of the animal. The aged rat demonstrates a considerably different dermal chemical response to cortisol and particularly Doca than does either the young or the mature animal.

The authors wish to acknowledge the assistance of Jean E. Johnston.

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Received June 28, 1961. P.S.E.B.M., 1961, v108.

## Relation of Selenium, Vitamin E and Other Factors to Muscular Dystrophy in the Rabbit. (26850)

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Among various species there are widely differing effects of a dietary lack of Vit. E, the most common manifestation of which is muscular degeneration. Morgulis and Spencer (10) found evidence for a factor in alfalfa or whole wheat germ which was necessary for preventing muscular dystrophy in the rabbit in addition to a fat-soluble factor (Vit. E). MacKenzie and McCollum(9) reported that Vit. E alone was capable of preventing this deficiency syndrome. A lack of many other nutritional factors has also been implicated in producing muscular dystrophy; among them are choline(6,8), potassium(7), phosphorus(13), Vit. C(4), Vit. $B_6$(3), and selenium(11,12). Other factors have been shown to increase the severity, such as iodide (1) and even exercise. Differences in these factors could explain the contradictory evidence presented by Morgulis and Spencer (10) and by MacKenzie and McCollum(9).

*Methods.* Two experiments were independently conducted at the Ontario Agricultural and Veterinary College and at Cornell University. The objectives of each were to determine the effect of alpha tocopherol and selenium upon incidence of muscular dystrophy in the rabbit. In addition, the Cornell experiment was designed to include diets to which natural feedstuffs had been added. These feeds were chosen because muscular dystrophy often occurs in lambs when these feeds are fed(5,12). Diets used in the experiments are shown in Table I.

*Results and discussion.* An alopecia was noticed in all of the rabbits fed diets containing no "natural feed." A loss of the long guard hairs began along the ventral part of the abdomen about one week after the rabbits were placed on the experimental diets. Since the rabbits were housed in groups of 5 it was not possible to determine the extent of hair chewing that might have taken place.

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TABLE I. Basal Diets Used in the 2 Experiments.

| Ingredients | I (Ontario) | II (Cornell) |
|---|---|---|
| | (%) | |
| Torula yeast | 40.0 | 39.0 |
| Dextrose* | 40.0 | 39.0 |
| Lard† | 10.0 | 10.0 |
| Bulk material‡ | 10.0 | 10.0 |
| NaCl | 1.0 | 1.0 |
| $CaCO_3$ | .5 | — |
| $Ca_3(PO_4)_2$ | .5 | 1.0 |
| Vitamins | —§ | —‖ |

* Cerelose 2001, Corn Products Refining Co.
† Stripped lard, furnished by Distillation Products Industries, Rochester, N. Y.
‡ Ontario experiment — Cellulose (Alpha-cel), Nutritional Biochemical Corp., Cleveland, O.
Cornell experiment — Cellophane (Jelflake) ground to a particle size that would pass a ⅛ inch mesh.
§ Vit. A, 1200 I.U./kg feed; Vit. D, 170 I.U./kg feed; Menadione, 2 mg/kg feed.
‖ Vit. A, 400 I.U./kg of diet, Nopcay 20, Nopco Chemical Co.; Vit. D, 165 I.U./kg of diet, Dupont Delsterol 3000-D.

Nevertheless, since the entire body covering was affected, it is believed that most of the hair loss was due to dietary inadequacies.

At death, or termination of experiment, all rabbits were examined for gross anomalies, and skeletal and cardiac muscle samples were subjected to histopathologic study. These data as well as average time of survival and body weight changes are presented in Table II.

Neither selenium nor Vit. E singly or in combination was effective in preventing muscular dystrophy at the levels fed. In the Ontario experiment the level of Vit. E was considerably above that which is generally considered the daily requirement. In the Cornell experiment, estimates of daily food consumption place the intake of Vit. E approximately at the requirement of the rabbit (0.30 I.U./kg body weight per day). The selenium content of the basal ration (Cornell), determined by a neutron activation procedure performed by Oak Ridge National Laboratory, Tennessee, was found to contain 0.02 ppm selenium. Thus, in diets where $Na_2SeO_3$ was added there was a total content of 1.02 ppm selenium. A 20% level of wheat bran or linseed oil meal in the diet did not prevent the condition entirely, although one and two rabbits survived the experiment on these 2 diets, respectively. Two rabbits survived the experiment on the diet containing 40% of cooked kidney beans; however, these rabbits showed microscopic lesions of muscular dystrophy.

Evidence exists(2,5) for a factor in some feeds which may enhance muscular dystrophy in the lamb. Torula yeast is commonly used in diets that will produce certain associated conditions in various species; *i.e.*, die-

TABLE II. Effects of Selenium, Vitamin E and Several Natural Feeds on Muscular Dystrophy, Survival and Body Weight Changes in Rabbits.

| Treatment | No. of rabbits | Avg days of survival | Body wt (g) Initial | Body wt (g) Final | No. surviving test period | No. showing muscular dystrophy: Clinical signs | No. showing muscular dystrophy: Lesions upon necropsy |
|---|---|---|---|---|---|---|---|
| | | Ontario Exp. | | | | | |
| Basal | 5 | 44 | 510 | 567 | 0 | | 5 |
| " + vit. E* | 5 | 43 | 472 | 598 | 1 | | 3 |
| " + selenium (1 ppm) | 5 | 45 | 530 | 629 | 0 | | 5 |
| | | Cornell Exp. | | | | | |
| Basal | 5 | 26 | 1360 | 1205 | 0 | 5 | 3‡ |
| " + vit. E† | 5 | 32 | 1324 | 1122 | 0 | 5 | 4‡ |
| " + selenium (1 ppm) | 5 | 28 | 1330 | 1177 | 0 | 5 | 3‡ |
| " + linseed oil meal (20%) | 5 | 52 | 1403 | 1642 | 2 | 3 | 5 |
| " + wheat bran (20%) | 5 | 45 | 1311 | 1287 | 1 | 4 | 5 |
| " + cooked kidney beans (40%) | 5 | 48 | 1368 | 1721 | 2 | 3 | 4‡ |
| " + vit. E† + selenium | 5 | 31 | 1306 | 1118 | 0 | 5 | 4‡ |

* 3.4 mg of dl-alpha tocopheryl acetate/kg of body wt daily.
† 22 I.U. of dl-alpha tocopheryl acetate/kg of diet.
‡ Complete data not obtained due to postmortem changes.

tary liver necrosis in rats(14) and exudative diathesis in chicks(15). It is therefore possible that the basal diet was deficient in certain factors involved in prevention of muscular dystrophy (Vit. E, selenium and perhaps methionine and cystine) as well as containing inhibitors or antagonists that may enhance the occurrence of muscular dystrophy.

*Summary.* Rabbits maintained on a torula yeast, Vit. E deficient diet developed a severe and rapidly progressing muscular dystrophy. This condition was not prevented by addition to the diet of 1 ppm selenium or of supplements of dl-alpha tocopheryl acetate alone or in combination. Additions of natural feedstuffs (wheat bran, linseed oil meal or kidney beans) to the semi-purified diet did not fully prevent the condition, although they did lessen the severity of the lesion and increase the average number of days of survival indicating deficiencies other than selenium and Vit. E were involved in the particular experimental diets used. A marked alopecia was observed in all animals fed diets not containing a natural feedstuff.

The authors gratefully acknowledge the advice and assistance of J. M. King, Dept. of Veterinary Pathology.

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Received June 29, 1961. P.S.E.B.M., 1961, v108.

## Immune Response to Actinophage in the Mouse.* (26851)

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Recently about 25 actinophages virulent for members of the genera Streptomyces, Nocardia, Micromonospora, Actinoplanes and Mycobacteria have been isolated and characterized with respect to host range(1). The conditions for growth of these bacterial viruses, their antigenic relationships to one another and their distribution in nature have been partially determined(2). Moreover, actinophage plaque-forming units can be enumerated easily, quickly and accurately(3). Therefore, actinophages, as well as bacteriophages of *Escherichia coli*(4), possess many desirable properties required of an antigen used in the study of onset of antibody formation. This report is concerned with the antigenicity of actinophage and uptake and retention of the viral particles by organs of the mouse.

*Uptake and retention of actinophage.* Inbred, male, adult, Bagg albino mice (a sub-

* Aided by grants from Nat. Inst. Health, U.S.P.H.S. and National Foundation.

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