The Effects Of Fiber Type And Fiber Levels On Digestibility And Volatile Fatty Acid Formation In The Orangutan (*Pongo pygmaeus*)

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INTRODUCTION

The diets of free-ranging orangutans are high in structural cell wall material, which comprises the fiber fraction in plants [Hamilton and Galdikas, 1994]. Microbial populations residing in the hindgut accomplish fiber digestion via fermentation. Animals use volatile fatty acids, end products of fiber fermentation, as a source of energy. Readily available produce items contain small amounts of fermentable fiber [Schmidt et al., 1999]. Commercially manufactured primate biscuits are limited in the amount of fiber they contain due to restrictions in the manufacturing method. Many feeds, used in the livestock industry, are high in fiber, but are generally not palatable to primates. Gels may be an effective tool to deliver high fiber ingredients to primates in a palatable form. Palatability trials were successful as the orangutans readily accepted the gels.

MATERIALS AND METHODS

Four different trial diets were fed to captive orangutans in this study each consisting of an experimental gel-diet at 67%, fruit at 15.6%, vegetables at 6.2% and leafy greens at 11.2% by weight on an as fed basis. Produce currently fed to primates does dilute the total dietary fiber. However, eliminating it would not be representative of a typical zoological diet and therefore was not considered an option for this project. The trial diets differed in the type of experimental gel fed. The gels differed in neutral detergent fiber content (NDF) and the fiber source; hence the trial diets were identified by the type of gel included. The control gel (Diet D), consisted of a ground primate biscuit in the gel matrix with 30% NDF. The second diet (Diet A) used soybean hulls as 66% of the gel matrix by weight with 50% NDF. The third (Diet B) and fourth (Diet C) diets used ground corn cob as the fiber source at 50 and 65% by weight resulting in 50% NDF and 60% NDF, respectively. A primate biscuit digestibility trial was also conducted to determine if the gel matrix altered digestibility of the diets in comparison to the biscuit. The amount of food offered daily per orangutan was equivalent to 1% of their bodyweight on a dry matter basis. Dry matter of each experimental gel and as an average for the produce across all categories is approximately 15%. Each gel diet was fed for a period of eight days prior to the three-day collection period. The animals were individually housed during the collection periods and all fecal matter was collected every 4 h, except between 2300 and 0700 when the apes are normally asleep. Orts were collected the following morning. Food samples, orts and feces were analyzed for dry matter, NDF, crude protein (CP) and ash. Differences in digestibility and volatile fatty acid formation between different fiber types and fiber levels were calculated.

RESULTS

As can be seen in Tables 1-2, increasing NDF levels in the gel led to increased NDF intake by the animals, with an exception for the male with Diet A where intake was poor. As NDF intake increased, dry matter digestibility of the diets decreased for only the highest NDF diet (Table 3). Digestibility of CP and OM for Diets A and B were higher for the male than the female; this may be due to decreased intake, increased retention time in the gut and an increased capacity for fiber fermentation in the hindgut of the male orangutan.

CONCLUSIONS

Orangutans were capable of extensive fiber digestibility in diets containing 60% NDF. The gel matrix did not appear to affect digestibility when compared to the biscuit digestibility trial. Total volatile fatty acid formation (Tables 4-5) increased as fiber intake increased, reflecting the ability of the orangutan to ferment the fiber types offered to them in this study. There was no apparent change in stool form. This study will be continued in three more orangutan pairs to complete a latin square for each sex.

REFERENCES

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Schmidt DA, Kerley MS, Dempsey JL, Porton IJ. 1999. The potential to increase neutral detergent fiber levels in ape diets using readily available produce. Proceedings of the Third Conference of the Am Zoo and Aquarium Association (AZA) Nutrition Advisory Group (NAG) on Zoo and Wildlife Nutrition. Columbus, Ohio. p 102-7.

TABLE 1. Dry matter and selected nutrient intakes by orangutans for 3-day collection period (g on DM basis)

Diet	NDF, %	Fiber source[1]		Intake, g (DMB)					Intake, g (DMB)			
				DM	CP	NDF	OM		DM	CP	NDF	OM
A	50	SH	♂	1399	142	284	1286	♀	1772	202	737	1624
B	50	CC	♂	2255	230	701	2109	♀	2063	244	808	1918
C	60	CC	♂	2026	203	1024	1926	♀	1868	246	932	1731
D	30	Biscuit in gel	♂	2493	304	538	2311	♀	1722	251	391	1593
Cntrol	30	Biscuit	♂	2948	445	651	2723	♀	1809	277	404	1673

[1]SH=soybean hulls, CC=ground corn cob.

TABLE 2. Dry matter and selected nutrient output by orangutans for 3-day collection period (g on DM basis)

Diet	NDF, %	Fiber source[1]		Output, g (DMB)					Output, g (DMB)			
				DM	CP	NDF	OM		DM	CP	NDF	OM
A	50	SH	♂	158	37	68	133	♀	480	110	198	410
B	50	CC	♂	344	46	190	292	♀	610	82	349	528
C	60	CC	♂	623	65	414	539	♀	613	64	417	545
D	30	Biscuit	♂	522	65	276	420	♀	385	54	192	312

Cntrol	30	in gel Biscuit	♂	605	75	351	494	♀	429	62	228	358

[1]SH=soybean hulls, CC=ground corn cob.

TABLE 3. Diet digestibility in orangutans consuming different fiber sources and levels

Diet	NDF, %	Fiber source[1]		Digestibility, %					Digestibility, %			
				DM	CP	NDF	OM		DM	CP	NDF	OM
A	50	SH	♂	89	74	76	90	♀	73	46	73	75
B	50	CC	♂	85	80	73	86	♀	70	66	57	72
C	60	CC	♂	69	68	60	72	♀	67	74	55	69
D	30	Biscuit in gel	♂	79	79	49	82	♀	78	78	51	80
Cntrol	30	Biscuit	♂	79	83	46	82	♀	76	78	44	79

[1]SH=soybean hulls, CC=ground corn cob.

TABLE 4. Volatile fatty acid (VFA) concentration in orangutan feces (ug g^{-1} dry feces)

Diet	NDF, %	Fiber source[1]		VFA ug g^{-1} (DMB)				VFA ug g^{-1} (DMB)		
				acetic	propionic	butyric		acetic	propionic	butyric
A	50	SH	♂	1886	649	371	♀	2300	862	523
B	50	CC	♂	4018	1518	581	♀	2535	1043	577
C	60	CC	♂	4728	2394	915	♀	4180	1507	841
D	30	Biscuit	♂	2876	972	460	♀	2576	799	497

Cntrol	30	in gel Biscuit	♂	1554	559	327	♀	1787	582	361

[1]SH=soybean hulls, CC=ground corn cob.

TABLE 5. Volatile fatty acids (VFA) in orangutan feces (molar, %)

Diet	NDF, %	Fiber source[1]		VFA molar, % (DMB) acetic	propionic	Butyric		VFA molar, % (DMB) acetic	propionic	butyric
A	50	SH	♂	70%	20%	10%	♀	71%	19%	10%
B	50	CC	♂	71%	20%	9%	♀	68%	21%	11%
C	60	CC	♂	71%	22%	7%	♀	67%	22%	11%
D	30	Biscuit in gel	♂	65%	26%	9%	♀	70%	20%	10%
Cntrol	30	Biscuit	♂	72%	20%	8%	♀	72%	18%	10%

[1]SH=soybean hulls, CC=ground corn cob.