet compared to that of the corn and sorghum diets ($P < 0.001$). The fat digestibility of the rice diet was also greater than that of the corn and sorghum diets ($P < 0.01$) (Table 2).

The nutrient digestibilities of the corn and sorghum diets were lower compared with that of the rice diet. However, the nutrient digestibilities of each diet were above the average digestibility values for commercial dog foods (6). The fecal score results did not reflect the nutrient digestibilities, with the corn and sorghum diets causing firmer feces, although the dogs on each diet all had ideal fecal quality. Because fecal quality is one of the most important factors by which dog owners judge the quality of a dog food, and the nutrient digestibility results were above the accepted industry standard, extruded sorghum and corn are good alternatives to rice as the primary cereal grain in dog foods.

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