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Prevention of Nutritional Myopathy of Ducklings by α-Tocopherol.

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The author of this paper with M. Goettsch described a nutritional disease of Pekin ducklings characterized by extensive degeneration of the voluntary muscles.[1] The disease was produced by the same diet (108) which in chicks brought about necrosis of the central nervous system (nutritional encephalomalacia). It has now been shown that this chick disease is a manifestation of vitamin E deficiency, definitely preventable by wheat germ oil and other vegetable oils, or their non-saponifiable fractions,[2] and by pure vitamin E in the form of natural or dl-α-tocopherol.[3, 4]

Preliminary experiments indicated that soy bean oil and wheat germ oil in adequate dosages protected ducklings against the development of muscle degeneration. Conclusive proof that the muscle disease is attributable to lack of vitamin E has not yet been given, and it is the purpose of this short communication to fill this gap in our knowledge.

Experimental. One day old white Pekin ducklings obtained from Sears Roebuck & Co. were given a commercial starting mash for several days, and then placed upon the experimental diet 108.* They were kept for about 2 weeks in battery brooders and then in individual wire cages. Dl-α-tocopherol was dissolved in sesame oil, the solution having been standardized so that with the pipette used, 1 drop was equivalent to 1 mg of α-tocopherol. It was administered daily in gelatin capsules. The controls received the same amount of

*Diet 108:

Skimmed Milk Powder	15.0
Casein (Merck's Technical)	20.5
Cornstarch	20.0
Lard	21.0
Cod Liver Oil (Mead Johnson)	2.0
Yeast (Fleischmann's Baker)	3.0
Salt Mixture (McCollum 185)	8.5
Paper Pulp	10.0

1 Pappenheimer, A. M., and Goettsch, M., *J. Exp. Med.*, 1934, **59**, 35.

2 Goettsch, M., and Pappenheimer, A. M., *J. Biol. Chem.*, 1936, **114**, 673.

3 Dam, H., Glavind, J., Bernth, O., and Hagens, E., *Nature*, 1938, **142**, 1157.

4 Pappenheimer, A. M., Goettsch, M., and Jungherr, E., *Storrs Agric. Exp. Sta.*, 1939, Bull. 229.

sesame oil without α-tocopherol. A complete autopsy was performed, and at least four pieces of skeletal muscle examined microscopically. The animals were killed when they exhibited definite symptoms of muscular weakness. The survivors were kept under observation for about 5 weeks and then killed by decapitation.

Gizzard erosions were an annoying complication, and several ducklings succumbed to perforating ulcers. Many of the animals also suffered from slipped tendon (perosis), in spite of the fact that the manganese content of the salt mixture in diet 108 in the first experiment was increased to 0.1%. Following the report of Jukes,[5] of the preventive effect of cholin upon perosis in turkeys, 1-3 drops of a millimolar solution of cholin acetate were given daily by pipette to one group of 12 ducklings during the first 2 weeks of the experiment. Only 2 of this group developed the deformity, in contrast to 10 of 13 in the control groups. Unfortunately, it was not possible to continue the administration of the cholin acetate throughout the experiment; it seems, however, to have exercised a distinctly protective effect.

Experiment I. In this experiment, 13 ducklings received daily 1 mg of dl-α-tocopherol acetate in sesame oil; 12 controls, 1 drop (approximately 1 mg) of sesame oil. The results are shown in Table I.

It is obvious that a daily dose of 1 mg of α-tocopherol did not

TABLE I.
Effect of α-Tocopherol upon Nutritional Myopathy.

Group A 1 mg dl-α-tocopherol acetate daily					Group B 1 drop of sesame oil daily				
No.	Days on diet	Total dosage, mg	Gross	Micr.	No.	Days on diet	Total dosage, mg	Gross	Micr.
4501	16	17	—	—	4515	16	17	+	++
4502*	15	15	—	—	4516†	23	20	?	+++
4504	D20	20	—	±	4517	14	14	++++	++++
4505	29	28	+++	++++	4518	27	27	—	±
4506*	19	20	—	—	4519	27	25	—	++
4507	31	31	—	+‡	4520	27	25	++	+++
4509	31	31	++	+++	4521	20	20	±	±
4510	31	31	—	+	4522	12	16	—	—
4511*	D14	14	—	+	4523	10	11	—	—
4512	31	31	—	±	4524	20	20	+++	++++
4513	20	21	—	++	4525	27	27	+	++
4514	D22	22	—	++	4527	27	26	—	+++‡
4580	29	28	+++	++++	4528	19	20	++++	++++

*Ulcers of gizzard.
†Killed by rat.
‡Healing.

[5] Jukes, T. H., *J. Biol. Chem.*, 1940, **134**, 789.

TABLE II.
Effect of α-Tocopherol upon Nutritional Myopathy.

Group A dl-α-tocopherol					Group B† Oil of sesame				
No.	Days on diet	Total dosage, mg	Gross	Micr.	No.	Days on diet	Total dosage, drops	Gross	Micr.
4530	31	98	—	—	4547	16	46	—	+§
4531*	D6*	14	—	—	4545	24	74	++++	++
4532	33	110	—	—	4549	27	74	++++	+++
4535	33	110	—	—	4550	24	82	++++	++++
4536	K6	12	—	—	4551	10	26	++++	++++
4537	17	50	—	—	4552	16	46	++	++++
4538	16	46	—	—	4553	28	106	++++	++++
4541	31	110	—	±	4554‡	17	50	—	—
4542	17	50	—	—	4548	28	102	+++	+++
4543	34	118	—	—	4556	11	26	++++	+++
4546*	18	56	—	—	4558	11	30	±	+++
4555	17	52	—	—	4557	34	98	++	++++
4598	34	118	—	—					

*Gizzard ulcer.
†Cholin acetate (1-3 gtt.) for 16 days.
‡Escaped from cage—killed before development of symptoms.
§Healing.

prevent the development of muscle degeneration. The experiment was therefore repeated with larger doses; 2 mg of dl-α-tocopherol acetate daily for the first 9 days, then 4 mg of dl-α-tocopherol daily until the end of the experiment. This amount was found to afford complete protection, as is shown in Table II.

Excluding ducks 4531 and 4536 which died of incidental causes before the period during which muscle lesions develop, all the animals of group A receiving the larger doses of α-tocopherol were completely protected. The controls receiving only an equivalent amount of sesame oil developed the disease in characteristic fashion, the only exceptions being ducks 4547 and 4554 which were killed prematurely.

Conclusion. The nutritional myopathy of ducklings which develops on vitamin E deficient diet is completely prevented through the experimental period by daily administration of 4 mg of synthetic α-tocopherol. A dosage of 1 mg daily does not afford protection.†

† We are indebted to the Hoffman-LaRoche Co. for the synthetic α-tocopherol. acetate used in the experiments, and to Merck & Co. for the dl-α-tocopherol.