THE EFFECT OF PRAWN PROTEIN ON THE BONE OF MATURE RATS

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The present study was undertaken in order to obtain data relative to the influence of the nutritional variations studied on the bones of normal limbs of mature rats. There is a wealth of knowledge pertaining to the effects of dietary deficiencies of minerals on the skeleton of young animals; and Sherman and co-workers (Sherman and Booher, 1939; Sherman and Sherman, 1938; Van Duyne *et al.*, 1941; Sherman *et al.*, 1941) have investigated extensively the beneficial effects of diets rich in calcium, on growth and calcium storage in young animals. While there is considerable information (Conner and Sherman, 1936; Osborne and Mendel, 1926; Quinn *et al.*, 1929) dealing with several phases of the influence of protein intake on skeletal growth of young rats, there appears to be little published knowledge with regard to the effect produced by protein deficient diets on the bones of *mature* animals. And also the finding (Armstrong, 1948) that severe restriction of protein content of the diet of mature rats produced marked effect on the humeri, suggested the present problem of the influence of different levels of prawn protein intake on the bones of such animals.

Method

Diets containing respectively 5%, 10%, 12·5%, 15%, 17·5% and 20% of prawn protein given in Table I were prepared according to the method described by Armstrong (1948). Additional sucrose was added on an equal weight basis, as a replacement for protein in the 3 diets of lower protein content.

From a colony that was fed with a stock diet (Table II) well balanced as regards fat, carbohydrate, protein, minerals and vitamins, 60 albino mature rats were selected with weights between 240–50 gm. They were fed again on stock diet and carefully watched until their weights were within the range of 260–65 gm. when they were started on dietary regimen. The rats were distributed equally with regard to sex and were housed in cylindrical cages. Water was also supplied *ad libitum*.

TABLE I

Composition in gm. per Kilogram of Diet

Diets	1	2	3	4	5	6
Prawn Protein (Pulp) ..	75	100	125	150	175	200
Sucrose	425	400	375	350	325	300
Sucrose and Vitamins* ..	280	280	280	280	280	280
Sweet Oil	169	169	169	169	169	169
Salt Mixture (Osborne and Mendel)	40	40	40	40	40	40
Yeast	10	10	10	10	10	10
Sodium Chloride	1	1	1	1	1	1

* Each 1,000 gm. of diet contained 2 mg. thiamine hydrochloride, 2 mg. pyridoxine hydrochloride 3 mg. riboflavin, and 4 mg. calcium pantothenate.

TABLE II

Stock Diet

Wheat flour	60 gm.	Sodium Chloride ..	0·50 gm.
Gram flour	20 ,,	Calcium Carbonate ..	1·50 ,,
Ankoria Baby Food ..	5 ,,	Milk	60 cc.
Sweet Oil	5 ,,	Sodium Phosphate ..	3·60 gm.
Meat Paste	2 ,,	Ascorbic Acid ..	6 mgm.

The six diets, *viz.*, 5, 10, 12·5, 15, 17·5 and 20% diets of Sode (*Parapæniopsis sculptilus*) were fed to the correspondingly numbered groups of animals, each group containing 10 animals, for a period of 30 days. The animals were sacrificed and after prolonged boiling of the fore-limbs in water, the humeri were dissected free of soft tissue. The bones were dried and rendered fat-free by continuous extraction in a Soxhlet apparatus for 48 hours with a mixture of equal parts of alcohol and ether. Again the

bones were dried and weighed, the length of the bones was determined to the nearest 0·1 mm. with a vernier micrometer. Finally they were ashed to constant weight at 700° C. and their weight recorded. The ash of the humeri of the individual animal was dissolved in hydrochloric acid and analysed for calcium and phosphorus. The calcium determinations were made by the method of Clark and Collip (1925) and the phosphorus analyses by the method of Fiske and Subbarow (1925).

TABLE III

Observations pertaining to the Animals and Results with regard to the Humeri†

Particulars	Protein content of diet					
	5%	10%	12·5%	15%	17·5%	20%
Initial Body Weight (g.)	258	261	254	261	260	261
Final Body Weight (g.)	246	283	274	312	312	312
Daily food Intake (g.)	11·80	11·56	12·72	12·60	12·77	12·38
Dry, Fat-free weight of Humeri (g.) ..	0·209	0·221	0·225	0·235	0·230	0·232
Ash weight of Humeri (g.)	0·140	0·149	0·149	0·158	0·156	0·157
Calculated Ash content (%)	67·07	67·85	68·18	68·80	68·21	68·34
Length of Humeri (mm.)	25·15	26·49	27·39	28·32	28·14	28·21
Ca/P Ratio of Ash:	0·029/0·012	0·031/0·013	0·032/0·013	0·034/0·014	0·033/0·014	0·036/0·014

† The data are shown as averages.

RESULTS AND DISCUSSION

In Table III are given the length, weight and ash content of the humeri of the rats at 5, 10, 12·5, 15, 17·5 and 20% protein intake respectively. All the data related to the humeri are the means of the average obtained with the two bones from the individual animal in each group. It is seen from Table III that the gain in weight of the animals varied in the same manner as the protein content of the food. The animals receiving 20% protein gained on an average 5 gm. while those receiving 5% protein lost on an average 16 gm. The humeri of the groups receiving 5 and 10% protein diet suffered a significant reduction in weight of the fat-free dry bone and

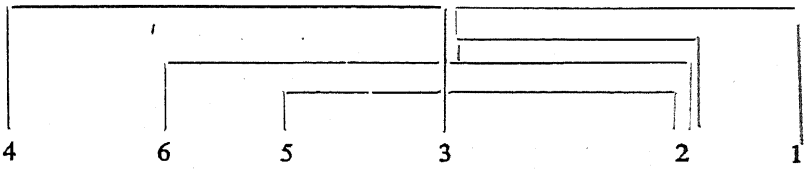
its ash weight. Increasing the protein from 12·5 to 20% in the diet effected a gradual increase in the skeletal growth and also in the weight of the ash. Maximum skeletal growth and ash weight were found at 15% protein level. Further with an increase in the prawn protein in the diet from 10 to 12·5% there is an increase in the skeletal growth as well as the ash content. It is seen that 12·5% protein level is the minimum level for normal skeletal growth. The 5 and 10% protein diets are inadequate to support normal skeletal constitution in mature rats equal to that of a diet containing 15% prawn protein.

TABLE IV

	Variations due to			
	Groups	Treatment	Error	Total
Sum of Squares ..	4·7102013	78·8669453	21·1676687	104·7528183
Degrees of freedom	9	5	45	59
Variance of Mean square ..	0·524245	15·77338966	0·47039264	..

F = 33·53239043. 1% = 3·45 t_{45} at 1% value = 2·69.

Difference of two means greater than 0·82508218 will be significant.



Statistical data obtained for these results confirmed the superiority of 15% prawn protein diet over the other diets, with regard to skeletal growth and body weight. The optimum level protein for normal skeletal growth was found to be 12·5% prawn protein.

The effect on body weight produced by feeding the mature rats for 30 days with diets containing 5, 10, 12·5, 15, 17·5 and 20% prawn protein was also determined. It is seen from Table III that 5% prawn protein did not support the body weight, of mature rats while diets containing 10, 12·5, 15, 17·5 and 20% permitted an increase in body weight in approximate proportion to the protein contents.

The composition of the bone ash in all the groups was not affected by protein deficient diets, as can be seen from the Ca : P ratio in Table III.

SUMMARY AND CONCLUSION

The body weight and humeri of mature rats fed for 30 days with diets containing 5, 10, 12·5, 15, 17·5 and 20% prawn protein have been determined. The following conclusions are drawn:

1. A diet containing 5% prawn protein will not support the body weight of mature rats, while diets containing 10, 12·5, 15, 17·5 and 20% protein permit an increase in body weight in approximate proportions.

2. A diet containing 12·5% prawn protein supports a degree of skeletal constitution in mature rats equal to that of a diet containing 15% prawn protein.

3. 5 and 10% prawn protein diets are inadequate to support normal skeletal constitution.

4. The compositions of the bone ash is not affected by feeding prawn protein deficient diets to mature rats.

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