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PERFORMANCE AND IMMUNE FUNCTION OF GROWING RABBITS AS AFFECTED BY VITAMIN C AND E THROUGH THE SUMMER SEASON

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Abstract

Forty New Zealand White rabbits about 5 weeks of age and 650 g average initial body weight, were assigned to four experimental groups (ten rabbits each). Rabbits were randomly placed in individual wire cages. Rabbits were fed a commercial diet containing 17% crude protein (CP) and 2700 Kcal digestible energy (DE) and orally supplemented with vitamins as follows: 0 supplementation as control group (1), 20 mg vit. C, 10 mg vit. E and 20 mg vit. C + 10 mg vit.E/animal/day for groups 2, 3 and 4, respectively.

Maximum and minimum temperature degrees and relative humidity were recorded daily out and indoor during the experimental periods (8 weeks). Experiment was conducted during summer season (June-July, 2001) with an average temperature ranging between 35 and 21 °C and 75% of relative humidity indoor and ranging between 36 and 20 °C and 73% of relative humidity outdoor.

Body weight and feed intake were recorded biweekly, body gain and feed conversion were calculated. Rectal temperatures (RT) and respiration rate (RR) were measured biweekly. By the end of the experimental period, blood samples were taken for haemoglobin (Hb), hematocrit (Ht), total protein(TP), albumin (Alb), cholesterol, glutamic oxaloacetic transaminase (GOT), pyruvic transaminase activity (GPT), blood urea nitrogen (BUN) and alkaline phosphatase assays. White blood cells differential and carcass traits have been done for four rabbits from each group.

Results showed that vitamins supplementation improved significantly ($P<0.05$) body weight, body weight gain and feed/gain ratio compared to the control group, while no significant differences between vitamin groups.

There were no appreciable effects for vitamins C and/or E on carcass traits, but great improvements were noticed for, Ht, Hb, GOT, GPT, TP, Alb, globulin and lymphocytes type due to vitamin Supplementation. A significant reduction were recorded for cholesterol, RR, RT, BUN and Alk. Phos. with vitamins groups compared to control group. Supplementation of vit. C and Vit. C + E recorded the best albumin/globulin ratio (Alb/glob) compared to other groups. It is easy to conclude that those two vitamins are essential in enhancing the immune system especially these days due to their roles as antioxidants and provide protection against toxicity of heavy metals and wide spread environmental pollution.

INTRODUCTION

Rabbits have a very rapid growth rate during the first three months of life. Rapid growth makes these animals very sensitive to non-specific syndrome because of the rate of metabolism and cell division which is very high compared to that of other mammals. So, during this period of rapid growth, any nutrient deficiency or any kind of physiological or environmental stress and diseases is likely to have major effects (Ismail, 1993).

Nutrition has a profound effect on growth, immunity and health in animals, etc...., and the nutritional deficiencies impair immune responsiveness and thereby, increase mortality, subsequently the production capacity.

Biological membranes contain relatively high concentration of polyunsaturated fatty acids, making them susceptible to lipid peroxidation, and it is important to use antioxidants to protect the lipid components against oxidation (Combs and Regenstein, 1980).

Highly reactive oxygen species such as superoxide anion radical (O_2), hydroxyl radical (Ho), hydrogen peroxide (H_2O_2) and single oxygen ('O_2) are continuously produced in the aerobic cellular metabolism. In addition, phagocytic granulocytes undergo respiratory burst to produce oxygen radicals to destroy the intracellular pathogens. However, these oxidative products can in turn damage health cells if they are not eliminated.

Antioxidants serve to stabilize these highly reactive free radicals, so maintaining the structural and functional integrity of cells. Therefore, antioxidants are very important to immune defense and animal health, consequently, to their production capacity (Chew, 1995).

Vitamins A, C and E are naturally antioxidant nutrients that play important roles in animal health by inactivating harmful free radicals produced through normal cellular activity and from various stressors (physiological or environmental), also, through increasing the immunity responses and disease resistance (McDowell, 1989).

Vitamin C may be, especially, important in this day and age of wide spread environmental pollution because it combats the effects of many toxins, including ozone, carbon monoxide, hydrocarbons, pesticides and heavy metals. It appears that, vitamin C fights off these pollutants by stimulating enzyme in the liver that detoxifies the body. Several studies indicated that, vitamin C reduced chromosome abnormalities in workers exposed to pollutants such as coal tar, styrene, methyl methacrylate and halogenated ethers (Gary, 1994 and Chew, 1995). Another way in which vitamin C protects us is by preventing the developments of nitrosamines, the cancer-causing chemicals that stem from nitrates contained in many foods.

Anyhow, we cannot neglect the big role of vitamin E in protecting leukocytes and macrophages during phagocytosis, where, vitamin E may help these cells to survive the toxic product that are produced in order to effectively kill ingested bacteria (McDowell, 1989). Mice fed vitamin E deficient diets are unable to produce a vigorous humoral response (McDowell, 1989), and, this decreased immune reactivity. Large doses of vitamin E protected chicks against *E. Coli* with increased phagocytosis and antibody production (McDowell, 1989). Supplementation with vitamin E to calves were able to maximize their immune responses compared to calves receiving low dietary vitamin E. Vitamin E as antioxidant helps to protect against the damaging effects of free radicals, which may contribute to the development of chronic disease such as cancer, and may block the formation of nitroamines which are carcinogens formed in the stomach from nitrites consumed in the diet. It may also protect against the development of cancer by enhancing immune function as reported by McDowell (1989) who suggested that, vitamin E defends against the ill-effects of smog, smoking and sun and that it might prevent certain cancers and aging of the skin and strengthens and boosts the immune system. Vitamin E stabilizes membranes and protects them against free radical damage; protects the lungs against damage from air pollutants, prevents tumour growth, protects tissues of the skin, eye, liver, breast and muscle, maintains the biological integrity of vitamin A and increase the body stores of this vitamin.

This study will discuss the role of vitamins C and E supplementation on enhance certain aspects of immune function, disease etiology and growth performance of growing rabbits through the summer season.

MATERIALS AND METHODS

Forty New Zealand White rabbits about 5 weeks of age and 650 g average initial body weight were assigned to four experimental groups. Ten rabbits were randomly placed in individual wire cages for each treatment. Rabbits were fed a commercial diet containing 17% CP and 2700 Kcal DE (Table 1), and orally supplemented with vitamins as follows: 0 supplementation as control group (1), 20 mg vit. C, 10 mg vit. E and 20 mg vit. C + 10 mg vit.E/animal/day for groups 2, 3 and 4 respectively. Feed and water were available *ad libitum*.

Maximum and minimum temperature degrees and relative humidity were recorded daily out and indoor during the experimental periods (8 weeks). Experiment was conducted during summer season (June-July, 2001) with an average house temperature (indoor) ranging between 35 and 21 ℃ and 75% of relative humidity and ranging between 36 and 20 ℃ and 73% of relative humidity outdoor. Body weight and feed intake were recorded biweekly, body gain and feed conversion were calculated. Rectal temperatures (RT) and respiration rate (RR) were measured biweekly. By the end of experimental period, blood samples were taken for determination of haemoglobin concentration, hematocrit, (total protein and blood urea nitrogen) by the colorimetric methods according to Merck (1974), albumin by colorimetric method of Doumas *et al.*(1971), cholesterol by Allain *et al.* (1974), (glutamic oxaloacetic transaminase [GOT] and pyruvic transaminase activity [GPT]) by kits from Bio Merieux according to Reitman and Frankel (1957), alkaline phosphatase was determined according to Teitz (1976) and white blood cells differential were done according to (Hawkey and Dennett, 1989). Carcass traits have been done for four rabbits from each group.

Statistical analysis was conducted by analysis of variance using SAS package (1995). The means and standard error of all parameters were estimated and Tukey's test was used to detect significant differences among means of the experimental groups.

Table 1. The ingredients and chemical composition of the pellted diet.

Ingredients %	
Wheat bran	35.0
Alfalfa meal (14%)	33.6
Yellow corn	10.5
Soybean meal (44%)	15.77
Molasses	2.6
Bone meal	1.4
Limestone	0.3
Salt	0.4
Vitamins &minerals premix*	0.3
DL- Methionine	0.11
L- Lysine	0.02
Total	100
Calculated analysis	
Digestible energy (DE),kcal/kg	2721
Crude protein (CP), %	17.12
Crude fiber (CF), %	13.30
Calcium (Ca), %	1.13
Phosphorus (Ph), %	0.82
L-Lysine, %	1.0

*Vitamins and minerals premix per kilogram contains:
Vit. A, 6000 IU; Vit. D, 900 IU; Vit. E, 40 mg; Vit. K_3, 2 mg; Vit. B_1, 2 mg; Vit. B_2, 4 mg; Vit. B_6, 2 mg; Vit. B_{12}, 10 µcg; Nicotinic acid, 50 mg; Biotin, 50 µcg; Folic acid, 10 mg; Choline chloride, 250 mg; Zinc, 50 mg; Manganese, 85 mg; lorn, 50 mg; Copper, 5 mg; Iodine, 0.2 mg; Selenium, 0.1 mg; Cobalt, 0.1 mg.

RESULTS AND DISCUSSION

1. Growth performance

The average final body weight, total body gain (TBG) and average daily gain (ADG), average daily feed intake and feed/gain ratio are shown in Table 2. There was a significant increase in live body weight in treated groups compared to control group with no significant differences between the treated groups.

Total body gain and average daily gain follow the same manner as in body weight. The best final body weight and total gain were recorded with vitamin E group which recorded also the best feed/gain ratio compared to other treatments.

Table 2. Means ± SE for final body weight (FBW), average daily feed intake (AFI), total body gain (TBG), feed gain ratio, average daily gain (ADG) and (F/G ratio).

Treatment	FBW g	AFI g	TBG g	ADG g	F/G ratio
Control	1720.00[b]	86.98	1059.50[b]	18.92	4.59
	±39.69	±7.92	39.34		
Vitamin C	1902.22[a]	95.88	1243.72[a]	22.21	4.32
	±37.42	±7.92	±37.09		
Vitamin E	1944.00[a]	93.13	1287.50[a]	22.99	4.05
	±35.50	±7.92	±35.19		
Vitamins	1894.00[a]	94.73	1236.50[a]	22.08	4.29
C + E	±35.50	±7.92	±35.19		

[a, b] means in the same column with different superscripts are significantly different ($P<0.05$).

Improvement of the growth performance as a result of vitamin C and/or vitamin E supplementation of growing rabbits, can be attributed mainly to the increased animals resistance during physiological and/or environmental stress, through the noticeable improvement in animal health, and increase of the responsiveness of immune system besides the other functions (numerous) being affected by growth performance. Actually, the role of vitamin E on growth performance was indirect as noticed for vitamin C, both of them improved the growth by complex ways. Vitamin E had a role in intercellular and intracellular antioxidant. It prevented oxidation of unsaturated lipid materials within cells, thus, protecting fats within the cell membrane from breaking down. As we know, if lipid hydroperoxides are allowed to form, direct cellular tissue damage can result, in which peroxidation of lipids destroys structural integrity of the cell and causes metabolic derangements. Morphological damage to muscle is common in cases of vitamin E deficiency, and dystrophic tissue membranes may leak creatine and transaminases (e.g. glutamic-oxaloacetic transaminase) into plasma (McDowell, 1989). Interruption of fat peroxidation and the production of free radicals by vitamin C and/or E can simply explains the observation that dietary vitamin C and/or E protect or spare body supplies of oxidizable materials such as vitamin A and carotenes. This observation can explain the significant increase in body weight and total gain in treated groups due to more bio-viability of vitamin A which is very important and essential for growth. Beyond that, vitamin E can improve the animal performance and growth through its role in disease resistance, regulates the biosynthesis of deoxyribonuclic acid (DNA) within cell, normal phosphorylation reactions, especially of high energy phosphate such as creatine phosphate and adenosine triphosphate, in synthesis of ascorbic acid, in synthesis of ubiquinone and in sulfur amino acid metabolism (McDowell, 1989). Also, vitamin E is reported to have a role in vitamin B12 metabolism (McDowell, 1989), where deficiency of vitamin E interfered with conversion of vitamin B12 to its coenzyme. For all these functions, the growth and other parameters of performance like total body gain, and feed gain ratio should be improved as shown in this study, regardless of the other improvement in the blood, thermo-regulatory, and immunity indicators parameters, where it is not easy to ignore the great role and effects of this vitamin on these parameters which are also reflected on growth performance and improved it. Also, the improvement of growth may be due to that vitamin E provided protection against toxicity, where vitamin E provided the protection against toxicity with three classes of heavy metals (McDowell, 1989). The first class included metals like cadmium and mercury, the second group included silver and arsenic. A third group of metals included leads as an example.

Since discovery of vitamin C, it has come to be known as a "wonder worker". In addition to its role in collagen formation and other life-sustaining functions, vitamin C supports the cardiovascular system by facilitating fat metabolism and protecting tissues and DNA of the cells from free radical damage and mutagens, and it assists the nervous system by converting certain amino acids into neurotransmitters (Gary, 1994). Also, vitamin C contributes to a variety biochemical function. These include the biosynthesis of the amino acid carnitine and the catecholamines that regulate the nervous system. It also helps the body to absorb iron and to break down histamine, the inflammatory component of many allergic reactions (Gaby and Singh, 1991). Vitamin C can do much to enhance the body absorption of iron, especially the (nonheme) variety found in plants and drinking water (heme iron comes from meat) ordinarily. So, vitamin C is very important to animal (which cannot produce vitamin C), whose feed depends mainly on plants and cannot get the heme from meat like us.

Looking to the carcass Table (3), it can be notice that vitamins supplementation showed a small improvements on dressing % compared to control, with no significant change.

2. Blood parameters:

Role of vitamin C on iron absorption was so clear, and it had been reflected on the blood parameters where the haematocrit and haemoglobin values were increased significantly ($P<0.05$) (Table 4). They had been improved from 28.70 to 38.05 and from 10.01 to 14.18 for control and vitamin C groups, respectively. Concerning vitamin E and its effects on Hb and Ht besides its role as antioxidant, it was important in the synthesis and maintenance of red blood cells and their constituents, and might have a direct effect on synthesis of hemoglobuin and helped to prevent anaemia. Vitamin E deficiency may result in damaging red blood cells, destruction of nerves and shortening red blood cell life span. These observations might explain our results in Ht and hemoglobin values, where vitamin E group (3) significantly ($P<0.05$) improved Ht and hemoglobin values compared to control group (31.55 & 11.76 vs. 28.70 & 10.01), respectively. Increased hematocrit values can be attributed to the rise in erythrocyte number through increase of hematopoiesis (Sahota *et al.*, 1994), and this is a good indicator that the animals either supplemented with vitamin C or "C+E" or (vitamin E) are not under heat stress compared to control group. Animals under heat stress might consume more water, and as a result, haematocrit value was decreased due to dilution of the blood, and this observation did not happen in this study. These results were supported by the other parameters such as rectal temperature (RT) and respiration rate (RR), where a significant ($P<0.05$) reduction was observed in both of them (RT and RR) in vitamin groups compared to control group. The best results for the two parameters (RT and RR) were obtained in group 4 (vitamin C + E) compared to all other treated groups. Vitamin C group occupied the second place. This was a good indicator that both two vitamins had a synergistic effect. The other parameter reflects clearly this phenomena in

GOT, GPT, globulin, BUN, lymphocytes and alkaline phosphatase, where vitamin C + E group recorded an increase in liver enzyme activities compared to control, but still within normal ranges as indicated by the non-significant changes between groups. The same trend was observed in Glob., where it significantly was increased in all treated groups compared to control with no significant changes between the vitamin group (Table 4). The last positive synergistically interactions between the two vitamins was noted with lymphocyte type where, it was significantly ($P<0.05$) increased in all vitamin groups compared to control group but the best percentage was recorded in groups 4 (C + E) and 2 (C) with no significant differences, followed by vitamin E group (3) with significant differences to both other two vitamin groups. Vitamin C can also work along with glutathion peroxidase (a major free radical-fighting enzyme) to revitalize vitamin E, a fat-soluble antioxidant. So, in addition to its work as a direct scavenger of free radicals in fluid, vitamin C also contributes to the antioxidant activity in the lipids. This observation can explain and interprete our results in the vitamin groups, and gave us a good picture about the synergistic effect between these two vitamins, and they can be effective partners in reducing the destructive process of lipid peroxidation. In human and animals studies, this reduction took place in subjects with diabetes, cerebral arteriosclerosis or heart disorder (Barta, 1991). They found that vitamins C and E can help to prevent the blood from clotting; a condition that contributes to the risk of stroke. Also, the effect of combination of the two vitamins in reducing blood urea nitrogen, cholesterol, and alkaline phosphatase compared to control or even when compared to each vitamin alone is so great with a little bit of exception. Vitamin E alone was more effective in reducing the cholesterol level compared to its combination, but still its effect together was significant compared to control group (83.64 vs 88.04). The low level of cholesterol, especially, in vitamin E group can be explained by the great in-flow of lipids for energy supply, and the great risk of tissue damage if vitamin E was limiting. Also, vitamins supplementation significantly improved the total protein, albumin, and globulin compared to control group (Table 4), and this was probably due to the activity of protein synthesis enzyme as reported by McDowell (1989). Vitamin E seemed to be more effective in improving the total protein and albumin compared to vitamin C, while, their improvements in globulin and their effects were equal. But looking to albumin/ globulin ratio as a good indicator for increasing the immunoglobulin and subsequently the immune responsiveness, vitamin C would be the first or in advance and preceded vitamin E. The best A/g ratio was recorded in vitamin C group (1.06 vs 1.18) in vitamin E group, and the combination of the two vitamins gave a good value either (1.08), it is easily to contribute this improvement to vitamin C effect. Combination of the two vitamins worked together to decrease the alkaline phosphatase in all treated groups. It was a good sign of health to have low level of alkaline phosphatase, because there was a risk of getting cancer with high levels. Supplementation of the two vitamins gave us another good signs that our animals were so healthy, where the cholesterol and blood urea nitrogen were significantly reduced compared to control group. This antioxidant property (interrupt production of free radicals at the initial stage) also ensures erythrocyte stability and maintenance of capillary blood vessel integrity (McDowell, 1989).

Table 3. Means ± SE and percentages for Carcass traits as affected by treatments.

Treatment		Live weight	Dressing	Liver	Kidneys	Spleen
Control	g	1767.00	941.90	52.80	11.53^{c}	0.62
		±16.83	±11.51	±0.52	±0.15	±0.03
	%	-	53.31	2.99	0.65	0.04
Vitamin C	g	1903.33	1031.83	54.77	12.50^{b}	0.73
		±16.83	±11.51	±0.52	±0.15	±0.03
	%	-	54.21	2.88	0.66	0.04
Vitamin E	g	1966.67	1085.93	56.40	13.53^{a}	0.74
		±16.83	±11.51	±0.52	±0.15	±0.03
	%	-	55.22	2.87	0.69	0.04
Vitamins	g	1950.00	1068.73	56.87	13.37^{a}	0.76
C + E		±16.83	±11.51	±0.52	±0.15	±0.03
	%	-	54.81	2.92	0.69	0.04

Preliminary research had led to a widely belief that vitamin E maintains healthy nerves and muscles, while strengthening capillary walls, improves circulation, promotes normal blood clotting and healing, reduces blood pressure and may help preventing or delaying coronary heart disease. Researchers are fairly certain that oxidative modification of low-density lipoprotein (LDL) [bad cholesterol] promotes blockages in coronary arteries that may lead to arheriosclerosis and heart attacks. Vitamin E may help preventing or delaying coronary heart disease by limiting the oxidation of LDL-cholesterol. Vitamin E carried through the blood stream in particles of low-density lipoprotein (LDL) or bad cholesterol, by blocking the oxidation of LDL, can prevent it from infiltrating cells and clogging arteries. Also, vitamin E may help in preventing the formation of blood clots, which could lead to heart attack. Our results fully agreed with the previous studies and observations where the lowest cholesterol value had been recorded with vitamin E supplemented group (81.52) compared to control (88.04) or even to other vitamins groups. So, observation studies have been associated with lower rates of heart disease with higher vitamin E intake, where a study of approximately 90.000 nurses suggested that the incidence of heart disease was 30% to 40% lower among nurses with highest intake of vitamin E.

3. Immune function

Vitamin C serves as a key immune system nutrient and a potent free radical fighter. This double-duty nutrient had been shown to prevent many illnesses from common cold to devastating diseases such as cancer. Vitamin C plays a major role in the manufacture and defense of our connective tissue, the elaborate matrix that holds the body together, as a primary ingredient of collagen that binds cells together to form tissue. Also, vitamin C helps some of most important systems. First and foremost, it helps the immune system to fight off foreign invaders and tumor cells. Vitamin C can enhance the body resistance to many diseases, including infections disorders and many types of cancer. It strengthens and protects the immune system in two ways by stimulating the activity of antibodies and interferon production (the protein that saves the protection from viral invaders and cancer cells) and immune system cells (white blood cells) such as phagocytes and nutrophils which attack foreign bodies such as bacteria and viruses as reported in our study (Table, 4). The role of vitamin C was so clear as Gaby and Singh (1991) reported. It prevents harmful genetic alterations within cells and protects lymphocytes from mutations to the chromosomes; this may explain the big increase in lymphocytes type in our study (62.40) vs (56.45) in control group. The same trend was observed in vitamin C + vitamin E group, and the role of vitamin C especially, in this properties is so clear, where the lymphocytes % in this group improved to 63.30 compared to control 56.45, or even to vitamin E group (59.50). Skin and the epithelial lining of the body orifices, contain collagen, serve as a first line of defense against invadors. So, we can detect how much vitamin C is important to immune system from the beginning (Gaby and Singh, 1991). They prevent these invadors from entering the body in the first place, where the immune system would have to go to war against them. Beyond that, vitamin C acts against the toxic, mutagenic and carcinogenic effects of environmental pollutants by stimulating liver detoxifying enzymes. It also stimulate the production of (PGE_1), a prostaglandin which assists lymphocytes and the defender cells in immune system.

As mentioned before, vitamin C can enhance the immune function in a number of ways: 1 gram of vitamin C intravenously, increased significantly the neutrophil motility and leukocyte transformation in the blood and enhances the leukocyte function and decreases the bacteriological activity (Gaby and Singh, 1991). Recent studies (Chew, 1995) showed that vitamin C has a positive effect on variety of chronic disorders, where 300 mg of vitamin C a day for several weeks exerts a remarkable immunomodulating action such as serum immunoglobulin and neutrophil phagocytosis in patient with viral hepatitis. Another study (Gary, 1994) with chronic brucellosis, concluded that vitamin C might partially restore peripheral monocyte function and helps the monocyte-macrophage system to mount an effective immune response against the infection. As an antioxidant, vitamin C primary role is to neutralize free radicals. Since ascorbic acid is water soluble, it can work both inside and outside the cells to combat free radical damage, where free radicals will seek out an electron to regain their stability. As we know, vitamin C is an excellent source of electron, therefore, it can donate electrons to free radicals such as hydroxyl and superoxide radicals and quench their reactivity. Many studies suggested that vitamin C antioxidant mechanisms may help to prevent cancer in several ways. It combats the peroxidation of lipids, where 400 mg of vitamin C per day for one year period reduced serum lipid peroxide levels. Vitamin C can also work inside the cells to protect DNA from the damage caused by free radicals, where vitamin C reduced the level of potentially destructive genetic alterations or chromosome aberrations (Gaby and Singh, 1991). As we know, many of the pollutants that now pervade our environment can cause toxic, carcinogenic or mutagenic effects and vitamin C may be able to arrest the harmful effects, in part, by stimulating detoxifying enzymes in the liver, block the formation of fecal mutagens, optimize the immune system surveying the body for the presence of cancer cells. It also enhances an intracellular material called ground substance that holds tissues together, where when this substance is strong, cancer cells have a harder time infiltrating cells (Passwater, 1985). Vitamin C can reduce the development of nitrosamines from nitrates, chemicals that are commonly used in processed foods. Once formed nitrosamine can become a carcinogen. But in several human and animal studies in which they consumed a nitrosamine precursor, the urinary levels of nitrosamin were significantly reduced by vitamin C. Animal studies support the preventive effect of vitamin C on nitrate-induced cancer and the formation of tumors was inhibited, suppressed or reduced in frequency in animals treated with vitamin C (Gary, 1994).

The synergistic combination of vitamin C and E was found to be effective in improving certain aspects of cell-mediated immunity, such as the number of T cells, T_4 subsets and the ratio of T_4 to T_8 cells (Gary, 1994).

Finally, after we reviewed the whole benefits of the two vitamins (C + E), especially their roles against the toxicity and pollution which can cause devastating diseases such as cancer, and after complete and total success of pollutants, pervade our environment (air, water resources, land) with heavy metals, pesticides and other pollutants resources. So, our foods, air and water became our complements, illness and dangerous sources of diseases instead of health. So, on behalf of our community, the conclusion or our recommendation will be for us. Our food should have these vitamins in abundant or we have to take these vitamins daily in preventive dose, which may help us and provides the required protection against the devastating diseases.

Table 4. Means ± SE for RT, RR, blood parameters and white blood cell's differential.

Treatment	Blood Parameters[1]										
	Ht %	Hb g/dl	TP g/100ml	Alb g/100ml	Glb g/100ml	U-N mg/dl	GOT m/dl	GPT m/dl	Chol. mg/dl	Alb/Glb ratio	Alk. Phos.
Control	28.70^{d}	10	5.95^{c}	3.11^{c}	2.84^{b}	16.04^{a}	26.5	21.6	88.04^{a}	1.10	16.75^{a}
	±0.70	±1.95	±0.05	±0.06	±0.05	±0.26	±0.29	±0.36	±0.49		±0.17
Vitamin C	38.05^{a}	14.2	6.59^{b}	3.39^{b}	3.20^{a}	15.00^{b}	27.6	22.4	82.87^{bc}	1.06	16.20^{b}
	±0.70	±0.06	±0.05	±0.06	±0.05	±0.20	±0.29	±0.36	±0.49		±0.17
Vitamin E	31.55^{c}	11.8	6.98^{a}	3.78^{a}	3.20^{a}	13.88^{c}	27.8	21.9	81.52^{c}	1.18	15.94^{b}
	±.70	±1.95	±0.05	±0.06	±0.05	±0.26	±0.29	±0.36	±0.49		±0.17
Vitamins	34.70^{b}	12.4	6.69^{b}	3.47^{b}	3.22^{a}	13.59^{c}	28.6	23.4	83.64^{b}	1.08	15.91^{b}
C + E	±0.70	±0.95	±0.05	±0.06	±0.05	±0.26	±0.29	±0.36	±0.49		±0.17

Table 4. Continued.

Treatment	Physiological Response[2]		White Blood Cells[3]				
	RT	RR	Lym %	Neut %	Mono %	Baso %	Eosino %
Control	40.04^{a}	169.80^{a}	56.45^{c}	37.05^{a}	3.25^{a}	1.95	1.15
	±0.06	±3.55	±0.88	±1.07	±0.15	±0.20	±0.10
Vitamin C	39.44^{c}	148.50^{bc}	62.40^{b}	32.10^{b}	2.65^{b}	1.90	1.15
	±0.06	±3.55	±0.88	±1.07	±0.15	±0.20	±0.10
Vitamin E	39.67^{b}	155.05^{b}	59.50^{b}	34.55^{a}	2.50^{b}	2.00	1.70
	±0.06	±3.55	±0.88	±1.07	±0.15	±0.20	±0.10
Vitamins	39.30^{c}	138.50^{c}	63.30^{b}	31.25^{b}	2.55^{b}	1.70	1.30
C + E	±0.06	±3.55	±0.88	±1.07	±0.15	±0.20	±0.10

[1]Ht, hematocrit value; Hb, hemoglobuin concentration; TP, total protein; Alb, albumin; Glb, globulin; U-N, urea-N; GOT, glutamic oxaloacetic transaminase; GPT, glutamic pyruvic transaminase; Chol., cholesterol; Alk. Phos., alkaline phosphatase.

[2]RT, rectal temperature; RR, respiration rate

[3]Lym, lymphocytes; Neut, neutrophils; Mono, monocytes; Baso, Basophils; Eosino, Eosinophils.

[a, b, c, d] means in the same column with different superscripts are significantly different ($P<0.05$).

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تأثير فيتامين ج و هـ على الوظائف المناعية ومظاهر النمو فى الأرانب خلال فصل الصيف

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أجريت تجربة لدراسة تأثير إضافة فيتامين ج و هـ على حدة أو معاً على أداء النمو وبعض مقاييس الدم وعلاقتها بالمناعة وذلك تحت ظروف الجو الحار خلال فصل الصيف حيث أُستخدم ٤٠ أرنب عمر ٥ أسابيع (الوزن ٦٥٠ جم) تم تقسيمهم عشوائياً إلى ٤ مجاميع تجريبية كالتالى: مجموعة كنترول بدون إضافة (١) وتم معاملة المجاميع الأخرى بالفيتامينات عن طريق الفم كما يلى مجموعة بـ ٢٠ مجم فيتامين ج/حيوان/يومياً عن طريق الفم (٢) والثالثة بـ ١٠ مجم فيتامين هـ والرابعة بـ ٢٠ مجم فيتامين ج + ١٠ مجم فيتامين هـ على الترتيب.

تم تسجيل درجة الحرارة العظمى والصغرى ودرجة الرطوبة النسبية داخل وخارج المزرعة يومياً طوال فترة التجربة (٨ أسابيع). تم تسجيل وزن الجسم والغذاء المستهلك كل أسبوعين وتم حساب الزيادة المكتسبة فى الوزن وكذلك معدل التحويل الغذائى. أيضاً تم قياس درجة حرارة المستقيم ومعدل التنفس وأُخذت عينات دم لتقدير الهيموجلوبين والهيماتوكريت والبروتين الكلى والألبيومين والكوليسترول والنشاط الإنزيمى الكبدى وكذلك اليوريا نيتروجين والألكالين فوسفاتيز وأيضاً تم حساب نسبة كرات الدم البيضاء. ومع نهاية التجربة تم ذبح أرانب من كل مجموعة لتقدير صفات الذبيحة ونسبة التصافى.

أوضحت النتائج ما يلى :

١- أن معاملة الأرانب خلال فصل الصيف بفيتامينات ج و هـ حسن معنوياً وزن الجسم وكذلك الزيادة المكتسبة فى الوزن، أيضاً معدل التحويل الغذائى مقارنة بمجموعة الكنترول.

٢- لم يكن للفيتامينات المستخدمة أثر كبير على تحسن نسبة التصافى أو فى صفات الذبيحة.

٣- كانت هناك زيادة كبيرة فى نسب كل من الهيماتوكريت والهيموجلوبين وأنزيمات الكبد والألبيومين والجلوبيولين وكذلك نسبة خلايا الليمفوثايتس مع تحسن نسبة الألبيومين/الجلوبيولين فى المجموعات المعاملة بالفيتامينات.

٤- أنخفضت نسبة الكوليسترول وكذلك درجة حرارة المستقيم وقل معدل التنفس واليوريا نيتروجين وأنزيم الألكالين فوسفاتيز نتيجة المعاملة بفيتامينات ج و هـ مقارنة بالكنترول.

نستخلص من هذه التجربة أن كل من فيتامين ج و هـ ضروريين جداً خصوصاً فى الجو الحار بجانب أهميتهما العظمى فى تحسين كفاءة الجهاز المناعى للحيوان وجعله أكثر مقاومة لكل الظروف المحيطة به وذلك لدورهما كمضادات للأكسدة وتوفيرهم الحماية اللازمة ضد السموم وكذلك الأضرار الناتجة عن تلوث البيئة والمنتشر بصورة مخيفة هذه الأيام سواء من المعادن الثقيلة أو المواد الأخرى كالنيتروزامين وفلوروكلوروكربون والمسببة للعديد من أنواع السرطانات.

هذا البحث يظهر أهمية فيتامين ج خصوصاً ضد كل ما سبق ذكره من مخاطر ونوصى بشدة بتناوله نحن كبشر يومياً بجرعات وقائية لما له من فاعلية ثبتت بالأبحاث سواء على البشر أو الحيوان.