Evaluation of *Arracaciaxanthorrhiza* Inclusion as a Starch Source in Diets for Mature Dogs

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Abstract

The effects of three extruded diets with different starch sources (brewer's rice and Arracaciaxanthorrhiza) on dog total tract apparent digestibility response and fecal quality were investigated. The experiment was carried out on twelve mature dogs (17.03 ± 0.1 kg) with four dogs per treatment in a completely randomized design. Treatments were brewer's rice (control), Arracacia50% of substitution of brewer´s rice (RA) and Arracacia100% of substitution of brewer´s rice (A). All diets were formulated to beisonitrogenous and isoenergetics. The food intake was calculate in reference to ME = 132 x $BW^{0,67}$*. The diets containing Arracacia, with or without brewer's rice, presented lower (P <0.05) fecal outputs (145,25g and 134,12g) than for control diets (163,11g). Dry Matter (DM), Nitrogen and Fat digestibility was similar (P> 0.05) for three diets. However, the diets containing Arracacia presented the greatest crude fibre and starch digestibility (p < 0.05) than brewer's rice. Difference in gross energy digestibility was observed for parsnip diets (P< 0.05) than control and RP treatments. Variations in fibre, starch and gross energy digestibility can be explained by differences in chemical composition of each carbohydrate source, specialty the amylose and amyl pectin relation, fibre content and starch granule structure. The results of this study demonstrate that Arracaciaxanthorrhizacan be include in mature dogs diets because the feces quality and total apparent digestibility is similar or greatest than brewer's rice..*

Keywords: Canine, digestion, fecal output, starch, parsnip, *Arracacia Xanthorrhiza.*

1. *Introduction*

Fermentable carbohydrates are important components of dog diets, including some fibres, starch and non-starch polysaccharides. Carbohydrate sources are often incorporated in canine diets because of the dependable supply and inexpensive price, but excessive inclusion can be produce low diet digestibility, high fecal output or flatulence because these no digest nutrients reach the colon and are suitable for bacterial fermentation (Murrayet al., 1999; Gibson and Roberfroid, 2008) on account of carnivores have a short and relatively simple large intestine where the undigested food resides for approximately 12h (Maskell and Johnson, 1993).Brewer's rice is a usual source of energy and starch in dog food, although studies investigating the digestibility of rice products have been inconsistent and suggest that use the high inclusion rice en animal companion diets increases the dietary requirement of taurine in cats (deGodoy et al., 2013). This inconsistency is believed to result from the many rice varieties that have different amylose and amylopectin ratio (Zhong et al., 2006; Benmoussa et al. 2007; Syahariza et al, 2013).

Additional, recent works demonstrate that high rice inclusion can be responsible by positive reactions of food allergens (Kanget al., 2014). Traditional carbohydrate sources, corn (Gajda et al., 2005; Kuakpetoon and Wang, 2007; Guevara et al., 2008; Zhang and Hamaker, 2008), rice (Spears et al., 2004; Zhong et al., 2006; Benmoussa etal. 2007; Syahariza et al, 2012), sorgum (Sang et al, 2008) wheat (Sa et al 2013) barley (de Godoy et al., 2013) and no traditional sources cassava (Carciofi,2007), potatoes (Panasevich et al., 2013), sweet potato (Charles et al; 2005, Senanayake et al; 2013) were investigated in last years, treat discover more digestible carbohydrate sources. Murray et al (1999) suggest that diets containing large amounts (>50%) of barley may not be advantageous for dog owners because produce has been a poor fecal consistency compare with corn, potato, rice, sorghum, and wheat, although potato and sorghum had the worst digestibility, followed by corn, rice and wheat. Organic matter digestibility, gas production and fermentation end-products were significantly correlated with chemical composition of substrates, in particular carbohydrate fractions (total dietary fibre and starch),(Cutrignelli et al., 2009). However, *Arracaciaxanthorrhiza* research only was development in human and about chemical composition (Perez et al; 1999; Rocha et al2011), but in canine nutrition don’t have any report. Arracacia can be an option because the energetic value and starch level of are high, several works reported that3,96 until 4,01 Mcal/kg and 82,62 until 85,58% to energy and starch respectively, but low protein level (< 5,2%)(Brito and Espín, 1999; Espín et al., 2004; Andino, 2008).

Starch digestibility depends of amylose amyl pectin ratio (Syahariza et al., 2013) Amylose is a curled butstraight-chained starch, whereas amylopectin is not straight-chained, but is branched. Depending on thevariety, starch generally contains 20 to 25% amylose and75 to 80% amylopectin by weight. Generality, about one part amylose to every three parts of amylopectin for normal grain sources. Barrera et al. (2004) suggest that Arracaciaxanthorrhiza has 20% and 80% of amylose and amylopectin respectively. Arracacia are not evaluated as a starch source in canine foods and probability have high digestibility because the amylose content is greatest than rice, cornor other traditional starch sources; the presence of amylopectin in the diet can limit the nutrient availability, specialty starch. More information is needed on the influence of amylose amylopectin ratio in digestibility of dog diet components. Incorporation of alternative starch sources into canine foods can lower the expense associated with adding starch and fiber. Therefore, the aim of this study was to evaluate the influence of Arracaciaxanthorrhiza inclusion as a starch source indiets for mature dogs through apparent digestibility and fecal quality in order to better understand the potential effects of their inclusion in dog diets.

Materials and Methods

Dogs

Twelve mature male dogs (17.03 ± 0.1 kg) were located in individual metabolic kennel and used to evaluate drymater, protein, fat, energy, fibre and starch apparent digestibility and the fecal output. The dogs were located in the Division of Laboratory Animal Companion Research at the Veterinary and Animal Production School of Central University of Ecuador (Quito) and were cared for in accordance with Institutional Animal Care and Use Committee-approved protocols. Dogs were housed in 18°C average environment temperature. The kennels were 1 m × 1.5 m, with a slotted floor sitting 0.2m above ground. The kennels were adapted to allow for total fecal collection. Each kennel was cleaned twice daily, following feeding. Dogs were allowed 20 min of exercise twice daily during adaptation period (15d).

During total fecal collection (5d), dogs were confined to the cages to ensure that all feces were collected. Water was available ad libitum throughout the experiment.

Feeding and Treatments

The starch sources (brewer’s rice and Arracacia) and diets (control and experimental) were analyzed to drymatter, nitrogenous, fat, fibre, starch (AOAC, 2005) and energy was obtained using calorimetric bomb (1341 Parr ®). Each food was kibbled and formulated in accordance with the AAFCO (2000) nutrient guide for dogs and balanced to meet maintenance requirements (NRC 2010).

Three diets were formulated to isoenergetic and isonitrogenus. Treatments were control (brewer’s rice as principal starch source), experimental RA (50% brewer’s rice and 50% Arracacia as starch sources) and experimental A (Arracacia as principal starch source).Amount daily food for each dog was calculate use the metabolic energy equation to maintenance ME =132 x$BW^{0,67}$. Food was weighed daily and divided into two equal portions and fed at 0700 and 1700 in stainless steel bowls. Each dog was allowed 20 min to consume the food, after which bowls were removed, and orts were weighed and recorded. Throughout the experimental period, food samples were collected daily and pooled into plastic collection bags for nutrient content analyses.

Sampling

Dog were allowed 15 d previous to samples collection for adaptation period. Experimental period was 5 d long. On the first day of fecal collection, all feces were removed from the cages and discarded before 0730. Fecal output was collected from this point on for the next 4 d at each mealtime and placed into labeled plastic bags. Fecal scores were evaluated by one person using a scale ranging from 1 (for hard and dry feces) to 5 (for liquid stools); was take account volume, stickiness, adhesiveness, and moisture. Feces were considered ‘optimal' at scores of 2.5-3.0, 'acceptable' at scores of3.0-3.75 and 'unacceptable' at scores >3.75. Samples were frozen as they were collected, and pooled by doguntil further analyses.

Table 1. Perceptual composition of control and experimental diets

Analyses

On collection, fecal samples were stored frozen until analyses. Frozen fecal samples were dry at 65^{o}C for 72h in a forced air oven. Brewer’s rice, Aracacia, diets and fecal samples were ground to pass a 1 mm screen in a Thomas mill. The dried and ground samples were then stored in labeled plastic bags at room temperature until further analysis. Brewer’s rice, aracacia, diets and fecal ground samples were analyzed to dry matter, nitrogenous, fat, fibre, starch and energy using AOAC recommendations (AOAC, 1995). Energy was obtained using bomb calorimetric (1341 Parr ®).

Calculations and Statistics

Diets and excreta proximal composition were used to calculate digestibility for dry matter, crude protein (nitrogenous), ether extract (fat), crude fibre, starch and energy using the following formula:

Digestibility % = [Nutrient in feed - Nutrient in feaces/Nutrient in feed] x 100

Data were analyzed as a randomizing experimental using the GLM and REG procedures of SAS (SAS Inst.,Inc., Cary, NC, 2000). Each dog represented an experimental unit. The model included treatment, dog and the error mean square. The statistical model was:

$yij = \mu + Treati + \varepsilon$

where:
y is the experimental data,
μ the general mean,
treat the treatment (i = 1, 2, 3),
ε the error term.

When significant differences among substrates were found in the analysis of variance, means were compared using the Tukey’s test. Differences were considered significant at $P < 0.05$.

RESULTS

All dogs remained healthy throughout the entire experiment. Ingredients and chemical composition of diets or starch sources and diets is shown in Tables 1 and 2.Arracacia used in this study contained 5,6 and 76,5% to protein and starch concentration. Tree diets were isoprotein and isoenergetic. No differences (P>0,05) in BW initial or final and daily DMI were observed during the experiment. Daily DMI averaged 214,44 ±8 g/d. Nutrient digestibility are shown in Table 3.

No differences (P>0.05) between treatments was to initial and final weight, because requirements were calculate to maintenance adult dog. Dry matter intake was similar for tree treatments. Feces dry matter was equal statistically (P> 0,05), nevertheless fecal output as a natural material differ among treatments (P< 0,05), greater volume and moisture was to control group than diets containing *Arracacia*, with or without brewer's rice.

Digestibility of DM, CP and EE was similar (P> 0,05)between treatments. But CF, starch and energydigestibility were greatest (P< 0,05) when use arracaciaen dog food.

Table 2. Brewer´s rice, arracacia and diets composition

Table 3. Nutrient digestibility, fecal output and weight in dogs feeding with brewer´s rice or arracacia as starch sources

DISCUSSION

Objective of this experiment was to evaluate *Arracaciaxanthorrhiza* as potential feed ingredient for canine foods. Earlier studies research the nutritional value of traditional and nontraditional starch sources in canine foods, but many works have been inconsistent or unsatisfactory responses (de Godoy et al., 2013). The reasons for these inconsistencies have not been determined; however can be related principally with fecal quality. It is often speculated that the negative effects sometimes noted when feeding starch sources to companion animals is the result of low digestibility, intestinal gas production, diabetes and obesity predisposition (Bosh et al., 2009;Mitsuhashi et al., 2012; Kimura, 2013). The presence of many carbohydrates sources with different class and amount oligosaccharides can also alter digestion by increasing the viscosity of digesta, which can interfere with digestion by decreasing the interaction of digestive enzymes with substrates in the intestine, (Smits and Annison, 1996). Digestibility of tree diets observed in the present study are similar those reported recently by several research (Castrillo et al., 2001; Hendick et al.,2013; Panasevich et al., 2013; Brambillasca et al.,2013; Tjernsbekk, 2014) and imply that arracacia can replacement to brewer's rice and can be include until30% in canine food without affect DM, N and Fat digestibility and improve fibre, starch and energy digestibility. The apparent digestibility of energy, potassium, sodium and chloride was impaired by high starch and cellulose (Kienzle, 2001). Concluded that arracacia improve the digestibility of the total diet. The greater digestibility observed in their study can be believed to be high amylose content in arracacia and other roots (Senanayake et al., 2013) compared with brewer's rice. Recent data suggest that starch nontraditional sources can shower larger digestibility compare with rice or corn in mature dogs, increase when enhanced starch level (Panasevich et al., 2013). Starch, Cf and energy digestibility increased into 4,5 to 6% when arracacia is add to dog food. Variations in fibre, starch and gross energy digestibility can be explained by differences in chemical composition of each carbohydrate source, specialty the amylose and amylopectin ratio, fibre content and starch granule structure (de Gody et al.,2013; Syaharizaa et al.; 2013; Brambillasca et al., 2013).Starch that escapes duodeno-ileal digestion can affect fecal quality by stimulating colonic bacterial fermentation (Goudez et al., 2011) therefore arracacia can be an important source en dog food.

Conclusion

The results of this study demonstrate that Arracaciaxanthorrhiza can be include in mature dogs diets because the feces quality and total apparent digestibility is similar or greatest than brewer's rice. Although diets were formulated to be isonitrogenous, small differences were observed between treatments resulting in small differences in nutrients intake.

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