CLXXXIII. VITAMIN A DEFICIENCY IN CASTRATED MALE RATS.

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IN a previous paper [Sampson and Korenchevsky, 1932] it was shown on the basis of paired feeding experiments, that vitamin A deficiency produces changes in various organs and functions of male rats and in particular degeneration of the seminiferous tissue of the testis.

The present paper describes the study of the effect of vitamin A deficiency on castrated male rats, from which both the seminiferous and the interstitial tissues of the testis are absent, in an attempt to collect data for the elucidation of the possible interrelationship of vitamin A and the testicular hormones.

TECHNIQUE.

Experiments were performed on 16 rats belonging to three litters. In litters Nos. 2 and 3 (Table I) the rats were divided into the following three groups: (i) castrated rats on an adequate, unlimited diet (CoU diet); (ii) castrated rats, on vitamin A-deficient diet (—A diet); and (iii) normal rats, on vitamin A-deficient diet. In litter No. 1 only the last two groups were present. All three litters were born on the same day. Some of the rats of each litter were castrated on the 22nd day after birth and the experimental feeding was started on the 31st day after birth.

The rats were killed on the dates given in Table I, so that in each litter, one rat of each group was sacrificed simultaneously. The only exception was rat

Table I. *Final weights of rats, their daily average food intakes per 200 g. of body-weight and average daily gains in body-weight per 10 g. of actual food intake (g.).*

No. of litter	Castrated on CoU diet				Castrated on —A diet				Normal on —A diet				Duration of exp. in days
	No. of rat	Final body-wt.	Food in-take	Gain in wt.	No. of rat	Final body-wt.	Food in-take	Gain in wt.	No. of rat	Final body-wt.	Food in-take	Gain in wt.	
1	—	—	—	—	1	142	26.6	0.9	4	175	26.1	1.2	48
	—	—	—	—	2	120	36.2	1.3	5	159	35.4	1.6	25
	—	—	—	—	3	140	23.1	0.6	6	143	29.0	1.1	70 & 40
2	7	201	33.1	2.0	9	147	31.2	1.5	11	157	31.5	1.3	34
	8	179	37.1	2.1	10	140	33.7	1.7	12	136	36.7	1.4	26
3	13	147	33.9	1.7	14	103	35.2	1.1	16	116	35.6	1.1	32
	—	—	—	—	15	102	34.3	1.1	—	—	—	—	32

No. 6 which was killed on the 40th day after being put on the experimental diet, while rat No. 3, the corresponding rat in the other group, was not killed until 30 days after. This was done because rat No. 3 was in good condition on the 40th day and it was decided to ascertain the length of time it would survive on the vitamin A-deficient diet.

The technique of the experiments was identical with that used in the previous investigation [Sampson and Korenchevsky, 1932] except that paired feeding was not used, as the influence of castration on the appetite of rats on a vitamin A-deficient diet was also investigated in the present experiments.

The rats were always killed on the day after the occurrence of the first significant decrease in appetite, so that they should not be investigated in the emaciated state due chiefly to a very decreased food intake.

EXPERIMENTAL RESULTS.

Changes in body-weight and appetite.

Although paired feeding was not used, the appetites of the groups of rats on —A diet which were killed at the same date, were nearly the same, *e.g.* rats 1 and 4, 2 and 5, 9 and 11, *etc.* (see Table I).

In some of the rats on CoU diet the appetite (per 200 g. of rat weight) was even less than that of those on —A diet, *e.g.* in litter No. 2, rat 7 ate less than rats 10 and 12; in litter No. 3, rat 13 ate less than any of the rats of this litter on —A diet (Nos. 14, 15 and 16). This is only the case when the food intake is calculated for the same unit of body-weight. In actual figures the appetite of the rats on CoU diet was larger than that of those on —A diet. For example, in the groups “castrated, on CoU diet,” “castrated, on —A diet” and “normal, on —A diet,” the average figures of the actual food intakes were in litter No. 2, 21.5, 17.9 and 19.6 respectively and in litter No. 3, 16.8, 14.8 and 16.3 respectively.

Since when these figures are calculated per 200 g. of body-weight this relationship is reversed for most rats, it is possible to draw conclusions, even from these experiments, about the anabolic properties of vitamin A, which have already been demonstrated and discussed in our previous paper [Sampson and Korenchevsky, 1932].

Thus for one unit of food intake the daily increase of body-weight of rat 8 was 2.1 g. whilst for the rats Nos. 10 and 12 on the —A diet it was 1.7 g. and 1.4 g. respectively.

In litter No. 3 the gain on the complete diet was 1.7 g. per unit of intake, while on the deficient diet it was 1.1 g.

These results, therefore, in agreement with those obtained previously, indicate an “anabolic principle” of vitamin A because of which one unit of adequate diet causes a greater increase in body-weight than the same unit of a diet deficient in vitamin A. No difference in this respect was noticed between the normal and the castrated rats. Thus, if rats 3 and 6 are excluded as having been

killed at different ages and rat 15 as having no normal rat on -A diet corresponding to it, the gain in body-weight per 10 g. of actual food intake for all the remaining rats was on the average 1.30 g. for the group of castrated rats on -A diet and 1.32 g. for the group of normal rats on -A diet, *i.e.* practically the same.

With the exception of two rats, killed 57 and 79 days after castration, all were killed 34 and 43 days after castration. It has already been shown [Korenchevsky, 1925, 1930] that some of the changes in castrated animals are not fully developed until some months after the operation. The absence of difference in the response of normal and castrated animals to vitamin A deficiency might disappear at a later period. The results obtained, therefore, can only be regarded as valid for the period about two months after castration.

Changes in organs.

In Table II are given the weights of those organs only in which constant and obvious changes were observed. In order to economise space the weights

Table II. *Average weight of organs of rats in each group of each litter (mg.).*

Organs	No. of litter	Castrated on CoU diet Weight		Castrated on -A diet Weight		Normal on -A diet Weight	
		Actual	Per 200 g. body-wt.	Actual	Per 200 g. body-wt.	Actual	Per 200 g. body-wt.
Penis	1	—	—	79	121	150	188
	2	53	56	51	71	137	188
	3	45	61	40	77	132	228
Av. of litters 2 and 3		49	59	46	74	135	208
Prostate and Sem. ves.	1	—	—	57	87	620	787
	2	65	70	67	93	355	475
	3	46	63	41	79	511	881
Av. of litters 2 and 3		56	67	54	86	433	678
Adrenals	1	—	—	42.8	65.3	36.8	46.6
	2	51.4	54.5	35.2	49.2	32.9	45.4
	3	49.4	67.2	25.8	50.2	26.9	46.4
Av. of litters 2 and 3		50.4	60.9	30.5	49.7	29.9	45.9
Pituitary	1	—	—	8.5	13.0	7.3	9.2
	2	10.3	10.9	8.5	11.8	7.3	9.9
	3	9.3	12.6	7.1	13.9	5.7	9.8
Av. of litters 2 and 3		9.8	11.8	7.8	12.9	6.5	9.9
Thymus	1	—	—	214	341	219	274
	2	518	544	454	632	242	332
	3	434	590	245	478	194	334
Av. of litters 2 and 3		476	567	350	555	218	333

of the organs of each rat are not included and only the average figures for each group in each litter given, for, as stated above, these changes were present in all the rats of the group.

Sexual organs. The penis, and prostate and seminal vesicles were much smaller in castrated than in normal animals. In the castrated animals while the average actual weights were nearly the same in both groups, when calculated per 200 g. of body-weight, those of the rats on —A diet were heavier than those of the rats on complete diet. On a vitamin A-deficient diet, therefore, the atrophied sexual organs of castrated rats undergo the same type of changes in weight as those observed in the sexual organs of normal rats [Sampson and Korenchevsky, 1932].

Adrenals and hypophysis. These glands, as shown by the weights calculated per 200 g. of body-weight, when compared with those of normal animals, were hypertrophied in castrated rats. This change had previously been found in castrated rats on normal diet [Korenchevsky, 1930] and is also present in castrated rats on —A diet.

No constant or considerable difference in these glands was noticed between the two groups of castrated rats, except that in rats on —A diet hypertrophy of adrenals was less pronounced than that in rats on CoU diet.

Thymus. This gland, both in actual weight and calculated per 200 g. of body-weight, was larger in castrated animals, but no constant or considerable difference was noticed between the glands of the two groups of castrated rats.

SUMMARY.

1. 16 male rats belonging to three litters were used in order to compare the influence of vitamin A deficiency on normal and castrated rats.
2. The conclusion, obtained previously on unoperated rats, was corroborated, namely that one unit of vitamin A-deficient diet produces a smaller increase in body-weight than the same unit of adequate diet.
3. Thus this fact, showing an anabolic principle of vitamin A, was also observed in castrated rats.
4. When calculated per unit of body-weight the atrophied sexual organs of castrated rats on —A diet were heavier than those of castrated rats on adequate diet. This change was previously observed in unoperated rats.
5. The adrenals and hypophysis of rats on —A diet undergo, after castration, a hypertrophy similar to that observed in castrated rats on normal diet.
6. Irrespective of the diet, the thymus was larger in castrated than in normal animals, but no essential difference was noted between the glands of castrated rats on adequate diet when compared with those on A-deficient diet.

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REFERENCES.

- Korenchevsky (1925). *Brit. J. Exp. Path.* **6**, 21.
 — (1930). *J. Path. Bact.* **33**, 607.
 Sampson and Korenchevsky (1932). *Biochem. J.* **26**, 1322.