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EFFECT OF VITAMINS SUPPLEMENT LEVEL ON GROWTH PERFORMANCE AND MEAT QUALITY IN GROWING RABBITS

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ABSTRACT

A trial was conducted to determine the effect of vitamins supplement levels on growing rabbits. The experiment was carried out in Intensive Rabbit Production Unit; belong to Agricultural Studies and Consult Center; Faculty of Agriculture, Ain Shams University. Sixty weaned male New Zealand White (NZW) rabbits, aged four weeks of age were randomly distributed into three comparable groups of 20 kids. The animals housed in cages provided with continued feeder and automatic waterers facilities during the experimental period, which lasted for 6 weeks. Treatments included three levles of vitamins supplement in rabbit rations. Control group supplemented with 100% of vitamins requirement for rabbit **(Ministerial Decree, 1996)**. No 1498), while treatment I and treatment II were supplemented 150 and 200 % of vitamins requirement for rabbit respectively .Growth was assessed by measuring body weight gain (BWG). At 10 weeks of age ten animals from each group were slaughtered for carcass evaluation. Results showed that kids in treatment (II) and (I) were significantly ($P < 0.05$) heavier in body weight than control group. Average daily gains during the study were 30.95 ± 1.23, 33.33 ± 1.23 and 37.02 ± 1.23 gm for control groups, treatments I and II respectively. Supplementation with 150 and 200 % of vitamins requirement of rabbits improved the dressing percentage by 3.43 and 5.65 % respectively. However, the hind part percentage, increased by 4.6% 10.66 % as compared with the control group. Meat protein increased ($P<0.05$) in treatment II and I. However ether extract decreased ($P<0.01$) in treatment II and I as compared with control group. Thiobarbituric acid reactive substance (TBARS) levels of stored meat was significantly ($P<0.01$) lower in the treatment II and I, as compared with control group .Rabbits in treatments II and I significantly ($P<0.01$) maintained the higher desirable polyunsaturated fatty acids (PUFAs) content of the stored meat. Blood plasma cholesterol decreased with treatments II and I as compared with control group. Treatments II and I increased blood plasma total protein and globulin and decreased Plasma glucose as compared with control group. It is concluded that vitamins supplementation successfully ameliorated the quality traits of meat produced in terms of improved oxidative stability and the introduce of a highly nutritional food (rabbit meat).

INTRODUCTION

Vitamins are essential for the metabolism and maintenance of body tissue. Although functional roles differ, the B vitamins are generally involved in nutrient metabolism, increase feed intake, whereas the fat-soluble vitamins and ascorbic acid needs are more constant, as they are involved in tissue growth processes and maintenance. Typically, vitamins represent only 0.05% of the weight and 1.5% of the complete feed cost. They also cause a specific deficiency disease if absent from the diet **(Cunha, 1977)**. Nutritionists typically pro-

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vide the minimum vitamin fortification to maximize performance and profitability plus some margin of safety based on field experience. However, a number of factors may affect vitamin requirements. For example, selection for faster growth rate may allow animals to reach much higher weights at much younger ages with less feed consumed. Intensive production systems impose higher metabolic stresses which, in turn, may cause increased vitamin deficiencies (**Cunha, 1982**). Because of the genetic improvement in muscling and leanness in recent decades, which may affect various nutritional requirements, they evaluated various levels of B vitamin premix added to the diets of starter and grower-finisher pigs (**Mahan, *et al* 2007**). The vitamin levels recommended by NRC do not appear to be adequate for growing trout.. (**Barrows, *et al* 2008**). Howeve, **Selim *et al* 2008** reported that vitamin E and C improved growth rate and feed efficiency in growing (NZW) rabbit.

Nutritional antioxidants vitamins E, C and carotenoids protects cellular membranes against oxidative damage, (**Morrissey, *et al* 1994 and Zadak, *et al* 2009**) vitamin E and/or vitamin C successfully ameliorated the quality traits of meat produced in terms of improved oxidative stability (**Corino, *et al* 2007** and **Selim *et al* 2008**). Antioxidant property of vitamin E is widely known and it protects polyunsaturated fatty acids from uncontrolled oxidation, called lipid peroxidation. Vitamin E content of the muscle needs to meet or exceed a threshold to show these meat quality improvements (**Faustman, *et al* 1989; Arnold *et al* 1993 and Selim *et al* 2008**). However, the negative correlation between the α-tocopherol content of the muscle and the rate of lipid oxidation (**Lopez-Bote *et al* 1997; Castellini *et al* 1998 & 2000; Corino, *et al* 1999 & 2007; Oriani, *et al* 2001; Botsoglou *et al* 2004 and Lo Fiego *et al* 2004**). **Bernardini *et al* (1996) and Dal Bosco *et al* (2004)** clarified that vitamin E (200 mg kg-1 diet) resulted in increase of polyunsaturated fatty acids (PUFAs) ratio of rabbit meat. The experiment was carried out to test if requirements for rabbit reported in Ministerial Decree 1996 (No.1498) need to be renewal.

MATERIALS AND METHODS

Animals and diets

Sixty weanded NZW rabbits, 28 days age and 441.6 gm live body weight were randomly distributed into three comparable groups of 20 kids. All experimental animals were housed in individual cages provided with continued feeders and automatic waterier during the experimental period which lasted for 6 weeks (70 days of age). The animals were fed according to Ministerial Decree, 1996 No. 1498 vitamins Supplementation / kg diet according **Table (1)**. Chemical analysis of the ration showed that the basal diet contained 7.93% moisture, 17.6% crude protein, 2.5% ether extract, 11.8% crude fiber, 51.37% nitrogen free extract (NFE) and 8.8% ash. Animals were weighed individually at weekly intervals.

Blood samples were withdrawn weekly from the ear vein of each animal in a heparinized syringe. The plasma was carefully separated after centrifugation and stored at -20°C for biochemical analysis. Total plasma proteins (TP) were estimated as described by **Henry *et al* (1974)**, albumin was determined according to **Doumas *et al* (1971)** cholesterol was determine according to **Stein (1986)** and glucose wasdetermined as described by **Bahram and Trinder, (1972)**.

Slaughtering and Carcass Traits

At the end of the experimental period (at 70 days of age) ten animals from each experimental groups were slaughtered according to the Islamic slaughtering technique using the procedure described by **Abou-Ashour and Ahmed (1983)**. Rabbits were weighed just before slaughter as well as after complete bleeding. The head, giblets (heart, liver and kidneys) and hot carcasses were weighed. The dressing percentage was calculated. For meat composition traits, all carcasses were divided longitudinal to two similar halves. The right half was physically separated into lean and bone. Lean samples from different carcass parts as a percentage of the carcass in the animal are mixed for chemical analysis. Meat dry matter, crude protein (CP), ether extract (EE) and ash were determined according to the **A.O.A.C. (1990)**.

Determination Thiobarbituric acid-reactive substance (TBARS)

For determining the rate of lipid peroxidation of frozen meat, the thiobarbituric acid-reactive substance (TBARS) test was carried out using four meat samples of each treatment., according to **AOAC (1990)**. The TBARS value is defined as the increase of absorbance measured at 530 nm due to the reaction of the equivalent of 1 mg of the sample per 1 ml volume with 2-thiobarbituric acid. Secondary oxidation products of oils and fats react with 2- thiobarbituric acid.

Table 1. Vitamins supplementation /Kg diet

Supplied vitamins / kg diet	Control group (100% of vitamin requirement)	Treatment I (150% of vitamin requirement)	Treatment II (200 % of vitamin requirement)
Vitamin A (IU)	6000	9000	12000
Vitamin D_3 (IU)	900	1350	1800
Vitamin E (mg)	40	60	80
Vitamin k_3 (mg)	2	3	4
Vitamin B_1 (mg)	2	3	4
Vitamin B_2 (mg)	4	6	8
Vitamin B_6 (mg)	2	3	4
Vitamin B_{12} (mg)	0.01	0.015	0.02
Vitamin PP (mg)	50	75	100
Vitamin B_5 (mg)	10	15	20
Vitamin Biotin (mg)	0.05	0.075	0.1
Vitamin B_9 (mg)	3	4.5	6
Choline chloride (mg)	250	375	500

Fatty acid profile of the meat

Fatty acids profile determination in meat was carried out in four samples of each treatment according to **AOAC (2000)** at days 7 and 30 at freezing storage (-20°C).

Statistical analysis

Data were subjected to a one-way analysis using **SAS (1990)**. Variables having significant differences were compared using **Duncan's Multiple Range Test (1955).**

RESULTS AND DISCUSSION

Growth Performance Traits

Data in **Table (2)** represent the rabbit performance as affected by vitamins supplementation. Treated rabbits (Treatment II and I) had heavier weight than the control rabbits. The final body weights were 1750 ±25.8, 1840 ± 25.8 and 1980 ± 25.8 gm for control, treatment I and II, respectively. Average daily gains followed the same trend of the body weight being higher for rabbits received more vitamins than control group . Animals in treatments II and I showed enhancement in average daily gain by 20.8 and 8.3% respectively, during the experimental period as compared with control group. Similar results were recorded by **Selim *et al* (2008)** who reported that vitamin E and C improved growth rate and feed efficiency in growing (NZW) rabbit. Howeve, **Lohakare, *et al* (2006)** reported that growing pigs were more responsive to additional fat soluble vitamin supplements over the requirements suggested by **NRC, (1998)**. **LilianaBader, *et al* (2006)**. Found that an increased vitamin concentration stimulates growth and improved feed conversion decreasing considerably the morbidity. **Kadim, *et al* (2004)** found that final live body weight was significantly heavier (P<0.05) for goat treated with vitamin B12 by 13.4% compared with the control. **Tiffany and Spears (2005)** found significant correlation between average daily gain and plasma vitamins in finishing steers. This improvement of body weight and daily gain may be due to the effect of vitamins on metabolism processes and / or animal appetite **(Cheeke, 2005)** .**However McDowell (2000)** reported that thiamin is necessary for carbohydrates metabolism

Carcass characteristics and meat quality

Data concerning the carcass characteristics of the growing NZW rabbits in control group, treatments I and II are shown in **Table (3)**. Slaughter body weight was heavier in treatment II and I than

Table 2. Effect of vitamins supplementation levels on body weight change and daily gain

Items	Control	Treatment I	Treatment II
Animal number	20	20	20
Initial Body weight (g) (4^{th} weeks of age)	460 ±7.18	440±7.18	425±7.18
Final body weight(g) (10^{th} weeks of age)	1750± 25.8 ^{c}	1840±25.8 ^{b}	1980±25.8 ^{a}
Daily body gain (g)	30.95±1.23^{c}	33.33±1.23^{b}	37.02±1.23^{a}

Table 3. Effect of vitamins supplement levels on carcass traits

Carcass traits	Control	treatmentII	treatmentII
Animal number	10	10	10
Slaughters body weight (g)	1750 ± 5.21^{c}	1850 ± 5.21^{b}	1950 ± 5.21^{a}
Hot carcass weight (g)	1070 ± 10.59^{c}	1170±10.59^{b}	1270±10.59^{a}
Dressing (%)	61.14 ± 0.22^{b}	63.24±0.22^{a}	64.6±0.22^{a}
Front leg + chest (%)	21.1± 0.14	21.8±0.14	22.2±0.14
Middle part (%)	12.10±0.2	12.4±0. 2	12.5±0. 2
Hind part (%)	16.6 ± 0.11	17.37±0.11	18.37±0.11
Head (%)	11.2 ± 0.15	11.3±0.15	11.1±0.15
Liver (%)	3.5±0.0.13	3.79±0.13	3.93±0.13
Kidney (%)	0.81±0.008	0.86±0.008	0.83±0.008
Heart (%)	0.3±0.00316	0.31±0.00316	0.33±0.00316
Lung (%)	0.8±0.0055	0.82±0.0055	0.82±0.0055

control group. That may be due to the differences in body weight gain and/or growth rate **(Table 2)**. Carcass weight followed the same trend being heavier for rabbit received excess vitamins (treatment II and I) than control group. The carcass weight improvement may be due to the effect of vitamins on metabolism of VFA and animal appetite **(Cheeke, 2005 and Smith, 1997)**, which led to increased growth rate and daily gain **(Table 2)**. The inclusion of excess vitamins supplementation for rabbits led to anincrease dressing percentage being 61.14±0.22, 63.24 ± 0.22 and 64.6±0.22 % for control group, treatment I and II respectively. Similar results obtained by **Kadim *et al* (2004)**. They found that the final live and carcass weights were significantly heavier ($P<0.05$) for goats treated with vitamin B_{12} by 13.4% and 8.3% compared with the control group. Vitamins supplement enhanced Hind part (%), Middle part (%) and Front leg + chest (%). This enhancement in the vitamins treated group may be due to the role of vitamins in methionine synthesis and activation metabolic enzymes, which increase lean mass **(Matthews, 1999 and Holm *et al* 2005)**. The percentage of rabbit head, liver, kidney, lung and heart did not differ significantly between treatment I, II and control groups. The chemical analysis of rabbit meat showed that vitamins increased ($P<0.05$) CP and decreased ($P<0.05$) EE % in rabbit meat **(Figure 1)**. That may be due to the effect of vitamins on energy and protein metabolism **(House and Fletcher 2003)**. Moreover, **Smith (1997)** found

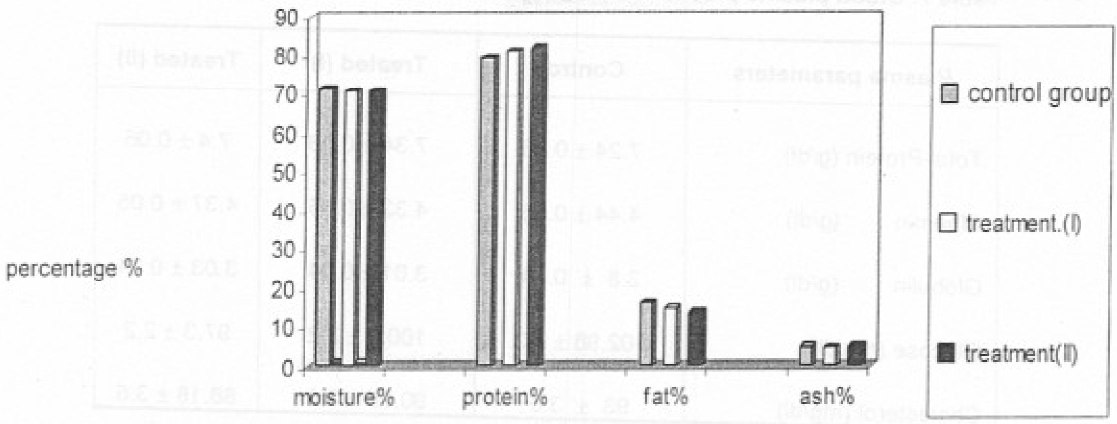

Figure 1. Showed that effect vitamins supplemented levels on meat composition

Table 5. Fatty acid profile (% of total fatty acids) of frozen rabbit meat (day 7)

Fatty acid	Control group	Treatment I	Treatment II
C14	3	2.75	3
C15	0.55	0.5	0.55
C16	31.9	32	33
C16:1	4.3^{b}	5.5^{a}	5.5^{a}
C17	.6	.8	0.8
C18:0	6.6	6.4	6.8
C18:1(n-9)	26^{a}	25^{b}	24^{c}
C18:2(n-7)	20.8^{c}	24.8^{b}	26.4^{a}
C18:3 (n-3)	1.2^{c}	1.7^{b}	1.9^{a}
C20: (n-6)	0.4^{c}	0.8^{b}	1^{a}

Table 6. Fatty acid profile (% of total fatty acids) of frozen rabbit meat (day 30)

Fatty acid	Control group	Treatment I	Treatment II
C14	2.95	2.9	3
C15	0.5	0.6	0.55
C16	32.6	31.6	32
C16:1	5.2	4.4	5
C17	0.6	0.6	0.6
C18:0	6.1	6.7	6.5
C18:1(n-9)	25	24	23.8
C18:2(n-7)	20.5^{c}	24^{b}	25.3^{b}
C18:3 (n-3)	1^{a}	1.2^{b}	1.35^{c}
C20: (n-6)	0.4^{c}	0.8^{b}	1^{a}

Table 7. Blood plasma parameters in growing rabbits

Plasma parameters	Control	Treated (I)	Treated (II)
Total Protein (g/dl)	7.24 ± 0.06	7.34 ± 0.06	7.4 ± 0.06
Albumin (g/dl)	4.44 ± 0.05	4.33 ± 0.05	4.37 ± 0.05
Globulin (g/dl)	2.8 ± 0.04	3.01 ± 0.04	3.03 ± 0.04
Glucose (mg/dl)	102.98 ± 2.2	100.3 ± 2.2	97.3 ± 2.2
Cholesterol (mg/dl)	93 ± 3.6	90.28 ± 3.6	88.18 ± 3.6

that New Zealand White male rabbits given additional vitamin B_{12} had significantly decreased surface area of fat deposition. Cobalamin causes a shift from body fat to body protein (**Holm *et al* 2005**) and the absorption of chromium picolinate to enhance lean mass building (**Keizo (2006)**. The muscle ash and moisture had not been affected by vitamins supplementation.

Oxidative stability of the muscle lipids

Lipid oxidation of the rabbit muscles (TBARS) at days 7 and 30 during frozen storage, and the increase in deterioration rate values is illustrated in (**Table 4**). It was found that TBARS values were lowered (P<0.01) by the supplementation of the diets with vitamins, especially antioxidant. Similar results were recorded by **Lopez-Bote *et al* (1997); Castellini *et al* (1998 & 2000); Corino *et al* (1999 & 2007); Oriani *et al* (2001); Botsoglou *et al* (2004) and Lo Fiego *et al* (2004).** They reported that a negative correlation between the α-tocopherol content of the muscle and the rate of lipid oxidation (TBARS value). Vitamin E increased the oxidative stability of muscular lipids, or in other terms, delayed lipid oxidation.

Fatty acid profile of intramuscular fat

Fatty acid profile of frozen meat at days 7 and 30 post mortem are shown in **Tables (5 and 6)**.The proportions of polyunsaturated fatty acids (PUFA), especially C18:2 and C18:3 were higher While the proportion of monounsaturated fatty acids (MUFAs) at day 30 were lower as compared to the control. This might be due to the high deposition of the antioxidant vitamins in the meat, protecting these fatty acids from oxidative damage during storage. These results are supported by the results of **Bernardini *et al* (1996); Dal Bosco *et al* (2004) and Zadak et al 2009** whose studies clarified that vitamin E (200 mg / kg diet) resulted increase of PUFAs ratio of rabbit meat and inhibits the per oxidation of PUFAs .

Blood plasma constituents

Blood plasma constituents of rabbits as affected by vitamins supplement are shown in **Table (7)**. There were no significant differences among treatment in plasma total protein, glucose, albumin and globulin concentration, Furthermore, plasma cholesterol was lower in treatments II and I as compared with control **Salim *et al* (1997)** reported that vitamin B_{12} inhibit hypercholesterolemia in rabbit fed high cholesterol diet. **In conclusion,** the vitamins requirements for rabbit reported in the Ministerial Decree, 1996 No .1498 must be renewal.

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حوليـات العلـوم الزراعية
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تأثير إضافة مستويات من الفيتامينات على أداء النمو وجودة اللحم في الأرانب النامية

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٢- قسم الإنتاج الحيواني-كلية الزراعة -جامعة عين شمس-شبرا الخيمة-القاهرة -مصر

الموجـــز

تم أجراء الدراسة بوحدة الإنتاج المكثف للأرانب التابعة لمركز الدراسات والاستشارات الزراعية بكلية الزراعة، جامعة عين شـمس. باسـتخدام ٦٠ ذكـر أرنب نيوزيلاندى ابيض مفطوم عمرها أربعة أسابيع لدراسة تأثير إضافة مستويات من الفيتامينـات علـى أداء النمو وجودة اللحم في الأرانب النامية . الأرانب قسمت عشوائيا إلى ثلاثة مجموعات بكل منهـا ٢٠ أرنب. تم أسكان الأرانب بالبوكسات مع توافر المـاء اتوماتيكيا والغذاء خلال فترة التجربة التي اسـتمرت لمدة ستة أسابيع. المعاملات احتـوت علـى ثـلاث مستويات من الفيتامينات المضافة في عليقة الأرانب . المجموعـة المقارنـة بهـا مـستوى ١٠٠% مـن الاحتياجات من الفيتامينات طبقـا للقـرار الـوزاري لسنة ١٩٩٦ برقم ١٤٩٨ والمعاملـة الأولـى بهـا مستوى ١٥٠% والمعاملة الثانية بها مستوى ٢٠٠%. وعند عمر ١٠ أسبوع تم ذبح ١٠ أرانب مـن كـل مجموعة تجريبية لتقيم الذبائح .

أوضحت النتائج أن الأرانب المعاملة بمـستويات ١٥٠ و ٢٠٠ % كانت أعلى معنويا ($P< 0.05$) فـي وزن الجسم من المجموعة الضابطة. وكان متوسـط معدل النمو اليومي ٣٠,٩٥ و٣٣,٣٣ و٣٧,٠٢ جم/ يوم للمجموعة الـضابطة والمعاملـة I و II علـى الترتيب. المعاملـة I و II أدت إلـى زيـادة نـسبة التصافي بنسب ٣,٤٣ و٥,٦٥ % وكذلك زيادة نسبة الأرباع الخلفية بـ ٤,٦ و١٠,٦٦ علـى التـوالي مقارنة بالمجموعة الضابطة، ذادت نسبة بروتين اللحم ($P< 0.05$) في المجموعتين I وII وانخفـضت نـسبة المستخلص الاثيـرى ($P< 0.01$) عـن المجموعـة الضابطة. المعاملة I و II قللـت مـستوى TBARS وكذلك حافظة على المحتوى اللحم مـن PUFAs الأحماض الذهنيـة عديـدة عـدم التـشبع مقارنـة بالمجموعة الضابطة كذلك لوحظ إن المعاملـة I و II زودت كلا من البروتين الكلـى والجلـوبيلين بينمـا انخفض مستوى جلوكوز ومستوى الكولسترول فـي بلازما الدم مقارنة بالمجموعة الضابطة.

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