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Vitamin C Supplementation to Growing Chick's Rations at Variable Temperature Levels

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THE EFFECT of supplementation of vitamin C to the diet of the growing chicks reared under high, normal or low temperature, on the feed efficiency, growth rate mortality rate, serum calcium and phosphorus, body temperature, respiration rate and blood pressure has been studied.

Rearing the growing chicks under high temperature (90°F) for 12 weeks decreased the feed consumption and efficiency, body-weight, relative growth rate and serum clacium and phosphorus, while mortality rate was increased. Addition of ascorbic acid to the ration counteracting the depression effect of the heat stress caused an increase in feed consumption, feed efficiency, body weight, relative growth rate, serum calcium and phosphorus and at the same time reduced the mortality rate.

High air temperature increased body temperature, respiration rate, and blood pressure. Supplementation of ascorbic acid decreased body tepmerature, while the respiration rate was inereased under high and normal tepmerature, and decreased under low temperature.

Vitamin C supplemeut did not affect blood pressure unaer the different temperature during the growing period.

Recently, the role of ascorbic acid in poultry physiology, nutrition and diseases has received considerable attention.

Reports in the literature on the influence of the addition of vitamin C to the growing chick ration are most contradictory, also the role of the environmental temperature has a significant effect. Thornton and Moreng (1958b) showed that supplementation of the ration with ascorbic acid did not affect body weight of S.C. White Leghorn pullets maintained under normal environmental conditions. Similar findings were reported by Gogus and Greminger (1959) and Thornton (1959b). Moreover, Subashandran and Balloun (1966) demonstrated that in heat stressed birds (38 °C) vitamin C was not effective in counteracting the weight depression. On the other hand, Thornton and Moreng (1958 b) found that the supplementation with ascorbic acid maintained the body weight of the pullets against the depression caused by

increasing the environmental temperature to 80-82° F. At the same time, Thornton (1959b) proved that the presence of the vitamin C in the parental diet of Leghorn hens appeared to increase growth of chicks hatched from summer eggs, but this effect has not been observed during winter. Also the author found that the heavier chicks had a highly significant heavier ash weight; he explained this by the effect on calcium metabolism.

Recently, Edrise (1973) demonstrated that dietary supplementation of vitamin C in a level of 100 mg per kg diet increased the growth rate of Dokki 4 chicks reared under atmospheric temperature-after the brooding the stage-varying from 26 to 36°C

It has been demonstrated that Vitamin C had a tendency to reduce body temperature in heat stressed birds (Ahmed and Moreng, 1944 and Subaschandran and Balloun 1966). Also grimes and moreng (1965) found the ascorbic acid treatment produced a significant depression in body temperature in S.C. White Leghorn, New Hampshire and Delaware at variable two temperature levels, 21°C and 29°C. Mreover, Thornton (1962) showed that supplementary ascorbic acid was of aid for maintaining normal body temperature of the chickens in either cool or warm atmosphere.

In heat stressed birds (38°C) vitamin C did not affect blood pressure signficantly (Subaschandran and Balloun, 1966).

Accordingly, the following experiment was designed to study the influence of vitamin C supplementation on feed efficiency, growth rate, mortality rate, body temperature, respiration rate, blood pressure and serum calcium and phosphorus in growing Fayoumi chicks up to 12 weeks of age reared under three variable temperature levels.

Experimental

Animal and diet

600 one-day -old Fayoumi chicks were used. They were reared in finishing batteries from hatch till the 12th week of age. Electric heating coils were the usual source of heat. Also, the brooder was supplied with electric thermostatic heater to keep the inside temperature almost constant as far as possible during the experimental period. The chicks were divided randomly into three groups. Chicks in the first group were brooded under constant high temperature of 90°F from the days of hatch until the 12th week of age. The second group was brooded under the normal temperature of the routine system. The temperature started at 90°F then decreased gradually by 3°F every week till it reached a constant temperature of 65°F. Chicks of the third group were subjected to colder temperature, starting by 85°F in the first week, 75 F in the second week and 65°F from the third week until the 12th week of age. Every group was divided into four subgroups (1-4). The subgroups were supplied repectively with 00,50,100 and 200 ascorbic acid in the ration.

The ration used was composed of 40% maize, 10% horse beans, 12% wheat bran, 12% rice bran, 20% decorticated cotton seed meal and 6% fish

meal. The ration was supplemented by 0.5% common salt, 1% bone meal, 2% calcium carbonate and 2 grams feed supplement pfizer vitamin A+D_3 per kg diet (vitamin A 5000 IU/g. and vitamin D_3 500 IU/g). Individual body weight and feed consumption were recorded at bi-weekly intervals. Monthly records for body temperature and respiration rate between 12 noon to 2.00 p.m. were tested in random group samples of 20 chicks. At the end of the experiment, 6 chicks from each subgroup were used to estimate blood pressure by the manometric method (Sturkie, 1954). After measuring blood pressure, blood samples were collected from the same chicks. The serum of each chick was used for the determination of calcium (Roe and Kahn 1929), and phosphorus (Fiske and Subbarow, 1925).

Statistical analysis were carried out (Steel and Torrie, 1960).

Results and Discussion

Effect of ascorbic acid on feed consumption and feed efficiency

From Table 1, it is evident that chickens reared from the date of hatch till the 12th week of age under low temperature consumed greater amount of feed, while those reared under high temperature consumed less amount of feed than those reared under normal or low temperature. Similar findings were reported by Muller (1962).

TABLE 1. **Average feed consumed (g/individual) at bi-weekly intervals for the different groups treated with ascorbic acid during the growing period**

Temp.	Levels of ascorbic acid ppm.	Periods in weeks						
		— 2	2—4	4—6	6—8	8—10	10—12	0—12
High 90°F . .	00	116	252	304	327	191	316	1507
	50	118	235	267	383	568	637	2209
	100	140	243	262	277	459	599	1983
	200	128	262	264	271	475	492	1894
Normal 90-87 65°F . . .	00	118	241	195	325	439	475	1796
	50	119	218	222	277	417	601	1856
	100	92	228	219	233	449	482	1706
	200	102	231	210	331	382	438	1697
Low 85-75-650 F	00	184	228	261	326	474	598	2072
	50	161	290	336	365	585	493	2232
	100	136	289	277	251	407	493	1855
	200	139	286	261	443	504	640	2096

Ascorbic acid supplementation to the ration of the growing chicks increased feed consumption (Table 1). The effect of ascorbic acid on feed consumption during the growing period was more pronounced under high temperature than under low or normal temperature.

Feed efficiency for increase in body weight was higher when chickens were reared under normal temperature followed by those reared under low temperature and lastly chicks reared under high temperature (Table 2). Prince *et al* (1965) came to the conclusion that feed efficiency was significantly lower at 12.6°C than at 23.8°C.

Addition of ascorbic acid to the ration of the growing chicks improved feed efficiency. This improvement was more pronounced under high temperature than under low or normal temperature. Also, the feed conversion was higher under the high level than the low level.

TBLE 2. **Feed efficiency at bi-weekly intervals for the different groups treated with ascorbic acid during the grownig period.**

Temp.	Level of ascorbic acid (ppm)	Period in weeks						
		0—2	2—4	4—6	6—8	8—10	10—12	0—12
High	00	3.06	3.87	4.20	5.06	5.73	6.45	4.73
	50	2.86	3.01	3.51	4.94	5.22	5 31	4.14
	100	2.78	3.07	3.23	3.42	4.57	5.13	3.70
	200	2.94	3.32	3.24	3.41	4.12	4.17	3.53
Normal . . .	00	2.51	2.94	3.20	3.61	4.55	5.16	3.66
	50	2.44	2.59	3.13	3.20	4.32	5.03	3.45
	100	1.95	2.50	2.94	3.17	3.95	4.02	3.14
	200	2.48	2.50	2.75	3.07	3.88	3.59	3.04
Low	00	3.60	3.67	3.89	4.29	4.76	5.17	4.23
	50	2.96	3.16	3.67	4.11	4.54	5.09	3.92
	100	2.54	2.90	3.27	3.98	4.39	4.77	3.64
	200	2.70	2.75	3.16	3.99	4.11	4.21	3.48

Thornton and Moreng (1959) proposed that ascobic acid had stimulating influence on the thyroid gland. This may in turn improve the feed efficiency.

Effect of ascorbic acid on growth

Absolute body weight

Average body weights at bi-weekly intervals from hatch to twelve weeks of age are shown in Table 3. Chicks reared under normal temperature gave the best absolute weight followed by those reared under low temperature then those under high temperature. It was shown that body size and weight of birds decrease if the surrounding temperature deviates from the optimal values, mainly due to loss of appetite (Kempster, 1938 and Huston *et al*, 1957).

TABLE 3. Absolute average weights (g/individual) at bi-weekly intervals for the different groups treated with ascorbic acid during the growing period.

Temp.	Levels of ascorbic acid (ppm)	Age Intervals in Weeks						
		0	2	4	6	8	10	12
High . . .	00	27.2	65.4	130.5	202.9	267.6	301.0	350.2
	50	27.4	68.8	146.8	223.0	300.6	409.6	529.6
	100	24.7	75.3	154.5	235.8	317.1	417.7	534.5
	200	25.1	68.7	147.9	229.6	309.2	424.6	542.6
Normal . .	00	24.7	72.1	154.3	215.5	305.6	402.1	494.2
	50	24.1	72.9	157.1	228.3	314.9	411.6	531.2
	100	24.7	72.2	159.6	234.4	308.1	421.9	541.9
	200	28.4	69.6	162.3	239.0	328.8	427.3	549.5
Low . . .	00	27.8	79.0	131.2	198.2	274.4	374.1	489.8
	50	27.4	82.0	174.0	265.5	354.3	483.3	580.2
	100	26.8	80.5	180.3	265.0	346.4	439.2	542.7
	200	24.0	75.8	179.9	262.6	373.9	496.6	606.1

Ascorbic acid supplementation to the ration of growing chicks from the date of hatch till 12the week of age improved absolute body weight. At 4 and 8 weeks the increase in absolute body weight was higher in chicks reared

under low temperature than those reared under high or normal temperature. Meanwhile, at 12 weeks the effect of ascorbic acid was more pronounced when chicks were reared under high than low or normal temperature.

Comparing between the effect of the different levels of ascorbic acid, at 4 weeks of age, the level of a 100 in the ration gave the best results in body weight than the low or high level (50 and 200 ppm). While, at 8 and 12 weeks the high level (200 ppm) produced the higher body weight. Concerning the effect of ascorbic acid on body weight in hot environment, our results are in agreement with Thornton and Moreng (1958b) and Edrise (1973).

Statistical differences between average body weights at 4,8 and 12 weeks of age for variable treatments of temperature and vitamin levels showed highly significant differences (Table 4). Also, highly significant differences were obtained for interactions of levels and temperature treatments at 12 weeks. The significant interaction between various levels and temperature indicate the importance of the suitability of variable levels of ascorbic acid to different temperature.

TABLE 4. Analysis of variance of absolute body weights at 4, 8 and 12 weeks of age for the different groups treated with ascorbic acid.

Items	S.V.	d.f.	M.S.	f-value
4 weeks	Levels (L)	3	18246.69	15.51**
	Temperature (T)	2	42692.33	36.28**
	L X T	6	830.98	00.71
8 weeks	Levels (L)	3	74583.95	23.15**
	Temperature (T)	2	106958.47	33.20**
	L X T	6	4122.6	1.28
12 weeks	Levels (L)	3	137528.19	30.49**
	Temperature (T)	2	46008.09	10.20**
	L X T	6	44966.23	9.97**

** $P < 0.01$

Relative rate of growth

It is apparent from Table (5) that birds grew initially faster then tended to slow down by advancing age. The relative increase in rate of growth during the early periods of life (0-4 weeks) in group reared under normaly temperature

is well illustrated as compared to groups reared under high or low temperature. Nevertheless, the attempt of groups to increase their rate of growth at later ages (4-12 weeks) was apparent for the group reared under low temperature.

TABLE 5. **Relative rate of growth at bi-weekly intervals for the different groups treated with ascorbic acid during the growing period.**

Temp.	Levels of ascorbic (ppm)	Periods in weeks					
		0.2	2—4	4—6	6—8	8—10	10—12
High	00	82.5	66.5	43.4	27.5	11.8	15.1
	50	85.9	72.4	41.2	29.6	30.7	25.6
	100	101.1	69.0	41.7	29.4	27.4	35.0
	200	93.0	73.1	43.3	29.8	31.5	24.4
Normal	00	97.9	72.6	33.2	34.6	27.3	20.6
	50	100.7	73.3	36.9	31.9	26.6	25.4
	100	98.1	75.5	37.9	27.2	31.2	24.9
	200	84.0	80.0	38.2	31.7	26.1	25.0
Low	00	95.9	59.2	40.7	32.2	30.7	26.8
	50	99.9	71.8	41.7	28.7	30.8	18.2
	100	100.1	76.5	38.0	26.6	23.6	21.1
	200	103.8	81.5	37.4	35.0	28.2	19.9

Under different temperatures the addition of ascorbic acid to the ration increased the relative growth rate from hatch till the fourth week of age, (Table 5). From 4-12 weeks of age, the addition of ascorbic acid under low temperature decreased the relative growth rate while under high or normal temperature it increased the relative rate of growth.

Effect of ascorbic acid on physiological reactions

From Table 6, it can be noted that high temperature caused an increase in body temperature and respiration rate of the chicks, while low temperature decreased their body temperature and respiraton rate. The body temperature of pullets rises whenever the environmental temperature exceeds 26.6°C. (Wilson, 1948). Baldwin and Kendeigh (1932). Thornton (1961a)

and Yeates *et al.* (1941) found that at air temperature of 32.2 °C the cloacal temperature of the birds begins to increase above the normal.

Addition of ascorbic acid to the ration of growing chicks from date of hatch till the 12th week of age decreased body temperature under different temperatures, while the respiration rate was increased under high and normal and decreased under low temperature (Table 6). The average reductions in in body temperature (compared to untreated groups) were 4.7, 1.8 and 2.7°C. in the groups reared under high, low and normal temperatures respectivelye The effect of ascorbic acid on body temperature and respiration rate mor pronounced under the higher levels than the lower levels of environmental temperature. The differences were highly significant (Table 8).

TABLE 6. Average body temperature, respiration rate and blood pressure for the different groups treated with ascorbic acid during the growing period.

Temp.	Levels of ascorbic acid (ppm)	Body temp. (°F)	Respiration rate (/minute)	Blood pressure (mm Hg)
High	00	112.3	141.3	118.7
	50	108.2	148.0	118.6
	100	107.3	153.0	117.9
	200	107.3	162.8	116.8
Normal	00	110.7	69.2	117.9
	50	109.2	75.7	116.8
	100	107.9	79.5	117.7
	200	107.1	89.8	116.8
Low	00	107.7	63.9	117.5
	50	106.6	53.3	117.4
	100	105.9	57.8	117.7
	200	105.3	56.4	116.6

Addition of ascorbic acid to the ration of growing chicks showed no significant effect on blood pressure under different environmental temperature (Tables 6 and 8).

These results are in good agreement with several authors such as Grimes and Moreng, 1965 : and Subaschandran and Balloun, 1966.

Effect of ascorbic acid on serum calcium and phosphorus

High temperature had highly significant effect on decreasing the levels of serum calcium and phosphorus (Table 7). This result is in agreement with Conrad (1939) who found that serum calcium levels were reduced at high temperatures.

TABLE 7. **Average serum calcium and phosphorus (mg/100 ml of serum) for the different groups treated with ascorbic acid during the growing period.**

Temp.	Levels of ascorbic acid (ppm)	Calcium (mg/100 ml)	Phosphorus (mg/100 ml)
High	00	10.00	4.79
	50	10.76	4.97
	100	11.85	5.13
	200	12.41	5.44
Normal	00	11.79	4.95
	50	12.60	5.21
	100	12.85	5.37
	200	12.92	5.58
Low	00	12.30	5.14
	50	12.83	5.34
	100	12.95	5.55
	200	13.16	5.78

Addition of ascorbic acid to the ration of the growing chicks increased the serum calcium and phosphorus. This effect was more pronounced under high temperature than low or normal temperature (Table 7). The differences were highly significant (Table 8). The high level of ascorbic acid supplementation caused greater increase in serum calcium and phosphorus than the low level.

TABLE 8. **Analysis of variance of body temperature, respiration rate, blood pressure and serum calcium and phosphorus for the different groups treated with ascorbic acid during the grwing period.**

Items	S. V.	d.f.	M. S.	F
Body Temp.	Levels (L)	3	158.17	4.08**
	Temp. (T)	2	437.19	11.29**
	L X T	6	34.57	0.89
Respiration rate	Levels (L)	3	2326.10	237.84**
	Temp. (T)	2	262833.82	26874.62**
	L X T	6	1440.27	147.27**
Blood pressure	Levels (L)	3	275.06	1.99
	Temp. (T)	2	160.41	1.16
	L X T	6	19.06	0.14
Calcium	Levels (L)	3	13.32	39.18**
	Temp. (T)	2	24.30	71.47**
	L X T	6	1.57	4.62
Phosphorus . .	Levels (L)	3	2.18	35.16*
	Temp. (T)	2	1.45	23.39***
	L X T	6	0.007	0.11

** = P — 0.01

Effect of ascorbic acid on mortality rate

Mortality rate increased when chicks were reared under high or low temperature with or without ascorbic acid than those reared under normal temperature (Table 9). As far as high temperature is concerned, our findings are supported by those of Muller (1962).

Ascorbic acid supplementation to the ration of growing chicks decreased the mortality rate (Table 9), by 12.7, 10.7 and 6.7% for chicks reared under high, low normal temperatures respectively. The higher levels of ascorbic acid caused greater reduction in mortality than the lower level. Our results are similar to those obtained by Edrise (1973).

TABLE 9. Mortality rate for the different groups treated with ascorbic acid during the growing period.

Levels of ascorbic acid (ppm)	Mortality %		
	High temp.	Normal temp.	Low temp.
00	24	14	22
50	18	10	16
100	14	6	10
200	6	4	9

From the previous results and discussion we can conclude that, in heat stressed birds, the addition of vitamin C to the growing ration countreacting the disastrous effect of the heat stress concerning the feed efficiency, growth rate, serum calcium and phosphorus and mortality rate. This beneficial effect of ascorbic acid supplementation was acquired through its role in maintaining the normal physiological activities (body temperature, respiration rate and blood pressure) against the heat stress.

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تأثير اعطاء فيتامين ج على التنظيم الحرارى للكتاكيت النامية

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ربيت الكتاكيت الى عمر ١٢ أسبوع تحت درجة حرارة مرتفعة وصلت الى ٩٠ف وكانت هناك مجموعة مقارنة ثم قسمت كل مجموعة الى مجاميع أعطيت فيتامين ج بنسب مختلفة . وأدى ارتفاع درجة الحرارة عامة الى انخفاض سرعة النمو والصفات المرتبطة . واضافة فيتامين ج على وجه العموم حسن سرعة النمو بصفة عامة والصفات المدروسة المرتبطة وساعد أيضا على تلافى التأثير الضار للحرارة الجوية .