

The Effect of Bamboo Intake on Fecal Consistency in Giant Pandas (*Ailuropoda melanoleuca*)

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Although taxonomically classified as a carnivore, the giant panda (*Ailuropoda melanoleuca*) has evolved to consume a herbivorous diet consisting primarily of bamboo. Traditional captive feeding strategies have not reflected the natural diet and instead combined readily digested animal products and high-starch grain mixtures fed with variable amounts of bamboo. Improper nutritional management may lead to gastrointestinal disorders, often manifested as loose and/or mucous stools. Mucous stools are unique to captive giant and red pandas, and occurrence in wild pandas has not been documented. Data collected on giant pandas ($n=2$) at the Zoological Society of San Diego allowed the determination of a relationship between fecal consistency and bamboo intake. Since 1996, diet of the giant pandas has been manipulated from a traditional captive diet to one consisting of bamboo browse offered *ad libitum*, high fiber biscuits and limited produce (e.g. carrot, yam, and apple). The feces were graded on a scale consisting of six categories, dry and crumbled to mucous. Feces scored as badly formed (4), loose (5) and mucous (M) was 10.5 % of total fecal output for the male vs 0.41% for the female during a two year collection period (01 Jan 98 – 31 Dec 99). Bamboo consumption for the male and female averaged 56% and 75% of the total ration (DM), respectively. Additional data collection is on going to support the benefits of feeding higher fiber diets (bamboo) to maintain appropriate fecal consistency and GI tract health in giant pandas.

Key words: food intake, mucous stool, fiber

INTRODUCTION

The giant panda (*Ailuropoda melanoleuca*) has evolved to consume a herbivorous diet consisting primarily, if not exclusively, of bamboo (Schaller et al., 1985; Dierenfeld et al., 1982). There are no documented reports suggesting that the captive giant panda have been fed diets containing primarily bamboo. Traditionally, daily diets have consisted mostly of highly digestible feedstuffs in gruel or steamed forms. The amount of bamboo fed has been variable. Dierenfeld, et al. (1995) reported that diets (as-fed) of captive giant pandas included 13-56% grain, 8-25% animal products (milk, eggs and/or meat), 17-82% bamboo, and 0-29% fruits and/or vegetables. The influence of dietary composition on fecal consistency has been well established (Cummings et al., 1976; Sunvold et al., 1995). Loose, unformed feces are commonly observed in captive giant pandas. The excretion of mucous stools has also been frequently observed, but the occurrence in free-ranging animals has not been documented (Pan, 1996). Bamboo intake has not been quantified relative to frequency of loose and/or mucous stools.

MATERIALS AND METHODS

In September 1996, the Zoological Society of San Diego (ZSSD) received two giant pandas as part of a long-term loan from the China Research and Conservation Center for the Giant Panda (Wolong, China). The female was born at the center in 1991 and the male (estimated birth, 1982) was rescued from the wild and transferred to the center in 1992. Daily dietary records have been maintained on the pandas since arriving at ZSSD and include body weights, diet components/weights fed, consumed and refused, fecal scores and total fecal output.

During the initial six months at ZSSD, the diet was gradually converted from the traditional diet offered in Wolong to one that more closely approximates the diet of a free-ranging giant panda. The changes included the elimination of milk and high-starch, steamed bread, and the introduction of a high fiber biscuit (Marion Zoological, Inc., Plymouth, MN 55441) as a supplement to the *ad libitum* bamboo browse. Animals were always fed individually and body weights were determined daily.

ZSSD has approximately 15-20 bamboo species available throughout the year, of which the pandas were fed two to four species daily. All bamboo fed was cultivated and harvested on-site. Harvested bamboo was stored upright in water bins with automatic misters to maintain the freshness of the material. The bamboo was weighed, then sprayed with water just prior to being offered to the animals. Bamboo orts were collected throughout the day and were not corrected for evaporative moisture loss. The amount of high fiber biscuits and commercial produce (carrots, yams, apples) fed throughout the day were quantified and recorded (as-fed). The latter two items were used for reinforcement of management behaviors, and were routinely consumed in their entirety.

Feces were collected daily, weighed, and scored based on a standardized fecal scale (Table 1). Initially, written descriptions of each category were utilized to score the stools. Photos of actual fecal samples were later incorporated into the scale along with the written descriptions, improving the accuracy of the evaluation. Feces scored as 4 and 5 were collectively grouped as “loose”.

Eighteen months of daily dietary data were analyzed. The relationship between fecal consistency and bamboo intake (dry matter basis) was analyzed. Dry matter was calculated using the following values: bamboo (51% DM, based on analysis of *Phyllostachys aurea* leaves); produce (11.8% DM, based on analysis of carrots); and high fiber biscuit (91.4% DM, manufacturer’s guaranteed analysis).

Table 1. Fecal grading scale for the giant panda

Score	Description
1	dry, crumbly
2	well formed
3	good, slightly moist, less formed
4	moist, badly formed
5	loose
M	mucous

RESULTS

Table 2 provides DM intake expressed as kg/d and % BW, bamboo intake expressed as kg/d and % intake, and fecal scores.

Table 2. Dry matter (kg/d, % BW) and bamboo intake (kg/d, % DMI) and percent of stools classified as loose of giant pandas fed a high bamboo diet.

Gender	DM Intake, kg/d	DM Intake, % BW	Bamboo Intake (kg/d, DM)	Bamboo Intake (% DM intake)	Scores 4, 5 & M as % fecal output) ^a
Male	2.86	2.73	1.67	56	10.5
Female	3.84	3.59	2.74	75	0.41

^a 4 = badly formed, 5 = loose, and M = mucous

During the initial 3 months at the ZSSD, loose and/or mucous stools made up approximately 8% and 2% of the male and female fecal output, respectively. During the subsequent 18 months the female consumed more bamboo than the male (2.74 vs 1.67 kg/d DM) and the bamboo consumed as a % DM intake by the female was also much higher than the male (75 vs 56%). Total dietary DM intake for the female was 3.84 kg/d (or 3.59% BW) compared to 2.86 kg/d (or 2.73% of BW). The females produced fewer feces that consisted of score 4, 5 and M than that produced by the male (10.5%). During this 18-month time period, the male produced 30 mucous stools compared to only 3 by the female. A correlation was calculated for the mean bamboo intake/month during the 18-month period vs. the % of feces that scored 4, 5 and M. There was a negative correlation ($r = -0.64$) between bamboo intake and loose fecal consistency/presence of mucous stools.

DISCUSSION

The male consistently consumed a smaller amount of bamboo than the female, which was reflected in DM intake. Records indicated that the male panda tended to concentrate his feeding on leaves and branches while the female readily consume all plant parts. The culm portion of the bamboo contain greater amounts of fiber when compared to other plant parts, thus the selectivity by the male would suggest that the female was consuming a larger amount of fiber (Dierenfeld et al., 1982; Schaller, et al. 1985).

The data does emphasize the importance of maintaining the natural high fiber food source as a large portion of the captive diet; especially since loose and mucous stools have not been documented in wild pandas. Bamboo is a fibrous plant. Additional collection of data, including the type of bamboo species fed, will be useful in furthering an understanding of the correlation between bamboo intake and fecal consistency. The data will also further opportunities to improve gastrointestinal tract health as well as overall animal health.

CONCLUSIONS

1. There was a negative correlation ($r = -0.64$) between bamboo intake and frequency of loose and/or mucous stool.
2. Nutritional analysis of bamboo fed to giant pandas is currently in progress, which along with this data, may allow for quantification of fiber concentrations necessary for appropriate fecal consistency.
3. This study helps emphasize the importance of maintaining the nutrient composition of the natural food sources in a captive diet, especially since loose and mucous stools have not been documented in the wild while they are common in captive pandas.

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