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Assay of hexahydrocoenzyme Q (phytylubiquinone) against muscular dystrophy in chicks

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With 2 tables

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Hexahydrocoenzyme Q (phytylubiquinone) has been reported to possess curative effect against muscular dystrophy caused by vitamin E deficiency in rabbits (1) and monkeys (2).

Dr. KARL FOLKERS, Institute for Biomedical Research, University of Texas, has kindly furnished us with a sample of this compound which we have tested against muscular dystrophy in vitamin E deficient chicks. We were unable to find any preventive effect of the substance in the dose in which it was tested.

Muscular dystrophy, appearing grossly as white striation of skeletal muscles, particularly the breast muscles, is easily developed in young chicks by vitamin E deficient diets low in sulfur-containing amino acids (3) and selenium (4). A high content of arginine in the diet further favors the appearance of this manifestation of vitamin E deficiency (5). Development of muscular dystrophy in chicks does not require dietary polyunsaturated fatty acids. The syndrome appears even with fat-free diets (3). It is completely prevented by vitamin E, and largely prevented by dietary cystine (3) and selenite (4). Unphysiological antioxidants such as methylene blue are (almost) ineffective against it (3). The degenerated muscles have a high content of cholesterol and a low content of creatine (3).

Experimental

40 day-old chicks (cockerels, crossbreed New Hampshire X White Leghorn) were kept in battery brooders with wire screen bottom, and given the "starter ration" indicated in our previous paper (6) during 8 days before being distributed into 4 groups of ten. Thereafter, 3 of the groups received the dystrophyinducing vitamin E deficient diet (no. 3490) indicated in table 1, whereas the fourth group received the same diet supplemented with 10 mg % all-rac- α -tocopheryl acetate (d, 1- α -tocopheryl acetate). The chicks in one of the groups on the unsupplemented diet received every day 0.1 ml ethyl oleate, administered from a graduated syringe through a polyethylene tube directly into the crop. The chicks in the second group on the unsupplemented diet received similarly 5 mg phytylubiquinone dissolved in 0.1 ml ethyl oleate, whereas the chicks in the third group on the unsupplemented received daily 1.5 mg α -tocopheryl acetate (d- α -tocopheryl acetate) in 0.1 ml ethyl oleate administered in the same way. At the end of the experimental feeding which lasted 5 weeks the chicks were killed and autopsied.

The degree of striation of the muscles was judged macroscopically and expressed as follows: 0 = no visible striation; 1 = slight striation; 2 = marked striation; 3 = very marked striation.

Table 1. Vitamin E deficient, muscular dystrophy inducing diet.
Diet 3490.

Casein, crude ¹⁾	15 g
Gelatine	10 g
Salt mixture ²⁾	5.17 g
Vitamin mixture ²⁾	0.1 g
Choline chloride	0.2 g
Lard	2 g
Sucrose	67.53 g
	<hr/> 100.00 g
Vitamin K substitute ³⁾	1 mg

¹⁾ "Dairinex" from Dansk Mejeri Industri & Export Kompani, Stege, Denmark.

²⁾ See reference (7).

³⁾ Synkavit, Roche (di-calcium salt of 2-methyl-1,4-napthohydroquinonediphosphoric acid ester).

Vitamins A and D₆ were given in the form of an aqueous solution, (reference (8)), twice a week, corresponding to 250 i. u. vitamin A and 20 i. u. vitamin D₃ per day.

Table 2

Group	Chick	Basal	Addition	Addition	Weight	Weight	Degree of
no.	no.	diet	incorporated	administered	at	after	striation
		no.	into diet	by tube	start	5	of skeletal
				per chick	of exp.	weeks	muscles
				per day	g	g	
				0.1 ml ethyl			
3490	3010	3490	none	oleate	53	200	2
"	3011	"	"	"	53	248	3
"	3012	"	"	"	68	188	2
"	3013	"	"	"	75	298	1
"	3014	"	"	"	53	274	2.5
"	3015	"	"	"	62	366	3
"	3016	"	"	"	59	276	2.5
"	3017	"	"	"	68	281	1.5
"	3018	"	"	"	59	320	3
"	3019	"	"	"	53	208	3
"	mean values with standard deviation				60±2	266±18	2.4±0.2
				5 mg phytyl- ubiquinone in 0.1 ml			
3491	3020	3490	none	ethyl oleate	60	234	2.5
"	3021	"	"	"	62	286	3
"	3022	"	"	"	58	222	1
"	3023	"	"	"	54	264	2.5
"	3024	"	"	"	60	261	1,5
"	3025	"	"	"	60	304	3
"	3026	"	"	"	59	333	2.5
"	3027	"	"	"	62	264	2.5
"	3028	"	"	"	68	289	3
"	3029	"	"	"	60	225	1
"	mean values with standard deviation				60±1	268±11	2.0±0.3

Table 2 continued

Group no.	Chick no.	Basal diet no.	Addition incorporated into diet	Addition administered by tube per chick per day	Weight at start of exp. g	Weight after 5 weeks g	Degree of striation of skeletal muscles
3492	2030	3490	none	1.5 mg α -tocopheryl acetate in 0.1 ml ethyl oleate	66	392	0
"	2031	"	"	"	43	201	0
"	2032	"	"	"	55	204	0
"	2033	"	"	"	55	228	0
"	2034	"	"	"	59	258	0
"	2035	"	"	"	67	310	0
"	2036	"	"	"	50	227	0
"	2037	"	"	"	74	225	0
"	2038	"	"	"	65	269	0
"	2039	"	"	"	69	295	0
"	mean values with standard deviation				60 \pm 3	261 \pm 19	0
3493	2040	3490	10 mg % all-rac- α -tocopheryl acetate	none	52	280	0
"	2041	"	"	"	65	191	0
"	2042	"	"	"	61	258	0
"	2043	"	"	"	57	296	0
"	2044	"	"	"	62	319	0
"	2045	"	"	"	67	240	0
"	2046	"	"	"	58	309	0
"	2047	"	"	"	57	366	0
"	2048	"	"	"	62	282	0
"	2049	"	"	"	62	237	0
"	mean values with standard deviation				60 \pm 1	278 \pm 16	0

Results

The results are presented in table 2.

It is seen that a dose of 5 mg phytylubiquinone per chick per day (group 3491) was not capable of preventing appearance of marked visible striation of skeletal muscles. The degree of striation in this group was practically the same as that in group 3490 where the dystrophogenic diet was given without dosage of phytylubiquinone. By contrast, visible striation was completely prevented by dosage with 1.5 mg α -tocopheryl acetate per chick per day (group 3492) or by incorporation of 10 mg % all-rac- α -tocopheryl acetate into the diet (group 3493).

Summary

Daily ingestion of 5 mg phytylubiquinone (hexahydrocoenzyme Q₄) to chicks reared on a dystrophogenic vitamin E deficient diet during 5 weeks did not prevent development of marked macroscopic signs of muscular dystrophy (white striation of skeletal muscles). Signs of muscular dystrophy did not appear in chicks reared on the same diet and receiving 1.5 mg α -tocopheryl acetate per day during the same period of time.

Zusammenfassung

Tägliche Eingabe von 5 mg Phytylubichinon konnte die Entwicklung makroskopisch erkennbarer Muskeldystrophie (weißgestreifter Skelettmuskulatur) in Küken, die während 5 Wochen mit einer Vitamin-E-defizienten dystrophogenen Nahrung gefüttert wurden, nicht verhindern. Wenn unter den gleichen Umständen anstatt 5 mg Phytylubichinon, 1.5 mg α -Tocopherylacetat gegeben wurde, kam die Muskeldystrophie nicht zum Vorschein.

References

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