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Biological evaluation of crab meat (*Scylla-Serrata*) in the rat

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1. The meat of the Indian species of crab was assessed for the quality of its protein with the use of protein-depleted adult rats.
2. The crab meat and casein had the same biological value, 88.
3. Crab meat supported a higher growth rate than casein in rats.

Shell-fish are of some significance in the human diet. Because of their high content of protein, low content of fat and high proportion of polyunsaturated fatty acids, they are commonly recommended in diets designed to treat atherosclerotic patients. However, little work on their nutritional value has been reported.

Assessments of the biological value of different crab-meat preparations indicate that there is variation in the quality of protein, and it has been claimed that crab-meat proteins are as effective as beef protein and superior to casein in promoting growth of rats (Suzuki, Okuda, Okimato & Nagasawa, 1919; Watson & Fellers, 1935; Lanham, Lee & Nilson, 1940; Sure & Easterling, 1952).

The work now presented was conducted to assess the protein quality of meat of a commercially important species of crab (*Scylla-Serrata*).

EXPERIMENTAL

Adult male albino rats (inbred original Wistar strain) weighing between 130 and 140 g were housed in individual suspended metabolic cages. For the 1st week the rats were fed on bread, vegetables and milk to accustom them to the feeding technique. Feeding was allowed only during the night (12 h). Water was given *ad lib.*

After the initial adaptation period, the rats were given a protein-free diet (Table 1) for 1 week, during which they consumed on average 6–7 g diet daily and lost 16–18 g in weight. Urine and faeces were collected from each rat daily as described by Chick & Roscoe (1930), and the nitrogen was determined for the 6-day period by the Kjeldahl method. Only those rats that showed similar weight losses were selected for N balance studies and these were separated into groups of four rats each. One of the groups was given a diet containing casein and the other group a diet containing crab meat as the only protein source. Water was supplied *ad lib.* A record of the food consumption and body-weight of each rat was kept. The urine and faeces of each rat were collected each day as before, for a period of 6 days.

From the gain in weight and the amount of N ingested and excreted, the different

indices of protein quality were calculated using the following definitions (Mitchell, 1923–4; Osborne, Mendel & Ferry, 1919; Sure & Easterling, 1952):

$$\text{biological value (BV)} = \frac{100 \times \text{N retained}}{\text{N absorbed}},$$

$$\text{true digestibility (TD)} = \frac{100 \times \text{N absorbed}}{\text{N intake}},$$

$$\text{protein efficiency ratio (PER)} = \frac{\text{gain in weight}}{\text{protein intake}},$$

$$\text{net utilization} = \frac{\text{true coefficient of digestibility} \times \text{BV}}{100},$$

$$\text{net protein value} = \% \text{ of crude protein} \times \frac{\text{digestibility coefficient}}{100} \times \frac{\text{BV}}{100}.$$

Table 1. *Expt* 1. *Composition* (*g*/100 *g*) *of protein-free diet, casein diet and crab-meat diet used in studies with protein-depleted rats*

Ingredient	Protein-free diet	Casein diet	Crab-meat diet
Casein	—	12·5 (10 g protein)	—
Crab meat (dried and powdered)	—	—	12·1 (10 g protein)
Sugar	31·2	31·2	31·2
Salt mixture*	4·0	4·0	4·0
Fat	5·0	5·0	5·0
Starch	59·8	47·3	47·3
Total	100	100	100

60 mg of vitamin mixture (Schultze, 1950) were supplied to each rat before giving the respective diets. 1200 i.u. vitamin A and 200 i.u. vitamin D daily were supplied to each rat in the diet.

* For composition see Hegsted, Mills, Elvehjem & Hart (1941).

Table 2. *Expt* 1. *Composition* (*g*/100 *g*) *of the diets supplemented with casein, crab meat or prawn meat*

Ingredient	Casein diet	Crab-meat diet	Prawn-meat diet
Casein	12·5 (10 g protein)	—	—
Crab meat*	—	50·0 (10 g protein)	—
Prawn meat*	—	—	42·0 (10 g protein)
Sugar	31·6	31·6	31·6
Salt mixture (Hegsted *et al.* 1941)	4	4	4
Fat (Dalda)	10	10	10
Starch	42·9	4·4	12·4
Total	100	100	100

* Freshly cooked homogenized crab meat and prawn meat were sealed in 6 oz cans and frozen. The required calculated amount was daily removed from the cans and used. 1200 i.u. vitamin A and 200 i.u. vitamin D daily were supplied to each rat in the diet.

In the second experiment, nine triads of litter-mate weanling male albino rats (inbred original Wistar strain), weighing about 35 g, were individually housed in screen-bottomed cages. The rats were divided into three groups of nine rats each, such that each group contained one rat from each of the triads and all the groups had equal average total weight. The three groups were given a 10% protein diet containing either casein, crab meat or prawn meat as the only source of protein (Table 2). Each rat was given daily 60 mg vitamin mixture (Schultze, 1950) in a small quantity of water before feeding. Diets and water were supplied *ad lib.* for a period of 3 months. Records were kept of the amount of food consumed daily and the weight gained each week.

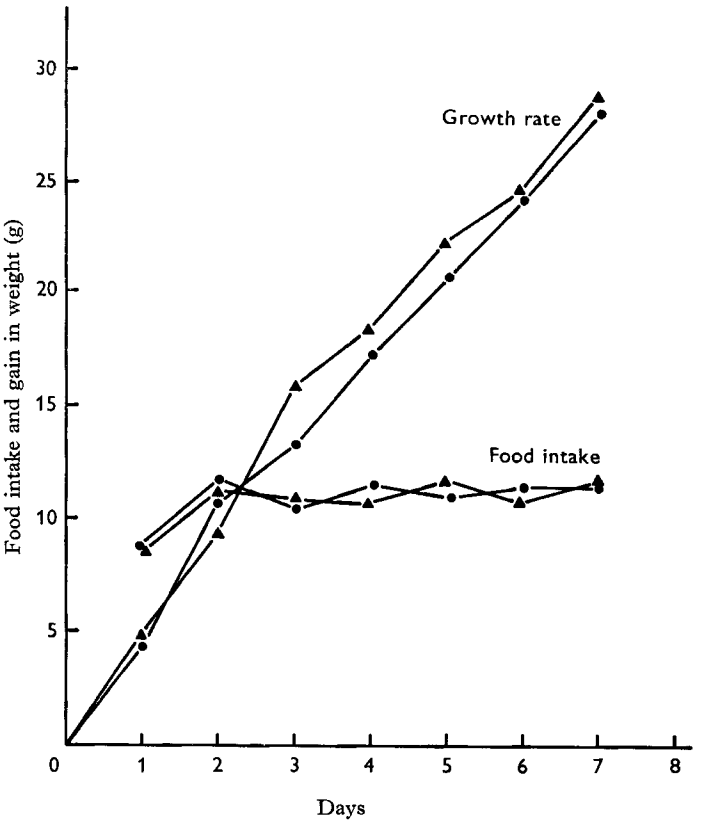

Fig. 1. Expt 1. Effect of feeding casein and crab meat on the growth rate of protein-depleted rats. ▲, crab meat; ●, casein.

RESULTS

Expt 1. The values for BV, TD, PER and net protein value of crab meat and casein are given in Table 3. Casein and crab meat were found to have similar biological values. The rate of gain in body-weight by the protein-depleted rats on the respective diets and the amounts of diets consumed have been represented graphically in Fig. 1.

Expt 2. Fig. 2 shows the growth rate of weanling rats on the respective diets. It can

be observed that after a period of 10–12 days the growth rate on the casein diet fell much below that on the shell-fish diets.

Table 4 shows that crab-meat protein and casein have different sequences of limiting amino acids for growth of the rats on a diet containing 10% protein.

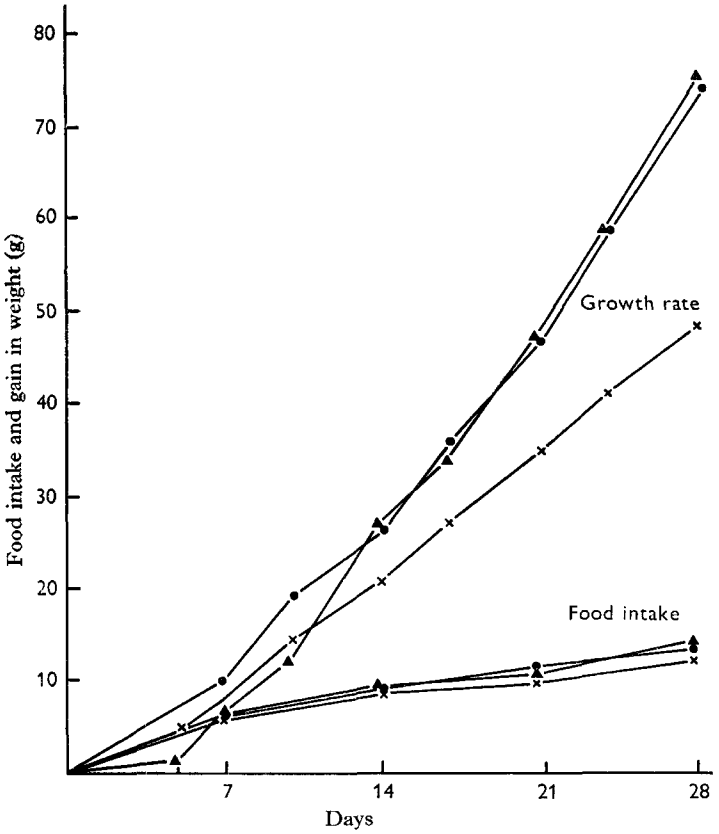

Fig. 2. Expt 2. Effect of feeding casein, crab meat and prawn meat on the growth rate of rats. ▲, crab meat; ×, casein; ●, prawn meat.

Table 3. *Expt* 1. *Comparison of utilization of crab meat and casein fed to four protein-depleted rats for* 6 *days*

(Mean values with their standard errors)

Index of nutritional status	Crab-meat diet	Casein diet
Total wt gain (g)	24·6 ± 3·2	24·5 ± 2·3
Total N ingested (mg)	1048·9 ± 47·6	1044·1 ± 37·4
Food N in urine (mg)	114·1 ± 2·8	107·2 ± 9·2
Food N in faeces (mg)	99·6 ± 4·7	99·3 ± 3·8
N absorbed (mg)	949·3	983·4
N retained (mg)	835·2	887·6
N retained (%)	79·6	82·1
Biological value*	88·0 ± 1·5	88·2 ± 4·8
True digestibility*	90·5 ± 0·29	90·4 ± 0·44
Protein efficiency ratio*	3·76 ± 0·25	3·69 ± 0·06
Net protein value*	64·2	63·7

* Definitions of these terms are given on p. 2.

Table 4. *Expt* 1. *Comparison of the deficit of the amino acids which became limiting for growth of the rat when crab meat or casein provided* 10% *of the diet*

Amino acid	Amino acid requirement (g/100 g diet*)	Amino acids in 10 g casein (g)	Deficit (%)	Amino acids in 10 g crab-meat protein† (g)	Deficit (%)
Methionine	0·6	0·33	45·8	0·61	—
Phenylalanine	0·9	0·50	44·0	0·40	55
Valine	0·7	0·70	—	0·48	31
Threonine	0·5	0·39	22·0	0·45	10
Tryptophan	0·2	0·14	32·0	0·19	2·5
Lysine	1·0	0·92	8·0	1·23	—
Histidine	0·4	0·39	2·5	0·28	30
Leucine	0·8	0·98	—	1·17	—
Isoleucine	0·5	0·65	—	0·69	—
Arginine	0·2	0·47	—	0·62	—

* Rose, Smith, Womack & Shane (1949).

† The values for amino acids in 10 g of crab meat were calculated from the composition given by Gangal & Magar (1962).

DISCUSSION

The N balance studies on adult rats (Table 3) showed that crab meat and casein have the same BV, 88, when supplying all the protein in a diet. Lanham *et al.* (1940) reported BVs of different crab-meat preparations, varying from 69·9 to 78·3 and digestibility values from 85·6 to 91·30. Sure & Easterling (1952) reported a BV of 90·50 for crab-meat protein which is more or less in agreement with that obtained (88) in our experiment. The values for digestibility (70·7) given by the above workers were however lower than those obtained by us. Our results suggest that crab-meat protein is as digestible as casein and has the same BV.

A long-term feeding experiment showed that, after the first 10–12 days, crab meat and prawn meat supplying all the protein in a diet containing 10% protein were much superior to the same amount of casein in supporting the growth of weanling rats (Fig. 2) even though the biological values were the same. This may be related to the differences in the sequence of limiting amino acids in the two proteins. From Table 4 it appears that methionine, which is the first limiting amino acid in casein, is present in sufficient quantity in crab-meat protein. The amino acid composition of crab-meat protein reported by Gangal & Magar (1962) revealed the fact that crab-meat protein formed a better source of essential amino acids than casein. Also, it has been reported that crab meat is a good supplement to soya-bean meal (Anonymous, 1952). The requirements of the rat for the amino acids methionine and lysine, which are usually deficient in vegetable proteins, can be fully supplied by 10% of crab-meat protein in the diet. Thus, crab-meat protein can serve as a supplement for a vegetable-protein diet.

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REFERENCES

Anonymous (1952). *Rep. Pa agric. Exp. Stn* p. 36.
Chick, H. M. & Roscoe, M. H. (1930). *Biochem. J.* **24**, 1780.
Gangal, S. V. & Magar, N. G. (1962). *Indian J. appl. Chem.* **25**, 133.
Hegsted, D. M., Mills, R. C., Elvehjem, C. A. & Hart, E. B. (1941). *J. biol. Chem.* **138**, 459.
Lanham, W. B., Lee, C. F. & Nilson, H. W. (1940). *Fishery Market News Fish Wildl. Serv. U.S.* **2**, 26.
Mitchell, H. H. (1923–4). *J. biol. Chem.* **58**, 873.
Osborne, T. B., Mendel, L. B. & Ferry, E. I. (1919). *J. biol. Chem.* **37**, 223.
Rose, W. C., Smith, L. C., Womack, M. & Shane, M. (1949). *J. biol. Chem.* **181**, 307.
Schultze, M. O. (1950). *J. Nutr.* **41**, 103.
Sure, B. & Easterling, L. (1952). *J. Nutr.* **48**, 401.
Suzuki, U., Okuda, V., Okimato, T. & Nagasawa, T. (1919). *J. Tokyo chem. Soc.* **40**, 385.
Watson, U. K. & Fellers, C. R. (1935). *Trans. Am. Fish. Soc.* **65**, 342.

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