APPENDIX V-t

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Digestibility and Utilization of the Energy and Protein of Wheat by Infants

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ABSTRACT

The lack of suitable foods for weaned infants is a major nutritional problem in most of the world. The tolerance to and digestibility of wheat as pasta was studied in the diets of nine convalescent malnourished infants ages seven to 18 months, weight 6 to 11 kg. Pasta diets provided 25%, 50% or 75% of energy as wheat. Protein provided 6.6% of energy in 25% wheat (50% casein-50% wheat proteins) and 50% wheat (100% wheat protein). The 75% pasta diet provided 9.8% energy as wheat protein. Balance studies were carried out during the last six days of seven nine-day dietary periods. Appropriate isoenergetic-isonitrogenous casein control periods separated pasta periods. Apparent N retention during consumption of a 50:50 mixture of casein and wheat protein equalled that of casein alone. Apparent N retention during consumption of pasta at 9.8% protein-energy did not differ from casein fed isonitrogenously. Digestibility of wheat at all three levels of intake was excellent. Apparent N absorption did not differ from casein. Analysis of variance showed no effect of consumption of increased amounts of wheat on apparent N absorption or stool wet weight. A linear relation to fecal energy and fecal carbohydrate content was found. Although the latter relationships were highly significant statistically, the incremental loss of energy in the stool at 75% pasta over 50% pasta was less than 3% of total energy intake, a value of minor biological significance. Pasta can reasonably provide a substantial proportion of the energy and protein in the diet of infants and should be valuable as a weaning food in developing countries.

admitted to the Instituto de Investigacion Nutricional for treatment of chronic malnutrition and its acute complications. All were well along in recovery and were remaining in hospital to consolidate recuperation and prevent relapse. Children were infection-free and gaining weight steadily when studied. Serum albumin concentration was >3.6 g/dl and remaining constant while consuming a diet adequate in high quality protein.

Diets: Three diets providing increasing amounts of wheat semolina noodles (82% extraction flour, hard winter Argentine wheat)[4] comprised the study diets (Table 2). To allow accurate nitrogen balance studies, a diet in which noodles provided all of 262 mg N per 100 Kcal was designed. This resulted in pasta providing 50% of energy intake. Two additional diets were prepared in which noodles provided half as much nitrogen and energy (25% pasta) or half again as much protein and energy (75% pasta). In the 25% pasta diet nitrogen intake was completed with casein. In the 75% pasta diet noodles provided all of 393.6 mg N per 100 Kcal. A blend (80:20) of soybean-cottonseed oil was added to all three diets to provide 25% of energy as fat. The remaining energy was supplied by sucrose in the 25% and 50% pasta diets.

Two control diets were designed. One provided 262 mg N per 100 Kcal as casein, the other 394 mg N per 100 Kcal, also as casein. The same oil blend was used to provide 25% of energy. The carbohydrate component was supplied by sucrose and cornstarch in nearly equal amounts. Cornstarch was added to avoid excessive sweetness and to parallel more

closely the carbohydrate in noodles.

Minerals were supplemented to provide intakes of Na and K of 2 and 3 mEq/kg body weight/day, respectively (Table 2). Intakes of trace minerals and vitamins exceeded U.S. Recommended Dietary Allowances (5).

Diets were prepared in blenderized form at a concentration of approximately 0.67 Kcal/ml. Diet analysis was performed regularly throughout the studies for N, Na and K to assure that intakes were as calculated. Total energy content of the diet was also determined regularly by bomb calorimetry (6).

Study Design and Analysis: Each study comprised seven nine-day dietary periods in one of four possible sequences (Table 3). The use of three levels of pasta intake allowed assessment of tolerance to and digestibility of increasing amounts of both the nitrogenous and carbohydrate components of processed wheat. All diets in periods 1 to 5 contained 6.6% of energy as protein (N x 6.25) and allowed accurate nitrogen balance studies comparing casein, a 50-50 blend of casein and wheat proteins and 100% wheat protein. Each pasta period was preceded and followed by a casein control period. Nitrogen balance was also assessed during periods 6 and 7. Although we regard balance studies carried out at these higher N intakes as less accurate, they are the only way to compare with casein the nitrogen utilization from wheat when wheat protein is fed at a level sufficiently high to meet as closely as possible the assumed requirement for lysine of the individual.

All children consumed either 100 or 125 Kcal/kg body weight/day, constant throughout the study, recalculated at the beginning of each

dietary period. Energy intake was based on that previously shown to maintain each child's rate of weight gain in an acceptable range (3-7 g/kg body weight/day). After a three-day period of adaptation to each diet, a six-day metabolic balance was carried out using methods standard for the unit (7). Urine and stool were collected separately in three-day pooled collections. Serum total protein (Biuret) and albumin (acetate gel electrophoresis) concentrations were measured at the beginning of the study and at the end of each successive dietary period.

Urinary and fecal nitrogen were determined by the micro-Kjeldahl method (8). Feces were weighed both wet and dry. Fecal fat was determined by the method of Van de Kamer et al (9). Total fecal energy content was measured by bomb calorimetry (6) and the carbohydrate content of the stool was then computed using the formula:

$$\text{Fecal CHO}_g = \frac{E - (N_g \times 6.25 \times 5.65 + \text{Fat}_g \times 9.4)}{4.15}$$

where CHO = carbohydrate in grams, E = fecal energy by bomb calorimetry, N = fecal nitrogen, fat = fecal fat, and 5.65, 9.4 and 4.15 are the accepted energy conversion factors for protein, fat and carbohydrate, respectively (10).

Apparent nitrogen absorption and retentions were calculated. Nitrogen retentions while consuming pasta were compared with those while consuming pasta + casein or casein by paired "t" test (11). Apparent absorptions, stool weights, fecal fats and computed fecal carbohydrate were first analyzed by a "t" test to ascertain if the value while consuming pasta minus either surrounding control value

(or the average of the corresponding control values) differed significantly from zero. Further analysis was then carried out by analysis of variance blocking on subjects and treatments with orthogonal contracts among the treatment means (12). Least squares linear regression analysis was used to correlate stool wet and dry weight with fecal energy content, fecal fat and computed fecal carbohydrate for both the pasta and control diets. Parameters of digestibility for both diets were further compared with analysis of covariance (11). P values of less than 0.05 were accepted as significant.

RESULTS

Apparent nitrogen retention from diets in which casein and wheat provided equal amounts of nitrogen did not differ from the casein control (Table 4). When wheat protein provided all of 6.6% of energy, nitrogen retention was, as expected, significantly less than while consuming casein (pasta: 20.4±5.8%, preceding control: 37.6±6.8%, $P<0.001$). Nitrogen retention during the control period following these pasta periods (42.4±5.5%) was elevated relative to the pasta period ($P<0.001$) and to the preceding casein period, although the latter difference did not attain statistical significance ($0.10>P>0.05$). When casein and pasta were compared using diets in which 9.8% of energy was supplied by protein, apparent nitrogen retention from pasta appeared to be somewhat less than that from casein but the difference was not significant. When values for individual children were scrutinized, the wheat diet was clearly inferior in five cases, virtually the same in three cases and superior in only one case.

There were no consistent diet related changes in serum albumin concentration during any of the seven periods.

Digestibility data and their statistical analysis are summarized in Tables 5, 6 and 7. Paired "t" (two tailed) analysis of treatment values versus the mean of control values at 25% and 50% pasta and against the single control value at 75% pasta showed some differences of statistical significance between the pasta and control diets among the six parameters used to measure digestibility. These were in general minor and of questionable biological significance at 25% and 50% pasta. All parameters except apparent nitrogen absorption and fecal fat were elevated during the 75% pasta period relative to control. This was most striking in the cases of stool energy (control 47.5±12.7 Kcal/day, 75% pasta 72.5±18.6 Kcal/day, $P<0.02$) and computed fecal carbohydrate (control 2.4±1.5 g/d, 75% pasta 7.4±2.3 g/d, $P<0.001$). Fecal fat during the 75% pasta period was significantly less than control (5.7±4.1% of intake versus 9.5±3.4% of intake, $P<0.05$).

Analysis of variance of these data was carried out in four ways: using absolute treatment values, using the treatment value minus preceding control value, the treatment value minus the following control value, and the treatment value minus the average of the two control values. The last analyses are shown in Table 6 and did not differ substantively from the other three, except in the case in which treatment values were analyzed without regard to control. There were no significant differences among subjects in any of the parameters examined. Consumption of increasing amounts of pasta had no effect on

apparent nitrogen absorption or stool wet weight. In contrast, fecal dry weight, fecal energy content and computed fecal carbohydrate showed highly significant linear increases across the three levels of pasta consumption (Table 6). Fecal fat excretion also showed a linear effect (decrease) of increasing pasta consumption ($P<0.05$) but inspection of the data raises questions about the biological significance of this finding.

Linear regression analysis of digestibility data during all three periods of pasta consumption (Table 7) showed a highly significant ($P<0.001$) relationship between stool wet and dry weights. Both in turn were correlated with fecal energy content and computed fecal carbohydrate ($P<0.001$ in all cases). There was no relationship during consumption of these diets between stool weight (wet or dry) or fecal energy content and fecal fat. Regression analysis of corresponding data from all five control dietary periods was similar in all respects. Analysis of covariance was carried out to determine if the regression lines derived from pasta data differed from those derived from the casein control data. Only the regression of stool dry weight on stool wet weight differed between the two diets ($P<0.01$).

DISCUSSION

These studies show that a substantial part of the daily requirement for both protein and energy in the diets of infants and children can be supplied by pasta in various forms. Although the pasta in these studies was blenderized to facilitate more accurate balance studies, the amounts consumed were not unreasonably large and most likely would

not have been excessively bulky so as to prohibit their consumption in an unaltered form. This is in clear contrast, for example, to rice, where bulk may limit consumption (13).

Pasta is frequently thought of as a source primarily of carbohydrate. The noodles used in these studies provided nearly 13% of energy as protein. Although nitrogen balance at 6.6% protein-energy was expectedly inferior to casein, the diet providing 50% of protein from pasta appeared fully adequate for growing infants during these short-term studies. When the intake of wheat protein was increased to 9.8% of energy, the absolute amount of lysine taken in by each child increased to a level that should have been adequate or nearly adequate to meet the lysine requirement (14). Despite the imbalance of essential amino acids that remained, nitrogen retention improved substantially when compared to casein consumed at the same level of intake. For four of the children this appeared to be adequate, at least in the short-term.

Previous studies of plasma free amino acids have demonstrated that when the intake of soy protein is increased to provide adequate amounts of methionine (in absolute terms) the characteristic postprandial change of the methionine molar ratio seen in methionine deficiency is obliterated (15). We are not aware of parallel data for wheat and lysine but it is likely that a similar change occurred here when wheat protein intake was increased. Whether long-term consumption of an imbalanced protein at this level would support growth to our knowledge has not been studied in the human. There are areas of India, Pakistan and Bangladesh where wheat is the staple and provides

75-80% of both energy and protein (1). Long-term studies are underway to see if a combination of 80% wheat protein and 20% animal protein consumed at 8% protein-energy is adequate. Preliminary data suggest that this is the case.

The assessment of overall digestibility was based on several assumptions: 1) that casein is nearly 100% digested and absorbed or, at a minimum, that digestion and absorption of casein was relatively constant for each child during the 63-day study; 2) that the sucrose in the diet was fully absorbed; and 3) that the efficiency of fat absorption would be constant for each child throughout. Granting the above to be valid, changes in stool parameters reflecting digestibility could be directly related to the amount of pasta in the diet.

Digestibility of both the nitrogen and carbohydrate components of pasta was excellent. The former relates most likely to the fact that virtually all protein in wheat is soluble matrix protein. This is distinct from most cereal grains in which protein is present as both matrix protein and protein bodies (16). Protein bodies have been shown to be quite resistant to digestion, at least in the case of rice (17). Digestibility of the starch component of pasta appeared to be virtually complete at 25% and 50% pasta. At 75% pasta, an increased loss of carbohydrate in the stool occurred. Even at these intakes, however, the incremental loss was on the average less than 3% of total energy intake, a figure of probably minor biological significance.

Both stool wet weight and dry weight correlated to a high degree with stool energy content. Only the regression of stool wet weight on stool dry weight showed a significant difference between the pasta

and control diets. Strong linear correlations of the same parameters were found in previous studies of the digestibility of rice (13). Plots of the regression lines suggest, however, that they may be closely related to the diet being consumed. Because stool dry weight is independent of the molecular form of the solid material in the stool (and consequently of its osmotic effect) it may prove in the long run to be a better diet-independent proxy for total fecal energy content.

Although the studies reported here were not carried out in very young infants, the "biological age" of the children studied and their high energy and protein requirements associated with catch-up growth allow some generalization of the results to infants of weaning age. Based on our data the inclusion of substantial amounts of pasta in the diets of these infants would seem to be reasonable. Excellent tolerance to and digestibility of pasta can be expected. Stool wet weight can be used as a reasonable guide to digestibility by an individual infant. Studies currently underway using diets providing 50% to 75% of energy as pasta in the acute management of malnutrition will provide information as to whether similar quantities can safely be consumed by children with more impaired digestive function.

FOOTNOTES

1 This study was supported by Research Grant AM-HD-10111-02 from the National Institutes of Health, U.S.P.H.S. and by Research Contract AID/Ta-C-1286 with the Agency for International Development, United States Department of State.

2 Address reprint requests to Dr. William C. MacLean, Jr., 615 North Wolfe Street, Baltimore, Maryland 21205.

3 The protocol for this study was approved by the Joint Committee on Clinical Investigation of the School of Medicine, the Johns Hopkins University. All children were admitted and participated in the studies with the informed consent of their parents.

4 Nicolini Cia, Lima, Peru.

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Table 1

Characteristics of subjects participating in these studies

Subject No.	Age Mos.	Wt. kg	Length cm	Serum Albumin Concentration g/dl Initial	Final
507	14	7.50	69.0	3.6	3.9
517	17	11.38	77.0	3.8	3.8
519	14	7.31	69.5	3.8	3.9
521	15	7.50	70.2	4.1	3.8
528	12	7.08	67.5	3.6	3.6
534	11	6.39	66.0	4.1	3.8
541	7	6.62	64.3	3.8	3.7
543	18	6.22	67.2	3.6	3.9
546	18	6.07	61.5	3.8	3.8

Table 2

Composition of study and control diets (per 100 Kcal)[1,2]

	DIET				
	25% Pasta	50% Pasta	Control[1] (25%P-50%P)	75% Pasta	Control (75%P)
Noodles - g	7.17	14.35	--	21.53	--
N - mg	131.2	262.4	--	393.6	--
Energy - Kcal	25	50	--	75	--
Ca Caseinate[3] - g	0.93	--	1.86	--	2.80
N - mg	131.2	--	262.4	--	393.6
Energy - Kcal	3.4	--	6.9	--	10.4
Sucrose - g	11.6	6.25	9.0	--	8.0
Energy - Kcal	46.4	25.0	36.0	--	32.0
Corn Starch - g	--	--	9.1	--	9.1
Energy - Kcal	--	--	32.6	--	32.6
Soybean-Cottonseed Oil - g	2.8	2.8	2.8	2.8	2.8
Energy - Kcal	25	25	25	25	25
Totals					
N - mg	262.4	262.4	262.4	393.6	393.6
Protein (Nx6.25) - % Energy	6.4	6.4	6.4	9.8	9.8
Energy - Kcal	100	100	100	100	100

1 Minerals were supplemented in all diets to provide intakes of 2 mEq Na and 3 mEq K/kg body weight/day. This was accomplished using a mineral mixture of the following composition (W/W): NaCl, 17.300%; $MgSO_4$, 12.850%; $CaHPO_4$, 23.450%; $KHCO_3$, 41.000%; KCl, 2.650%; Ferric citrate, 2.000%; $CuSO_4 \cdot 5H_2O$, 0.352%; $ZnSO_4 \cdot 7H_2O$, 0.200%; $MnSO_4 \cdot H_2O$, 0.156%; KI, 0.014%; NaF, 0.028%. The mineral mixture was prepared and assayed by Pfizer Pharmaceuticals, Pfizer Incorporated, Eastern Point Road, Groton, Connecticut 06340.

2 Vitamins were supplemented by a single daily dose of 0.6-1.2 ml of Polyvisol, Mead Johnson, Evansville, Indiana 47721. The composition (per ml) of this preparation is as follows: retinyl palmitate, 1,500 I.U.; ergocalciferol, 400 I.U.; Vitamin E, 5 I.U.; Ascorbic acid, 35 mg; thiamin, 0.5 mg; riboflavin, 0.6 mg; Niacin, 8 mg; Vitamin B_6, 0.4 mg; Vitamin B_{12}, 2 μg.

3 Casec, Mead Johnson, Evansville, Indiana 47721. 1.88 g Casec were used to provide 1.6 g Casein.

Table 3

Sequence of dietary periods[1]

1	2	3	4	5	6	7
$Control_1$	25%P	$Control_1$	50%P	$Control_1$	75%P	$Control_2$
$Control_1$	25%P	$Control_1$	50%P	$Control_1$	$Control_2$	75%P
[2]$Control_1$	50%P	$Control_1$	25%P	$Control_1$	75%P	$Control_2$
$Control_1$	50%P	$Control_1$	25%P	$Control_1$	$Control_2$	75%P

[1] Composition of pasta and control diets is shown in Table 1.

[2] This sequence was used three times, all others twice.

Table 4

Summary of data on apparent nitrogen retention[1]

APPARENT N RETENTION - % OF INTAKE							
6.6% Protein Energy			6.6% Protein Energy			9.8% Protein Energy	
$Control_1$	Noodles + Casein	$Control_1$	$Control_1$	Noodles	$Control_1$	$Control_2$	Noodles
39.6	39.2	42.1	37.6	20.4[2]	42.4	37.9	33.3
± 8.1	± 9.9	± 5.9	± 6.8	± 5.8	± 5.5	± 7.1	± 6.1

1 $Control_1$ and $Control_2$ refer to diets outlined in Table 2. Data were analyzed statistically comparing each study dietary period with its preceding and following control period.

2 Differs from both corresponding casein control periods, $P<0.001$. Casein control periods did not differ significantly, $0.1>P>0.05$.

Table 5

Summary of digestibility data at three levels of pasta intake

	25% Studies			50% Studies			75% Studies	
	Control$_1$	Pasta 25%	Control$_1$	Control$_1$	Pasta 50%	Control$_1$	Control$_2$	Pasta 75%
Apparent N Absorption - %	86.8 ± 2.3	85.8 ± 2.3	86.3 ± 3.2	84.8 ± 3.5	81.4[b] ± 3.0	85.5 ± 3.1	88.6 ± 4.5	84.7 ± 3.5
Stool Wet Weight - g/d	68.0[c] ±29.0	64.0[a] ±33.0	89.0 ±39.0	73.0 ±28.0	95.0 ±33.0	78.0 ±37.0	88.0 ±59.0	124.0[f] ±43.0
Stool Dry Wet - g/d	10.0[d] ± 2.2	9.9 ± 3.1	11.7 ± 2.8	10.8 ± 2.6	13.3[b] ± 2.5	10.4 ± 2.5	11.6 ± 2.7	17.0[f] ± 4.0
Stool Energy Kcal/d	43.8 ± 9.6	42.9 ±10.7	50.4 ±12.6	47.8 ±11.8	59.6 ±13.1	46.3 ±15.3	47.5 ±12.7	72.5[f] ±18.6
Stool Fat % Intake	7.5 ± 2.0	6.7 ± 1.9	6.8 ± 2.0	7.7 ± 2.0	7.1 ± 2.7	6.7 ± 2.0	9.5 ± 3.4	5.7[e] ± 4.1
Stool CHO g/d	3.0[c] ± 1.3	2.4[a] ± 2.4	4.2 ± 2.3	3.6 ± 2.6	4.2 ± 2.6	2.8 ± 1.4	2.4 ± 1.5	7.4[g] ± 2.3

[a] Significantly different from mean of corresponding casein periods, 2 tailed paired "t" test, $P<0.05$.

[b] Significantly different from mean of corresponding casein periods, 2 tailed paired "t" test, $P<0.02$.

[c] Differs from corresponding post-pasta control period, 2 tailed paired "t" test, $P<0.05$.

[d] Differs from corresponding post-pasta control period, 2 tailed paired "t" test, $P<0.02$.

[e] Significantly different from the single corresponding control period at 75% pasta consumption, 2 tailed paired "t", $P<0.05$.

[f] Significantly different from the single corresponding control period at 75% pasta consumption, 2 tailed paired "t", $P<0.02$.

[g] Significantly different from the single corresponding control period at 75% pasta consumption, 2 tailed paired "t", $P<0.001$.

Table 6

Analysis of variance of digestibility data[1]

		Nitrogen Absorption			
	df	SSQRS	MS	F	P
Treatment	2	59.24	29.62	1.28	NS
linear	1	46.72	46.72	2.02	NS
quadratic	1	12.52	12.52	0.54	NS
Subjects	8	146.37	18.30	0.79	NS
Error	16	370.84	23.18		
TOTAL	26	576.45			

		Stool Wet Weight			
	df	SSQRS	MS	F	P
Treatment	2	12147.69	6073.84	2.38	NS
linear	1	11628.12	11628.12	4.56	.05
quadratic	1	519.56	519.56	0.20	NS
Subjects	8	20624.74	2578.09	1.01	NS
Error	16	40785.15	2549.07		
TOTAL	26	73557.57			

		Stool Dry Weight			
	df	SSQRS	MS	F	P
Treatment	2	184.48	92.24	7.99	.01
linear	1	183.04	183.04	15.85	.01
quadratic	1	1.43	1.43	0.12	NS
Subjects	8	139.23	17.40	1.51	NS
Error	16	184.75	11.55		
TOTAL	26	508.46			

		Fecal Energy			
	df	SSQRS	MS	F	P
Treatment	2	3871.83	1935.91	7.53	.01
linear	1	3845.64	3845.64	14.96	.01
quadratic	1	26.18	26.18	0.10	NS
Subjects	8	3052.08	381.51	1.48	NS
Error	16	4114.06	257.13		
TOTAL	26	11037.97			

Table 6 (Cont'd)

	df	SSQRS	Fecal Fat MS	F	P
Treatment	2	79.67	39.83	4.95	.05
linear	1	52.36	52.36	6.51	.05
quadratic	1	27.31	27.31	3.40	NS
Subjects	8	97.78	12.22	1.52	NS
Error	16	128.67	8.04		
TOTAL	26	306.11			

	df	SSQRS	Computed Fecal Carbohydrate MS	F	P
Treatment	2	3093.48	1546.74	17.55	.001
linear	1	3004.41	3004.41	33.90	.001
quadratic	1	89.06	89.06	1.00	NS
Subjects	8	964.69	120.59	1.36	NS
Error	16	1417.94	88.62		
TOTAL	26	5476.11			

Analyses presented are those for the treatment value minus the average value for the surrounding control periods at 25% and 50% pasta. Each 75% pasta period had only one corresponding control period. Similar analysis using the treatment value minus either the preceding or following control period value at 25%, 50% and 75% pasta yielded no substantive differences.

Table 7

Linear regression analysis and analysis of covariance of parameters of digestibility of the pasta and the casein control diets[1]

	Regression Equation	r	P
Stool Wet Weight (Y)			
Stool Dry Weight (X)			
Pasta	y = 9.06x - 27.04	0.906	<0.001
Casein	y = 12.85x - 60.56	0.832	<0.001
Pasta vs. Casein			<0.01[2]
Fecal Energy (X)			
Pasta	y = 1.96x - 19.75	0.842	<0.001
Casein	y = 1.88x - 9.43	0.589	<0.001
Pasta vs. Casein			NS
Fecal Fat (X)			
Pasta	--	0.068	NS
Casein	--	-0.245	NS
Pasta vs. Casein			--
Computed Fecal Carbohydrate (X)			
Pasta	y = 11.62x + 40.53	0.852	<0.001
Casein	y = 2.12x + 51.20	0.435	<0.003
Pasta vs. Casein			NS
Stool Dry Weight (Y)			
Fecal Energy (X)			
Pasta	y = 0.22x + 0.69	0.938	<0.001
Casein	y = 0.16x + 3.17	0.792	<0.001
Pasta vs. Casein			NS
Fecal Fat (X)			
Pasta	--	0.167	NS
Casein	--	-0.193	NS
Pasta vs. Casein			NS
Computed Fecal Carbohydrate (X)			
Pasta	y = 1.16x + 8.04	0.848	<0.001
Casein	y = 0.22x + 8.04	0.683	<0.001
Pasta vs. Casein			NS

Table 7 (Cont'd)

	Regression Equation	r	P
Fecal Energy (Y)			
Fecal Fat (X)			
Pasta	--	0.305	NS
Casein	--	0.056	NS
Pasta vs. Casein			--
Computed Fecal Carbohydrate (X)			
Pasta	y = 5.22x + 34.12	0.888	<0.001
Casein	y = 1.08x + 32.82	0.709	<0.001
Pasta vs. Casein			NS

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1 Analysis of data from all dietary periods included: pasta n = 27, casein control n = 45.

2 The slopes of these two lines differed significantly.