The Interaction Effect Of Calcium And Vitamin C on the Performance Of Commercial Broilers chicks Under Summer Condition.

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ABSTRACT

The present work was performed to study the effect of dietary calcium level, vitamin C (ascorbic acid) and their interaction on the performance of broiler chicks during hot summer season (28-35°C).

A 3X3 factorial treatment arrangement was carried out including three levels of dietary calcium (0.7, 1.0 and 1.3 %) and three levels of supplemented ascorbic acid (0, 300 and 600 mg /kg diet). A total number of 270 Cobb broiler chicks were randomly distributed into nine treatment groups (three replicate each). Chicks in all treatments were equal in number and had nearly similar initial body weight.

The results obtained showed significant ($p<0.05$) improvement in live body weight at 4 and 7 weeks of age and body weight gain during all the experimental periods when chicks were fed either 0.7 or 1.0% dietary calcium as compared with those fed 1.3% . No significant differences were observed on feed intake due to dietary calcium levels during all the experimental periods while feed conversion for both the starter and the whole experimental period improved significantly ($p<0.05$ or $p<0.01$) when chicks were fed 0.7% dietary calcium as compared with other treatments. The ascorbic acid supplementation didn't affect significantly ($p<0.05$) on live body weight, body weight gain and feed conversion ratio at any level compared to the unsupplemented one. However, feed consumption during all the experimental periods were significantly increased ($p<0.05$). The interaction effects between dietary calcium and ascorbic acid levels were significant ($p<0.01$) on body weight gain and feed conversion ratio. In conclusion, from the nutritional and economical point of view, it could be concluded that, a minimum level of 0.7 % calcium and optimum one of 1% calcium with 300 mg vitamin C /kg diet are recommended for the feeding of Cobb broiler chicks, from 1-7 weeks of age under Egyptian summer conditions.

INTRODUCTION

Animals are subject to stress from a number of sources, among them management husbandry practices, nutrition and environmental temperature. For poultry in tropical and sub–tropical countries environmental temperature is the major stress. Heat stress is known to have a negative effect on productive of chickens such as growth feed intake, feed conversion, carcass traits and mortality rate.....etc .(1,2).

Calcium is one of the key elements required for maintenance and egg production. It plays a major role in a wide variety of biological functions. Under tropical conditions, the optimum Ca level should be greater than 1.0% but should not exceed 1.2%.*(3)*.

Recent studies in poultry have shown that supplemental ascorbic acid given in feed or drinking water or by injection has improved performance of chickens during heat stress. Other studies have reported that ascorbic acid had little or no beneficial effect on broiler performance (1,4).

Dietary supplementation with Vitamin C increased the growth rate by 4.5%, and improved the tolerability to stresses and reduced the mortality by 5% (5).

In view of the above, it seems there may exist a significant interaction between vitamin

C and calcium with respect to metabolism and bone formation, which has not been explored in species that synthesize ascorbic acid. Therefore, Vitamin C nutrition should have influence on calcium and phosphorus metabolism in young chicks which possess no ability to synthesize vitamin C. Supplemental vitamin C enhanced the mineralization of the skeleton of young poultry ***(6, 7)***.

Therefore, the objective of the present study was to assess the effect of different levels of vitamin C and calcium on performance of broiler chicks.

MATERIALS AND METHODS

A total number of 270 unsexed one week old Cobb chicks were randomly distributed into 9 groups (each of 30 chicks). The chicks were not statistically different in average of body weight. Each group was divided into three replicates (each of 10 chicks).

A factorial design arrangement (3 X 3) was performed included three levels of calcium (0.7, 1.0, and 1.3 %) during the starter period (1-4 weeks of age) and the finisher period (4 - 6 weeks of age) and three levels of supplemented ascorbic acid (0, 300, 600 mg/kg diet. The basal experimental diets were formulated to contain 0.7, 1.0 and 1.3 % calcium during the starter and the finisher periods (Table 1). Each diet was fed either without or with ascorbic acid at levels 0, 300 and 600 mg/kg diet.

The experiment was carried out during summer season. The maximum and minimum ambient temperatures were recorded daily at noon (12:00 pm). The ambient temperatures ranged between 28 and 35°C, while the relative humidity was between 54.5 and 62.6 %.

Chicks were individually weighted at 1, 4 and 7 weeks of age. Also body weight gain was calculated. Feed intake data were recorded at the end of starter, finisher and the whole experimental periods on a replicate basis during the experimental periods consequently, feed conversion was estimated (g feed/g gain). Economical efficiency (EEF) of the each experimental groups was also calculated according to the following equation: EEF% = (A-B)/B X 100, where A is the selling cost of the obtained gain and B is the feeding cost of this gain.

At the 7^{th} week of age, three birds from each group were randomly taken around the average of body weight and deprived of feed for 12 hours, weighted and slaughtered to complete bleeding by plucking the feathers then weighed, The carcass traits studied were giblets, carcass and dressed weight (carcass weight plus giblets weight /100g preslaughter weight).

Data obtained were statistically analyzed (3 dietary calcium level and 3 ascorbic acid levels) ***(9)***. Differences among treatment means were tested using Duncan's new multiple range test ***(10)***.

Table 1. Composition of the experimental diets.

Ingredient	STARTER RERIOD (1-4 weeks)			FINISHER PERIOD (4-7 weeks)		
	Ca 0.7 %	Ca 1.0%	Ca 1.3 %	Ca 0 .7%	Ca 1.0%	Ca 1.3 %
Yellow Corn	62.96	62.66	62.28	73.96	73.67	73.26
Soybean meal (44% CP)	25.30	23.53	22.00	9.83	8.03	6.55
Corn gluten 60%	8.50	9.73	10.82	12.84	14.10	15.15
Di-Calcium Phosphate	1.73	1.73	1.72	1.32	1.32	1.33
Limestone	0.62	1.43	2.23	0.97	1.77	2.57
Premix*	0.30	0.30	0.30	0.30	0.30	0.30
NaCl	0.30	0.30	0.30	0.30	0.30	0.30
Lysine – HCL	0.17	0.21	0.23	0.05	0.06	0.06
DL- Methionine	0.08	0.07	0.06	0.41	0.45	0.48
Choline Chloride	0.04	0.04	0.05	0.03	0.01	0.00
TOTAL	100	100	100	100	100	100
Calculated values**						
C.P %	22	22	22	19.08	19.08	19.08
ME (Kcal/Kg)	3000.48	2997.83	2992.56	3194.3	3192.43	3185.83
M.E /C.P	136.39	136.27	136.03	167.42	167.32	166.97
Lysine %	1.1	1.1	1.1	1	1	1
Methionine + cystine %	0.9	0.9	0.9	0.8	0.8	0.8
Calcium %	0.7	1	1.3	0.7	1	1.3
Av. Phosphorus%	0.45	0.45	0.45	0.35	0.35	0.35
Ca : P	1.56	2.22	2.89	2.00	2.86	3.71
Choline	1300	1300	1300	1000	1000	1000

* Vitamins and minerals mixture provide per kilogram of diet vitamin A (as alltransretinyl acetate); 12000 IU; Vitamin E (all racatocopheryl acetate); 10 IU; k_3 3mg; Vit.D_3, 2200 ICU; Riboflavin, 10 mg; Ca pantothenate, 10 mg; Niacin, 20 mg; ; Vitamin B_{12}, 10mg; Vitamin B_6, 1.5 mg; Thiamine (as thiamine mononitrate) ; 2.2 mg; Folic acid, 1 mg; Dbiotin, 50mg. Trace mineral (milligrams per kilogram of diet) Mn, 66; Zn, 50; Fe, 30;Cu, 4; Se, 0.1 and Ethoxyquin 3mg.

** Calculated as previously described *(8).*

RESULTS AND DISCUSSION

Growth performance

Calcium effect

The results obtained showed significant ($p<0.05$) improvement in live body weight at 4 and 7 weeks of age and body weight gain during all the experimental periods when chicks were fed either 0.7 or 1.0% dietary calcium as compared with those fed 1.30% (Table 2).

On the same time, no significant differences were observed between 0.7 or 1.0%. It's worth to note that increasing dietary calcium level decreased live body weight and body weight gain. Moreover, no significant differences were observed on feed intake due to dietary calcium levels during all the experimental periods while feed conversion for both the starter and the whole experimental period improved significantly ($p<0.05$ or $p<0.01$) when chicks were fed 0.7% dietary calcium as compared with other treatments. This improved the efficiency of utilizing Ca for growth at low levels of dietary calcium (0.7%) might have been due to increased intestinal absorption of calcium as a result of up-regulation of plasma and intestinal 1,25 dihydroxycholecolciferol concentrations *(11,12)* with a consequent increase in the

concentration of duodend calibindin, a protein which lines the gut and blinds Ca from the lumen *(13)*.

It is clear that a total dietary concentration of 0.7% calcium was sufficient to achieve normal broiler performance.

The depression in growth among our chicks fed high dietary calcium has been also reported by several investigators suggesting that the growth depressing effect of high calcium diets was caused by an increase in microbial activity in the intestine, which increased the deamination of amino acid with the production of ammonia, which is not used by the chicken *(14-16)*.

Feed conversion ratio was influenced by the levels of Ca and P on the diet significantly ($p<0.05$) which reduced by decreasing their levels *(17)*. 0.99 to 1.07% calcium was needed for maximum growth *(18)*. While it has been shown that the dietary calcium supplementation reduced gain and feed intake at 1.25 level *(19)*. The higher dietary calcium reduced growth performance and feed efficiency for broiler chicks *(20)*.

Ascorbic acid effects

The results presented in Table 2 indicated that live body weight, body weight gain and feed conversion ratio were not significantly ($p<0.05$) affected by ascorbic acid supplementation at any level compared to the unsupplemented one. It is worth to note that chicks fed the diet supplemented with 300 mg/kg diet insignificantly improved live body weight, feed conversion and body weight gain. However, feed consumption during all the experimental periods were significantly increased ($p<0.05$). Feed intake was increased in case of supplementing with ascorbic acid *(5,21,22)*. The improving in feed consumption increased with increasing the dietary ascorbic acid level. The beneficial effects of growth performance due to ascorbic acid supplementation may be due to that ascorbic acid helps to control the increase in body temperature and plasma corticosterone concentration. It also, protects the immune system and it has an important role in bone formation through the growth rate *(23)*.

The present results are consistent with those reported that an improvement in growth performance of broiler chicks reared in tropical environment or exposed to high temperature, when their diets were supplemented either with 200 or 250 mg vitamin C /kg diet *(2,24)*. Likewise it has been that an increase in growth rate of broilers reared under summer conditions and fed diets containing 150, 300 and 600 mg vitamin C /kg diet *(25)*. Optimum responses in growth, feed efficiency and/or livability in broilers under heat stress seem to occur with supplements of about 250 mg ascorbic acid /kg *(26)*. Supplementation of ascorbic acid at 200 ppm is beneficial for improving the performance and immunity and for exploiting the full genetic potential of the commercial broilers *(27)*. On the other hand, it has been reported that 200 mg vitamin C /kg diet had no significance on body weight gain and feed conversion of broiler chicks reared under hot climate *(1)*. Better growth has not been recorded by the supplementation with vitamin C *(28)*.

Interaction effects

The interaction effects between dietary calcium and ascorbic acid levels were significant ($p<0.01$) on body weight gain and feed conversion ratio and energy utilization during finisher period (4-7 weeks of age). Wherever the live body weight and feed consumption didn't affected by the interaction during starter, finisher and the whole experimental periods. It worthy to note that chicks fed on diets containing 0.7% calcium level and supplemented with 300 mg vitamin C /kg diet had the best growth performance rates followed by that of 1% calcium with the same level of ascorbic acid.

Carcass traits

Calcium level effect

There are significantly increasing ($P<0.05$) in dressing and carcass percentages associated with low and medium level of

calcium (0.7 and 1.0%) when compared with higher one. No significant differences between treatments of calcium level in case of giblets percentages except the liver percentage it increased significantly with high level calcium (1.3%)

Ascorbic acid effects

Results in Table 4 did not show any effect on carcass traits studied except only heart percentage which affected significantly ($p<0.01$) due to the supplementation of ascorbic acid in broiler chicks. Similar findings reported that carcass giblets did not significantly affected by ascorbic acid supplementation in the diet heat stress ***(29)***.

Interaction effects

No significant interaction effects were found between dietary calcium and ascorbic acid on all traits of carcass studied (Table 4).

Mortality rate

Mortality rate during the whole experimental periods (1-7 weeks of age) was not significantly affected by dietary calcium level, vitamin C supplementation and their interaction (Table 2 and 3).

Economical efficiency

Data indicated that feeding broiler chicks on diet containing 0.7% calcium gave the best economical efficiency (EEF) compared to those fed on 1.0 or 1.3% (Table 2). At the end of experimental period, chicks fed on diet without ascorbic acid supplementation recorded better EEF compared with the supplemented diet. It is worth to note that EEF rates tended to decrease with increasing calcium level or ascorbic acid in the diet.

Regarding the interaction effect results in Table 3 demonstrated that the best EEF value obtained by birds fed diets containing 0.7% calcium with 300 mg vitamin C/kg diet.

In conclusion, from the nutritional and economical point of view, it could be concluded that, a minimum level of 0.7% and optimum one of 1% calcium with 300 mg vitamin C /kg diet is recommended for the feeding of Cobb chicks, from 1-7 weeks of age under Egyptian summer condition.

Table 2. Growth performance (Mean ± S.E) of broiler chicks as affected by different levels of calcium and ascorbic acid during the experimental period.

Items	Calcium levels (%)			Sign	Ascorbic acid levels (mg)			Sign
	0.7	1.0	1.3		0	300	600	
Live body weight								
1 week	111.94 ± 0.04	112.09 ± 0.05	111.97 ± 0.04	NS	111.99 ± 0.04	112.02 ± 0.06	111.99 ± 0.04	NS
4 weeks	953.46 ± 6.21 ^{a}	923.13 ± 21.00 ^{a}	865.18 ± 7.66 ^{b}	**	912.44 ± 16.46	926.58 ± 24.19	902.74 ± 12.22	NS
7 weeks	1866.50 ± 22.84 ^{a}	1809.99 ± 23.40 ^{a}	1712.08 ± 23.88 ^{b}	**	1770.84 ± 23.24	1812.65 ± 45.22	1805.09 ± 21.36	NS
Body weight gain								
1 - 4 weeks	841.51 ± 6.22 ^{a}	811.04 ± 20.96 ^{a}	753.21 ± 7.67 ^{b}	**	800.46 ± 16.45	814.56 ± 24.17	790.76 ± 12.21	NS
4 - 7 weeks	913.05 ± 18.83 ^{a}	886.86 ± 12.29 ^{ab}	846.91 ± 19.60 ^{b}	*	858.40 ± 14.60	886.07 ± 25.24	902.342 ± 13.90	NS
1 - 7 weeks	1754.56 ± 22.84 ^{a}	1697.90 ± 23.36 ^{a}	1600.12 ± 23.88 ^{b}	**	1658.85 ± 23.23	1700.63 ± 45.22	1693.10 ± 21.36	NS
Feed intake								
1 - 4 weeks	1679.44 ± 9.52	1676.78 ± 6.06	1664.44 ± 12.35	NS	1657.00 ± 6.98 ^{b}	1672.78 ± 10.79 ^{ab}	1690.89 ± 7.68 ^{a}	*
4 - 7 weeks	2334.67 ± 26.13	2329.78 ± 15.63	2294.00 ± 33.81	NS	2273.22 ± 20.47 ^{b}	2320.56 ± 28.95 ^{ab}	2364.67 ± 20.32 ^{a}	*
1 - 7 weeks	4014.11 ± 35.61	4006.56 ± 21.60	3958.44 ± 46.11	NS	3930.22 ± 27.41 ^{b}	3993.33 ± 39.69 ^{ab}	4055.56 ± 27.94 ^{a}	*
Feed conversion								
1 - 4 weeks	1.997 ± 0.017 ^{b}	2.078 ± 0.053 ^{b}	2.212 ± 0.022 ^{a}	**	2.077 ± 0.036	2.067 ± 0.061	2.143 ± 0.032	NS
4 - 7 weeks	2.563 ± 0.049 b	2.631 ± 0.038 ^{ab}	2.720 ± 0.058 a	*	2.654 ± 0.048	2.633 ± 0.068	2.627 ± 0.042	NS
1 - 7 weeks	2.289 ± 0.029 ^{b}	2.364 ± 0.033 ^{ab}	2.477 ± 0.035 ^{a}	**	2.372 ± 0.027	2.360 ± 0.061	2.398 ± 0.029	NS
Mortality ratio								
1 - 4 weeks	0.00	0.00	0.00	NS	0.00	0.00	0.00	NS
4 - 7 weeks	2.22 ± 0.786	2.59 ± 0.741	1.85 ± 0.980	NS	2.22 ± 0.786	1.85 ± 0.585	2.59 ± 1.080	NS
1 - 7 weeks	2.22 ± 0.786	2.59 ± 0.741	1.85 ± 0.980	NS	2.22 ± 0.786	1.85 ± 0.585	2.59 ± 1.080	NS
Economic eff	84.35 ± 2.53 ^{a}	77.47 ± 2.51 ^{b}	68.56 ± 2.86 ^{c}	**	79.50 ± 2.14	78.49 ± 4.81	72.39 ± 2.28	NS

$^{a, b, c}$ Means (± SD) in the same row with different superscripts are significantly different ($p<0.05$)
(NS Means Not significant) (* Means significant $P< 0.05$) (** Means significant $P< 0.01$)

Table 3. Growth performance (Mean ± S.E) of broiler chicks as affected by the interaction effect of different levels of calcium and ascorbic acid during the experimental period.

Calcium level %	0.7			1.0			1.3			sign
Ascorbic acid (mg)	0	300	600	0	300	600	0	300	600	
Live body weight										
1 week	111.9±0.06	111.9±0.09	112.0±0.06	112.1±0.06	112.2±0.09	112.0±0.10	111.9±0.07	111.9±0.09	111.9±0.07	NS
4 weeks	948.13±10.97	971.03±9.22	941.20±3.77	926.73±33.68	964.23±41.00	878.43±25.01	862.47±2.79	844.47±13.74	888.60± 4.00	NS
7 weeks	1796.66±14.81	1944.06±15.86	1858.79±17.69	1794.20±43.31	1832.26±48.21	1803.51±44.44	1721.67±50.73	1661.62±41.59	1752.96±19.61	NS
Body weight gain										
1 - 4 weeks	836.23±11.03	859.10±9.14	829.20± 3.83	814.63±33.63	852.07±40.93	766.43±24.96	750.50±2.76	732.50±13.83	776.63± 3.97	NS
4 - 7 weeks	848.52±4.31^{bc}	973.03±7.52^{a}	917.593±17.05^{b}	867.47±9.88^{bc}	868.03±15.41^{bc}	925.07±19.54^{ab}	859.20±48.48^{bc}	817.16±32.18^{c}	864.36±23.48^{bc}	*
1 - 7 weeks	1684.76±14.87	1832.13±15.77	1746.80±17.73	1682.10±43.25	1720.10±48.12	1691.51±44.40	1609.70±50.67	1549.66±41.67	1640.99±19.66	NS
Body weight gain										
1 - 4 weeks	1660.33±6.06	1676.00±21.93	1702.00±11.27	1674.00±12.42	1682.00±16.01	1674.33±3.18	1636.67± 6.01	1660.33±23.10	1696.33±18.89	NS
4 - 7 weeks	2284.00±15.31	2322.67±62.08	2397.33±28.00	2326.33±32.95	2350.00±38.02	2313.00±7.02	2209.33±14.17	2289.00±61.85	2383.67±45.54	NS
1 - 7 weeks	3944.33±21.26	3998.67±83.91	4099.33±39.27	4000.33±45.34	4032.00±54.03	3987.33±09.94	3846.00±20.07	3949.33±84.94	4080.00±64.38	NS
Feed conversion										
1 - 4 weeks	1.987±0.019	1.950±0.006	2.053±0.017	2.060±0.072	1.983±0.113	2.190±0.070	2.183±0.015	2.267±0.046	2.187±0.032	NS
4 - 7 weeks	2.690±0.006^{ab}	2.387±0.055^{b}	2.613±0.020^{ab}	2.683±0.029^{ab}	2.707±0.047^{a}	2.503±0.047^{ab}	2.590±0.154^{ab}	2.807 ±0.047^{a}	2.763±0.043^{a}	**
1 - 7 weeks	2.340± 0.010	2.180±0.031	2.347±0.003	2.383±0.043	2.350±0.087	2.360±0.060	2.393±0.079	2.550±0.040	2.487±0.023	NS
Mortality ratio										
1 - 4 weeks	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NS
4 - 7 weeks	2.22±1.110	2.22±1.110	2.22±2.223	2.22±1.110	2.22±1.110	3.33±1.925	2.22±2.223	1.11±1.110	2.22±2.223	NS
1 - 7 weeks	2.22±0.786	2.22±1.111	2.22±2.224	2.22±1.111	2.22±1.111	3.33±1.926	2.22±2.224	1.11±1.111	2.22±2.224	NS
EEF	82.80 ± 0.71^{b}	93.27 ± 2.86^{a}	76.98 ± 0.27^{d}	78.65 ± 3.21^{c}	78.72 ± 6.41^{c}	75.03 ± 4.44^{e}	77.04 ± 5.93^{d}	63.49 ± 2.53^{g}	65.16 ± 1.46^{f}	*

$^{a, b, c}$ Means (± SD) in the same row with different superscripts are significantly different ($p<0.05$)
(NS Means Not significant) (* Means significant $P< 0.05$) (** Means significant $P< 0.01$)

Table 4. Some carcass Traits (Mean ± S.E) of broiler chicks as affected by different levels of calcium , ascorbic acid and their interaction during the experimental period at 7 weeks of age.

Items		Pre-slaughter weight (g)	Dressing %	Carcass %	Giblets %	Liver W%	Gizzard W%	Heart W%
Ca levels (Ca) %								
0.70		1962.22 ± 46.317 [a]	79.75 ± 0.520 [a]	76.03 ± 0.570 [a]	3.72 ± 0.121	1.77 ± 0.085 [b]	1.58 ± 0.061	0.37 ± 0.015
1.00		1902.11 ± 25.941 [a]	78.29 ± 0.537 [ab]	74.38 ± 0.550 [ab]	3.91 ± 0.118	1.99 ± 0.078 [ab]	1.53 ± 0.070	0.39 ± 0.022
1.30		1783.44 ± 26.631 [b]	77.42 ± 0.598 [b]	73.32 ± 0.745 [b]	4.10 ± 0.152	2.13 ± 0.076 [a]	1.54 ± 0.095	0.43 ± 0.029
Sign		**	*	*	NS	*	NS	NS
Ascorbic Acid (AA)								
0		1838.22 ± 37.649	78.44 ± 0.786	74.68 ± 0.894	3.76 ± 0.159	1.86 ± 0.092	1.52 ± 0.082	0.38 ± 0.018 [b]
300		1902.11 ± 54.555	78.51 ± 0.579	74.63 ± 0.661	3.88 ± 0.130	1.95 ± 0.100	1.57 ± 0.063	0.36 ± 0.017 [b]
600		1907.44 ± 28.842	78.50 ± 0.555	74.41 ± 0.638	4.09 ± 0.107	2.08 ± 0.074	1.55 ± 0.083	0.46 ± 0.024 [a]
Sign		NS	NS	NS	NS	NS	NS	**
Interaction between calcium level and ascorbic acid								
Ca %	**AA (mg)**							
	000	1867.00 ± 83.530	80.84 ± 0.649	77.41 ± 0.506	3.43 ± 0.300	1.59 ± 0.139	1.50 ± 0.176	0.34 ± 0.006
0.7	**300**	2052.67 ± 93.112	78.70 ± 1.042	74.89 ± 1.137	3.81 ± 0.105	1.79 ± 0.162	1.67 ± 0.074	0.35 ± 0.018
	600	1967.00 ± 38.223	79.70 ± 0.776	75.78 ± 0.853	3.92 ± 0.094	1.94 ± 0.098	1.56 ± 0.015	0.42 ± 0.020
	000	1898.33 ± 16.796	76.63 ± 0.892	72.80 ± 1.143	3.83 ± 0.256	1.95 ± 0.145	1.52 ± 0.150	0.37 ± 0.032
1.0	**300**	1909.33 ± 48.923	79.21 ± 0.532	75.35 ± 0.330	3.86 ± 0.251	2.01 ± 0.184	1.48 ± 0.072	0.36 ± 0.049
	600	1898.67 ± 73.217	79.03 ± 0.567	75.00 ± 0.563	4.03 ± 0.165	2.01 ± 0.130	1.58 ± 0.168	0.44 ± 0.021
	000	1749.33 ± 59.823	77.86 ± 1.237	73.84 ± 1.480	4.02 ± 0.242	2.03 ± 0.064	1.55 ± 0.163	0.44 ± 0.022
1.3	**300**	1744.33 ± 29.007	77.62 ± 1.413	73.66 ± 1.757	3.96 ± 0.350	2.05 ± 0.200	1.55 ± 0.168	0.36 ± 0.024
	600	1856.67 ± 7.688	76.78 ± 0.664	72.46 ± 0.901	4.33 ± 0.238	2.30 ± 0.055	1.53 ± 0.232	0.50 ± 0.063
Sign		NS	NS	NS	NS	NS	NS	NS

[a, b, c] Means (± SD) in the same row with different superscripts are significantly different ($p<0.05$)
(NS Means Not significant) (* Means significant $P< 0.05$) (** Means significant $P< 0.01$)

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الملخص العربي

تأثير التداخل بين مستويات الكالسيوم وفيتامين ج على أداء بداري التسمين تحت ظروف الصيف.

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أجري هذا البحث في الفترة من أغسطس وحتى سبتمبر عام ٢٠٠٧م لدراسة أثرالتداخل بين مستوى الكالسيوم وفيتامين على أداء بداري التسمين أثناء فترات الصيف الحار (٢٨- ٣٥م°).

صممت التجربة كتصميم عاملي (٣ x ٣) ويتضمن ثلاث مستويات من الكالسيوم (٠,٧، ١,٠ ، ١,٣%) وثلاث مستويات من فيتامين ج (حمض الاسكوربيك) هى (٠، ٣٠٠، ٦٠٠ جزء في المليون/ كجم عليقة). وتم توزيع ٢٧٠ كتكوت عمر أسبوع عشوائيا في ٩ مجموعات (كل مجموعة ثلاث مكررات) وكل الكتاكيت في جميع المجموعات متساوية في العدد ومتشابهة الوزن الأولى تقريبا فلا توجد بينها اختلافات معنوية في الوزن.

أوضحت النتائج وجود تحسن معنوي ($P<0.05$) في وزن الجسم الحي ومعدل الزيادة في الوزن عند ٤ ، ٧ أسابيع من العمر فى جميع فترات التجربة عند تغذية الكتاكيت على عليقة تحتوى على ٠,٧ ، ١% كالسيوم بالمقارنة بالعليقة التي تحتوى على ١,٣% كالسيوم. بينما لاتوجد اى تأثيرات معنوية لمستوى الكالسيوم على معدل استهلاك العليقة فى جميع فترات التجربة. وتحسن معدل كفاءة التحويل الغذائى معنويا($P<0.05$ أو $P<0.01$) في فترة البادىء والفترة الكليه للتجربة عندما غذيت الكتاكيت على عليقة تحتوى على ٠,٧% كالسيوم مقارنة بالمعاملات الأخرى. وأما مستوى إضافة فيتامين ج فلم يؤثر معنويا على وزن الجسم الحي ولا على معدل الزيادة فى وزن الجسم ولا معدل كفاءة التحويل عند اى فترة من فترات التجربة مقارنة بالمعاملات الأخرى التي لم يضاف إليها فيتامين ج، بينما اثر معنويا ($P<0.05$) على معدل استهلاك العليقة فى جميع فترات التجربة. وكذلك تأثير التداخل بين مستويات الكالسيوم ومستوى إضافة فيتامين ج كان تأثير معنويا ($P<0.01$) على معدل الزيادة فى وزن الجسم ومعدل التحويل الغذائى.

ومن خلال هذا البحث من الناحية الغذائية والاقتصادية يمكن التوصية باستخدام عليقة تحتوى على ٠,٧% كالسيوم كحد أدنى و١% كحد أقصى مع إضافة ٣٠٠ جزء فى المليون من فيتامين ج / كجم عليقة في الفترة من الأسبوع الأول إلى السابع من العمر لبدارى التسمين (Cobb) تحت ظروف الصيف الحار.