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CASSAVA: CONSUMPTION AND DIGESTIBILITY BY SMALL CHILDREN

(THIRD REPORT to AID, covering period 1st. July - 31st.Dec.,1984)

During this period of the contract, the First Study in which the consumption, digestibility, and protein quality of three standarized diets containing three levels of cassava were compared - was completed. The following report therefore details the results of the study.

1.0 Methods - The methods were presented in detail in the original protocol, thus only a brief review will be presented herein.

1.1 Diets: A fresh batch of cassava from the Peruvian jungle was lyophilized in order to provide a single homogenous lot sufficient to meet the needs of the study. Three study diets containing 25, 50, and 75% of energy as cassava were compared with a control diet in which the carbohydrate source was a mixture of sucrose and dextrimaltose, vegetable oil (soybean : cottonseed, 1:1)provided 20% of energy in all diets. The major protein source was calcium caseinate, and the protein provided 8% of energy.

In the "25", "50", and "75" cassava diets, cassava provided 4.5%, 8.5%, and 12.9% of the protein respectively; all of the protein in the control diet was derived from casein, vitamin and mineral supplements were added to meet the US' RDA's.

Each child received the cassava diets during three nine - day periods. A nine - day period with the control diet preceeded the first study period; this period was followed by a six - day period with the control diet, and all subsequent cassava diets periods were preceeded and followed by six - day periods in which the control diet was given. The order of the cassava diet periods was randomized among different patients.

1.2 Study subjects: Eight male infants between 20 and 38 months of age were included in the study, all were recovering from severe malnutrition, but had achieved at least 10th. percentile of NCHS reference of weight for length, serum albumin >3.5g/dl, and had demonstrated normal intestinal absorption of a casein, sucrose - vegetable diet before inclusion in the present studies. The clinical characteristics of these subjects are summarized in Table 1.

2.0 Results -

2.1 25% of dietary energy from cassava (Table 2).

The mean apparent absorption of nitrogen was similar during the cassava dietary period and during the preceeding and following control periods. The apparent nitrogen retention, however, was lower during the cassava period than during the control periods. Nitrogen retention during the latter control period was statistically significantly greater than during the cassava period.

Although the children gained slightly less weight during each successively higher level of cassava consumption, these differences were not statistically significant. As the amount of cassava in the diet increased, the children required progressively greater periods of time to consume their feedings.

3.0 Discussion:

These studies provide the first quantitative information on the digestibility and nutritional quality of cassava - containing diets for infants and young children. All results are compared with a control diet known to be highly digestible and of superior nutritional quality. The apparent absorption and retention of nitrogen deteriorated moderately with successive increases in the amount of cassava consumed. Although most of the fall in nitrogen retention could be explained by the reduced absorotion, the biological value of the protein also tended to decrease very slightly. These results were unexpected since the vast majority of the protein in the study was provided by casein, which is a high quality reference protein source. Although the amount of protein provided by cassava increased slightly with each increment in the proportion of dietary energy provided by cassava, this small change in protein source cannot explain the observed differences in absorption and retention. Apparently some factor present in cassava interfered with the utilization of the casein present in the study diets. Furthermore, the decline in energy absorption with greater intake of cassava may have impaired somewhat the retention of the nitrogen that was absorbed. Further research will be required to identify the anti-nutritional factor (s) present in cassava.

The increased fecal losses of carbohydrate and energy with cassava were not surprising since non - digestible fiber contributes to the total carbohydrate (and energy) content of the product, but not to the control diet. Further laboratory analyses will attempt to distinguish between fiber and non - fiber carbohydrate and energy losses in the stool.

The reduced fat excretion with cassava as compared with the control diet cannot be explained, but it is consistent with previous observations noted during studies of other staple foods such as: potatoes and noodles.

The physical properties of the cassava diet undoubtedly contributed to its delayed consumption with increasing amounts of cassava, the diet was progressively more galatinous, (voluminous) and required greater effort by the caretakers to assure complete consumption. Whereas the control (and 25, and 50%) diet was liquid and consumed from a feeding bottle, the 75% diets had to be fed by spoon. Prolonged feeding times may result in reduced intakes in home settings where already overburdened mothers may not be able to contribta the necessary time to assure that their infants consume the entire ammount of the preparation that is offered.

4.0 Stimulation program for undernourished children:

The Stimulation Program at the IIN was initiated late in December 1983 with the goal of facilitating the recovery of motoric, linguistic, emotional and intelectual skills in children suffering from severe malnutrition. Both, the evaluation and programatic aspects of the program are adaptations of the "Programa Integral de Estimulación Temprana con Base en la Familia" (PIETBAF), developed by the Instituto Nacional de Investigación y Desarrollo en Educación (INIDE), del Ministerio de Educación, en 1983.

The stimulation program includes both a clinical and a research component.

4.1 Clinical program

All children admitted to the IIN for treatment of malnutrition eligible for the clinical component of the stimulation program. Developmental evaluation serve as the basis for individualized stimulation programs. The play therapist coordinates the stimulation activities through direct contact with the children and recommendations to the nurses, parents, and volunteers.

The PIETBAF has been operationalized to be used as an evaluation procedure with children recovering from malnutrition. The initial evaluation is scheduled as soon after admission as the child's medical condition is stable, usually within the first 10 days. Thereafter, evaluations are done on a monthly basis, with a final evaluation at discharge.

Evaluation selection scoring, and results are developed, from the results of evaluation the therapist writes a report, including a resume of the child's developmental status and individualized recommendations for stimulation activities designed to facilitate further change.

4.2 Evaluation Results

During each evaluation the therapist also observes the child's general health status and the child's cooperation, sociolibility, and attention. For each area the child receives a score of Low, Medium, or High. Finally, the therapist notes whether the child has displayed a representative repertoire of behavior, which is coded as Complete or Incomplete.

From the results of the evaluation the therapist writes a report, including a resume of the child's developmental status and individualized recommendations for stimulation activities designed to facilitate further change. These recommendations are based on the PIETBAF and are practical and easy to implement.

The results of the developmental evaluations and recommendations for developmental activities are communicated to the IIN staff through weekly case conferences, Thursdays between 2:00 - 3:00, and through bulletin boards in the two primary hospital rooms for children.

4.3 Play Therapist

The Play Therapist maintains an individualized program for each nutritionally deprived child recovering at the IIN. The programs are designed to facilitate growth in each of the six developmental areas and are administered in a context of play. The Play Therapist visits each child daily and coordinates stimulation activities either in the children's hospital room or in the Play Room. For children who are in metabolic collection and in bed, she provides bed activities, including resistive exercises for their legs. When possible children in metabolic collection spend part of each day in one of the four specially adapted metabolic strollers. During stimulation children who are not in metabolic collection spend as much time out of their beds as possible. Children with similar developmental skills are programmed together for group activities, thus learning from one another in a social context.

The Play Therapist serves as a resource to the IIN staff. Although she works with each child daily, she alone is unable to provide the stimulation needed by children recovering from nutritional deprivation. Consistent, affective involvement by parents, hospital staff, and volunteers who have been trained in appropriate developmental activities, is necessary for optimal behavioral rehabilitation.

4.4 Training in Stimulation Activities

In order to provide a baseline of knowledge about child development and stimulation activities, a series of five training sessions were held with the nursing staff. To supplement these discussions, large charts were made for the wall of the nursing area depicting the age categories and representative tasks in each developmental area, based on PIETBAF. These

The mean fecal wet weight during the cassava period was greater than during the contiguous control periods. The difference from the earlier period only was statistically significant. There were no differences in fecal dry weight in any dietary interval.

Fecal fat was slightly less and fecal carbohydrate slightly more with the cassava diet than with the comparisson diets. These differences were statistically significant when compared with the second control period. These opposing effects resulted in similar fecal total energy excretion during each period. There were no differences in increments in body weight or serum albumin or in the average duration of feedings during any interval of the study.

2.2 50% of dietary energy from cassava (Table 3).

With 50% of dietary energy provided by cassava apparent nitrogen absorption declines slightly with respect to the control diets. This difference was statistically significant when compared with the second control period. Apparent nitrogen retention was significantly, less with cassava than during either control period.

Fecal wet weight was almost twice as great during the cassava period than during the paired control periods. These differences as well as those for fecal dry weight were statistically significant in relation to the prior and subsequent control diets.

Fecal carbohydrate excretion was approximately three times greater with cassava, whereas fat excretion was only half as much as with the control diets. As a result, fecal energy losses were only moderately greater with the cassava diet. All of these findings were statistically significant.

As with the "25%" cassava diet there were no differences in weight gain or serum albumin levels by dietary intervals. Approximately eight minutes were required to consume each feeding of cassava as offered to approximately five minutes for the control diets, a difference that was statistically significant for the first cassava control period.

2.3 - 75% dietary energy from cassava (Table 4).

As noted with the "50%" cassava diet, the apparent absorption and retention of nitrogen were reduced with the "75%" cassava diet compared with its respective controls The fecal wet and dry weights, fecal carbohydrate, and fecal energy were all significantly greater with the cassava diet. Fecal fat was less during the cassava period, but not significantly. There were no significant differences in increments of body weight or serum albumin. The children required a feeding period that was approximately two and a half times longer in order to consume the cassava diet than the control diet.

2.4 - Comparisson of three levels of cassava (Table 5).

The apparent absorption and retention of nitrogen decreased significantly as a greater proportion of dietary energy was provided by cassava. Likewise, fecal wet and dry weight and fecal excretion of carbohydrate and energy were greater with increasing cassava consumption. Although fecal fat excretion was consistently less with cassava than with the control diet, there was no apparent relation between the amount of cassava consumed and the efficiency of fat absorption.

charts serve as a permanent reminder of normal child development activities for both staff and visitors.

4.5 Parent Involvement

Parents are taught appropriate developmental activities for their children during visitation and prior to discharge. However, parent visitation patterns vary, with some families visiting several times a week and others practically abandoning their children. Currently there are no funds to support transportation, thus formalized parent education is beyond the scope of the present Stimulation Program.

Similarly, follow-up is an expensive process, which should be included as part of a Stimulation Program. Children are periodically reevaluated when they return to the outpatient department after discharge, but not on a regularly scheduled basis. Additional financial support is necessary to implement the follow-up phase of the program.

5.0 DETERMINATION OF THE HYDROGEN CONCENTRATION IN EXPIRED AIR.

5.1 INTRODUCTION:

Breath hydrogen tests have been used during the last twelve years for gastrointestinal diagnoses. This non-invasive procedure is useful in the diagnoses of carbohydrate malabsorption, bacterial over growth in the small intestine, and small intestinal transit time. It has also been successfully applied in the study of colonic metabolism of fiber and non-absorbable carbohydrates.

Certain colonic bacteria are capable of fermentingavailable carbohydrates with the concomitant production of hydrogen gas. Although the majority of the hydrogen is eliminated as flatus, 14 to 21 % is absorbed and subsequently excreted through the lungs. The excretion of expired hydrogen provides semi-quantitative information regarding the intestinal fermentation of carbohydrates and appears to be the best index of carbohydrate malabsorption.

The first studies of breath hydrogen excretion used a closed system of continuos respiration for the collection of expired air, but presently a hydrogen sampling system at fixed intervals after an oral dose of carbohydrate has been developed. The procedure is non-invasive and is suitable for infants and young children.

During the present studies the breath hydrogen test was performed on children consuming cassava at three different levels (25, 50 and 75%) of total dietary energy in order to determine whether excess carbohydrate entered the colon. Additionally, results of breath hydrogen excretion were compared with data for fecal energy excretion as determined by bomb calorimeter.

5.2 PATIENTS, PROCEDURES AND METHODS:

Eight partially recovered malnourished children participated in this study. Determinations of hydrogen concentration of expired air were done during each period of yuca, 25%, 50 % and 75% and in the initial CASEC control period. Control tests were also done with lactulose (a non-absorbable carbohydrate) in each child before starting the study to assure that the colonic flora were capable of producing hydrogen. For the control experiment with lactulose, 11 children were studied (3 of them did not participate in the yuca study). They received a dose either 3.33g or 6.7g of lactulose in a 10% solution in water, after obtaining a basal sample of expired hydrogen. This basal sample was obtained after 8 to 12 hours of fasting. Samples were obtained at 30 minute intervals for 180 to 240 minutes.

For the cassava study basal samples of fasting breath H2 concentration were collected. Samples of expired air were the collected at 30 minute intervals up to 240 minutes after the first feeding and at 60 minute intervals for an additional 240 minutes after the second feeding.

The expired air was collected in a pediatric anesthetic mask that was connected through a polyethylene tube to a 15 cc syringe. At the end of each expiration, 1 to 3 cc of air were aspirated into the syringe until a total volume of 40 cc was obtained.

The hydrogen concentration of the air samples were analysed during same day using a Quintron model S gas chromatograph, which uses a thermal conductivity detection system. Argon was used as the carrier gas. The results were compared with a commercial standard of 55 ppm of hydrogen in air.

Five parameters were used for interpretation of the breath hydrogen data:

a) Basal value.- The measurement of the hydrogen concentration in breath immediately before feeding.

b) Peak increment.- The difference between the highest post-prandial value and the basal value.

c) Maximal differences.- The differences between the highest and the lowest pre or post-prandial values.

d) The time required to reach the maximal peak of hydrogen excretion.

e) Excess concentration of expired hydrogen, i e, the integration under a discontinuous curve of the excess hydrogen excreted during each interval, which has been calculated by the following formula of the sum of the trapezoids:

$$(T_o - T_o) \frac{+}{2} (T_i - T_o) + (T_i - T_o) \frac{\pm}{2} (T_{ii} - T_o) + \cdots\cdots$$

$$+ (T_n - i - T_o) \frac{\pm}{2} (T_n - T_o)$$

Where T_o is the hydrogen concentration in ppm in time zero; T_i is the hydrogen concentration in ppm at the end of the first interval. T_{ii} is the hydrogen concentration in the last interval.

5.3 RESULTS:

Lactulose Tests: The lactulose test resulted in a marked increase (> 20 ppm) in the expired hydrogen concentration in all the patients, except in the case of patient number 871 in whom there was no increase with either of the two levels of lactulose (Table I). The average time required to reach the maximal peak in hydrogen concentration was 120 minutes, while the excess in the hydrogen concentration in ppm was greater than 2000 ppm for all patients except for patient 871 in whom there was no significant increase and patient 839 whose basal level was greater than 40 ppm. Patient 825 had a significant increase in the total hydrogen excretion despite a basal level of 53 ppm.

The concentration of expired hydrogen following lactulose doses of 3.33 g and 6.7 g are shown for three patients in figure 1. Patient 806 shows the best hydrogen excretion curve; for dose 6.7 g., the excess in hydrogen concentration in ppm increased proportionally.

In patient 871 the hydrogen excess was negative with 3.3 g. of lactulose and did not increase importtantly increasing the dose to 6.7 g. In this same patient we may see variations in hydrogen concentration in ppm for each time interval (Figure 2).

5.4 Basal H2 Excretion with Cassava:

When analyzing the effect of the diet previously ingested on the basal expired hydrogen we observe that as the proportion of calories derive from cassava increased, there was an increase in the hydrogen concentration of the basal expired air (Table II (Fig.3). It can also be observed in the same table that the fecal excretion of carbohydrate increased progressively with the increment of yuca in the diet.

5.5 Excess Hydrogen Excretion with Cassava:

The excess breath hydrogen concentration was calculated for an eight hour - period following ingestion of cassava. (Table

The first patient only had samples taken for four hours post prandially. We may clearly see that the hydrogen concentration is greater in the afternoon (B interval) after receiving the second feeding in that morning (A interval) for those patients with the full eight hours of observation. This is true for all four diet periods.

In the patients who didn't have hydrogen samples in the B interval, the hydrogen excess was zero. For the majority of patients the hydrogen excess for the Yuca 75% was zero because the basal value was greater than any other value measured.

DISCUSSION

The control test with lactulose perform in all 11 children, showed that only one child (9%) was not able to produce hydrogen in significant amounts. This child probably did not have microbial flora in the colon capable of fermenting lactulose. But, by the curve obtained with a dose of 3.3g of lactulose (Figure 2) in which the maximal peak was at 30 min., it seems a typical curve of microbial contamination of the small intestine.

The effect of the diet previously ingested in the basal expired hydrogen suggests that the non - absorbed carbohydrate (fiber) content in Yuca (around 8%) influenced the hydrogen excretion.

Other investigators have demonstrated that certain types of dietary fiber or complex carbohydrates affect the concentration of basal expired hydrogen. These studies were performed with a legume - based diet, in which a small increase in the concentration of expired hydrogen with a maximal peak observed 5 - 8 hours after the first intake of feeding was shown.

In Yuca, we have observed something similar although we have not been able to charaterize specifically the type of fiber in Yuca, it seems to affect the hydrogen excretion, delaying it and so affecting the basal hydrogen excretion the following day.

In the control period of casein, we also observed a tendency of the hydrogen concentration to increase in the afternoon (Figure 2). This may be due to the fact that this control diet contained not only sucrose, which is a highly digestible carbohydrate, but also dextrimaltose and corn starch. To be able to clearly differentiate a diet with fiber or complex carbohydrates from a control one a diet of casein - sucrose will have to be prepared.

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TABLE 1

CLINICAL CHARACTERISTICS OF EIGHT CHILDREN AT THE BEGINNING OF THE FIRST STUDY OF CASSAVA

IIN N°	Hospital Day	Chronologic Age (m)	Weight (g)	Weight Age (m)	Height (cm)	Height Age (m)	Weight by Height Percentil	Serum Alb g/d
827	57	20.0	7.600	5.6	71.4	8.25	5	3.62
825	63	26.4	9.600	10.25	78.2	13.75	15	3.79
842	59	21.0	6.980	4.4	70.0	7.25	<3	3.85
849	57	35.9	6.780	4.1	74.7	10.75	< 3	3.59
848	86	20.1	10.380	12.75	79.1	14.75	35	3.83
868	36	28.5	8.830	8.0	81.0	16.5	< 3	3.50
872	85	20.5	8.600	7.5	72.8	9.25	20	4.24
891	22	37.8	9.660	10.25	79.7	15.25	5	4.17

TABLE 2

PROTEIN QUALITY AND DIGESTIBILITY OF DIET CONTAINING 25% OF ENERGY FROM CASSAVA COMPARED WITH CONTROL DIET (n = 8)

			CONTROL-PRE	CASSAVA "25"	CONTROL-PRE
NITROGEN					
Absorption	(% intake)	$\bar{X}$	83.1	83.4	82.1
		SD	± 3.7	± 6.0	± 6.0
Retention	(% intake)	$\bar{X}$	34.5	32.9[c]	44.6
		SD	± 6.3	± 8.0	±10.6
FECAL WEIGHT					
Wet	(g/d)	$\bar{X}$	84.7	120.9[a]	100.6
		SD	± 27.7	± 35.6	± 13.8
Dry	(g/d)	$\bar{X}$	16.8	16.4	18.5
		SD	± 3.9	± 3.3	± 2.9
FECAL FAT	(% intake)	$\bar{X}$	9.7	9.2[c]	12.2
		SD	± 5.2	± 4.5	± 4.7
FECAL CHO	(% intake)	$\bar{X}$	2.1	2.8[d]	1.6
		SD	± 1.0	± 0.5	± 0.9
FECAL ENERGY	(% intake)	$\bar{X}$	5.3	5.9	5.6
		SD	± 1.4	± 1.3	± 0.8
BODY WEIGHT	(g/kg/d)	$\bar{X}$	4.3	3.8	5.0
		SD	± 2.1	± 2.0	± 2.0
SERUM ALBUMIN	(g/dl/prd)	$\bar{X}$	0.17	0.07	0.19
		SD	0.28	± 0.25	± 0.27
DURATION FEEDING	(min)	$\bar{X}$	5.0	6.0	6.4
		SD	± 2.0	± 5.6	± 5.4

Statistical significance of differences (paired "t" test)

Cassava vs Control - pre: a = $p < 0.05$
Cassava vs Control - pre: b = $p < 0.01$
Cassava vs Control - post: c = $p < 0.0$
Cassava vs Control - post: d = $p < 0.0$

TABLE 3

PROTEIN QUALITY AND DIGESTIBILITY OF DIET CONTAINING 50% OF ENERGY FROM CASSAVA COMPARED WITH CONTROL DIET (n = 8)

			CONTROL-PRE	CASSAVA "50"	CONTROL-POST
NITROGEN					
Absorption	(% intake)	$\bar{X}$	81.3	78.6[c]	81.5
		SD	± 6.8	± 5.1	± 3.7
Retention	(% intake)	$\bar{X}$	39.1	31.0[a,c]	39.3
		SD	±13.1	± 7.8	±10.4
FECAL WEIGHT					
Wet	(g/d)	$\bar{X}$	100.6	195.7[b,d]	117.9
		SD	± 52.7	± 44.1	± 40.8
Dry	(g/d)	$\bar{X}$	18.8	23.8[a,d]	20.6
		SD	± 4.4	± 3.8	± 3.1
FECAL FAT	(% intake)	$\bar{X}$	17.1	8.0[b,c]	14.0
		SD	± 8.0	± 4.2	± 7.2
FECAL CHO	(% intake)	$\bar{X}$	1.5	6.0[b,d]	2.3
		SD	± 0.8	1.1	± 1.0
FECAL ENERGY	(% intake)	$\bar{X}$	6.7	9.5[a,d]	6.3
		SD	± 1.8	± 3.2	± 1.4
BODY WEIGHT	(g/kg/d)	$\bar{X}$	3.8	3.0	4.6
		SD	± 3.0	± 1.9	± 3.6
SERUM ALBUMIN	(g/dl/per)	$\bar{X}$	0.09	0.16	0.04
		SD	± 0.28	± 0.26	± 0.35
DURATION FEEDING	(Min)	$\bar{X}$	4.8	8.0	5.2
		SD	± 0.7	± 4.8	± 2.3

Statistical significance of differences:

Cassava vs Control pre : a $p < 0.025$ Cassava vs Control post : c $p < 0.025$
Cassava vs Control pre : b $p < 0.001$ Cassava vs Control post : d $p < 0.001$

TABLE 4

PROTEIN QUALITY AND DIGESTIBILITY OF DIET CONTAINING 75% OF ENERGY FROM CASSAVA COMPARED WITH CONTROL DIET (n = 8)

			CONTROL - PRE	CASSAVA "75"	CONTROL - POST
NITROGEN					
Absorption	(% intake)	$\bar{X}$	82.7	75.6[b]	80.8
		SD	± 4.1	± 5.7	±16.0
Retention	(% intake)	$\bar{X}$	38.4	28.6[a,c]	37.3
		SD	± 9.3	± 8.5	± 11.0
FECAL WEIGHT					
Wet	(g/d)	$\bar{X}$	94.5	240.0[b,d]	132.3
		SD	± 23.0	48.6	± 61.1
Dry	(g/d)	$\bar{X}$	17.3	31.4[b]	20.8
FECAL FAT	(% intake)	$\bar{X}$	13.1	10.6	14.5
		SD	± 5.0	± 4.8	± 4.0
FECAL CHO	(% intake)	$\bar{X}$	1.8	8.6[b,d]	1.7
		SD	± 0.8	± 0.8	± 0.8
FECAL ENERGY	(% intake)	$\bar{X}$	5.6	10.0[b,c]	6.3
		SD	± 1.4	± 4.4	± 2.6
BODY WEIGHT	(% intake)	$\bar{X}$	4.5	3.6	3.7
		SD	± 2.2	± 2.2	± 2.1
SERUM ALBUMIN	(g/dl/prd)	$\bar{X}$	-0.11	0.30	0.06
		SD	± 0.41	± 0.45	± 0.31
DURATION FEEDING	(min)	$\bar{X}$	6.0	16.5[a,c]	6.0
		SD	± 5.4	± 12.3	± 4.3

Statistical significance of Differences (paired "t" test)

Cassava vs Control pre : a = p < 0.025 Cassava vs Control post : c = p < 0.0
Cassava vs Control pre : b = p < 0.005 Cassava vs Control post : d = p < 0.0

TABLE 5

DIGESTIBILITY AND TOLERANCE PARAMETERS ON EIGHT CHILDREN RECEIVING THREE ENERGY INTAKE LEVELS FROM CASSAVA

		CASSAVA 25	CASSAVA 50	CASSAVA 75
NITROGEN:				
Absorption	(%)	83^{*b}	79	76
Retention	(%)	33	31	29
Biological Value	(%)	40	39	38
FECES:				
Wet Weight	(g/d)	121^{*d}	196	240^{***c}
Dry Weight	(g/d)	16.4^{*d}	23.8^{**a}	31.4^{***d}
FAT:				
% Intake		9.2^{*a}	8.0	10.6
CARBOHYDRATES:				
% Intake		2.8^{*d}	6.0^{**d}	8.6^{***d}
ENERGY:				
% Intake		5.9^{*d}	9.5^{**b}	10.0^{***d}
BODY WEIGHT:				
	(g/day)	35	28	34
	(g/kg/day)	3.8	3.0	3.6
SERUM ALBUMIN:				
Initial g/dl		3.81	3.56	3.81
Final g/dl		3.88	3.72	3.51
Difference		0.07	0.16	-0.30
DIET TOLERANCE:				
Min/Feeding		6.0	8.0^{**b}	16.5^{***a}

* Cassava 25% vs. Cassava 50%
** Cassava 50% vs. Cassava 75%
*** Cassava 25% vs. Cassava 75%

a) $p < 0.05$
b) $p < 0.025$
c) $p < 0.01$
d) $p < 0.001$

T A B L A I

EXSESO DE LA CONCENTRACION DE H2 ESPIRADO EN PPM, INCREMENTO DEL PICO Y TIEMPO REQUERIDO PARA LLEGAR A ESE PICO LUEGO DE UNA DOSIS DE LACTULOSA

PT. N°	DOSIS (gr)	EXSESO H2 (ppm)	INCREMENTO (Δ) (ppm)	TIEMPO DEL Δ (min)
800	6.7	7095	55.9	105'
800	3.33	4295	78.8	120'
806	6.7	4700	39.1	90'
806	3.33	3295	31.4	90'
871	6.7	1769	19.6	120'
871a	3.33	195	8.9	30'
825b	6.7	6008	88.0	120'
827	6.7	6111	58.4	120'
839b	3.33	384	28.3	180'
842	3.33	12456	121.1	150'
848	3.33	5587	62.7	120'
868	3.33	3987	79.3	90'
872	3.33	4298	54.8	90'
891	3.33	9563	68.8	210'

a= Basal = 20 ppm

b= Basal > 40 ppm

T A B L A II

EFECTO DE LA DIETA PREVIAMENTE INGERIDA EN EL H_2 ESPIRADO BASAL Y EN LA EXCRECION FECAL DE CARBOHIDRATOS EN 8 NIÑOS CONSUMIENDO DIETAS DE CASEINA-SUCROSA O DIFERENTES NIVELES DE YUCA

	PT.N°	PERIODO DE CASEC	PERIODO DE YUCA 25%	PERIODO DE YUCA 50%	PERIODO DE YUCA 75%
H_2 Esp. Basal (ppm)	827	10.8 ± 3.6	27.7 ± 0.1	11.7 ± 0.1	14.6 ± 1.9
	825	21.6 ± 7.0	11.5 ± 1.7	13.0 ± 1.8	24.8 ± 8.6
	842	8.5 ± 1.4	8.8 ± 2.6	18.8 ± 5.6	31.9 ± 8.2
	849	10.0 ± 3.4	7.6	31.6 ± 28.7	18.4 ± 4.2
	848	10.8 ± 2.1	-	11.1 ± 2.5	15.6 ± 8.2
	868	10.3 ± 1.1	8.1 ± 1.6	25.4 ± 3.8	49.2 ± 22.9
	872	8.7 ± 2.1	7.2 ± 0.5	9.3 ± 1.1	10.1 ± 3.6
	891	12.3 ± 3.0	8.0 ± 0.7	9.2 ± 1.5	8.4 ± 2.7
	Mean ± S.D.	11.6 ± 4.2	11.3 ± 7.4	16.3 ± 8.3	21.6 ± 13.5
	C.V.	36%	65%	51%	62%
CHO Fecal Exc. (% Ingesta)	827	2.60	3.10	7.25	8.60
	825	1.75	3.05	5.70	9.60
	842	2.69	3.33	6.75	9.02
	849	2.69	2.69	8.56	9.23
	848	0.54	1.68	4.96	7.29
	868	1.53	2.73	4.04	7.43
	872	1.26	2.83	6.60	9.20
	891	2.52	2.86	6.97	8.28
	Mean ± S.D.	1.95 ± 0.80	2.78 ± 0.49	6.35 ± 1.41	8.58 ± 0.86

T A B L A III

EXSESO DE LA CONCENTRACION DE HIDROGENO TOTAL EN ppm EN NIÑOS CONSUMIENDO DIETA DE CASEINA-SUCROSA-ALMIDON O DIFERENTES NIVELES DE YUCA

	CASEC		YUCA 25%		YUCA 50%		YUCA 75%	
PAT Nº	INT.A	INT.B	INT.A	INT.B	INT.A	INT.B	INT.A	INT.B
827	234	0b	43	0b	64	67	0	0b
825	23	0	3.6	649	0	0b	0	0b
842	396	0b	136	0b	0.2	538	0	0
848	349	825	-	-	173	906	0	0
868	993	709	395	729	69	0	0	0
849	3813=	12312c	283	1338	0.7	1189c	0	28
872	24	918	421	1224	108	1959	1236	3108c
891	78	398	291	1071	0	2250c	11	1851
Promedio	739	2560	225	1002	52	987	136	831
n	8	6	7	5	8	7	8	6

a = Intervalo A ≤ 240; Intervalo B ≥ 240'

b = Muestras Tomadas solo hasta los 180' (Int.A)

c = Incremento (Δ) > 20ppm

FIGURA N°1

CAMBIOS EN LA CONCENTRACION DE H_2 ESPIRADO SOBRE EL NIVEL BASAL (EXCESO DE LA CONC. DE H_2 ESP.) A 0.5h INTERVALOS CON DOSIS DE 3.33 Y 6.7g. DE LACTULOSA, EN 3 NIÑOS RECUPERADOS,

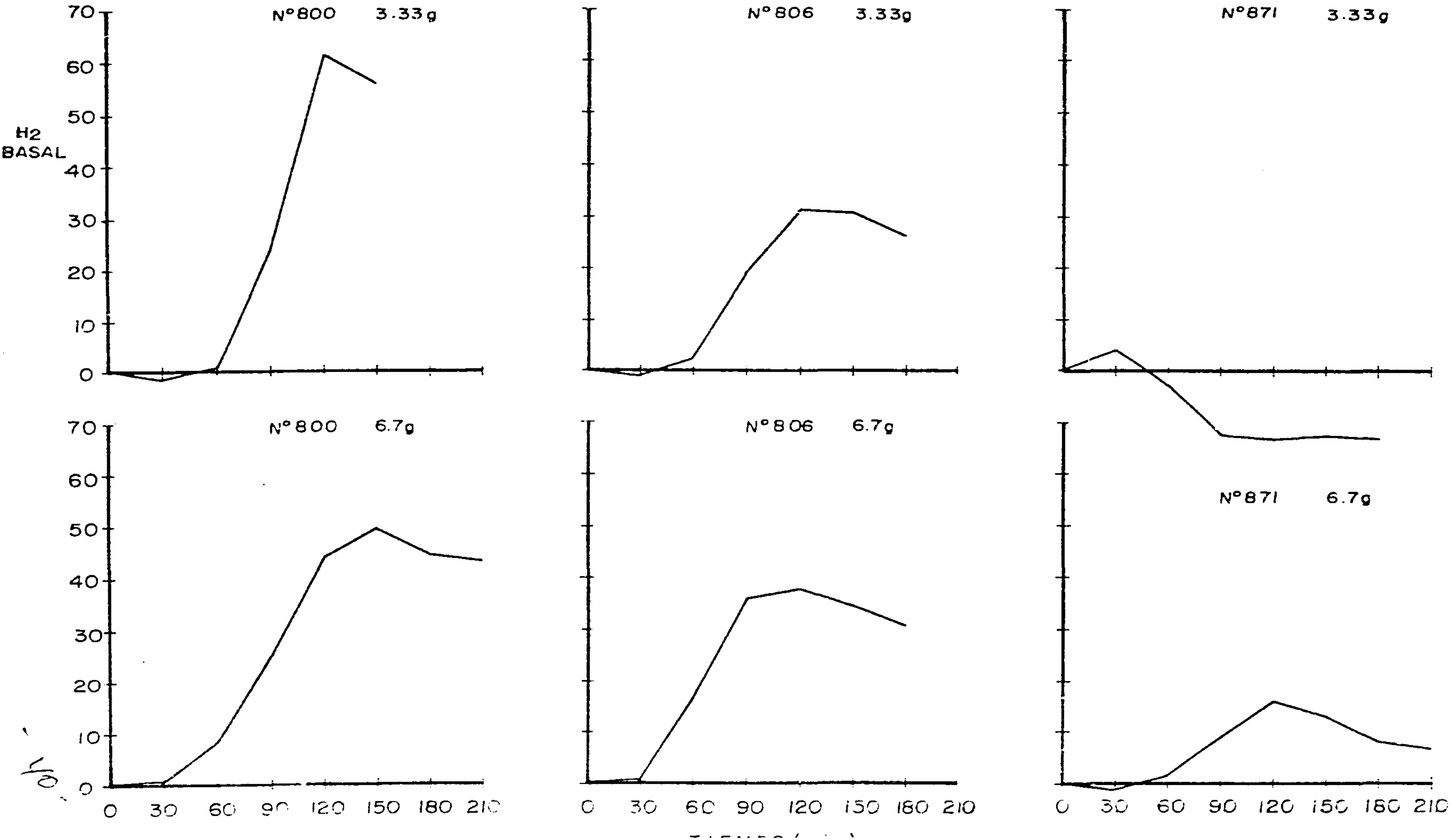
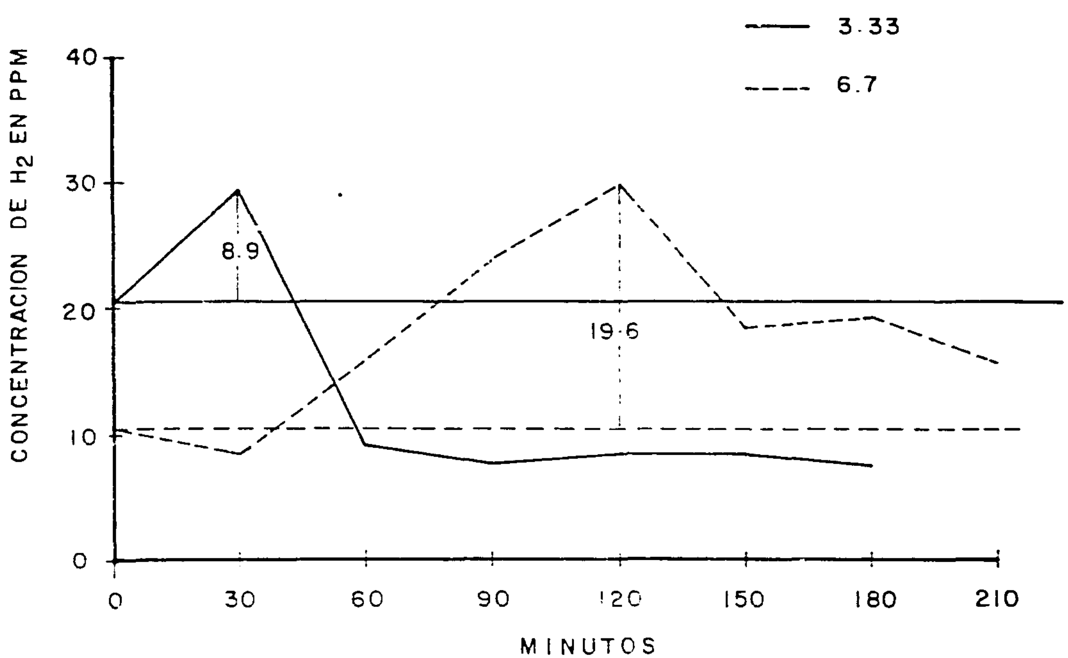


FIGURA N°2

CAMBIOS EN LA CONCENTRACION DE H_2 EN PPM, A INTERVALOS DE 30min. SOBRE 3 1/2 HORAS, CON DOSIS DE 6.7 Y 3.33gr. DE LACTULOSA, EN EL PACIENTE No 871.



EFECTO DE LA DIETA PREVIAMENTE INGERIDA EN EL H_2 ESPIRADO BASAL EN 8 NIÑOS RECUPERADOS.