UTILIZATION OF AMINO ACIDS FROM FOODS BY THE RAT [1]

II. LYSINE

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Use of the protein-depleted adult male rat as a test animal for studying the quantitative utilization of lysine and the techniques necessary to carry out such experiments have been described in the previous paper (Schweigert and Guthneck, '53). Through application of the methods studied, it was possible to determine the per cent utilization of lysine by the rat from several test products. Among those tested were purified proteins, animal protein products, cereal foods and legumes. The results of these studies are reported in the present paper.

EXPERIMENTAL AND RESULTS

The fresh, cooked and processed meats employed were lyophilized, and the fat removed by ether extraction. The purified proteins, cereal and legume products were used as received. All test products were ground in a hammer mill and incorporated into the rations in a dried form to provide

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known amounts of lysine (150 to 350 mg/100 gm of ration) as determined microbiologically using the test organism *Leuconostoc mesenteroides* P-60. The techniques used in the animal experiments, preparation of the basal rations, and so forth, were the same as those outlined in the accompanying paper.

As a further test of the utilization of lysine from foods, based on the rates of gain for groups fed purified supplements, the amount of lysine excreted in the feces of certain groups was determined. A composite collection of the feces was made for each group once a day for a 4-day period in 150 ml of 3 N HCl. After the last collection, each composite was autoclaved for 16 hours at 15 lb. pressure, cooled, neutralized and diluted to the proper proportion for determination of lysine microbiologically using *Leuconostoc mesenteroides* P-60 as the test organism.

The excretion data for the groups fed graded levels of L-lysine and several of the test products with the sesame meal basal ration appear in table 1. Only one set of data was obtained with the amino acid basal ration, and not all the lysine-supplemented groups were included in the collection. The amount of lysine excreted by the groups receiving no lysine supplement was subtracted from the amount of lysine excreted by all other groups, receiving lysine either in the purified form or as present in a test product. The fecal samples for each group were collected from the 5th through the 9th days, during which period the rates of gain and food consumption data were also obtained. From this information the per cent lysine excreted was calculated, based on the ratio between the milligrams of lysine excreted, minus those for the control, and the milligrams of lysine ingested.

Certain limitations of this method of calculating the percentage of lysine excreted in the feces and attributable to ingestion of the test supplement are recognized. With the sesame meal ration a known, but varying, amount of lysine is contributed to the diet by the sesame meal. The effect of additional lysine on the "basal excretion" of lysine that

should be attributed to the sesame meal ingested cannot be ascertained. It will be noted that an increased excretion of lysine occurred when the L-lysine supplements as well as the test products were fed. The figures presented for the lysine excreted, therefore, are based on a combination of the lysine contributed by the sesame meal consumed, over and above

TABLE 1

Fecal excretion of lysine by rats fed lysine supplements and test products with the amino acid and sesame meal basal rations

SUPPLEMENT PER 100 GM RATION	AMOUNT	AMINO ACID RATION			SESAME MEAL RATION		
		Lysine excreted/rat	Lysine ingested/rat	Lysine excreted	Lysine excreted/rat	Lysine ingested/rat	Lysine excreted
	gm/100 gm ration	*mg*	*mg*	*%*	*mg*	*mg*	*%*
No supplement		14			64	89	
					66	111	
100 mg L-lysine					85 [1]	155	13.6
					90	218	11.1
150 mg L-lysine					96	257	12.3
					102	278	12.8
225 mg L-lysine					111	328	14.4
					107	319	12.9
300 mg L-lysine		22 [2]	363	2.2	89	371	6.6
					111	434	10.3
Rolled oats	15.1				94	236	12.7
					110	274	15.9
Split peas	8.2	70	263	21.5	102	241	15.7
					110	260	17.1
Soybean oil meal	4.5	43	242	12.2	93	216	13.4
Pork luncheon meat	2.3				82	257	7.0
					88	254	8.7
Beef round	1.9	20	152	4.3	88	256	8.7
Beef rib (cooked)	1.7				79	244	6.1
					96	273	11.0

[1] Supplement equivalent to 75 mg L-lysine per 100 gm ration.
[2] Supplement equivalent to 450 mg L-lysine per 100 gm ration.

that ingested by the control group, and on that contributed by the test supplement. Since the total lysine ingested when the test products were fed varied within narrow limits (216 to 274 mg per rat), the relative values presented are assumed to be valid. This conclusion is further attested to by the similarity in the values observed when the amino acid ration (devoid of added lysine) was fed.

The excretion data (tables 1 and 2) indicate a higher percentage of lysine excreted by animals fed the cereal-type foods (21.5, 15.7 and 17.1% for split peas and 12.7 and 15.9%

TABLE 2

Per cent lysine utilized for gain, the amount excreted in the feces and the total accounted for when various test products were fed

PRODUCT	PROTEIN IN DRIED SAMPLE	LYSINE IN DRIED SAMPLE [1]	UTILIZATION [2]	LYSINE EXCRETED	TOTAL ACCOUNTED FOR
	%	%	%	%	%
Casein	91.2	7.7	76 ± 8 (2)	7.6	84
Lactalbumin	73.8	9.3	60 ± 5 (1)		
Skim milk (dried)	33.1	3.1	83 ± 5 (2)	13.1	96
Whole eggs (dried)	47.8	3.7	98 ± 15 (1)	11.2	109
Wheat germ	34.6	2.1	65 ± 8 (2)	14.0	79
Rolled oats	16.8	0.86	77 ± 9 (2)	14.3	91
Split peas	22.9	1.9	81 ± 6 (3)	16.4	97
Soybean oil meal	51.5	3.2	76 ± 8 (2)	12.8	89
Soybean grits	51.9	3.5	80 ± 7 (2)	16.4	96
Soybean flakes [3]	48.9	3.7	49 ± 8 (1)	19.1	68
Pork and beef (canned)	66.3	7.2	71 ± 9 (2)	11.7	83
Pork luncheon meat	55.7	6.3	69 ± 7 (2)	7.8	77
Pork ham	89.3	8.8	82 ± 7 (2)	11.2	93
Pork ham (cooked)	92.2	8.9	73 ± 9 (2)	9.7	83
Beef round	88.1	7.8	87 ± 4 (3)	6.5	93
Beef rib	89.9	8.6	88 ± 9 (2)	14.9	103
Beef rib (cooked)	90.1	8.7	68 ± 6 (2)	8.5	76
Lamb leg	87.5	8.2	80 ± 5 (1)	11.6	92
Lamb leg (cooked)	89.5	9.1	96 ± 8 (1)	9.0	105

[1] Percentages of lysine in the dried sample represented at least 7 analyses. The protein analyses were made by the Service Laboratory, American Meat Institute Foundation.

[2] Unheated, solvent-extracted.

[3] Mean and standard error. The number of tests conducted with each product is indicated in parentheses.

for rolled oats) than by those fed meat products. Kuiken and Lyman ('48) also observed that small amounts of lysine ingested as part of roast beef were excreted in the feces by young, growing rats. A good correlation was obtained between the excretions for the same test product with the amino acid and sesame meal basal rations (i.e., rats fed soybean oil meal excreted 12.2 and 13.4%, respectively).

The total per cent of lysine that can be accounted for from the test products (derived from the average amount utilized for gain and the average amount excreted) is presented in table 2. The per cent utilization ranged from 49 to 98 for the different foods, and the total accounted for ranged from 68 to 109%. It is also of interest to note that there was greater utilization of lysine by the rat, as was found to be true of tryptophan for chick growth (Schweigert, '48), from casein and processed soybean meal than from unheated soybean flakes. Of the products tested, the unheated soybean flakes gave the lowest lysine utilization (49%) and highest excretion (19%). However, the amount of lysine utilized was much higher than that observed for tryptophan with the chick (20%).

The utilization of lysine from uncooked meats, dried eggs and skim milk ranged from 80 to 98%, while that from the purified proteins and cereal foods ranged from 60 to 82%. The cooked and processed meats showed a per cent utilization of from 68 to 96. A tendency for lower utilization was indicated from the cooked and processed cuts as compared to the uncooked meats, without a greater percentage of lysine being excreted. The lysine content of lamb leg appeared to be more readily utilized by the animal after cooking (96%) as compared to before cooking (80%). However, these results were not consistent enough to make it possible to detect small differences in utilization due to processing (see also accompanying paper).

SUMMARY

The per cent lysine utilized by the protein-depleted rat from purified proteins, animal protein products, cereal and

legume foods was determined. On an over-all basis, the results indicate a greater utilization of lysine from dried eggs and skim milk (91%) and from fresh meats (84%) than from cereal and legume foods (71%) and cooked or processed meats (70%). The fecal excretion of lysine was determined, and the results showed that a greater amount of lysine was excreted in the feces of animals fed the cereal foods and unheated soybean flakes than of those fed other test products.

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