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Effects of Vitamin C, *Echium Amoenum* and Lavender Extract on Blood Metabolite and Meat Quality of Broiler Chickens Under Transport Stress

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ABSTRACT

A study was conducted with broiler chickens to determine the effect of some additives in drinking water on transport stress. Two hundred forty Ross 308 broilers aged 35 d were randomly assigned to 8 treatments with factorial arrangement (2×2×2) with 3 types of additives (vitamin C, echium amoenum and lavender extract) and tow levels (0 and 1200 ppm per liter of drinking water). Each treatment consisted of 4 replicates with 8 birds in each. On d 43, after collecting blood from the brides (2 birds from each replicate), all birds were transported (2 h under 8˚c temperature), then blood recollected. After slaughtering breast and thigh meat pH and water loss detected. Results showed that transport stress decreased blood glucose (mg/dl) and LDL (mg/dl), heterophile, H: L ratio but increased HDL, lymphocytes, eosinophile and heamatocrite of transported chickens ($P<0.05$). Additives didn't have significant effect on glucose, Cholesterol, triglyceride, HDL and LDL ($P>0.05$). Combination of 3 dietary supplements significantly decreased Heterophiles and H: L ratio of transported Birds ($P<0.05$). Echium amoenum and lavender extract were significantly lowered the breast meat pH. Broiler chickens which get lavender extract and Vitamin C have the highest L* and the lowest a* and lowest b* values belonged to vitamin C treatment birds ($P<0.05$). Drip losses of breast meat appeared to be significantly ($P<0.05$) lower in the combination of three dietary treatment received birds. ($P<0.05$). It is concluded that transport induced the reduction of blood glucose and LDL, heterophil, H: L ratio which are indexes of the stress in broiler chickens and combination of 3 supplements alleviate the adverse effects of transport stress.

Keywords: Transport stress, Herbal extract, Broiler, Blood Metabolism, Meat Quality.

INTRODUCTION

Domestic animals are invariably transported for a variety of reasons, including breeding, biomedical purposes, and slaughter, which exposes animals to potential stress and induces various psychological, physiological, and metabolic changes (Fazio and Ferlazzo, 2003, Fazio *et al.*, 2005). Transport stress reduces the animals' live weight gain (Kannan *et al.*, 2000, Fazio et al., 2005) and the quality of animal products (Pérez *et al.*, 2002), increases the animals' susceptibility to diseases (Hansson *et al.*, 2005) and impairs the animals' immune function (Stanger *et al.*, 2005). Transport stress can cause huge economic losses to the poultry industry because of stress-induced injuries, bird's mortality, and poorer quality of produced broiler meat (Voslářová *et al.*, 2007). Thus, the importance of reducing transport stress adverse effects on meat quality and improving broiler welfare is becoming widely recognized.

Undoubtedly, the appearance of meat is a critical factor influencing the desire of consumers to purchase meats and ultimately their satisfaction. Meat quality of domesticated animals can be affected by several ante-mortem stressors (Kannan *et al.*, 1997), one of which is pre-slaughter transportation. Transport alters both the metabolism and psychological state of animals, which may produce undesirable changes in meat quality (Owens and Sams, 2000). Concentrations of certain plasma metabolites such as cholesterol and glucose have been suggested to be sensitive parameters indicating the level of stress and muscle damage in poultry, also it stimulates glucagon release, which increases lipolysis and raises plasma concentrations of nonesterified fatty acids (Savenije *et al.*, 2002, Nijdam *et al.*, 2005, Huff *et al.*, 2010). The induction of physiological stress by transportation apparently activate the hypothalamo-adenohypophyseal-adrenocortical axis and it is consistent with the observation of post-transport increases in heterophil:lymphocyte ratios (Maxwell, 1993).

In poultry, the quality of meat products results from complex interactions between the genotype and the environment, more especially the stresses undergone before slaughter (Debut *et al.*, 2003). Pre-slaughter stressed animals have usually high temperatures, rapid glycolysis (pH drop), and early onset of rigor mortis in their muscles. Although the postmortem changes are rapid, some degree of ante-mortem muscle temperature rise, lactic acid buildup, and depletion of ATP also occurs. This combination of conditions results in an exaggeration of the muscle-to-meat transformation (rapid pH decline and an elevated carcass temperature resulting in protein denaturation) that normally occur. Muscles from pre-slaughter stressed birds usually become pale, soft, and moist or exudative (PSE) after a normal 18 to 24 h chilling period condition. This condition most often results lower possessing yields, increased cooking losses, and reduced juiciness (Froning and Uijttenboogaart, 1988). Ante-mortem stress, including heat-stress struggle before slaughter have shown to accelerate glycogen depletion, increase the rate of pH decline and possibly results in tough meat (Papinaho *et al.*, 1995). Again, Glycogen deficiency usually occurs when animal survive stress, such that associated with fatigue, exercise, fasting, excitement, fighting or electrical shock but are slaughtered before they have sufficient time to replenish their muscle glycogen stores. Muscle glycogen deficiency in these birds' results in limited glycolysis in the muscles after death and results in a high ultimate pH. As a consequence of a high ultimate pH, changes in muscle color that otherwise occur during the post-mortem transformation of muscle to meat, do not occur. The ultimate pH, color, and water holding capacity of broiler meat, and meat was paler in birds that underwent a commercial 2-h journey than in birds that were created for only 10 min and not transported (Kannan et al., 2000). These reports suggest that transport stress can influence the color and texture of broiler meat.

Increased antioxidative status in the living animal and a following increased oxidative stability of the raw product is considered beneficial for both the consumer and the processing industry. Feeding and conditions under which the animals are produced and slaughtered may influence the oxidative stability of the meat. Studies have mainly focused on the effects of

medicinal and aromatic plants on mortality; stress hormone levels, blood and muscle metabolism, meat quality and even immune function of domesticated animals although there is very little evidence clarifying how using medicinal plants before and during transportation affect metabolism and meat quality. Ascorbic acid may reduce the stress induced response, which follows the inevitable environmental stress imposed on the animals in connection with transport and slaughter procedure. Plants, such as tea (Tang *et al.*, 2000), rosemary and sage (Lopez-Bote *et al.*, 1998), containing high concentrations of antioxidants have also been demonstrated to reduce lipid oxidation in chicken muscle, and substantial antioxidative activity has been shown for Lavender in various in vitro model systems (Dorman *et al.*, 2000). The aim of the present work was to study some antioxidative defense mechanisms and their importance for blood metabolite; blood cell concentration and meat quality parameters such as color, pH and drip loss fluid.

MATERIALS AND METHODS

Chickens, Diet and Management

Broiler chickens Ross 308 were obtained from a commercial broiler chicken farm at 28 d of age and raised at our local facility under standard conditions with free access to water and feed. A total of 240 chickens were used for blood metabolites, cell concentration and meat color and pH measurements (see below). All chickens were weighted and assigned to dietary treatments based on equal average body weight and fed a basic diet as used for commercial production of broilers. Room temperature was 21°C during the first 35-45 d period. The relative humidity was maintained at 70% and a photoperiod of 20L: 4D was used. In order to accustom the birds to our farm condition, they were raised with commercial nutrients from 28-32. Broiler chickens were assigned to 8 dietary treatments, consisting 4 replicates of 8 birds each, according to a randomized complete block design with factorial arrangement (2×2×2). Experimental factors consist of 2 levels (0 and 1200 ppm per liter of drinking water) of 3 types of additives (vitamin C, *echium amoenum* and lavender ethanolic extract). The birds were kept under conventional conditions for temperature, ventilation, and lighting based on Ross catalogue recommendations (Ross, 2009) and were fed experimental diets from 33 to 45 d of age (table 1).

Table 1- Ingredients and nutrient composition of finisher diets

Ingredient (%)	Percent	Nutrient composition	
Corn	66.23	AME (MJME/Kg DM)	13.02
Soybean meal	27.69	Crude Protein %	18.00
Vegetable oil	1.00	Lysin (SID)[2] %	0.90
Fish meal	2.00	Meth (SID) %	0.40
DL-Methionin	0.13	Cys (SID) %	0.26
L-Lysin	0.10	Meth + Syc (SID) %	0.66
Di-Calcium Phosphate	0.90	Thr (SID) %	0.61
Oyster shell	1.05	Arg (SID) %	1.13
Salt	0.30	Ca %	0.86
NaHCO3	0.05	P %	0.52
Vitamin premix[1]	0.25	Na %	0.20
Mineral premix[2]	0.25	Cl %	0.23
		DCAB meq/Kg	204
		Linoleic Acid%	1.50
		Fiber %	4.33

[1]Each kg of vitamin premix provided: vitamin A 13 500 i.u., vitamin D3 2 000 i.u., vitamin E 30 mg, vitamin K3 2 mg, vitamin B1 1 mg, vitamin B2 6 mg, niacin 30 mg, pantothenic acid 12 mg, vitamin B6 3 mg, vitamin B12 10 µg, biotin 0.1 mg and choline chloride 500 mg.
[2]Each kg of mineral premix provided: Fe 50 mg, Cu 8 mg, Mn 80 mg, Zn 60 mg, I 0.5 mg, Co 0.2 mg, Se 0.15 mg, monensin sodium 100 mg and flavophospholipol 3 mg
[3]SID= Based on Standardized ileal digestibility.

Transport stress and biochemical parameters detection

At the age of 45d from 5 broilers from each treatment, blood samples were collected and blood metabolites like glucose, cholesterol, total protein, LDL-cholesterol and HDL-cholesterol were analyzed and white blood cell concentration like heterophile, lymphocyte and heterophil to lymphocytes ratio (H:L ratio) were calculated. After blood collection they crated, put in the baskets and transported for 2h at 25˚C, after coming back, blood samples recollected and blood metabolites and cell concentration again were analyzed. After that broilers were killed and hung by the legs for approximately 10 min to bleed out. Thereafter they followed standard processing conditions then burs and thymus glands also breast and thigh meat samples were collected. Bursa and thymus percentage were calculated based on body weight of broiler chickens.

Analytical Methods

Biochemical Examinations

The heparinized blood was centrifuged at 837 × g at 4°C for 10 min, and plasma samples were stored at −80°C in Eppendorf test tubes until the analyses were performed. Selected plasma biochemical indices (glucose, cholesterol, LDL, HDL, triglycerides and total protein) were measured by a Cobas Emira Biochemical Analyzer using commercial test kits (BioVendor Laboratorni medicina a.s., Modrice, Czech Republic).

Color Measurements

The (CIE, 1978) system color profile of L*, a*, and b* was measured by a reflectance colorimeter (Minolta Chroma Meter CR-300, Minolta Italia S.P.A., Milano, Italy) using illuminant source C. For breast (pectorals major) and thigh meat color evaluation, measurements were taken on the cranial, medial surface (bone side) in an area free of obvious color defects (bruises, discolorations, hemorrhages, full blood vessels, or any other condition that may have affected uniform color reading).

pH Measurement

The pH was determined using a modification of the iodoacetate method initially described by (Jeacocke, 1977). Approximately 2.5 g of breast and thigh meat was removed from the cranial end of each fillet, minced by hand, homogenized in 25 mL of a 5 mM iodoacetate solution with 150 mM potassium chloride for 30 s, and the pH of the homogenate was determined using a pH meter (pH meter HI98240 equipped with electrode FC230, Hanna Instrument S.p.A., Padova, Italy) calibrated at pH 4.0 and 7.0 at 45 minute and 24h after slathering.

Drip Loss Determination

The 2 fillets from each whole breast and thigh were separated and used for the determination of drip and cook loss. Drip loss was carried out on 1 intact fillet kept suspended in a sealed glass box for 48 h at 2-4°C and expressed as percentage of weight loss during storage.

Statistical Analysis

All measured criteria were analyzed by two-way ANOVA using GLM of (SAS, 2001) with Vitamin C, *echium amoenum* and lavender extracts as main effects. Comparisons of means of dietary treatments were done by Duncan's multiple range tests at the confidence interval of 95% ($P<0.05$).

RESULTS AND DISCUSSION

Blood Metabolites

Serum biochemistry is a labile biochemical system which can reflect the condition of the organism and the changes happening to it under influence of internal and external factors (table 2 and 3). Results of this study showed that both of the dietary treatments and transport stress did not have significant effects on blood biochemical parameters ($P<0.05$). The concentration of glucose, cholesterol and TG as major indicators of transport stress did not influence by dietary treatments although transport stress change them drastically (glucose, cholesterol and TG decreased) although in all of the treatments reduction amount of these parameters were equal (tables 2 and 3).

Table 2- Effects of dietary treatments on blood metabolites before transport stress

Treatments	Glucose	Cholesterol	TP	TG	HDL-Ch	LDL-Ch
Control	222.71	90.13	3.32	53.76	36.32	43.06
Vit. C	207.27	75.44	3.63	62.72	21.52	51.38
Lavender	220.72	92.54	3.61	50.29	24.16	58.33
E. A.	234.46	102.19	3.44	61.85	29.60	60.22
Vit. C + Lavender	229.38	103.51	3.35	65.32	25.28	65.17
Vit. C + E. A.	236.55	98.46	3.39	58.96	39.76	46.91
Lavender + E. A.	220.92	85.53	3.42	51.73	48.88	41.73
Vit. C + Lavender + E. A.	239.56	83.77	3.71	51.12	48.88	30.97
SEM	41.17	12.31	0.48	12.18	12.17	11.23
P-Value	0.60	0.50	0.56	0.88	0.31	0.91
ANOVA	*P-Value*					
Vitamin C	0.48	0.79	0.31	0.41	0.69	0.78
Lavender	0.31	0.98	0.24	0.78	0.39	0.86
E. A.	0.51	0.81	0.32	0.98	0.06	0.25

Means within a column with no common superscript are significantly different ($P < 0.05$)
TP= total protein, TG= triglyceride, Ch= cholesterol, Vit= vitamin, E.A= echium amoenum, LDL= low density lipoprotein, HDL= high density lipoproteins.

The burse and thymous percentage were not affected by dietary treatments ($P> 0.05$). After slaughter, the substrates glycogen, glucose, and glucose-6-phosphate are converted to lactate. As is shown in the study by (Ondrašovičová *et al.*, 2008), rough handling and long journeys have the greatest adverse effects on poultry welfare. They found that the time in transit and the distance between the farm and the slaughterhouse increased the corticosterone level in plasma and reduced the glucose level in blood.

Similarly, (Pijarska *et al.*, 2006) detected a lower glucose concentration in birds after transportation lasting 18 h. Also triglycerides, total protein and glucose levels of broilers decreased with travel distance so that their levels were decreased after 130 km of transport when compared with broilers before transport at fall and winter temperatures (Vosmerova *et al.*, 2010). At the other hand no significant differences in plasma glucose or lactate concentrations in broilers transported for 1.5 h were found. (Savenije et al., 2002, Delezie *et al.*, 2007).

Dietary essential oils like borneol, cineole, citral, geraniol, menthone, menthol, fenchone and β–ionone suppresses the hepatic HMG–CoA reductase activity (Yu *et al.*, 1994). The hypo-cholesterolemic effect of lemongrass oil is due to the inhibition of hepatic 3-hydroxy-3-methylglutaryl coenzyme A (HMG–CoA) reductase activity which is a key regulatory enzyme in cholesterol synthesis (Cooke *et al.*, 1998, Crowell, 1999). Significant reduction in the serum cholesterol level of broiler fed with cinnamon powder at 250 and 500 ppm (97.43 and 94.87 mg/dl vs 116 mg/dl) were reported (Gopi *et al.*, 2013).

Table 3- Effects of dietary treatments on blood metabolites after transport stress (mg/dl)

Treatments	Glucose	Cholesterol	TP	TG	HDL-Ch	LDL-Ch
Control	91.83	104.39	3.11	55.20	40.96	52.39
Vit. C	113.15	86.40	3.61	46.84	44.16	32.88
Lavender	149.10	98.25	3.80	45.95	37.52	51.53
E. A.	146.24	105.70	3.28	48.84	63.04	32.98
Vit. C + Lavender	120.12	104.61	3.84	51.73	71.60	31.58
Vit. C + E. A.	120.92	98.25	3.38	44.51	62.88	26.46
Lavender + E. A.	129.98	92.54	3.70	49.71	56.80	25.19
Vit. C + Lavender + E. A.	157.37	111.18	3.81	57.80	53.76	45.80
SEM	22.96	10.61	0.34	7.28	10.12	10.79
P-Value	0.92	0.95	0.13	0.93	0.25	0.38
ANOVA	*P-Value*					
Vitamin C	0.72	0.98	0.47	0.96	0.25	0.41
Lavender	0.46	0.69	0.76	0.32	0.15	0.23
E. A.	0.14	0.64	0.02	0.95	0.76	0.74

Means within a column with no common superscript are significantly different ($P < 0.05$)
TP= total protein, TG= triglyceride, Ch= cholesterol, Vit= vitamin, E.A.= echium amoenum, LDL= low density lipoprotein, HDL= high density lipoproteins.

The broilers showed a dose dependent reduction in serum cholesterol levels. Poultry are renal synthesizers of vitamin C, but its quantity becomes insufficient under praxis conditions as a result of increased rate of usage in combating the free radicals thus generated (Gopi et al., 2013). In the other study researcher reported that separately or as a combination, supplemental vitamin C and E decreased plasma concentrations of cholesterol and glucose of laying hens reared under condition of high ambient temperature and humidity(Ajakaiye *et al.*, 2010). Furthermore, the supplementation of vitamin C and E have been reported to increase serum concentration of total protein, but decrease corticosterone, glucose, and cholesterol concentrations in Japanese quails exposed to 33 °C (Sahin *et al.*, 2003). Several authors have documented (Altan *et al.*, 2003, Imik *et al.*, 2009) that free radical generation affects blood serum metabolites of total protein, cholesterol and glucose which is manifested in bird's adaptation response through decreased production performance. Vitamin C has been demonstrated to be a powerful antioxidant that acts through a two way mechanism, those are, through its conversion to L-dehydroascorbic acid and formation of an ascorbate radical, a particularly inert radical, this reaction is reversible and the interconversion of these molecules forms a redox system which is the basic physiology of their actions, because both show vitamin C activity (Yildiz *et al.*, 2009). In the present study, vitamins C and lavender or borage supplementation did not improve the stability of serum metabolites of broiler chickens under transport stress. Increases in concentrations of glucose during stress may be attributed to induced glucocorticoid secretion which increases glucogenesis. Glucocorticoids are well known not only as hormones essential for maintaining life and normal growth, but also as stress hormones. Dietary vitamin C, lavender and borage extracts may reverse these changes, probably by reducing the secretion or synthesis of glucocorticoids (McDowell, 2008). These results are agreement with our study, in which we found no significant effect of transport stress on the glucose level in broilers. The results obtained indicate that pre-transport treatment (dietary supplementation) may be less useful for broilers than bettering handling procedures (catching, crating in good condition and loading) in order to reducing transport stress effect on blood biochemical parameters.

White Blood Cell Counts

White blood cell differential counts are summarized in Table 4. Before transport stress, vitamin C and combination of extracts with citamin C significantly decreased heterophil and increased Lymphocyte percentage as compared with control group but after transport stress, addition of vitamin and plant extracts alone or in combination with the other compounds significantly decreased heterophil percentage and H: L ratio and increased Lymphocyte percentage as compared with control group ($P< 0.05$). In general, animals respond to transport stress by increasing the number of total WBC and specific types of WBC (heterophils, eosinophils, and mononuclear cells) in circulation (Kent and Ewbank, 1986). Heterophil counts, which are sensitive indicators of changes in plasma corticosteroid levels and extent of stress (Post *et al.*, 2003) were highest in control group birds after transport stress and among the dietary treatments birds those received all of the additives had lowest heterophil percentage and this led to a significant decrease in H/L ratio after stress. It is suggested that H/L ratios of 0.2, 0.5, and 0.8 characterize low, optimum, and high levels of stress, respectively. In this study, H/L ratios were significantly varies among the preslaughter treatments, most likely due to long and sever duration of the transport stress (Gross and Siegel, 1982) and significant increase in H/L ratio in broilers after extended (actual transport time was 3 h) transportation were reported (Mitchell *et al.*, 1992). In conclusion, in this study substitution of medicinal plant extracts beside vitamin C because of their antioxidant effect could reduce the detrimental effect of transport stress on white blood cell count and decrease the heterophil percentage in blood of broiler chickens.

Table 4- Effects of dietary treatments on blood cell population before and after transport stress

	Before stress			After stress		
Treatments	H%	L%	H/L	H%	L%	H/L
Control	28.25^{b}	60.25^{c}	0.469^{ab}	35.75^{a}	52.75^{f}	0.683^{a}
Vit. C	26.25^{bc}	66.00^{b}	0.398^{ab}	19.50^{b}	72.25^{cbd}	0.271^{cb}
Lavender	22.25^{cd}	72.75^{a}	0.306^{cd}	14.00^{de}	75.00^{b}	0.187^{de}
E. A.	33.5^{a}	60.00^{c}	0.563^{a}	17.50^{bc}	71.25^{ced}	0.246^{bcd}
Vit. C + Lavender	33.5^{a}	61.25^{c}	0.549^{a}	20.75^{b}	68.00^{e}	0.307^{b}
Vit. C + E. A.	21.75^{d}	71.50^{a}	0.311^{cd}	15.50^{cd}	74.75^{cb}	0.208^{cde}
Lavender + E. A.	33.5^{a}	60.75^{c}	0.553^{a}	19.25^{b}	69.50^{de}	0.277^{bc}
Vit. C + Lavender + E. A.	20.00^{d}	71.50^{a}	0.281^{d}	11.00^{e}	78.75^{a}	0.141^{e}
SEM	1.39	1.54	0.03	1.11	1.18	0.024
P-Value	0.009	0.009	0.001	0.001	0.001	0.001
	P-Value			*P-Value*		
Vitamin C	0.004	0.001	0.001	0.001	0.001	0.001
Lavender	0.72	0.07	0.64	0.001	0.001	0.001
E. A.	0.93	0.43	0.82	0.001	0.001	0.001

Means within a column with no common superscript are significantly different ($P < 0.05$)
Vit.= vitamin, E.A.= echium amoenum, H= heterophil, L= lymphocyte, H/L= H to L ratio

Meat Quality Parameters

Table 5 shows the effects of treatment on initial and final pH, drip loss and CIE Lab color coordinates on breast and thigh samples. Addition of plant extracts and vitamin C one week before transport significantly influenced meat quality characteristics such as initial and final pH and color of breast and thigh meats. Treatment also influenced the drip loss of breast meat, but it did not influence the drip loss level of thigh meat ($P < 0.05$). Mean initial pH of breast meat of the birds those received echium amoenum extract was significantly lower ($P < 0.05$) than that of the other dietary treatment birds and the final breast meat pH of lavender received

birds was lower than that of others. In the case of thigh meat there was a little inconsistency in initial and final pH and it was difficult to describe the results. The color indexes (L*, a* and B*) of breast meat were differ between treatments so that birds which get lavender extract and Vitamin C have the highest L* and the lowest a* and lowest b* values belonged to vitamin C treatment birds ($P<0.05$). No effects of the dietary treatments were found for L* of thigh meat ($P>0.05$). In contrast, a significant differences between treatments were observed for a* and b*, with lower values in the birds those received lavender extract and also vitamin C and echium amoenum ($P<0.05$). Drip losses of breast meat appeared to be significantly ($P<0.05$) lower in the combination of three dietary treatment received birds. The antioxidative properties of various extracts of plant oils like oregano, thyme, marjoram, spearmint, lavender and basil which were assessed by addition them to lard kept at 75 °C and found out that extract containing Oregano was the most effective followed by thyme, dittany, marjoram and lavender (Economou *et al.*, 1991, Raza *et al.*, 2009). However, ΔpH tended to be high in plant extract fed birds than control birds, indicating that plant extracts and vitamin C because of their antioxidant activity may slow the pH decline and help maintain meat quality.

This variation in meat quality may be related to the chemical changes in muscle myoglobin pigment, which is predominantly converted into purple reduced myoglobin and brown metmyoglobin during the first days postslaughter (Millar *et al.*, 1994) in chickens, (Sante *et al.*, 1993) in turkeys. There was an indication of a positive relationship between plasma corticostrone (CORT) concentrations and color of thigh meat and an increase in CORT concentration is associated with a higher hue value, indicating that the meat becomes lighter and less red in color (Kannan et al., 2000). This result suggests that very high stress levels in broilers may cause production of paler thigh meat. It is likely that different preslaughter stressors can affect the metabolism of different fiber types (red, white or intermediate) in animals (Fernandez *et al.*, 1994).

CONCLUSION

According to this results of this study it is concluded that using lavender and echium amoenum extract and vitamin C as natural and synthetic anitioxidants can reduced adverse effects of transport stress by lowering heterophil percentage and H; L ratio, those are the indexes of stress in broiler chickens also they prevented the effect of long period transport stress on breast and thigh meat quality by elevating the l* value and lowering the a* and b* values of these meats. At the other hand transport stress had unfavorable affect on blood metabolites and using synthetic and organic antioxidants compensate these effects on blood metabolites of transported broiler chickens. It is suggested that antioxidant can alleviate the adverse effect of transportation on blood metabolite and meat quality and in some cases we can use of lavender and echium amoenum extract beside vitamine C in order to reducing transport stress bad effects on meat quality.

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Table 5- effects of dietary treatments on broiler chicken meat quality of after transport stress

	Treatment[1]												
Meat	A	B	C	D	E	F	G	H	SEM	*P-Value*	*P-Value*[2]		
Breast Color[3]											V	L	EA
L*	46.88^{b}	48.38^{ab}	56.68^{ab}	48.38^{ab}	58.60^{a}	56.67^{ab}	49.34^{ab}	50.97^{ab}	3.55	0.001	0.59	0.82	0.81
a*	12.29^{a}	9.60^{ab}	8.68^{b}	10.44^{ab}	8.85^{b}	10.36^{ab}	10.82^{ab}	10.19^{ab}	1.02	0.001	0.073	0.64	0.28
b*	6.08^{ab}	4.18^{b}	9.23^{a}	8.33^{a}	9.24^{a}	9.11^{a}	7.65^{ab}	9.16	1.26	0.001	0.11	0.12	0.72
pH 45min	6.78^{a}	6.50^{abc}	6.57^{abc}	6.20^{c}	6.39^{abc}	6.62^{ab}	6.63^{ab}	6.36^{bc}	0.12	0.028	0.37	0.016	0.38
pH 24 h	6.02^{ab}	6.24^{a}	5.92^{b}	6.13^{ab}	6.07^{ab}	5.99^{ab}	5.97^{ab}	6.36^{bc}	0.08	0.04	0.54	0.14	0.59
ΔpH	0.76^{a}	0.41^{bc}	0.27^{c}	0.44^{abc}	0.35^{bc}	0.63^{ab}	0.59^{abc}	0.39^{bc}	0.10	0.010	0.35	0.03	0.38
D.L. %	2.18^{c}	2.45^{c}	2.65^{bc}	2.70^{bc}	3.43^{bc}	3.742^{ab}	2.988^{bc}	4.73^{a}	0.39	0.032	0.45	0.44	0.11
Thigh Color													
L*	44.54	44.81	54.64	52.14	46.14	52.34	47.54	51.75	3.72	0.228	0.71	0.20	0.56
a*	17.07^{a}	15.47^{abc}	13.49^{bc}	16.77^{ab}	16.59^{ab}	13.06^{c}	13.45^{bc}	14.89^{abc}	1.05	0.003	0.42	0.14	0.19
b*	4.08^{bc}	8.98^{a}	3.28^{c}	9.26^{a}	7.81^{ab}	6.17^{abc}	5.94^{abc}	6.12^{abc}	1.29	0.036	0.52	0.82	0.15
pH 45min	6.632^{b}	6.91^{a}	6.58^{b}	6.595^{b}	6.51^{b}	6.52^{b}	6.58^{b}	6.52^{b}	0.08	0.039	0.77	0.06	0.08
pH 24 h	6.28^{ab}	6.60^{a}	6.29^{ab}	6.56^{ab}	6.40^{ab}	6.38^{ab}	6.24^{b}	6.24^{b}	0.10	0.018	0.36	0.03	0.61
ΔpH	0.35	0.30	0.29	0.04	0.11	0.13	0.34	0.27	0.11	0.532	0.84	0.36	0.63
D.L. %	1.61	1.54	1.64	1.97	1.69	2.33	2.29	2.57	0.40	0.768	0.22	0.04	0.41

Means within a row with no common superscript are significantly different ($P < 0.05$)

1- A= Control, B= Vitamin C , C= Lavender, D= echium amoenum, E= Vitamin C + Lavender, F= Vitamin C + echium amoenum, G= Lavender + echium amoenum, H= Vitamin C + Lavender + echium amoenum,

2- V= Vitamin C, L= Lavender, EA= echium amoenum, VLEA= Vitamin C + Lavender + echium amoenum

3- L* = Lightness; a* = Redness; b* = Yellowness, D.L.= drip loss

4- ΔpH= pH at 45 Min Postmortem - pH at 24 h Postmortem.