Egypt. Poult. Sci. Vol. (41) (I): (93-111)(2021) **(2101-1139)**

Egyptian Poultry Science Journal

http://www.epsj.journals.ekb.eg/

ISSN: 1110-5623 (Print) – 2090-0570 (Online)

EFFECT OF SUPPLEMENTED SOME ANTIOXIDANTS TO BROILER DIETS ON GROWTH PERFORMANCE, IMMUNE RESPONSE AND ANTIOXIDANT STATUS DURING SUMMER SEASON

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Received: 17/01/2021 Accepted: 10/02/2021

ABSTRACT: The current experiment aimed to estimate some antioxidants ability mainly, selenium, vitamins B_6 and C to overcome adverse effect of heat stress during summer months. Total of 360 one- day-old broiler chicks were randomly divided into 9 treatments with four replicates (10 chicks/each). The experiment period extended from 1 day to 40 days of age where ambient temperature ranged from 36 to 41°C and relative humidity ranged from 30 to 55%. The 1st group fed basal diet that satisfied strain requirement as control treatment. The 2nd group fed control basal diet supplemented with vitamin E (50 mg/kg diet) and acted as control plus to estimate efficiency of antioxidants. Experimental treatments from the 3rd to the 9th fed basal diet supplemented with 3 mg vitamin B_6, 200mg vitamin C, 0.10 mg Se, 3 mg vitamin B_6+ 200mg vitamin C, 3 mg vitamin B_6 + 0.10 mg Se, 200 mg vitamin C + 0.10 mg Se, or 3 mg vitamin B_6 +200mg vitamin C+ 0.10 mg Se respectively.. Parameters of growth performance, carcass characteristics, some plasma constituents, immunity and antioxidant status were investigated. Malondialdehyde was estimated in frozen (6 months at -20 °C) thigh muscles to determine antioxidant status.

The results appeared significant improvement of growth performance and malondialdehyde were reduced in plasma and thigh muscles. Dressing, abdominal fat and giblets percentages did not affect. While, significant improvement was observed in some hematological parameters, cellular immunity and antioxidant status. In contrast antibodies titer against Newcastle Disease Virus and Avian flow Virus (H5N1) did not affect. Briefly, the overall experimental results showed that supplementing broiler diets with selenium combined with vitamin B_6, vitamin C or both were more effective to improve growth performance, broiler meat quality, immunological and antioxidant status for broiler chicks reared during hot summer months.

Key words: Broilers, performance, antioxidants, immunity, vitamin B_6, vitamin C, selenium

INTRODUCTION

The term of heat stress divided into two main types, the first one is acute heat stress which happens artificially in short periods not more than 8 hours. The second is chronic heat

scavenged free radicals (Ismail *et al.*, 2013)when supplemented to broiler diets, where it react with oxygen free radicals to produced hydroascorbyl and transform radical from lipid stage to aqueous compounds (Ciftci*et al.*,2005) during chronic heat stress. So inserting ascorbic acid in diets during chronic heat stress reduced negative effects of heat stress (Ismail *et al.,* 2013) and ameliorate feed intake, feed conversion and weight gain(Kadim*et al.*,2008 stress that happens in tropical and subtropical regions during summer season (Abu-Dieyeh, 2006). Chronic heat stress encourages oxidative damage and oxidative stress via stimulating metabolic oxidation and producing malondialdehyde more than double fold from lipid peroxidation (Azad *et al.,* 2010). Oxidative stress enhanced reactive oxygen species and produced free radicals like HO and O^{2-} that harmed cell membranes (Abidin and Khatoon, 2013) and decreased antioxidant defense (Belhadj Slimen *et al.*, 2016). Chronic heat stress caused DNA and protein damages (Song and King 2015), moreover it decreased capacity of metabolic oxidation through scavenging system (Hosseini -Vashan *et al.,* 2012). Performance of broiler subjected to chronic heat stress deteriorated clearly where appetite decreased, feed intake lowered and body weight gain decreased significantly (Sohail *et al.*, 2012).

Vitamin E alleviated negative effects of chronic heat stress and can use as a management practice for protecting poultry from its side effects (Sahin and Kucuk, 2001). Moreover vitamin E resulted in significant improvement antibody responses in broilers exposed to heat stress (Habibian *et al.,* 2015). Selenium is a portion from selenoproteins, some antioxidant enzyme that possess ability to improve antioxidant defenses action, and able to stop tissues damages (Habibian, *et al.*, 2015). As vitamin E reduce heat stress side effects and improved oxidative status as selenium achieved the same function (Harsini *et al.*, 2012).

Broiler possess ability to synthesize ascorbic acid in natural conditions, when broiler exposed to chronic heat stress synthesis of ascorbic acid decreased sharply (Lohakare *et al.*,2005)and its requirement increased(Sahin *et al.*, 2003).Ascorbic acid reduced plasma malondialdehyde (Erdoğan *et al.*, 2005)and**)**.

Pyridoxine (B_6), is one of water soluble B vitamins that assist in the metabolism of proteins, fats, and carbohydrates (Angel, 1980).Vitamin B_6 is essential for participating enzymatic reactions, including biosynthesis of carnitine, protein metabolism and sodium and potassium balance. In addition, vitamin B_6 facilitates the release of glycogen from the liver and skeletal muscles so that it can be used for energy (Kannan and Jain, 2004).The active form of vitamin B_6 is pyridoxal 5-phosphate a coenzyme of many enzymatic systems include transferase, amino acid synthase, racemase and phosphorylase. Pyridoxal acts as cofactor for breaking down of selenohomocysteine to produce hydrogen selenide. Hydrogen selenide can then be used to incorporate selenium into selenoproteins (Combs 2008).Vitamin B_6 deficiency lowered significantly glutathione levels than normal levels of vitamin B_6 under toxic condition Patrick, (2006). Supplementation of vitamin B_6 improves oxidative stress and lipid profile in rats (Tas *et al.,* 2014).

The present experiment was conducted to overcome heat stress disorders during summer season that effect on growth performance of broiler chicken by scavenge free radical and improving antioxidant system through supplementing broiler diets with some antioxidants.

MATERIALS AND METHODS

Birds, diets and experimental design:

The current experiment was carried at Fayoum poultry research station- animal production research institute- agriculture research center. Three hundred and sixty, one- day-old unsexed Arbor Acres broiler chicks were used in this study. The chicks were reared for 40 days under natural summer condition (36- 41°C and 30- 55% RH). The chicks were individually weighed and randomly assigned into nine treatment groups with four replicate where each replicate contains 10 chicks. The first group fed corn-soybean meal basal diet that represented control treatment and the 2^{nd}, 3^{rd}, $4^{th}$and 5^{th}groups fed control diet supplemented (per kg diet) with 50 mg vitamins E , 3 mg vitamin B_6, 200 mg vitamin C and 0.10 mg selenium (in sodium selenite form), respectively. The 6^{th} group fed control diet supplemented with the same levels of vitamin B_6 and vitamin C combined together but, the7^{th} group fed control diet supplemented with the same levels of vitamin B_6 and Se combined together. The 8^{th} group fed control diet supplemented with the same levels of vitamin C and selenium combined together. Lastly group 9 fed control diet supplemented combined with the same levels of vitamin B_6 combined with vitamin C and selenium. Basal diet made to meet strain requirements during starting (1-10 d), growing (11-24 d) and finishing (25-40 d) periods (Table, 1) and formed mainly from corn-soybean meal. All chicks were kept under similar management conditions. The environmental temperature and humidity surrounding chicks were recorded daily during the experimental period. Live body weights and feed consumption of chicks were recorded at 10, 24 and 40 days of age, then live body weight gains and feed conversion ratios were calculated.

Carcass characteristics and tissues examinations:

At 40d of age, 36 birds (4 birds per treatment which were around the average body weight were slaughtered and carcass characteristics including dressing, giblets and abdominal fat as percentage from life body weight were recorded. After slaughtering one thigh muscle of each carcass was frozen (6 months at -20 °C) then carried out assay of malnodialdhyde (MDA).

Blood sample and plasma parameters:

During the last day of experiment 4 blood samples were collected from each replicate, where 3 blood samples collected in heparinized tubes and the last one of blood sample collected in non-heparinized tube. The 1^{st} sample centrifuged at 3500 rpm for 15 minute then plasma collected and stored at 20ºC to estimate total cholesterol, LDL-cholesterol, HDL-cholesterol, triglycerides, glutathione reductase, total antioxidant capacity (TAOC) and malnodialdhyde (MDA) by colorimetric methods. The 2^{nd} sample used to determine blood hematological parameters, but the 3^{rd} sample from each treatment group sent directly to determine activity of glutathione peroxidase activity (GSH-Px) in red blood cells. All blood examinations were done by using analytical kits produced by Bio diagnostic Company.

Antibody titer:

The last non-heparinized blood sample from each replicate sent to Reference Lab for Veterinary Quality Control on Poultry Production, Egypt and used to examined the antibody titer against Newcastle Disease Virus (NDV), and avian flow Virus (H5N1) by measuring titer against these viruses using preventing from hemagglutination method and using commercial Elisa Kits, respectively.

Statistical analysis:

Data of all experimental treatments were statistical analyzed using General Linear Models (G LM) procedure (SAS, 1999). Variables showed significant differences at F-test ($P \leq 0.05$) were compared to each other's using Duncan's Multiple Range Test (Duncan, 1955).

RESULTS AND DISCUSSION

Growth performance

Body weight and body weight gain:

Fed broiler chickens diets supplemented with selenium combined with Vit.B_6, Vit. C or both caused significant increase in body weight and gain during grower and finisher periods compared with control diet (Table, 2). Total body weight gain increased significantly ($P \leq 0.001$) when broiler chicks fed diet supplemented selenium combined with Vit. B_6 and Vit. C compared with feeding control diet and didn't differ significantly compared with Vit. E. Single selenium supplementation improved body weight and gain during grower and finisher periods, total body weight gain increased significantly ($P \leq 0.001$) compared with control diet. The result of single supplementation agree with Dlouha *et al*. (2008) who found significant increase in body weight during grower and finisher periods for single selenium supplementation compared with control diet. The insignificant effect of Vit.B_6 and Vit. C in single supplementation during heat stress compared with control treatment agree with (Irani *et al*., 2015) who found no effect of dietary Vit.B_6 on body weight gain for starter and grower broiler. Moreover Attia *et al*. (2011) found no significant response in body weight during starter, grower and finisher periods between Vit.C and control treatment for broiler under heat stress. On the other hand, Naseem *et al*. (2005) reported that ascorbic acid improved the live body weight and body weight gain.

The significant improvement in body weight and body weight gain that achieved when selenium combined with Vit. B_6 may be due to Vit. B_6 increased retention of selenium in the tissues (Jin andYin, 2005) and plays important role in amino acids metabolism, where Vit. B_6 is essential for activation selenocysteine lyase enzyme that catalyzed selenocysteine and play important role in selenoprotein biosynthesis (Mihara *et al*., 2000).Vitamin B_6 assist in the metabolism of proteins, fats, and carbohydrates (Angel, 1980).Consequently Vit. B_6 in adequate quantity improved tissues development and enhanced growth (Jin and Yin, 2005).The remarkable improvement of growth when Vit. C combined with selenium may be due to selenium dependent enzymes able to reconvert the oxidized forms of ascorbic acid and ascorbyl free radical to ascorbic acid (Bertinato *et al*., 2007).

Feed intake and feed conversion:

No significant effects of experimental treatments on feed intake were observed during starter, grower and finisher periods (Table, 2).The insignificant effect of Vit. C on feed intake in hot climate whether agree with Ismail *et al.* (2013). Also, the insignificant effect of Vit. B_6 approve with Irani *et al*. (2015) who reported that Vit. B_6 didn't change feed consumption during starter, grower and overall period. There were slightly deceases in total feed intake when diets supplemented with Vit. C singly or combined with selenium, Vit. B_6 or both. The results agree with Attia *et al*. (2011) who found decreasing in feed intake when Vit. C incorporated in diets when chicks exposed to chronic heat stress. Moreover Skrivan *et al.* (2013) found the similar result when Vit. C combined with selenium.Supplemented control basal diet with selenium, Vit. C and Vit. B_6 in a single form caused insignificant improvement in feed conversion compared with control diet during the different experimental periods (Table, 2). While, the combination of selenium with Vit. B_6, Vit. C or both caused significant improvement in feed conversion rate compared with control basal diet. It was found that high ambient temperature significantly reduced body weight and feed efficiency. However the supplementation of some antioxidants was able to alleviate many of these effects. Heat stress increases lipid oxidation as a consequence of increased free radical generation, a condition that enhances the formation of reactive oxygen species (ROS) and induces oxidative stress in cells. Glutathione peroxidase enzyme play a vital role in protecting cells from harmful effects of ROS (Altan *et al.,* 2003). Supplementing ascorbic acid in diets during chronic heat stress reduced negative effects of heat stress and ameliorate feed intake, feed conversion rate and weight gain (Kadim *et al.,* 2008, Naseem *et al*., 2005 and Ismail *et al.,* 2013). Feed conversion rate improved significantly when broiler chicks fed diet supplemented selenium combined with Vit. B_6 and Vit. C compared with feeding control basal diet and differed insignificantly compared with Vit. E during grower, finisher and overall periods (Table, 2). This improvement attributed to selenium incorporated in glutathione peroxidase structure and regulates its activity in broiler serum and tissues (Boostani *et al.,* 2015) and ascorbic acid had ability to stimulate secretion of glutathione peroxidase enzyme (Ismail *et al.,* 2013). As well as, vitamin B_6 inhibited the oxygen radical generation, reduced lipid peroxidation and damage of mitochondrial membrane (Kannan and Jain, 2004).

Carcass characteristics:

Effects of different experimental treatments on carcass characteristics are shown in Table 3. The results showed that no significant differences observed in carcass characteristics due to experimental treatments. Fed broiler chickens diets supplemented with selenium combined with Vit. B_6, Vit. C or both caused insignificant increase in dressing% and giblets. Results of Vit. C agree with Konca *et al.* (2009) and Celik and Ozturkcan, (2003), and the results of selenium agree with Khajali *et al.* (2010). In contrast, the results didn't agree with Sahin *et al.* (2002) and Sahin *et al.* (2003) who reported that dietary Vit. C supplementation significantly increased carcass and giblets yields. Abdominal fat % insignificantly decreased by addition of singly Vit. C or selenium to control diet and the results agree with Khajali *et al*. (2010), Konca *et al.* (2009) and Celik and Ozturkcan (2003). Selim *et al*., (2015) reported that neither giblets% nor abdominal fat% affected by supplemented diet with selenium. The insignificant decrease of abdominal fat for selenium treatment may be due to selenium has a crucial role in controlling the effects of thyroid hormone on fat metabolism (Masukawa *et al.,* 1983). In addition, Vadhanavikit and Ganther (1994) indicated that selenium supplementation declined the activity of cytosolic malic enzyme leading to decline in abdominal fat deposition. The high ambient temperature that reduced accumulation of abdominal fat for all treatments (Kucuk *et al.,* 2003) may lead to disappear of selenium effect.

Antioxidant status:

Plasma glutathione peroxidase concentration increased significantly ($P \leq 0.05$) when broiler fed diets contain additional selenium combined with Vit. B_6, Vit. C or both compared with feeding control and Vit. E diets (Table 4). Similarly, fed broiler diets contain excess selenium in single or combined forms significantly ($P \leq 0.05$) increased plasma glutathione reductase concentration compared with feeding control and Vit. E diets. Increasing glutathione peroxidase and glutathione reductase values by selenium and Vit. C combination were in agreement with (Skrivan *et al.*, 2013) and this may be due to Vit. C increased selenium concentration in the cells (Clement, 1986) that enhance glutathione peroxidase during heat stress (Mahmoud and Edens, 2003). On the other hand, increasing glutathione peroxidase and glutathione reductase when combined selenium with Vit. B_6 may be due to Vit. B_6 related enzymes such cystathionine γ-lyase and cystathionine β-synthase that play role in hydrogen sulfide production. Hydrogen sulfide has ability to adapt oxidative stress and its concentration in livers decreased in broilers fed diet dropped in selenium (Zheng, *et al*., 2018). Moreover deficiency of Vit. B_6 lowered significantly glutathione levels than normal levels of Vit. B_6 (Patrick, 2006). Regarding effect of selenium compared with Vit. E on glutathione peroxidase under heat stress the results agree with Harsini *et al.,* (2012). This may be due to Vit. E must combined with selenium, where there was synergism between them (Skrivan *et al*., 2008).

Values of plasma total antioxidant capacity of broiler fed diets supplemented with selenium singly or combined with Vit. C, Vit. B_6 or both were significantly higher ($P < 0.05$) than control treatment and differed insignificantly compared with Vit. E. Significant reduction in plasma and tissues malondialdehyde were observed for broiler fed diet supplemented with selenium in a single or combination forms compared with control treatment (Table 4). Supplemented selenium in a combination with Vit. C, Vit. B_6 or both decreased malondialdehyde values in plasma and tissues compared with control treatment. The reduction in malondialdehyde values may be attributed to the significant increase in glutathione peroxidase activity (Dlouhá *et al*., 2008). Tas *et al.* (2014) observed that plasma and tissues malondialdehyde levels were reduced for rats fed diet with Vit.B_6 and this reduction might be attributed to antioxidant effects of vitamin B_6. It was suggested that vitamin B_6 acts as a powerful chain-breaking antioxidant in biological systems related to its ability to scavenge peroxyl radicals (Matxain *et al.,* 2006 and Ohta and Foote, 2002).The improvement in antioxidant status by mixing selenium with Vit. B_6 andVit. C may be due to Vit. B_6 is a cofactor in cystathionine-synthase and cystathionine-lyase, methionine-lyase, cysteine desulfurase, cysteine sulfinatedesulfinase, and D-selenocystine,-lyase and selenocysteine lyase enzymes that participates in metabolism of selenoamino acid (Mihara, and Esaki, 2011) and (Soda *et al.,* 1999). Mahfouz and Kummerow (2004) indicated that vitamin B_6 prevented the oxidative stress and had an antioxidative effect in homocysteinemic rats. Kannan and Jain (2004) reported that vitamin B_6 inhibited the oxygen radical generation, reduced lipid peroxidation and damage to mitochondrial membrane. Moreover supplemented ascorbic acid in combination with selenium in broiler diets increased glutathione peroxidase activity and decreased thiobarbituric acid reactive substances (Skrivan *et al.*, 2013). This attributed to selenium incorporated in glutathione peroxidase structure and regulates its activity in broiler serum and tissues (Boostani *et al.,* 2015) moreover ascorbic acid had ability to stimulate secretion of antioxidant enzymes (Ismail *et al.,* 2013). Supplemented chicken diets with ascorbic acid assist antioxidant system and improved antioxidant status by decreasing production and accumulation of oxygen metabolites for heat stressed chickens (Mahmoud, *et al.,* 2004). They added that increasing Vit. C amount converted reduce α-tocopheroxyl form back to α-tocopherol that scavenge reactive oxygen metabolites generated by heat stress. Supplemented broiler diets that contain sodium selenite with vit.C significantly decreased thiobarbituric acid concentration (Skrivan, *et al.*, 2012).

Lipid profile:

When broiler fed diets supplemented with selenium combined with Vit.B_6, Vit. C or both recorded significant lower total cholesterol and greater HDL-cholesterol values compared with control treatment (Table, 4). Insignificant effects were observed on total cholesterol, LDL-cholesterol, HDL- cholesterol and triglycerides of broiler chicks fed diet contained selenium combined with Vit. B_6 and Vit. C compared with feeding Vit. E. Irani *et al*. (2015) reported that no significant effects on blood triglyceride and total protein were indicated with addition of vitamin B_6. On the other hand, Tas *et al.* (2014) found that significantly decreased in total cholesterol and increased HDL-cholesterol values without influence on triglyceride values in serum rats fed on diet with vitamin B_6. Selenium supplementation caused a significant reduction in plasma total lipid, total cholesterol and LDL- cholesterol, and increased HDL-cholesterol, (Attia *et al.,* 2010; and, Radwan *et al*., 2015).

Complete blood count:

The increase in red blood count than normal range (Table 5), may be due to this experiment was conduct under chronic heat stress condition in subtropical condition lower humidity. Moreover the broiler chickens in this experiment were males that brought from parent flocks. Ladokun *et al.* (2008) found that red blood count increased up to 4.84 in subtropical condition and Albokhadaim (2012) found that red blood count in male higher by 0.6×10^6 than female chickens. In similarly condition of our experiment (Storm-Suke *et al.* 2012) reported that lower humidity caused an increase in evaporative water losses and 27% from red blood cell variation refers to sex in lower humidity condition. The results of complete blood count appeared insignificant effects of treatments on MCV, MCH and MCHC (Table 5), this mean that anemia's disorders not observed. So we can suppose that no side effects were observed for Se, Vit. B_6 and

Vit. C when supplemented to broiler diets in a singly or in a combinable forms. Vitamin B_6 assists in hemoglobin synthesis, by serving as a coenzyme for the enzyme 5-aminolevulinic acid synthase so vitamin B_6 reasonable number of some anemia types (Shoolingin-Jordan *et. al.*, 2003). It also binds to two sites on hemoglobin to enhance the oxygen binding of hemoglobin (Combs 2008). Combination of vitamin B_6 with sodium selenite was more effective than single treat on biochemical and hematological parameters (Ali, *et. al.*, 2010).

Cellular and liquid immunity:

Humeral immunity against Newcastle Disease Virus and Avian flow Virus (H_5N_1), content in plasma did not affected (Table 5). While**,** significant decrease in heterophilus and H/L ratio were observed when selenium supplemented to broiler diets combined with Vit. B_6 and Vit. C or both compared with control treatment. Moreover similar results obtained for single supplementation of Vit. E. heterophilus increased significantly ($P < 0.05$) by supplemented diets with selenium combined with Vit. C and Vit. C with Vit. B_6 collectively. This may be due to protective action of vitamin C that comes from the ability to interact with DNA in lymphocyte (Basiak and Kowalik, 2001). Moreover, the combination of selenium with Vit. C may be caused cooperative action where selenium improved immunity by modified cytokines secretion and enhanced immune cells resistance against oxidative stress (Habibian *et al.*, 2015). Furthermore, ascorbic acid improved bursa abnormality when broilers exposed to chronic heat stressed(Aengwanich, 2008).The significant increase in lymphocytes and decreased significantly H/L ratio agree with Selim *et al.* (2015) who reported that supplemented selenium to control diet caused significant increase in lymphocytes but decreased significantly H/L ratio.

CONCLUSION

The results from this study suggested that supplementing broiler diets with a combination from vitamin B_6, vitamin C and selenium able to overcome the harmful effects of heat stress conditions on the oxidative status and improved growth performance compared with control diet. Moreover mixing vitamin B_6, vitamin C and selenium in one diet caused significant improvement in antioxidant status and cellular immunity compared with single supplementation of vitamin E.

Table (1): Composition and calculated analysis of control basal diet.

Composition (per 100 Kg)	Starter (1-10 day)	Grower (11-24day)	Finisher (25-40 day)
Yellow corn	52.28	59.05	63.19
Soybean meal (44%CP)	34.00	26.70	22.5
Corn gluten (60% CP)	6.00	7.00	6.30
Soy bean Oil	3.00	3.00	4.00
Di-Calcium phosphate	1.84	1.67	1.59
Limestone	1.43	1.20	1.10
L- Lysine Hcl	0.32	0.31	0.28
Dl -Methionine	0.26	0.20	0.17
Sodium Chloride	0.24	0.24	0.24
Sodium bicarbonate	0.23	0.23	0.23
Vitamins Premix *	0.10	0.10	0.10
Minerals Premix**	0.30	0.30	0.30
Total	100.00	100.00	100.00
Calculated analysis %			
Crude protein	23.17	21.25	19.04
Metabolizable energy (Kcal/Kg)	3100	3110	3207
Ether extract	5.63	5.08	6.88
Crude fiber	3.80	3.45	3.22
Calcium	1.04	0.90	0.84
Av. Phosphorus	0.50	0.45	0.43
Lysine	1.44	1.24	1.09
Methionine	0.68	0.60	0.54
Methionine+Cyctine	1.06	0.95	0.86
Sodium	0.15	0.16	0.17

* Supplied per kg of diet: Vit. A, 11000 IU; Vit. D_3, 5000 IU; Vit. E, 50 mg; Vit K_3, 3mg; Vit. B_1, 2mg; Vit. B_2 6mg; B_6 3 mg; B_{12}, 14 mcg; Nicotinic acid 60mg; Folic acid 1.75 mg, Pantothenic acid 13mg; and Biotine 120 mcg.

**Supplied per kg of diet: Choline 600 mg; Copper 16mg; Iron 40mg; Manganese 120 mg; Zinc 100mg; Se 0.20 mg and Idoine 1.25mg.

Table (2): Effect of experimental treatments on growth performance

Performance items	**Body weight (g)**			**Body weight gain (g)**				**Feed intake (g)**				**Feed conversion**			
Treatments	**S.**	**G.**	**F.**	**S.**	**G.**	**F.**	**Total**	**S.**	**G.**	**F.**	**Total**	**S.**	**G.**	**F.**	**Total**
Control	207	864^{c}	2009^{d}	155.	656^{c}	1145^{d}	1957^{e}	228	1044	2073	3344	1.47	1.59^{a}	1.81^{a}	1.71^{a}
Vit. E	206	900^{a}	2090^{a}	153	694^{a}	1190^{ab}	2037^{a}	220	1022	2044	3285	1.44	1.47^{c}	1.71^{c}	1.61^{d}
Vit. B_6	209	880^{abc}	2034^{cd}	156	671^{bc}	1153^{cd}	1980^{cde}	228	1044	2081	3353	1.46	1.55^{ab}	1.80^{a}	1.69^{ab}
Vit. C	204	874^{bc}	2029^{cd}	152	669^{bc}	1156^{bcd}	1976de	220	1050	2072	3341	1.45	1.57^{ab}	1.79^{ab}	1.68^{ab}
Se	208	883^{abc}	2047^{bc}	157	675^{abc}	1164^{abcd}	1996^{bcd}	223	1033	2076	3330	1.43	1.53^{abc}	1.78^{abc}	1.67^{ab}
Vit.B_6+ Vit.C	205	885^{abc}	2057^{abc}	154	680^{ab}	1173^{abcd}	2007^{abcd}	221	1030	2081	3333	1.43	1.52^{bc}	1.77^{abc}	1.66^{bc}
Vit B_6+Se	204	890^{ab}	2074^{ab}	153	686^{ab}	1185^{abc}	2023^{ab}	216	1029	2053	3299	1.41	1.50^{bc}	1.73^{bc}	1.63^{cd}
Vit C+ Se	205	888 ^{ab}	2068 ^{abc}	153	683^{ab}	1180^{abcd}	2016^{abc}	219	1036	2080	3335	1.42	1.51^{bc}	1.76^{abc}	1.65^{bc}
Vit.B_6+ Vit.C+Se	206	893^{ab}	2086^{a}	153	688^{ab}	1193^{a}	2033^{a}	217	1020	2052	3290	1.42	1.48^{c}	1.72^{c}	1.62^{cd}
SEM±	0.89	2.57	5.67	0.89	2.64	4.22	5.67	1.75	4.25	8.85	10.74	0.01	0.01	0.01	0.01
Probability	NS	0.03	0.001	NS	0.02	0.04	0.001	NS	NS	NS	NS	NS	0.010	0.028	0.0001

a,b,...= Means in the same column with different superscripts, differ significantly ($P \leq 0.05$);
N.S = Not Significant ($P>0.05$); SEM=Standard Error of Means.
S=Starter G=Grower F=Finisher

Table (3): Effect of experimental treatments on carcass characteristics (% live body weight)

Treatments	Abdominal fat (%)	Giblets (%)	Dressing (%)
Control	1.76	4.85	70.36
Vitamin E	1.73	5.00	71.99
Vitamin B_6	1.70	4.69	71.40
Vitamin C	1.67	4.74	71.27
Se	1.65	4.83	71.57
Vit. B_6+ Vit. C	1.71	4.88	71.94
Vit. B_6+Se	1.85	5.15	72.84
Vit. C+ Se	1.82	5.11	72.05
Vit. B_6+ Vit. C+ Se	1.88	5.18	73.07
SEM±	0.03	0.05	0.25
Probability	N.S	N.S	N.S

N.S = Not Significant (P>0.05); SEM=Standard Error of Means.

Table (4): Effect of experimental treatments on malondialdehyde of tissue, antioxidant status and lipid profile.

Treatments	MDA tissue (nmol/g.t.)	Glutathione enzymes		Antioxidant components		Plasma lipid profile			
		Per. (mU/mL)	Red. (U/L)	TAOC (mM/L)	MDA (nmol/ml)	Tch. (mg/dl)	LDL (mg/dl)	HDL (mg/dl)	Triglycerides (mg/dl)
Control	1.80^{a}	29.73^{c}	0.83^{c}	0.356^{c}	7.44^{a}	157.82^{a}	113.62	22.05^{b}	56.94
Vitamin E	1.15^{bc}	30.14^{c}	0.90^{c}	0.730^{a}	5.55^{cd}	133.95^{d}	90.99	27.73^{a}	42.26
Vitamin B_6	1.83^{a}	29.25^{c}	0.97^{bc}	0.476^{bc}	7.04^{ab}	139.06^{bcd}	94.40	25.66^{ab}	48.16
Vitamin C	1.62^{ab}	54.26^{a}	1.19^{ab}	0.590^{ab}	6.63^{ab}	153.05^{ab}	100.05	24.67^{ab}	56.98
Se	1.49^{abc}	37.36^{bc}	1.36^{a}	0.646^{ab}	6.08^{bcd}	150.64^{abc}	99.32	24.72^{ab}	54.36
Vit.B_6 + Vit.C	1.53^{abc}	32.06^{bc}	1.21^{ab}	0.610^{ab}	6.28^{bc}	144.58^{abcd}	97.62	25.00^{ab}	50.00
Vit B_6 +Se	1.13^{bc}	42.38^{b}	1.38^{a}	0.713^{a}	5.25^{cd}	137.74^{bcd}	93.44	27.20^{a}	45.42
Vit C+ Se	1.18^{bc}	55.60^{a}	1.37^{a}	0.703^{a}	5.43^{cd}	140.12^{bcd}	96.25	25.33^{ab}	48.53
Vit.B_6 + Vit.C + Se	1.04^{c}	60.28^{a}	1.40^{a}	0.723^{a}	5.15^{d}	135.62^{cd}	92.00	28.30^{a}	43.23
SEM ±	0.07	2.50	0.05	0.03	0.18	2.06	1.88	0.48	2.13
Probability	0.010	0.0001	0.001	0.001	0.001	0.02	N.S	0.04	N.S

a,b,...= Means in the same column with different superscripts, differ significantly ($P<0.05$) N.S = Not Significant.
MDA = malondialdehyde Per=Peroxidase Red=Reductase Tch= Total cholesterol
LDL = low density lipoprotein HDL= high density lipoprotein

Table (5): Effect of experimental treatments on complete blood count and immunity parameters.

Treatments	Complete blood count						Immune response				
							Cellular immunity			Antibody titer	
	RBC	Hb	Ht	MCV	MCH	MCHC	L	H	H/L	NDV	H_5N_1
Control	3.97^{c}	13.13^{c}	33.62^{c}	83.83	33.25	39.88	63.23^{c}	30.10^{a}	0.476^{a}	8.73	7.63
Vitamin E	4.24^{ab}	13.76^{a}	37.00^{a}	87.22	32.43	37.18	66.03^{ab}	27.51^{bc}	0.418^{bcd}	8.89	8.05
Vitamin B_6	3.96^{c}	13.20^{c}	34.20^{bc}	86.64	33.83	39.04	64.79^{bc}	29.99^{a}	0.463^{ab}	8.74	7.70
Vitamin C	4.20^{ab}	13.51^{bc}	36.30^{ab}	86.91	32.45	37.34	64.76^{bc}	28.83^{ab}	0.446^{abc}	8.81	7.80
Se	4.35^{ab}	13.73^{a}	36.36^{ab}	84.95	31.84	37.48	65.89^{ab}	28.10^{abc}	0.426^{bcd}	8.92	7.97
Vit.B_6+ Vit.C	4.23^{ab}	13.86^{ab}	37.00^{a}	87.47	32.77	37.48	65.49^{abc}	28.67^{abc}	0.438^{abcd}	8.82	7.92
Vit B_6+Se	4.33^{ab}	14.16^{a}	36.96^{a}	84.61	32.70	38.64	65.62^{abc}	26.90^{bc}	0.410^{cd}	8.87	8.03
Vit C+ Se	4.17^{b}	13.96^{a}	35.33^{abc}	84.91	33.53	39.49	66.69^{ab}	27.70^{bc}	0.415^{bcd}	8.85	7.95
Vit.B_6+ Vit.C+Se	4.40^{a}	14.20^{a}	36.75^{a}	82.65	32.27	39.05	68.03^{a}	26.55^{c}	0.390^{d}	8.94	8.07
SEM ±	0.03	0.08	0.32	0.51	0.16	0.25	0.38	0.29	0.01	0.02	0.04
Probability	0.001	0.001	0.03	N.S	N.S	N.S	0.02	0.01	0.01	N.S	N.S

a,b,...= Means in the same column with different superscripts, differ significantly ($P<0.05$) N.S = Not Significant
RBC= red blood cells count Hb = hemoglobin concentration Ht% = hematocrit percent MCV = Mean corpuscular volume
MCH = mean corpuscular hemoglobin MCHC = mean corpuscular hemoglobin concentration
L % =Lymphocytes% H %= heterophils% H/L = heterophils/ Lymphocytes ratio
NDV= antibody titer against Newcastle disease virus H_5N_1= antibody titer against avian influenza H_5N_1

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Broilers, performance, antioxidants, immunity, vitamin B_6, vitamin C, selenium.

الملخص العربي

تأثير إضافة بعض مضادات الأكسدة لعلائق بدارى التسمين على الأداء الإنتاجي، الاستجابة المناعية وحالة مضادات الأكسدة خلال فصل الصيف

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هدفت هذه التجربة لتقدير قدرة بعض مضادات الأكسدة والتي تشمل كلا من السيلينيوم وفيتامين ب٦ وفيتامين ج في التغلب على الآثار الضارة للإجهاد الحراري خلال شهور الصيف. تم توزيع ٣٦٠ كتكوت عمر يوم من بدارى التسمين الأربور ايكرز عشوائياً لتسع معاملات تجريبية تحتوي كل واحدة على ٤ مكررات ويحتوي كل مكرر على ١٠ كتاكيت. استمرت التجربة من عمر يوم حتى ٤٠ يوم من العمر تحت ظروف اجواء الصيف الطبيعية حيث تراوحت درجات الحرارة من ٣٦-٤١°م وتراوحت الرطوبة النسبية بين ٣٠-٥٥%. غذيت المجموعة الأولي على العليقة الأساسية التي تغطي احتياجات الطائر واستخدمت كمعاملة للمقارنة. غذيت كتاكيت المعاملة الثانية على عليقة المقارنة مضاف اليها فيتامين هـ (٥٠مجم/كجم عليقة) واستخدمت كمجموعة كنترول موجب لمعايرة كفاءة مصادر مضادات الأكسدة المختلفة. غذيت المعاملات من ٣ الى ٩ على عليقة الكونترول مضاف إليها ٣مجم فيتامين ب٦؛ ٢٠٠مجم فيتامين ج؛ ٠.١٠ مجم سيلينيوم؛ ٣مجم فيتامين ب٦ + ٢٠٠مجم فيتامين ج ؛ ٣مجم فيتامين ب٦ + ٠.١٠ مجم سيلينيوم؛٢٠٠مجم فيتامين ج + ٠.١٠ مجم صوديوم سيلينات؛٣مجم فيتامين ب٦ + ٢٠٠مجم فيتامين ج + ٠.١٠ مجم سيلينيوم على الترتيب.
نفذت ٣ مراحل تغذية خلال التجربة (١-١٠يوم، ١١-٢٤يوم – ٢٥- ٤٠يوم) حيث ربيت كل الطيور تحت نفس الظروف. تم دراسة مقاييس الأداء الإنتاجي، صفات الذبيحة، بعض مكونات بلازما الدم، الحالة المناعية ومضادات الاكسدة. وتم تقدير المالون داي ألدهيد في عضلات الفخذ المجمد لمدة ٦ شهور على درجة حرارة -٢٠°م لتقدير حالة مضاد الأكسدة.
اوضحت النتائج تحسن معنوي في الأداء الإنتاجي ونقص المالون داي ألدهيد في البلازما وعضلات الفخذ. لم تتأثر النسبة المئوية للذبيحة ولا الاجزاء المأكولة بينما لوحظ تحسن معنوي في بعض مقايس الدم والمناعة الخلوية وحالة مضادات الأكسدة. وعلى العكس لم يتأثر مستوى منحنى الأجسام المضادة لمرض إنفلونزا الطيور (H_5N_1) والنيوكاسل. و بإيجاز أظهرت النتائج أن إضافة السيلينيوم مع فيتامين ب٦ وفيتامين ج أو الإثنين معاً كان لهم أثر فعال في تحسين الأداء الإنتاجي وجودة اللحم والحالة المناعية ومضادات الأكسدة لبدارى التسمين المرباة خلال شهور الصيف.
الكلمات الدالة: اداء البدارى، مضادات الأكسدة، فيتامين ب٦، فيتامين ج، السيلينيوم.