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DIGESTION OF SUGARCANE BY THE POLYNESIAN RAT

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DIGESTION OF SUGARCANE BY THE POLYNESIAN RAT

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Abstract: Polynesian rats (*Rattus exulans*) were fed semi-purified rations containing varying levels of sugarcane (*Saccharum officinarum*) pith in order to determine digestibility. As the percentage of sugarcane pith increased in the rations, the dry matter digestibility decreased significantly ($P < 0.05$).

The Polynesian rat is probably the most important of three species of rats creating costly damage to sugarcane crops in Hawaii (Hood 1967). Kami (1966) showed that sugarcane was the largest single component in the stomachs of Polynesian rats found in the sugarcane fields (67 percent of the food material) and in gulches between cane fields (52 percent).

One way of controlling damage by these animals may be through nutritional means. For example, if sugarcane were found to lack essential nutrients or to be indigestible, removing other food sources from the cane fields could cause the rats to starve or leave. This study was conducted to determine, if possible, why Polynesian rats eat large quantities of sugarcane—whether it is of value to them as a food source (that is, well digested), or whether it is ingested simply as a luxury to obtain the sweet cane juice.

METHODS

Adult female Polynesian rats were wild-trapped in sugarcane fields near Hilo, Hawaii, and shipped to the Denver Wildlife Research Center. The rats were fed a commercial laboratory chow ad libitum and allowed to acclimatize to laboratory conditions for at least 30 days. Females were maintained separately from males throughout the study.

The sugarcane used in this study was 14-month-old, variety 49.5. Because of quarantine restrictions, the sugarcane was placed in an insulated container, packed with dry ice, and shipped to the Denver Center immediately after cutting. On arrival, the frozen sugarcane was stored at –17 C until needed.

Lindsey (1969) found that when rats fed on sugarcane stalks, they discarded numerous rind chips. Since this indicated that the rats did not ingest large amounts of rind, only the pulp was used in our study. Proximate analyses of sugarcane pith and rind are shown in Table 1.

The caged rats refused to eat either the thawed whole sugarcane or dried ground sugarcane, even when it was offered to them as the only source of food. This was also true in studies conducted at Hilo, Hawaii, where freshly cut cane was fed daily to Polynesian rats as their only source of food (G. A. Hood, personal communication).

Only rats weighing 50 g or more were used. Each rat was placed in a metabolism cage containing a 3-inch piece of conduit pipe for shelter. A 3-day preliminary feeding and adjustment period and a 7-day collection period were used. Since the rats refused to eat a ration composed of 100 percent sugarcane pith, four graded levels of sugarcane pith (Table 2) were added to a semi-purified isocaloric ration in order to obtain an estimate of the digestibility of a 100 percent sugarcane pith ration. Fifty rats were assigned at random to each treatment group. Each received a known quantity (20 g) of one of the five rations daily.

Table 1. Proximate analyses of sugarcane pith and rind.

	Crude Protein	Crude Fiber	Nitrogen-free Extract	Ether Extract	Ash	Dry Matter
	Percent					
Pith	1.2	22.1	72.8	0.1	0.9	97.1
Rind	2.2	49.5	44.8	0.9	1.0	98.4

Water was provided ad libitum. Fecal material and uneaten food samples were collected and weighed each morning prior to daily feedings. Seven-day composite individual fecal samples were stored at 5 C. Proximate analyses were made according to A.O.A.C. procedures (1965).

The data were subjected to analysis of variance (Snedecor 1956). Mean separation was accomplished by Duncan's New Multiple-Range Test (Steel and Torrie 1960). A prediction equation, to obtain an estimate of the digestibility of a 100 percent sugarcane pith ration, was obtained on ration dry matter digestibility by least-square regression analysis (Snedecor 1956).

RESULTS AND DISCUSSION

The effect on digestibility of increasing the sugarcane pith in the rations is shown in Table 3. Since the dry-matter digestibility of the basal ration (ration I, no sugarcane pith) was high, the decrease in digestibility with the increase of sugarcane pith reflects the indigestibility of the pith. This difference in digestibility probably occurred because the basal ration was essentially void of crude fiber, while the pith ration contained about 2–6 percent (Table 4). There was no difference in digestibility among the pith-containing rations.

Table 3. Influence of sugarcane pith on the apparent digestibility of the ration components.

Experimental Treatments	Apparent Digestibility Coefficients (Mean Percent)				
	Dry Matter	Crude Fiber	Nitrogen-free Extract	Ether Extract	Crude Protein
I	94.5[a]	59.5	98.3	97.6	92.1
II	91.4	1.5	96.6	96.5	88.6
III	89.0	3.8	95.0	96.0	87.6
IV	85.4	0.3	92.2	95.7	86.0
V	83.6	3.2	90.8	95.8	86.2

[a] Any means not connected by the same line are significantly different ($P < 0.05$).

The digestibility of nitrogen-free extract (NFE) decreased significantly as sugarcane pith increased (Table 3). This probably can be explained by the difference between the NFE of the basal rations, which is supplied by highly digestible sucrose, and that of the pith, which contains more undigestible fractions. On the other hand, the differences in the digestibility of ether extract among rations did not appear to be due to the varying amounts in the different rations, since there was a significant difference between rations I and II (9.9 and

Table. 2. Composition of experimental rations.

Ration Components	Percent in Experimental Treatment				
	I	II	III	IV	V
Casein[a] [b]	24	24	24	24	24
Sugarcane pith	0	6	12	18	24
Sucrose	60	52	43	35	27
Corn oil	10	12	15	17	19
Salt mix[a]	4	4	4	4	4
Vitamin mix[a]	2	2	2	2	2

[a] Nutrition Biochemical Corporation, Cleveland, Ohio. Reference to trade names does not imply endorsement of commercial products by the Federal Government.
[b] Vitamin free.

Table 4. Proximate analyses of experimental rations.

Proximate Composition	Percent in Experimental Treatments				
	I	II	III	IV	V
Crude protein (N × 6.25)	21.5	22.0	22.3	22.2	22.3
Crude fiber	0.2	1.5	2.9	4.3	5.7
Nitrogen-free extract	65.0	61.0	56.2	52.6	49.5
Ether extract	9.9	11.9	15.1	17.4	18.8
Ash	3.4	3.6	3.4	3.5	3.6
Dry matter	98.5	98.0	97.8	98.1	97.6

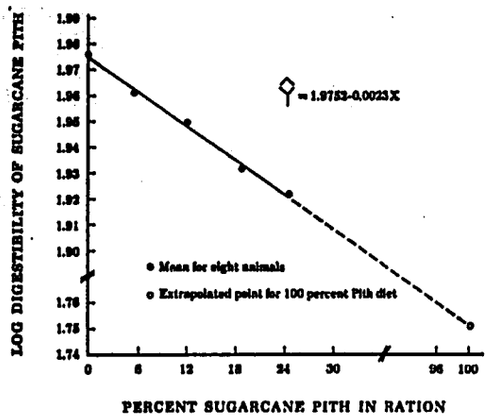

Fig. 1. Values for digestibility of sugarcane pith, converted to logarithms. The extrapolated segment of the curve is indicated by a broken line.

11.9 percent ether extract) but no significant difference between rations II and V (11.9 and 18.8 percent).

No significant difference in the digestibility of crude protein was found among rations. This was expected, since casein supplied approximately 99 percent of the protein in all rations.

Because of our interest in the digestibility of the sugarcane pith itself, the relationship between dry matter digestibility and percent of sugarcane pith in the rations was used as a basis to estimate sugarcane pith digestibility. The data were converted to logarithms with the resulting equation:

$$\hat{Y} = 1.9752 - 0.0023X$$

where $\hat{Y}$ = percent dry matter digestibility and X = percent sugarcane pith. The regression is shown graphically in Fig. 1.

The equation was then used to extrapolate the digestibility of a 100 percent pith ration. Although this might not be completely valid, it is the best estimate available of the digestibility of a 100 percent pith ration, since rats refuse to eat a 100 percent ration of either fresh or dried cane. The extrapolated digestibility of a 100 percent cane pith ration was only 56 percent. This is very poor digestibility for a material that contains 73 percent NFE, most of which is sugar. We therefore concluded that rats attack standing sugarcane not primarily as an energy or food source, since they utilize only half of what they consume, but rather as a luxury consumption to obtain the sweet sugar juice. This view is supported by the work of Burright and Kappauf (1962) and Young et al. (1963), who found that concentrated aqueous sugar solutions were the best attractants for rats.

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