Effects of Allicin and Lycopene on Performance, Carcass, Hematological Profile and Antioxidant Status of Growing Rabbits Through Summer Season

H. S. Zeweil, S. M. Zahran, M. H. Ahmed, Y. El- El-Gindy and W. G. M. Shaglouf
Department of Animal and Fish Production, Faculty of Agriculture (Saba Basha), Alexandria University.

ABSTRACT: Forty-five growing V-line rabbits of both sexes, 5 weeks old, were used for the study through summer season from July to September. The rabbits were randomly allocated to five treatments groups of 9 rabbits each. Each treatment was further sub-divided into 3 replicate of 3 rabbits. Group one fed control diet free of feed additives and served as a control. Group 2 and 3 supplemented with 100 and 200 mg allicin / kg diet. Group 4 and 5 supplemented with 100 and 200 mg lycopene / kg diet, respectively. Results showed that the groups fed allicin 200 mg/kg and lycopene100 mg/kg in their diets recorded the best ($P \leq 0.05$) significant average daily weight gain as compared with the control group. The other experimental groups were numerically best in comparison with the control group. Significant improvement in feed conversion ratio was recorded in all experimental groups in comparison with control. Carcass traits and hematological parameters were insignificantly affected by different treatments. All feed additives used in the present study significantly increased antibody titters against $SRBC_s$ compared with control group at 7, 14 and 21 days after vaccination. Serum total lipids was significantly ($P \leq 0.05$) decreased due to addition of different feed additives, except with 200 mg allicin in the diet serum total lipids was equal to the control group. Blood serum total cholesterol and triglycerides were significantly ($P \leq 0.05$) reduced by feeding diets containing different levels of allicin or lycopene in comparison with the control group. The results showed that low density lipoprotein was numerically decreased, however, high density lipoprotein and HDL/LDL ratio were numerically increased due to inclusion different feed additives in the diets. Exposing growing rabbits to high temperature conditions during summer season resulted in elevated ($P \leq 0.05$) serum MDA, while serum total antioxidant capacity was decreased as presented in the control group, however, supplementation of allicin and lycopene appeared to antagonize the effect of high temperature. In conclusion, rabbit dietary supplementation with allicin or lycopene could have beneficial effects on performance under summer environment without any side effects.

Key words: Allicin, lycopene, rabbits, performance, blood lipid profile, blood serum

INTRODUCTION

Large number of feed additives are available for inclusion in animal and poultry diets to improve animal performance. However, the use of chemical products especially antibiotics, may cause unfavorable side effects. Moreover, there is evidence indicating that some products could be considered as pollutants for human which threaten health on the long-run. Attempts to use the natural materials such as medical plants could be widely accepted as feed additives to improve the efficiency of feed utilization and animal productive performance (Zeweil *et al.,* 2013). Lycopene (LP) is an aliphatic hydrocarbon, a bright red pigment, which is a naturally present carotenoid in fruits and vegetables. Tomatoes are known to be the major source of LP with the content of 3100–8600 µg per 100 g of tomatoes or their products (Stahl and Sies 1996). The most well-known

biological effects of LP intake are acting as antioxidant or hypocholesterolemic agent (Di Mascio *et al.,* 1989). It has been known that the hypocholesterolemic or triglyceride-lowering effect of LP is attributed to inhibition of de novo cholesterol synthesis and lipogenesis (Chung *et al.,* 2012; Palozza *et al.,* 2012). Indeed, Fuhrman *et al.* (1997) proved that LP suppressed the cholesterol synthesis from acetate by 73 % using the macrophage cell line, and confirmed *in vitro* observation in healthy males *in vivo* that the concentration of plasma low-density lipoprotein (LDL) cholesterol was reduced by 14 % by LP intake for 3 months. Allicin is an organosulfur compound obtained from garlic, a species in the family Alliaceae (Eric, 1985). Allicin has a distinctively pungent smell and exhibits antibacterial, anti-fungal, anti-inflammatory and antioxidant properties (Lindsey *et al*., 2005). Allicin has been found to lower serum and liver cholesterol (Qureshi *et al*., 1983), inhibit bacterial growth (Cavallito *et al.,* 1994) and reduce oxidative stress (Lindsey *et al*., 2005 and Choudhary, 2008). Also allicin has immune-stimulatory effect (Cho *et al*., 2006). The objective of this study is to investigate the effect of feeding allicin and lycopene in two different doses on performance, carcass traits, hematological, blood serum lipid profile and antioxidant status of growing rabbits through Egyptian summer season.

MATERIALS AND METHODS

Forty-five growing V-line rabbits of both sexes, 5 weeks old, with initial weights of 791.7 ± 14.1 g were used for the study. The rabbits were randomly allocated to five treatments groups of 9 rabbits each. Each treatment was further sub-divided into 3 replicate of 3 rabbits. Rabbits were housed in wire floor batteries of 45 x 36 x 36 cm and were offered diets for duration of the feeding trial until reaching 15 weeks of age through summer season from July to September. All animals were kept under similar hygienic conditions. Rabbits were housed in well ventilated block building. Fresh air circulated in the house using exhaust fans. The rabbits were kept within a cycle of 16 h light and 8 h dark. Five pelleted diets were prepared. Group one fed control diet free of feed additives and served as a control group. Group 2 and 3 contained 100 and 200 mg allicin (Double Ok Life Co., Ltd-Fujian China “Mainland”) / kg diet. Group 4 and 5 contained 100 and 200 mg lycopene (Roche, Levent-Istanbul) / kg diet, respectively. Each group of rabbits was fed one of five experimental diets. Fresh water was automatically available at all times through stainless steel nipples for each cage. The experimental diets were offered to rabbits *ad libitum*. The formula of basal experimental diet is presented in Table (1) that formulated to cover the requirements of rabbits according to NRC (1977).Individual body weight and feed consumption were recorded weekly. Body weight gain and feed conversion ratio were also calculated. The incidence of dangerous diseases was largely avoided and rabbits have never been treated with any kind of systematic vaccination or medication. At the end of the feeding trial, 3 rabbits were selected from each treatment group randomly, starved of food but not water for 12 hours and slaughtered for carcass analysis. Before slaughtering, 6 ml of blood sample was taken from the ear vein with a sterile syringe. 3 ml of the

blood was put into a bijon bottle containing ethylene diamine tetracetic acid (EDTA) as an anticoagulant for haematological assay. The remaining 3ml of the blood sample was put into a sterile vacutainer tube without an anticoagulant for serum biochemical analysis. The haematological assay was carried out to determine erythrocyte indices such as packed cell volume (PCV), and haemoglobin (Hb) values. Red blood cell (RBC) counts were counted on an AO Bright line hemocytometer using a light microscope at 400X magnification after diluting blood samples 200 times with a physiological saline (0.9% NaCl solution) before counting (Natt and Herrick, 1952). White blood cell (WBC) were counted on an AO Bright line hemocytometer using a light microscope at 100X magnification after diluting blood samples 20 times with a diluting fluid (1% acetic acid solution with a little of Leishman's stain) before counting (Hepler, 1966). Total lipids, triglycerides, cholesterol, low density lipoprotein (LDL) and high density lipoprotein (HDL), concentrations in serum were estimated using commercial kits (Bio Merieux, France) according to the procedure outlined by the manufacturer.

Table(1). Composition and chemical analyses of the basal experimental diet.

Ingredients	%
Yellow corn	19.0
Wheat bran	11.0
Barley	17.2
Berseem hay	33.0
Soybean meal (44%)	15.0
Molasses	3.0
Di-calcium phosphate	1.0
L-lysine	0.1
DI-Methionine	0.1
Premix	0.3
Salt	0.3
Total	**100**
Chemical analyses:	
Dry matter (DM), %	91.36
Crude protein%	17.24
Ether extract%	3.26
Crude fiber%	12.58
Nitrogen free extract%	50.47
Ash%	7.57
Organic matter (OM), %	92.42
DE (kcal/kg DM)[2]	2749.78

[1]Vit+Min mixture provides per kilogram contains: Vit A 6000 IU; Vit D_3 450 IU; Vit E 40 mg; Vit K_3 1 mg; Vit B_1 1 mg; Vit B_2 3 mg; Vit B_3 180 mg; Vit B_6 39 mg; Vit B_{12} 2.5 mg; Pantothenic acid 10 mg; biotin 10 mg; folic acid 2.5 mg; choline chloride 1200 mg; Manganese 15 mg; Zinc 35 mg; Iron 38 mg; Copper 5 mg; Selenium 0.1 mg; Iodine 0.2 mg; Selenium 0.05 mg. [2]Analyzed values according to AOAC (1995). DE calculated according to Fekete and Gippert (1986) as: DE (kcal/kg DM) = 4253 - 32.6(Crude fibre % DM) - 144.4(ash% DM).

Three rabbits of each treatment were immunized with 0.1 ml of a 2.5% Sheep Red Blood Cells (SRBCs) via the marginal ear vein at 15 days after starting the dietary treatment supplementation, to measure Antibody titer against Sheep Red Blood Cells.

The dosage of SRBC for inoculation was pre-determined by a separate trial. Antiserum to SRBCs was collected 7, 14 and 21 days post challenge. One ml of blood without any anticoagulant was refrigerated to allow red blood cells to settle. If sedimentation was not complete, samples were centrifuged for 1 to 2 min at 3000 rpm to separate serum and erythrocytes, and the supernatant was collected. Briefly, 96-well plates were first filled with 25 µl of physiological saline solution in each well. Then 25 µl of antiserum was pipetted into the first well in duplicates after which 25 µl from the first well was pipetted into the second well, and so forth using an automatic pipette. Finally, a 0.75% of SRBC solution was added to each well. Plates were incubated at 37 ^{o} C for 3 hours and then examined visually for agglutination Wegmann and Smithies, (1966). The agglutination titer was expressed as the $\log^2$ of the reciprocal of the highest serum dilution giving complete agglutination (Nelson *et al.,* 1995). The results were expressed as the mean ± SEM. All data were analyzed using one way analysis of variance (ANOVA) using SPSS 11.0 statistical software (SPSS, Inc., Chicago, Il, 2001). Significant differences between means were detected using new Duncan multiple range test (Duncan, 1955).

RESULTS AND DISCUSSIONS

Results concerning the effect of dietary supplementation of allicin and lycopene on performance of growing V-line rabbits are illustrated in Table 2. It was observed that there were no significant differences in initial body weight among different treatments showing the random distribution of the experimental rabbits among treatments.

The results illustrated in Tables 2 showed that dietary allicin and lycopene supplementation did not significantly influence the final live body weight of the V-line growing rabbits. But in general it was noted that all the experimental groups including different levels of allicin and lycopene showed numerical increase in final live body weight in comparison with the control one. The obtained results showed that the groups fed allicin 200 mg/kg and lycopene 100 mg/kg in their diets recorded the best ($P \leq 0.05$) significant average daily weight gain. As compared with the control group. These groups surpassed the control one by 8.2 and 7.6 %, respectively.

Table (2). Effect of allicin and lycopene on performance of growing V-line rabbits

Characteristics	Control	Allicin		Lycopene	
		100 mg/kg diet	200 mg/kg diet	100 mg/kg diet	200 mg/kg diet
Initial body weight, g	775.6±31.5	761.2±27.5	704.4±29.3	755.0±26.7	793.3±23.5
Final body weight, g	2380.0±24.9	2424.4±42.1	2440.0±28.4	2482.2±25.4	2468.1±33.3
Daily weight gain, g	22.92±0.52^{b}	23.76±0.36^{ab}	24.79±0.47^{a}	24.67±0.34^{a}	23.93±0.30^{ab}
Daily feed intake, g	87.1±0.6	82.7±0.7	83.0±1.7	85.0±1.9	83.3±1.7
Feed conversion ratio	3.82±0.09^{a}	3.49±0.07^{b}	3.36±0.09^{b}	3.45±0.09^{b}	3.49±0.11^{b}

Different letters (a-b) within a raw denote significant differences between treatments (P ≤ 0.05)

Feed intake was insignificantly affected by the difference treatments. Jain *et al.* (1999) reported that live weight and feed intake were not affected by lycopene supplementation in rat diets. Significant improvement in feed conversion ratio reached to 8.6, 12.0, 9.7 and 8.6 % for the rabbits fed diets supplemented with 100 and 200 mg allicin and 100 and 200 mg lycopene in comparison with the control group, respectively. The results suggested by Onyimonyi *et al.* (2012) found that broilers fed garlic essential oil at a level of 100 mg/Kg improved feed conversion ratio. The possible explanation for this positive growth promoting effect could be attributed to allicin, an organosulfur compound contained in garlic that promotes the performances of the intestinal flora there by enhance digestion (Pourali *et al.,* 2010). Ramakrishna *et al.* (2003) showed that garlic supplementation enhances the activity of pancreatic enzymes and provides an environment for better absorption of nutrients. Also, Stanaćev *et al.* (2011) demonstrated that the chicks fed diets with garlic have achieved better feed conversion ratio since it reduced by 10%, while the birds maintained good health status in comparison with the control group. On the other hand, Aji *et al.* (2011) reported that administration of 100 mg of garlic resulted in improved body weight gain of broiler chicks, without change in feed conversion ratio.

The results in Table 3 showed that the different treatments had insignificant effect on all carcass traits at 15 weeks of age. Hossian *et al.* (2015) reported that there was no significant(P ≤ 0.05) differences in carcass traits of rabbits fed control group and rabbits fed diets containing 0.25 and 0.50 % dried garlic.

Table (3). Effect of allicin and lycopene on carcass traits of growing V-line rabbits at 15 weeks of age

Characteristics	Control	Allicin		Lycopene	
		100 mg/kg diet	200 mg/kg diet	100 mg/kg diet	200 mg/kg die
Pre-slaughter weight,g	2353.3±73.8	2266.7±33.8	2365.0±16.0	2416.7±26.8	2405.0±58.9
Cold carcass,%	52.5±2.5	53.6±1.3	55.9±3.4	53.2±0.3	53.5±1.0
Total edible parts,%	60.5±2.0	58.1±0.9	64.9±4.6	59.0±0.7	60.4±0.4
Non-edible	39.5±2.0	41.9±0.9	35.0±4.6	41.0±0.7	39.6±0.4
Parts,%Head,%	5.2±0.2	5.7±0.2	5.6±0.2	5.9±0.2	4.9±0.3
Fur, %	13.7±0.6^{ab}	13.1±0.4^{abc}	11.7±0.2^{c}	14.5±0.8^{a}	12.5±0.6^{bc}
Liver, %	2.59±0.26	2.80±0.32	2.33±0.15	3.09±0.32	2.61±0.23
Heart, %	0.34±0.05	0.28±0.03	0.31±0.02	0.32±0.04	0.35±0.04
Kidney, %	0.47±0.00	0.49±0.04	0.53±0.06	0.57±0.05	0.51±0.01
Kidney fat,%	0.20±0.05	0.18±0.06	0.18±0.04	0.18±0.05	0.18±0.06
Giblets, %	3.40±0.26	3.56±0.25	3.17±0.18	3.98±0.24	3.47±0.20
Lungs, %	0.50±0.07	0.67±0.08	0.55±0.02	0.65±0.07	0.54±0.01
Spleen%	0.06±0.01	0.05±0.01	0.07±0.01	0.07±0.01	0.06±0.01

Different letters (a-c) within a raw denote significant differences between treatments ($P \leq 0.05$).

The findings of Fadlalla *et al.* (2010), using broilers reported a non-significant effect on broiler dressing percentage values, but numerically higher, due to the inclusion of garlic powder. El Azab *et al.* (2012) reported that all carcass traits did not find any significant difference between the different groups of rabbits fed diets containing 0, 5 and 10% tomato pomace as a source of lycopene for 8 weeks, except lungs weight.

Results presented in Table 4 showed that the average values of hematological parameters were within the normal range without any significant differences among treatments and the control group, indicating that all tested feed additives had no adverse effects on blood components. Results of Ademola *et al.* (2009) reported that the red blood cells and hemoglobin concentration of broiler chickens were not affected by dietary garlic. Abd El-Latif *et al.* (2013) reported that addition of garlic essential oils to broiler diets did not significantly affect RBCs count and it was similar to those of the control group. The RBCs, PCV and Hb values were nearly similar among the control and treatment groups and also fall within the normal range of 3.7 - 8.0 x10^6, 25 – 50% and 8.9 – 17.5 mg/dl reported for healthy rabbits by Mitruka and Rawnsley (1977). The normal PCV indicates the absence of normocytic anaemia which only detected by a decreased number of RBCs or PCV (Coles, 1986). The normal hemoglobin concentration for all the experimental rabbits is probably an indication that different levels of allicin and lycopene used in the present study supported hemoglobin synthesis, which according to Sirosis (1995) is among other factors, primarily affected by protein intake. Njidda *et al.* (2006) reported that normal range of values for Hb indicated that the vital physiological relationship of hemoglobin with oxygen in the transport

of gases (oxygen and carbon dioxide) to and from the tissues of the body has been maintained and was normal. The WBCs counts are used as indicator of stress response and are sensitive biomarkers crucial to immune functions (Graczyk *et al.,* 2003). In the present study, WBCs values were not significantly affected by the dietary treatments as compared with control group. However, the WBCs counts fell within the normal physiological range reported by Mitruka and Rawnsley (1977). This indicates that body defense system of the rabbits in all the treatment groups was not negatively affected by different levels of allicin or lycopene used in the present study. High WBCs counts are usually associated with microbial infection or the presence of foreign body or antigen in the system (Ogbuewu *et al.,* 2010). The comparable mean WBCs counts in all the treatment groups in this study ruled out the possibility of microbial infection.

Antibody titters against SRBCs determined are shown in Table (4) as affected by allicin and lycopene. The results indicated that all feed additives used in the present study significantly increased antibody titters against SRBCs compared with control group at 7, 14 and 21 days after vaccination. The use of different feed additives used in the present study played a role in increasing immune response against some diseases. It is shown that allicin and lycopene were an immunomodulatory. It stimulated humoral immune response of growing rabbits in comparison with the control group.

Table 5 represents the results of the effects of allicin and lycopene on rabbit's serum total lipids, triglycerides, total cholesterol, LDL and HDL concentrations. Results indicated that serum total lipids was significantly ($P \leq 0.01$) decreased due to addition of different feed additives, except with 200 mg allicin in the diet serum total lipids was equal to the control group. Blood serum total cholesterol and triglycerides were significantly ($P \leq 0.05$) reduced by feeding diets containing different levels of allicin or lycopene in comparison with the control group. The results showed that low density lipoprotein was numerically decreased; however, high density lipoprotein and HDL/LDL ratio were numerically increased due to inclusion different feed additives in the diets. It was noticed that lycopene was more pronounced on these traits than allicin. Cholesterol is one of the cell and tissue components and is used as a starting material for synthesis of numerous compounds. The animal body utilizes both dietary and endogenous cholesterol. The endogenous part can be converted into bile acids and steroid hormones, while the exogenous portion undergoes intestinal emulsification by bile acids. Roussel *et al.* (1982) reported that circulating cholesterol level is known to be influenced by the activity of steroid producing organs. Rao and Shen (2002) showed a decrease in blood plasma cholesterol as a result of dietary lycopene supplementation. Sahin *et al.* (2006) described an increase in the blood plasma HDL concentration of Japanese quail and a significant decrease in the LDL concentration because of lycopene addition. Oshima *et al.* (1997) reported that human LDL could be protected against photosensitized oxidative damage by lycopene. Paran and Engelhard (2001) reported that lycopene supplementation reduced blood lipids,

lipoproteins and oxidative stress markers in hypertensive patients. Tocopherols and tocotrienols in dried tomato pomace lowers serum cholesterol by suppressing the posttranscriptional action of 3-hydroxy-3-methylglutaryl coenzyme A (HMG-CoA) reductase, the rate -limiting enzyme in the mevalonate pathway of endogenous cholesterol synthesis by the liver (Song-Hae *et al.,* 1999). The literature concerning cholesterol lowering by bioactive phytochemicals often concludes that the excretion of bile acid and cholesterol and the resulting depletion of the enterohepatic bile acid pool are important mechanisms of cholesterol-lowering. The physiological observations are supported by changes in expression of genes regulating bile acid and cholesterol metabolism. Enhanced excretion of bile acid, cholesterol and total fat were observed in dried tomato seed supplemented diet and the related genes expressions were also modulated (Shao *et al.,* 2013). There is a linear relationship between enzyme activity and CYP7A1 gene expression (Bartley *et al.,* 2010), so the observed up-regulation of CYP7A1 likely indicates bile acid synthesis was increased although the bioactive component is not known. Although the expression of HMGCoA reductase (3-hydroxy- 3-methylglutaryl CoA reductase) was not determined, the reduction of hepatic cholesterol and up-regulations of gene CYP51 and CYP7A1 would suggest that the expression of HMGCoA would also be increased.

It is generally accepted that dietary garlic supplementation inhibits the hepatic activities of lipogenic and cholestrogenic enzymes in pigs (Qureshi *et al.,* 1987) and rats (Mathew *et al.,* 2004). Similarly, significant reductions in blood plasma concentrations of triglycerides were observed in broilers (Al-Homidan, 2005) in response to feeding garlic-supplemented diets compared with control birds. The present results are in accordance also with the findings obtained by Prasad *et al.* (2009), who found that blood plasma total cholesterol; triglycerides, low density lipoprotein and very low density lipoprotein were significantly decreased, while high density lipoprotein was significantly increased by garlic supplementation in broiler chickens in comparison to the control group.In addition, Choi *et al.* (2010) indicated that dietary garlic powder significantly decreased total and low-density lipoprotein cholesterol and increased high-density lipoprotein cholesterol in broiler blood. Mirhadi *et al.* (1992), reported allicin that present in garlic, significantly inhibited hypercholesterolemia, reduced tissue cholesterol, lowered low density lipoprotein concentration (LDL) and raised high density lipoprotein concentration (HDL). This may probably be due to the possible mechanism of hypocholesterolaemic and hypolipidemic action of garlic products which depresses the hepatic activities of lipogenic and cholesterogenic enzymes such as malic enzyme, fatty acid synthase, glucose-6-phosphatase dehydrogenase (Chi *et al.,* 1982; Qureshi *et al.,* 1983a) and 3-hydroxyl-3-methyl-glutaryl-CoA (HMG-CoA) reductase (Qureshi *et al.,* 1983b, 1987). Afzal *et al.* (1985) reported that polyunsaturated fatty acids prevent atherosclerosis through the formation of cholesterol esters. They further reported the presence of higher polyunsaturated fatty acids like arachidonate and eicosapentenoate in garlic which could well be responsible for preventing atherosclerosis. Furthermore, garlic powder can

facilitate activity of enzymes which are involved in the conversion of cholesterol to bilious acids and subsequently, there will be less cholesterol in the carcass (Bordia *et al.,* 1975; Raeesi *et al.,* 2010).

Exposing growing rabbits to high temperature conditions during summer season resulted in significant decrease ($P \leq 0.05$) in serum total antioxidant capacity which was obtained in the control group, however, supplementation of allicin and lycopene appeared to antagonize the effect of high temperature. The different levels of allicin (100 and 200 mg) and lycopene (100 and 200 mg) increased total antioxidant capacity in blood serum to rich an increase their value by 75.3, 43.2, 51.9 and 49.4 %, respectively, in comparison with the control group. Heat stress causes increased free radical production (Halliwell and Gutteridge, 1989) and lowers the concentrations of antioxidant vitamins and minerals such as E, C, A and Zn in serum and tissues (Sahin and Kucuk, 2003). Free radicals trigger the metabolic disorder, cell death and growth retardation (Okada, 1996).

Malondiaidehyde (MDA) used as a marker of the oxidative stress. Exposing growing rabbits to high temperature through summer season resulted in elevated ($P \leq 0.05$) serum MDA as presented in the control group, however, supplementation of allicin and lycopene appeared to antagonize this effect. The mean concentration of malondialdehyde (MDA) level was significantly ($P \leq 0.05$) lower in the group given 100 mg/kg dietallicin containing diet (13.07), followed by those group had 200 mg allicin containing diet (14.37), then lycopene 100 and 200 mg fed groups (15.0 and 15.57, respectively) without significant differences between the last two groups. The control group recorded the highest value of MDA (17.57). Therefore, the obtained results showed that 100 and 200 mg/kg dietallicin and 100 and 200 mg lycopene resulted in lowering blood serum MDA in descending order by 25.6, 18.2, 14.6 and 11.4 %, respectively, in comparison with the control group. Generally it was observed that the low levels of allicin and lycopene was more effective in decreasing blood serum lipid peroxidation in comparison with the high levels. These results were in disagreement with those presented by Farag (2014) who showed that the lowest MDA value was obtained from the highest levels of lycopene and of allicin (300 mg/ kg diet). Also, the obtained results indicated that allicin was more superior in comparison with lycopene fed groups.

Phytochemicals present in aged garlic extract are believed to act in synergistic way and they exert their antioxidant activity by promoting scavenging of reactive oxygen species by means of enhancing the cellular antioxidant enzyme superoxide dismutase, catalase, glutathione peroxidase, and increase the level of glutathione in cells and some of the important defense mechanism in living cells. Some of the potential benefits of aged garlic extract include decreasing the cardiovascular diseases by suppressing/inhibiting lipid peroxidation and oxidation of LDL (Amagase *et al.,* 2001 The overall effect of the garlic compounds would perhaps be to prevent or reduce injuries through oxidative stress and free radicals.

Lycopene, a major carotenoid present in tomatoes, is one of the most potent antioxidants among the dietary carotenoids. Antioxidant properties of lycopene are thought to be responsible primarily for its biological effects, which may be important in the prevention of chronic diseases associated with oxidative stress such as cancer and cardiovascular diseases. Studies have provided evidence in support for the protective role of lycopene in chronic diseases (Rao and Shen, 2002). Lycopene is the most potent singlet oxygen quencher natural carotenoid (Rao and Agarwal, 1999; DiMascio *et al.,* 1989; Nguyen and Schwartz, 1999; Agarwal and Rao, 2000). Lycopene was reported to inactivate hydrogen peroxide and nitrogen dioxide (Bohm *et al.,* 1995). Agarwal and Rao (1998) have shown that blood lycopene levels increased by dietary lycopene supplementation. Also, Jain *et al.* (1999) reported that dietary lycopene increased serum and liver lycopene and thiols levels and decreased serum TBARS (14% reduction) concentration in rats. This supports the findings of Rao and Agarwal (1998) which showed that dietary lycopene protected lipid, protein and DNA from oxidation. The protective action of lycopene on MDA confirms previously reported findings of other investigators (Rao and Agarwal, 1999; Rao and Shen, 2002; Jain *et al.* 1999). Leal *et al.* (1999) reported that the broilers exposed to lycopene showed a reduction in MDA production. Paran and Engelhard (2001) reported that lycopene supplementation reduced oxidative stress markers such as homocysteine in hypertensive patients. However, an inverse association between MDA and antioxidant vitamins has been mentioned by others (Halliwell and Gutteridge, 1989).

Table (4). Effect of allicin and lycopene on hematological parameters and sheep RBCs rabbits

Characteristics	Control	Allicin		Lycopene	
		100 mg/kg diet	200 mg/kg diet	100 mg/kg diet	200 mg/kg diet
Red blood cells * 10^6	3.87±0.12	3.30±0.36	3.57±0.08	3.53±0.12	3.54±0.09
White blood cells* 10^3	6.07±0.18	5.53±0.32	6.40±0.31	7.37±0.43	5.57±0.92
Hemoglobin (Hb) g/dl	11.47±0.29	10.67±0.33	10.70±0.26	10.53±0.26	10.50±0.17
PCV, %	32.70±3.17	33.30±9.10	33.03±0.73	33.30±0.85	33.30±0.65
Sheep RBCs					
7 days	0.66±0.03^{c}	0.79±0.02^{ab}	0.79±0.02^{ab}	0.84±0.00^{a}	0.77±0.00^{b}
14 days	0.69±0.00^{b}	0.77±0.00^{a}	0.82±0.02^{a}	0.82±0.02^{a}	0.82±0.02^{a}
21 days	0.66±0.03^{c}	0.82±0.02^{ab}	0.77±0.00^{b}	0.82±0.02^{ab}	0.84±0.00^{a}

Different letters (a-c) within a raw denote significant differences between treatments ($P \leq 0.05$)

In conclusion, rabbit dietary supplementation with allicin or lycopene could have beneficial effects on performance under summer environment without any side effects.

Table (5). Effect of allicin and lycopene on blood serum lipid profile of growing V-line rabbits at 15 weeks of age

Characteristics	Control	Allicin		Lycopene	
		100 mg/kg diet	200 mg/kg diet	100 mg/kg diet	200 mg/kg diet
Total lipids, mg/dl	310.67±7.22^{a}	264.00±1.73^{b}	320.00±2.65^{a}	226.67±4.06^{c}	230.00±2.89^{c}
Triglycerides, mg/dl	76.33±1.33^{a}	63.70±1.10^{c}	70.10±0.95^{b}	63.97±0.80^{c}	71.20±0.52^{b}
Cholesterol, mg/dl	97.40±1.22^{a}	87.63±1.48^{c}	93.00±1.15^{b}	70.53±0.86^{d}	61.90±0.46^{e}
HDL, mg/dl	48.67±0.67	49.67±0.33	50.00±0.58	50.33±0.88	50.67±0.67
LDL, mg/dl	47.00±1.15	45.33±1.45	46.87±2.44	43.33±1.20	43.67±2.03
HDL/LDL ratio	1.04±0.02	1.10±0.04	1.07±0.05	1.16±0.03	1.17±0.05
TAC, mmol/l	0.81±0.06^{c}	1.42±0.08^{a}	1.16±0.07^{b}	1.23±0.06^{ab}	1.21±0.05^{ab}
MDA, nmol/ml	17.57±.23^{a}	13.07±.15^{d}	14.37±.07^{c}	15.00±.25^{b}	15.57±.19^{b}

Different letters (a-e) within a raw denote significant differences between treatments ($P \leq 0.05$)
HDL= high density lipoprotein, LDL= Low density lipoprotein, TAC= tTotal antioxidant capacity, MDA = malondialdehyde

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الملخص العربى

تأثيرات اللأليسين والليكوبين على معدل الأداء ، الذبيحة ، والصفات الهيماتولوجية للدم والحالة الضد تأكسدية للأرانب النامية خلال فصل الصيف

حسن زويل ، سليمان زهران ، محمد حسن ، ياسمين الجندى ، وليد شقلوف

قسم الانتاج الحيوانى والسمكى – كلية الزراعة – سابا باشا – جامعة الاسكندرية

أستخدم ٤٥ أرنب من سلالة V–line من كلا الجنسين عمر خمسة أسابيع خلال موسم الصيف من شهر يوليه الى سبتمبر ٢٠١٤ ووزعت الأرانب عشوائيا على خمسة معاملات وبكل معاملة ٩ أرانب. وبكل معاملة ٣ مكررات وبكل مكررة ٣ أرانب. المجموعة الأولى تناولت عليقة أساسية لا تحتوى أى أضافات وأستخدمت كمجموعة شاهد. المجموعة الثانية والثالثة تناولت ١٠٠ ، ٢٠٠ ملجم أليسين / كجم عليقة على التوالى. المجموعة الرابعة والخامسة تناولت ١٠٠ ، ٢٠٠ ملجم ليكوبين / كجم عليقة على التوالى. أوضحت أهم النتائج أن المجاميع التى تناولت ٢٠٠ ملجم أليسين ، ١٠٠ ملجم ليكوبين / كجم عليقة حققت أفضل زيادة معنوية فى وزن الجسم مقارنة مع مجموعة الشاهد. كما حققت المجاميع الأخرى زيادة رقميه ولكن لم تكن معنوية. حدث تحسن معنوى فى الكفاءة التحويلية فى جميع المجاميع التجريبية مقارنة مع مجموعة الشاهد. لم يتأثر كل من صفات الذبيحة والصفات الهيماتولوجية بالمعاملات المختلفة. جميع المعاملات التجريبية أدت الى تحسن معنوى فى الأ ستجابة المناعية لكريات الدم الحمراء للاغنام وجدت عند٧ ، ١٤ ، ٢١ يوم من الحقن . أنخفض الدهن الكلى فى سيرم الدم نتيجة للمعاملات المختلفة مقارنة مع مجموعة الشاهد بأستثناء المجموعة التى تناولت ٢٠٠ ملجم أليسين حيث كانت متساوية مع مجموعة الشاهد. أنخفض كل من الكولسترول الكلى والدهون الثلاثية نتيجة لاضافة النسب المختلفة من الأليسين والليكوبين مقارنة مع مجموعة الشاهد. تلاحظ أنخفاض رقمى فى الكولسترول منخفض الكثافة بينما تلاحظ أرتفاع رقمى فى الكولسترول مرتفع الكثافة والنسبة بين الكولسترول مرتفع الكثافة الى الكولسترول منخفض الكثافة نتيجة لجميع الاضافات المستخدمة ولكن هذه الاختلافات لم تصل الى المعنوية مقارنة مع مجموعة الشاهد. وجد أن تعرض الأرانب للحرارة المرتفعة خلال فصل الصيف أدى الى زيادة المالوندهايد بينما انخفضت السعة التاكسدية الكلية فى سيرم الدم فى مجموعة الشاهد. ولكن أضافة الأليسين والليكوبين حد من تأثير الحرارة المرتفعة على هذه الصفات. وقد خلصت الدراسة الى أن أضافة كل من الأليسين والليكوبين له تأثير مفيد على أداء الأرانب خلال فصل الصيف بدون أى تاثيرات جانبيه.