

**EFFECT OF VITAMINS A AND/OR C ON
PRODUCTIVE AND PHYSIOLOGICAL
PERFORMANCE OF GROWING
SPANISH V-LINE RABBITS**

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ABSTRACT: This work was conducted to study the effect of vitamins A and / or C on productive and physiological performance of growing Spanish V-line rabbits. Injection of Spanish V-line growing rabbits with vitamins A and / or C with different levels insignificantly improved growth performance (live body weight, body weight gain, feed consumption and feed conversion) and carcass characteristics. However, the mortality rate was within the normal range. Furthermore, injection of vitamins A and / or C at different levels on growing rabbits hadn't deleteriously affects on blood haematological or biochemical parameters.

Key words: Rabbits, vitamins A and C, growth performance, physiological parameters.

INTRODUCTION

The information about the suitable level of vitamins to growing rabbits under Egyptian conditions is lacking. In this respect, some safe feed additives may be used such as vitamins A and C, to increase the productivity of rabbits. Vitamin A has an over

all effect on cellular processes either directly or indirectly. It plays a role in regulating the stability and structure of biological membranes (Roels *et al.*, 1969). Live body weight and body weight gain were increased as well as feed consumption and feed conversion were improved in rabbits injected with vitamin A (Elmarimi *et al.*,

1989). Vitamin C is involved in several biochemical processes and its function is related to its reversible oxidation and reduction characteristics in the endogenous of cells such as mixed function oxidation involving in corporation of oxygen in the substrate (McDowell, 1989.; Frei *et al.*, 1991 and Linder, 1991).

MATERIALS AND METHODS

This study was carried out at the Poultry Research Farm, Faculty of Agriculture, Alexandria University, during the summer conditions of Egypt from June till August, 2004. Fifty-four male Spanish V-line rabbits at 5 weeks of age with an average initial body weight (705.74 ± 43.02 gm) were allocated at random, nine experimental groups (6 rabbits each). Rabbits were housed in galvanized wire cages (60 x 55 x 40 cm) provided with feeders and automatic watering system, in a well ventilated building and were kept under the same managerial, hygienic and environmental conditions.

Basal diet was formulated to cover the nutrient requirements of rabbits during growing period as recommended by NRC (1977).

The composition and calculated analysis of the experimental basal diet are presented in Table 1. Rabbits of the 1st group served as control, while, rabbits of the 2nd, 3rd, 4th and 5th groups were injected subcutaneously (under neck skin) weekly by vitamin A at levels of 1200(A₁) and 2400 (A₂) I.U. / kg body weight (BW) and by vitamin C at levels of 250 (C₁) and 500 (C₂) mg / kg BW, respectively. Rabbits of the 6th, 7th, 8th and 9th groups were injected subcutaneously (under neck skin) weekly by vitamins A and C at levels of 1200 I. U plus 250 mg, 1200 I. U plus 500 mg, 2400 I.U. plus 250 mg and 2400 I.U. plus 500 mg / kg BW, respectively, for 8 weeks treatment period.

During the experimental period individual live body weight was recorded weekly, also feed consumption was recorded during the course of the study. Feed conversion was calculated as the quantity of feed required obtaining one gram of gain during a certain period (g feed / g weight gain). Mortality number was recorded daily. At the end of the experimental period, three fasted rabbits from each treatment were chosen randomly for slaughtered. Rabbits were slaughtered by severing the

Table 1: Composition and calculated analysis of the experimental basal pelleted diets

Ingredients	(%)
Clover hay	44.00
Yellow corn grains	15.00
Wheat bran	23.95
Soybean meal (42 % CP)	10.00
Molasses	5.00
Bone meal	1.10
Calcium carbonate	0.60
Vitamins & minerals Premix*	0.25
DL - Methionin	0.10
Total	100.00
Calculated analysis **: 	
Digestible energy (Kcal/kg)	2670.00
Crude protein %	17.30
Crude fat %	3.20
Crude fiber %	13.50
Calcium %	1.19
Total phosphorus %	0.65
Lysine %	0.82
Methionin plus Cystine %	0.57

* The Vit. & Min. premix per 2.5 kg contain: Vit. A 4,000,000 IU, Vit. D₃ 500,000 IU, Vit. E 16.7 g, Vit. K₃ 0.67 g, Vit. B₁ 0.67 g, Vit. B₂ 2.0 g, Vit. B₆ 0.67 g, Vit. B₁₂ 0.004 g, Niacin 16.7 g, Biotin 0.07 g, Choline Cholride 400 g, Pantothenic acid 6.67 g, Nicotinic acid 30,000 mg, Folic acid 1.67 g, Manganese 10 g, Zinc 23.3 g, Iron 25 g, Copper 1.67 g, Iodine 0.25 g, Selenium 0.033 g, Magnesium 133.4 g and carrier (CaCO₃) 2.5 kg.

** Calculated according to N R C (1977).

carotid artery and jugular veins according to Islamic method. Carcass traits included body weight before and after slaughter (Bleeding) as well as, weights of hot carcass blood, giblets (kidney, heart, liver and lungs), head, pelt, leg, spleen, abdominal fat, loin region, hindquarter and thoracic of carcass (cut - points were between 7th and 8th ribs). Blood samples were collected from each rabbit in clean tubes with heparin. Plasma was obtained by centrifugation of blood at 2000 gravity for 15 minutes and the blood plasma were kept in vials at - 20°C until biochemical assay, using specific commercial kits produced by Boehringer and Merck Companies. Plasma was submitted for determinations of total protein, albumin, aspartate aminotransferase (AST), alanine aminotransferase (ALT), creatinine, urea-N as well as total lipids and cholesterol. Blood haematological parameters haemoglobin (Hb), red blood cells (RBC's), white blood cells (WBC's) and packed cell volume (PCV) were determined using PHAI (Programmable Hematology Analyzer).

Data were statistically analyzed using SAS (2001) program. Duncan's multiple range tests was

used for the comparison between means (Duncan, 1955).

RESULTS AND DISCUSSION

Live Body Weight and Body Weight Gain

Live body weight and weight gain of Spanish V-line growing rabbits insignificantly affected with vitamin A and / or C at different levels during the experimental periods (Table 2).

Live body weight insignificantly higher with vitamin A at a level of 2400 I.U./kg than control and other groups.

These results are in partially agreement with those obtained by Elmarimi *et al.* (1989) who reported that rabbits were injected with vitamin A weekly for 3 weeks, there was no differences in body weight between groups. Skrivanova and Marounek (1997) and Castellini *et al.* (2001) found that growth of rabbits supplied with ascorbic acid was not significantly affected. Schmeling and Nockles (1978) and Pardue *et al.* (1986) proposed that vitamin C influences the synthesis of corticosterone hormone. Increased amounts of corticosterone caused a reduction in growth rate, number

Table 2: Means (\bar{x}) \pm standard errors (SE) of live body weight (gm) and body weight gain of Spanish V-line rabbits as affected by vitamins A and /or C injection during the experimental growing periods

Traits	Age (weeks)	Sig.	Items									
			Control	A ₁	A ₂	C ₁	C ₂	A ₁ +C ₁	A ₁ +C ₂	A ₂ +C ₁	A ₂ +C ₂	
Live body weight	5	NS	704.17 \pm 32.74	744.17 \pm 82.72	756.67 \pm 103.12	675.00 \pm 43.07	701.67 \pm 72.03	715.00 \pm 74.53	686.67 \pm 49.53	681.67 \pm 109.49	686.67 \pm 71.37	
	7	NS	1065.00 \pm 46.85	1114.17 \pm 113.28	1161.67 \pm 74.92	1095.83 \pm 154.76	1078.33 \pm 114.60	1146.67 \pm 121.22	1019.83 \pm 98.75	1011.67 \pm 122.10	1051.67 \pm 106.90	
	9	NS	1375.00 \pm 93.01	1438.33 \pm 102.31	1445.83 \pm 110.96	1450.00 \pm 199.87	1386.67 \pm 174.57	1425.00 \pm 137.02	1364.17 \pm 100.84	1364.17 \pm 170.71	1405.83 \pm 138.75	
	11	NS	1686.00 \pm 77.32	1788.33 \pm 111.48	1885.00 \pm 92.82	1790.00 \pm 101.68	1740.00 \pm 113.90	1732.50 \pm 153.06	1698.33 \pm 144.55	1726.67 \pm 156.18	1708.33 \pm 161.39	
	13	NS	1961.00 \pm 78.60	2050.00 \pm 134.67	2131.67 \pm 137.29	1996.00 \pm 113.86	1978.33 \pm 145.74	1961.67 \pm 151.96	1926.67 \pm 118.55	2013.33 \pm 158.85	1948.33 \pm 152.58	
Body weight gain	5-7	NS	360.84 \pm 36.67	370.00 \pm 8.33	405.01 \pm 1.66	420.84 \pm 25.00	376.67 \pm 10.00	431.68 \pm 0.83	404.17 \pm 14.17	330.00 \pm 35.00	365.00 \pm 48.33	
	7-9	NS	312.50 \pm 0.00	324.18 \pm 19.16	284.17 \pm 2.50	346.25 \pm 27.50	308.34 \pm 18.33	278.34 \pm 426.67	270.84 \pm 5.83	352.50 \pm 13.33	354.17 \pm 20.00	
	9-11	NS	322.50 \pm 2.50	350.01 \pm 1.66	439.18 \pm 26.22	333.34 \pm 23.33	353.34 \pm 15.00	307.50 \pm 2.50	296.67 \pm 10.00	362.50 \pm 12.50	302.50 \pm 3.33	
	11-13	NS	270.84 \pm 9.17	261.67 \pm 8.33	246.67 \pm 25.00	229.17 \pm 34.59	238.34 \pm 13.33	229.17 \pm 33.33	268.33 \pm 22.50	286.67 \pm 1.66	240.01 \pm 3.33	
	5-13	NS	158.34 \pm 9.17	163.23 \pm 21.15	171.88 \pm 18.54	166.20 \pm 15.47	159.59 \pm 35.83	155.84 \pm 38.33	155.00 \pm 10.00	166.46 \pm 21.04	157.71 \pm 26.04	

NS : not significant

A₁ = A 1200 I.U./kg , A₂ = A 2400 I.U./kg , C₁ = C 250 mg/kg and C₂ = C 500 mg/kg .

of lymphocytes, size of lymphoid organs (spleen, bursa, and thymus) and their response to antibodies.

The results of weight gain are in agreement with the previous reports of Grobner *et al.* (1985), Daader *et al.* (1999) and Yousef *et al.* (2003) who found no effect on body weight gain of rabbits which received vitamins A or C. Contrarily, Ayyat *et al.* (2003) reported that rabbits were supplemented with vitamin A (3000 IU/kg diet) recorded higher daily body weight gain at 0 - 8 weeks with 4.76 %, than those fed diet without supplementation. Hamidy and El-Malat (2000), El-Adawy *et al.* (2001) and Al-Shanti (2003) they found that the ascorbic acid supplementation improved daily body weight gain on growing rabbits over that of the control group.

Feed Consumption and Feed Conversion

Feed consumption of Spanish V-line growing rabbits insignificantly affected with vitamins A and / or C at different levels during the experimental periods except at 7 - 9 weeks of age (Table 3). Feed consumption significantly ($P < 0.05$) improved by 25.20, 36.81, 1.88, 11.02, 24.16, 9.35 and 21.72 % with vitamins A₁, A₂, C₁, A₁ plus C₁, A₁

plus C₂, A₂ plus C₁ and A₂ plus C₂, respectively, while its significantly ($P < 0.05$) increased by 0.10 % with vitamin C₂ at 7 - 9 weeks of age when compared with the control group. The results are in agreement with those obtained by El-Husseiny *et al.* (1997) who reported that injection rabbits with either 2400 or 4800 I. U. vitamin A resulted in a significant ($P < 0.05$) decreased in the feed intake. Skrivanova and Marounek (1997) found that feed intake of rabbits supplied with ascorbic acid was not significantly affected.

Feed conversion of Spanish V-line growing rabbits insignificantly affected with vitamin A and / or C at different levels during the experimental periods (Table 3). The results are in agreement with those obtained by El-Adawy *et al.* (2001) found that feed conversion of growing rabbits insignificantly affected by vitamin C. On the other hand Kormann and Schlater (1984); El-Husseiny *et al.* (1997); Abd El-Monem *et al.* (2003) and Ayyat *et al.* (2003) reported that values of feed conversion ratio of growing rabbits were improved with vitamin A supplementation.

Mortality

Injection growing rabbits with vitamins A and / or C did not show any effect on mortality during the

Table 3: Means (\bar{x}) \pm standard errors (SE) of feed consumption (gm), feed conversion and mortality (n) of Spanish V-line rabbits as affected by vitamins A and /or C injection during the experimental growing periods

Traits	Age (weeks)	Sig.	Means								
			Control	A ₁	A ₂	C ₁	C ₂	A ₁ +C ₁	A ₁ +C ₂	A ₂ +C ₁	A ₂ +C ₂
Feed consumption	5-7	NS	183.00 \pm 0.00	1085.50 \pm 1.70	940.15 \pm 28.35	918.15 \pm 56.65	1040.85 \pm 32.65	1015.20 \pm 36.00	1038.85 \pm 21.65	1013.50 \pm 35.00	970.70 \pm 8.50
	7-9	*	1198.75 \pm 7.50	896.65 \pm 9.15	757.50 \pm 14.15	1176.25 \pm 30.40	1200.00 \pm 35.85	1066.65 \pm 31.70	909.15 \pm 10.85	1006.70 \pm 43.35	938.35 \pm 25.00
	9-11	NS	1392.50 \pm 15.00	1254.50 \pm 18.30	1618.50 \pm 6.00	1455.50 \pm 38.00	1406.50 \pm 58.30	1445.00 \pm 50.85	1274.15 \pm 16.65	1409.15 \pm 40.85	1428.50 \pm 23.00
	11-13	NS	1401.25 \pm 13.50	1505.35 \pm 28.00	1628.50 \pm 16.50	1401.00 \pm 66.75	1551.50 \pm 43.95	1583.35 \pm 33.00	1396.65 \pm 23.30	1645.35 \pm 30.35	1479.50 \pm 24.85
	5-13	NS	635.25 \pm 8.65	586.55 \pm 15.45	601.75 \pm 2.75	622.45 \pm 54.75	65.75 \pm 55.95	623.00 \pm 33.00	570.00 \pm 23.30	641.65 \pm 30.35	599.15 \pm 40.85
Feed conversion	5-7	NS	3.00 \pm 0.66	2.93 \pm 0.17	2.32 \pm 0.22	2.18 \pm 0.09	2.76 \pm 0.34	2.35 \pm 0.21	2.57 \pm 0.37	3.07 \pm 0.50	2.66 \pm 0.86
	7-9	NS	3.84 \pm 0.05	2.77 \pm 0.24	2.67 \pm 0.19	3.40 \pm 0.89	3.89 \pm 0.26	3.83 \pm 0.37	3.36 \pm 0.76	3.08 \pm 0.67	2.65 \pm 0.12
	9-11	NS	4.32 \pm 0.19	3.58 \pm 0.13	3.69 \pm 0.44	4.37 \pm 0.98	4.21 \pm 0.22	4.70 \pm 0.75	4.29 \pm 0.20	4.11 \pm 0.23	4.72 \pm 0.84
	11-13	NS	5.17 \pm 0.30	5.75 \pm 0.19	6.60 \pm 1.26	6.11 \pm 0.39	6.51 \pm 0.87	6.91 \pm 0.62	5.20 \pm 0.40	5.74 \pm 0.22	6.16 \pm 0.39
	5-13	NS	4.01 \pm 0.19	3.59 \pm 0.38	3.5 \pm 0.37	3.75 \pm 0.74	4.08 \pm 0.40	4.00 \pm 0.55	3.68 \pm 0.09	3.85 \pm 0.07	3.80 \pm 0.26
Mortality (n)			1	0	0	1	0	0	0	0	0

Means bearing different letters within the same classification, differ significantly ($P < 0.05$).

NS: not significant * : ($P < 0.05$)

A₁ = A 1200 I.U./kg , A₂ = A 2400 I.U./kg , C₁ = C 250 mg/kg and C₂ = C 500 mg/kg .

experimental period from 5 – 13 weeks of age (Table 3), the range of mortality rate between 0.00 – 16.67%. Similar results were obtained by Iversen and Hahn (1999) and Elghaffar *et al.* (2000) found that vitamin A supplementation improvement of the immune system of rabbits. Abd El-Hamid (1994); Skrivanova and Marounek (1997) and Elghaffar *et al.* (2000) reported that survival rate of rabbits enhancement with vitamin C supplementation. These results may be due to vitamin C suppressing the free radicals (Karakilcik *et al.*, 2004 and Yousef, 2004). These results may be due to antioxidant vitamins (A, C and E) administration led to marked reductions in the severity of histopathological degeneration in liver, lung and kidney tissues (Okolie and Iroanya, 2003).

Carcass Characteristics

Results for carcass characteristics as affected by different levels of vitamin A of Spanish V-line growing rabbits are presented in Table 4. Weight of spleen was significantly ($P < 0.01$) decreased by 25.49% with vitamins A₂ plus C₁ as compared with the control group. The results are in agreement with those obtained by Ayyat *et al.* (2003) and Sonbol *et al.* (2005)

who reported that carcass characteristics of growing rabbits insignificantly affected by vitamin A supplementation as compared with the control group. Abd El-Hamid and El-Adawy (1999); Abd El-Monem (2001) and Al-Shanti (2003) demonstrated that vitamin C supplementation insignificantly affected on the carcass characteristics of growing rabbits as compared with the control group.

Blood Haematological and Biochemical Parameters

Blood haematological and biochemical parameters as affected by different levels of vitamins A and / or C of Spanish V-line growing rabbits at 13 weeks of age are presented in Table 5. Packed cell volume was significantly ($P < 0.001$) decreased by 8.24, 9.41 and 9.41 % with vitamins A₂, C₁, and A₂ plus C₂, respectively, when compared with the control group. Platelets was significantly ($P < 0.01$) decreased by 27.92 and 46.35% with vitamins A₂ and A₂ plus C₁, respectively, as compared with the control group. White blood cells was significantly ($P < 0.001$) decreased by 25.58 % with vitamin A₂, whereas its significantly ($P < 0.001$) increased by 27.91, 62.79, 29.07 and 44.19% with vitamins C₁, A₁ plus C₁, A₁ plus C₂ and A₂ plus C₂,

Table 4: Means (\bar{x}) \pm standard errors (SE) of carcass characteristics (gm) of Spanish V-line rabbits as affected by vitamins A and /or C injection at the end of the experimental growing periods (13 weeks of age)

Traits	Sig.	Items									
		Control	A ₁	A ₂	C ₁	C ₂	A ₁ C ₁	A ₁ C ₂	A ₂ C ₁	A ₂ C ₂	
Body weights (gm)	Pre slaughter	NS	1871.67 \pm 73.33	1943.33 \pm 119.04	2033.33 \pm 83.33	1845.00 \pm 8.66	1720.00 \pm 113.58	1676.67 \pm 60.64	1833.33 \pm 67.66	1830.00 \pm 73.71	1736.67 \pm 112.15
	After full bleeding	NS	1805.00 \pm 77.51	1855.00 \pm 120.31	1975.00 \pm 77.51	1790.00 \pm 8.66	1656.67 \pm 113.19	1615.00 \pm 65.38	1763.33 \pm 66.92	1760.00 \pm 73.7	1686.67 \pm 112.15
	Hot carcass	NS	926.67 \pm 42.06	853.33 \pm 16.41	1023.33 \pm 53.41	886.67 \pm 4.41	821.67 \pm 89.08	770.00 \pm 49.24	901.67 \pm 56.45	875.00 \pm 39.05	878.33 \pm 60.85
Cut weights (gm)	Fore-quarter	NS	253.33 \pm 12.02	236.67 \pm 21.67	281.67 \pm 11.67	248.33 \pm 1.67	231.67 \pm 18.33	221.67 \pm 11.67	256.67 \pm 14.53	256.67 \pm 13.33	245.00 \pm 18.93
	Lion	NS	290.00 \pm 23.09	313.33 \pm 33.33	308.33 \pm 13.64	281.67 \pm 1.67	256.67 \pm 39.30	228.33 \pm 20.28	275.00 \pm 30.41	256.67 \pm 14.53	260.00 \pm 20.82
	Hind-quarter	NS	383.33 \pm 7.26	303.33 \pm 64.18	433.33 \pm 28.92	356.67 \pm 4.41	333.33 \pm 31.80	320.00 \pm 18.03	370.00 \pm 12.58	361.67 \pm 14.24	373.33 \pm 26.03
Organ weights (gm)	Blood	NS	66.67 \pm 4.41	88.33 \pm 19.22	58.33 \pm 6.01	55.00 \pm 0.00	63.33 \pm 3.33	61.67 \pm 10.14	70.00 \pm 5.77	70.00 \pm 6.00	50.00 \pm 0.00
	Giblets	NS	78.47 \pm 5.39	90.01 \pm 8.90	78.91 \pm 2.33	73.53 \pm 0.28	78.32 \pm 2.82	77.05 \pm 2.51	84.31 \pm 18.33	78.41 \pm 2.89	76.41 \pm 4.66
	Head	NS	130.00 \pm 7.64	135.00 \pm 12.58	135.00 \pm 7.64	131.67 \pm 4.41	115.00 \pm 7.64	123.33 \pm 4.41	128.33 \pm 1.67	128.33 \pm 7.26	116.66 \pm 3.33
	Abdominal fat	NS	5.40 \pm 2.62	4.42 \pm 0.15	8.91 \pm 2.70	3.01 \pm 0.08	2.30 \pm 0.23	2.89 \pm 0.07	4.34 \pm 1.79	3.74 \pm 0.75	6.79 \pm 2.55
	Spleen	**	1.53 \pm 0.06	1.16 \pm 0.02	1.38 \pm 0.13	1.59 \pm 0.10	1.37 \pm 0.17	1.36 \pm 0.21	1.92 \pm 0.18	1.14 \pm 0.10	1.42 \pm 0.07
	leg	NS	66.67 \pm 1.67	70.00 \pm 5.00	76.67 \pm 4.41	71.67 \pm 1.67	66.67 \pm 1.67	65.00 \pm 2.89	65.00 \pm 0.00	66.67 \pm 1.67	70.00 \pm 0.00
	pelt	NS	261.67 \pm 1.67	260.00 \pm 32.15	270.00 \pm 15.28	240.00 \pm 5.77	231.67 \pm 9.28	233.33 \pm 1.13	241.67 \pm 4.41	273.33 \pm 14.53	223.33 \pm 19.65
	Dressing (%)	NS	63.19 \pm 0.43	58.84 \pm 3.58	63.04 \pm 0.71	61.16 \pm 0.20	61.21 \pm 2.53	60.20 \pm 0.79	63.34 \pm 2.26	61.67 \pm 4.88	63.94 \pm 0.15

Means bearing different letters within the same classification, differ significantly ($P < 0.05$).

NS: not significant

** : ($P < 0.01$)

A₁ = A 1200 I.U./kg, A₂ = A 2400 I.U./kg, C₁ = C 250 mg/kg and C₂ = C 500 mg/kg.

Table 5: Means (\bar{x}) \pm standard errors (SE) of blood haematological parameters and biochemical blood components of Spanish V-line rabbits as affected by vitamins A and /or C injection the end of the experimental growing periods (13 weeks of age)

Traits	Sig.	Items									
		Control	A ₁	A ₂	C ₁	C ₂	A ₁ + C ₁	A ₁ + C ₂	A ₂ + C ₁	A ₂ + C ₂	
Blood haematological parameters	Hb (%)	NS	11.70 \pm 0.17	11.70 \pm 0.46	11.20 \pm 0.12	11.35 \pm 0.26	11.65 \pm 0.26	10.95 \pm 0.49	11.70 \pm 0.17	11.40 \pm 0.00	12.10 \pm 0.00
	RBC's (10 ⁶ /mm ³)	NS	4.07 \pm 0.07	4.01 \pm 0.17	3.83 \pm 0.04	3.84 \pm 0.16	4.13 \pm 0.15	3.85 \pm 0.23	4.11 \pm 0.06	3.90 \pm 0.01	4.41 \pm 0.03
	PCV (%)	**	42.50 \pm 0.29 _{ab}	42.50 \pm 0.87 _{ab}	39.00 \pm 0.58 _c	38.50 \pm 2.02 _c	44.00 \pm 0.58 _a	41.00 \pm 1.15 _{bc}	44.50 \pm 0.29 _a	40.00 \pm 1.15 _{bc}	38.50 \pm 0.29 _c
	Platelets (10 ⁶ /mm ³)	*	274.00 \pm 16.17 _{ab}	255.50 \pm 12.41 _{abc}	197.50 \pm 12.99 _{cd}	207.00 \pm 4.62 _{bed}	290.00 \pm 5.77 _a	242.50 \pm 4.33 _{abc}	302.00 \pm 1.73 _a	147.00 \pm 68.13 _d	302.50 \pm 12.99 _a
	WBC's (10 ³ /mm ³)	***	4.30 \pm 0.17 _{de}	5.00 \pm 0.35 _{cd}	3.20 \pm 0.35 _f	5.50 \pm 0.12 _{bc}	5.10 \pm 0.17 _{cd}	7.00 \pm 0.12 _a	5.55 \pm 0.03 _{bc}	3.50 \pm 0.06 _{df}	6.20 \pm 0.69 _{ab}
Biochemical blood components	Total protein (g/dl)	NS	6.18 \pm 0.14	5.78 \pm 0.12	6.00 \pm 0.22	6.31 \pm 0.06	5.92 \pm 0.31	6.21 \pm 0.25	6.00 \pm 0.21	5.72 \pm 0.20	6.30 \pm 0.14
	Albumin (g/dl)	NS	3.60 \pm 0.08	3.56 \pm 0.04	3.71 \pm 0.06	3.57 \pm 0.05	3.44 \pm 0.01	3.33 \pm 0.08	3.52 \pm 0.11	3.52 \pm 0.09	3.63 \pm 0.16
	Globulin (g/dl)	NS	2.57 \pm 0.08	2.22 \pm 0.14	2.29 \pm 0.21	2.74 \pm 0.10	2.48 \pm 0.00	2.88 \pm 0.23	2.49 \pm 0.14	2.20 \pm 0.12	2.67 \pm 0.28
	A/G	NS	1.39 \pm 0.01	1.61 \pm 0.12	1.65 \pm 0.15	1.31 \pm 0.07	1.43 \pm 0.20	1.16 \pm 0.10	1.42 \pm 0.07	1.60 \pm 0.06	1.40 \pm 0.21
	AST (U/L)	NS	6.00 \pm 2.00	5.00 \pm 1.00	7.00 \pm 0.00	5.50 \pm 0.87	4.00 \pm 0.00	5.00 \pm 1.00	4.00 \pm 0.00	4.33 \pm 1.45	7.00 \pm 1.73
	ALT (U/L)	***	5.33 \pm 0.33 _b	5.00 \pm 1.00 _{bc}	8.00 \pm 0.00 _a	5.50 \pm 0.29 _b	4.67 \pm 0.88 _{bc}	5.00 \pm 0.00 _{bc}	2.66 \pm 0.33 _d	3.66 \pm 0.67 _{cd}	5.33 \pm 0.33 _b
	Creatinine (mg/dl)	*	1.44 \pm 0.45 _a	0.87 \pm 0.16 _{abc}	1.36 \pm 0.17 _a	1.26 \pm 0.14 _{ab}	1.21 \pm 0.17 _{ab}	0.70 \pm 0.18 _{bc}	0.62 \pm 0.23 _{bc}	0.26 \pm 0.01 _c	0.90 \pm 0.18 _{abc}
	Urea-N (mg/dl)	**	40.93 \pm 1.93 _a	39.50 \pm 0.80 _{ab}	40.30 \pm 1.14 _a	40.80 \pm 0.12 _a	39.30 \pm 0.60 _{ab}	38.03 \pm 2.09 _{ab}	35.50 \pm 2.54 _{bc}	31.20 \pm 0.72 _c	38.10 \pm 1.34 _{ab}
	Total lipids (mg/dl)	NS	10.77 \pm 1.93	13.15 \pm 1.90	14.13 \pm 0.52	11.75 \pm 0.84	10.38 \pm 2.99	16.10 \pm 0.93	14.60 \pm 0.75	11.41 \pm 1.62	14.97 \pm 1.87
	Cholesterol (mg/dl)	NS	70.33 \pm 11.02	89.33 \pm 13.78	92.00 \pm 2.08	79.00 \pm 5.77	70.00 \pm 20.65	105.67 \pm 7.22	94.67 \pm 5.78	74.67 \pm 9.82	99.33 \pm 12.84

Means bearing different letters within the same classification, differ significantly (P<0.05).

NS: not significant

* : (P<0.05)

** : (P<0.01)

*** : (P<0.001)

A₁ = A 1200 I.U./kg , A₂ = A 2400 I.U./kg , C₁ = C 250 mg/kg and C₂ = C 500 mg/kg .

Hb: haemoglobin

RBC's: red blood cells

PCV: packed cell volume

WBC's: white blood cells

A/G: albumin/globulin ratio

AST: aspartate aminotransferase ALT: alanine aminotransferase

respectively when compared with the control group. The increase in WBC's may be to an increase in the membrane protection from auto-oxidation (Afify and Makled, 1995). The beneficial effect of ascorbic acid supplementation on WBC's count supports the findings of the other researchers who reported that ascorbic acid is involved in the immunological and antibacterial function of WBC's by several ways (Androsen, 1981; Jaffe, 1984 and Cummins and Brunner, 1989) they reported that ascorbic acid increased the WBC's mobility, stimulating the energy-producing monophosphate shunt within the cell and consequently coupled their phagocytic process. Sahota *et al.* (1994); Mady (1998); Abd El-Hamid and El-Adawy (1999) and Yousef (2004) they showed that red blood cells, packed cell volume and white blood cell's of rabbits were significantly ($P < 0.05$) increased with vitamin C administration as compared with the control group. Al-Shanti (2003) observed that haemoglobin of rabbits insignificantly affected with vitamin C supplementation as compared with the control group.

Total protein, albumin, globulin, A/G ratio, aspartate transaminase, total lipids and cholesterol insignificantly affected

by vitamins A and / or C at different levels as compared with the control group. These results are in agreement with those obtained by Ayyat *et al.* (2003) who revealed that albumin and aspartate transaminase concentrations of growing rabbits were insignificantly affected with vitamin A supplementation in rabbit diets. Abd El-Monem *et al.* (2003) found that total protein and albumin of rabbits insignificantly affected by vitamin A supplementation. Mady (1998) and Al-Shanti (2003) who found that total protein and its fractions of rabbits insignificantly affected with vitamin C supplementation. Also, Shetawi (1998) and El-Gamal (2002) they observed that feeding growing rabbits dietary contains vitamin C resulted insignificantly affects on total lipids and cholesterol. Alanine transaminase was significantly ($P < 0.01$) increased by 50.09% with vitamin A₂, whereas its significantly ($P < 0.001$) decreased by 50.09 and 31.33% with vitamins A₁ plus C₂ and A₂ plus C₁, respectively when compared with the control group. Creatinine was significantly ($P < 0.05$) decreased by 51.39, 56.94 and 81.94% with vitamins A₁ plus C₁,

A₁ plus C₂ and A₂ plus C₁, respectively when compared with the control group. Urea-N was significantly ($P < 0.05$) decreased by 13.27 and 23.77 % with vitamins A₁ plus C₂ and A₂ plus C₁, respectively when compared with the control group. Similar results were obtained by Ayyat *et al.* (2003) who demonstrated that serum creatinine and urea-N concentrations were significantly ($P < 0.001$ and 0.01) decreased due to vitamin A supplementation in rabbit diets. Al-Shanti (2003) and Yousef (2004) who found that urea-N and creatinine concentrations of rabbits were significantly decreased with vitamin C addition when compared with the control group. These results may be due to antioxidant vitamins (A, C and E) supplementation reduced the severity of histopathological degeneration in liver and kidney tissues Okolie and Iroanya (2003). Also, Durak *et al.* (2004) who reported that reduction of antioxidant capacity may play part in the cyclosporine A-induced hepatotoxicity and use of some antioxidants may give beneficial results.

The present results showed no any positive or adverse effects on

the studied traits. It is possible to recommend to injection of Spanish V-line growing rabbits with higher levels of vitamins A and / or C than the used levels in this study to improved growth performance of this rabbits.

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تأثير فيتامين أ مع أو بدون فيتامين ج على الأداء الإنتاجي و الفسيولوجي للأرانب الأسباني النامية

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أجريت التجربة العملية في مزرعة أبحاث الدواجن التابعة لقسم الدواجن - كلية الزراعة - جامعة الإسكندرية - مصر خلال شهور الصيف الحارة في الفترة من يونيو إلى أغسطس لعام ٢٠٠٤.

استخدم في هذه الدراسة عدد ٥٤ أرنب أسباني (Spanish V-line) ذكر مقطوم عمر ٥ أسابيع و كان متوسط وزن الجسم الحي 43.02 ± 714.45 جم ، ووزعت الأرانب عشوائيا إلى تسعة مجاميع بكل مجموعة ٦ أرانب، تركت المجموعة الأولى بدون حقن كضابط للتجربة (مجموعة الكنترول) ، بينما تم حقن المجموعة الثانية و الثالثة تحت جلد الرقبة أسبوعياً بفيتامين أ مذاب في زيت السمسم بمستويات ١٢٠٠ و ٢٤٠٠ وحدة دولية / كجم وزن حي على التوالي ، بينما تم حقن المجموعة الرابعة و الخامسة بفيتامين ج مذاب في ماء مقطر بمستويات ٢٥٠ و ٥٠٠ ملجم / كجم وزن حي، و حقنت السادسة و السابعة بفيتامين أ بمستوى ١٢٠٠ وحدة دولية/كجم وزن حي مع فيتامين ج بمستوى ٢٥٠ و ٥٠٠ ملجم / كجم وزن حي و المجموعة الثامنة و التاسعة حقنت بفيتامين أ بمستوى ٢٤٠٠ وحدة دولية/ كجم وزن حي مع فيتامين ج بمستوى ٢٥٠ و ٥٠٠ ملجم / كجم وزن حي، و ذلك خلال فترة التجربة (٨ أسابيع).

و كانت أهم النتائج المتحصل عليها:

- وزن الجسم الحي زاد بصورة غير معنوية عند الأعمار المختلفة من ٥ - ١٣ أسبوع عند الحقن بفيتامين أ مع أو بدون فيتامين ج عند مقارنتها بالكنترول، كن كانت أفضل زيادة في المجموعة التي حقنت بفيتامين أ بمستوى ٢٤٠٠ وحدة دولية / أرنب.

- معدل الزيادة في وزن الجسم زادت زيادة غير معنوية في الفترة ٥ - ١٣ أسبوع باستخدام فيتامين أ مع أو بدون فيتامين بمستوياتهم المختلفة و ذلك عند مقارنتها بمجموعة الكنترول .

- معدل استهلاك الغذاء الأسبوعي قل معنوياً عند عمر ٧ - ٩ أسابيع باستخدام فيتامين أ مع أو بدون فيتامين ج مقارنة بمجموعة الكنترول.

- كفاءة تحويل الغذاء تحسنت بصورة غير معنوية في معظم الأعمار عند استخدام المستويات المختلفة من فيتامين أ مع أو بدون فيتامين ج و ذلك مقارنة بمجموعة الكنترول.

- تحسنت بعض قياسات النبيحة (الطحال) معنوياً باستخدام الحقن بفيتاميني أ مع أو بدون ج بمستوياتهم المختلفة مقارنة بمجموعة الكنترول.

- معظم قياسات صورة الدم و مكونات الدم الكيماوية تأثرت معنوياً باستخدام الحقن بفيتاميني أ مع أو بدون ج بمستوياتهم المختلفة مقارنة بمجموعة الكنترول.

أظهرت الدراسة عدم وجود تأثير معنوي أو عكسي على الصفات المدروسة، و نستطيع أن نوصي بأن حقن الأرانب الأسباني (Spanish V-line) النامية بمستويات أعلى من فيتامين أ مع أو بدون فيتامين ج عن المستويات المستخدمة في هذه الدراسة لتحسين الصفات الإنتاجية لهذه الأرانب.