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Influence of fish oil and antioxidants supplementation on carcass traits, immune response, minerals and amino acid composition of broiler meat

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ABSTRACT

The objective of this study was to investigate the possibility to increase omega-3(n-3) long chain Polyunsaturated fatty acids (PUFAs) especially Eicosapentaenoic acid (EPA) and Docosahexaenoic acid (DHA) fatty acids and to preserve meat quality in broiler by adding fish oil (FO) and some antioxidants to the diet.

The present experiment was carried out at the Poultry Physiology Researches Laboratory, Poultry Production Department, Faculty of Agriculture, Ain Shams University, and Laboratories of Animal Production Department, National Research Centre, Cairo, Egypt, Agriculture Research Centre. A total of 120 (one-day-old) Cobb-500 broiler chicks were obtained from a local commercial hatchery. The birds were randomly divided into four groups with three replicates, 10 chicks each. The first group was fed on the basal diet containing 2% soy bean oil (control), the 2^{nd} , 3^{rd} and 4^{th} groups were given the basal diets containing 2% FO; 2% FO + 200 mg vitamin E (Vit. E)/ kg or 2% FO + 0.2% Sweet Chestnut Tannin (SCT) for 5 weeks, respectively.

Results showed that there was no significant (P>0.05) difference among treatments in carcass traits (carcass %, liver %, heart %, gizzard %, abdominal fat %, breast %, wings % and femur %) of broilers. Also, no difference was recorded among treatments in Amino acids, protein , moisture and minerals of broilers meat compared to control. No significant (P= 0.53) difference among treatments was observed in chemical properties (Moisture %, CP %, EE % and Ash %) of broilers meat. Dietary inclusion of 2% FO + 0.2%SCT in broiler diets improved immune response and n-3 long chain PUFAs in broiler meat. On the other hand, all experimental treatments were differed significantly on the sensory characteristics of chicks breast and thigh meats. In which, the most preferred breast and thigh meat was from birds receiving the basal diet (control). The sensory quality scores were obtained for the group of single FO addition, followed by those fed FO in blend with either vit E or SCT. Thus, supplementation of these antioxidants with FO slightly improved the eating quality traits of broiler meats when compared with the single FO addition.

Key words; Broiler, fish oil, antioxidants, PUFAs, meat, immune response, broiler chicks.

INTRODUCTION

Several studies had been conducted to increase the content of polyunsaturated fatty acids (PUFAs) in chicken meat and eggs by using dietary fat sources such as natural oil containing PUFAs (Kim *et al*., 2007). Fish oil (FO) is derived from the tissues of oily fish and has been recognized as a healthy promoting food. It contains particularly n-3 long chain polyunsaturated fatty acids (PUFAs), in the form of long chain eicosapentaenoic acid (EPA, C20:5 n-3) and docosa-hexaenoic acid (DHA, C22:6 n-3) that are the most effective fatty acids (Kavouridou *et al*., 2008).There was significant increase in the relative liver percentage to carcass weight due to dietary FO content (Cortinas *et al.*, 2005). Birds, which fed a high level of n-3 PUFAs such as FO, had a significantly higher antibody production than that fed other animal fat (Wang *et al.*, 2000). In addition, the level and sources of n-3 PUFAs had positive effects on

antibody production in chicks where the n-3 long chain PUFAs, EPA and DHA had the ability to increase the immune response (Calder, 2001). Fish oil added to chicken diets increases the content of long chain n-3 PUFAs and the susceptibility to oxidation of meat lipids ((Koreleski and Swiatkiewicz, 2006). Polyunsaturated fatty acids are prone to oxidation since they are the first target for free radical strike at initiating peroxidation (Scislowski *et al*., 2005). The lipid oxidation products lead to deterioration of food quality such as nutritional value, flavor, color, texture and may be responsible for tissue and organ damage (Priscilla and Prince, 2009).The quality of stored frozen meat may deteriorate because of lipid oxidation, especially in cooked and refrigerated meat (Cortinas *et al*., 2005).Vitamin E (Vit. E) is considered as a very potent antioxidant in biological systems and found to be beneficial in counteracting the adverse effect of oxidative stress (Panda and Cherian, 2014). In addition, one of the primary functions of Vit. E is to maintain cell membrane integrity via preventing oxidation of PUFAs in membrane phospholipids (Gropper *et al.*, 2009). Also, Vit. E is essential for many body functions, i.e., tissue integrity, reproduction, disease prevention, and antioxidant function in biological systems (DalleZotte and Szendro, 2011). Sweet chestnut is an important source of hydrolyzed tannins "phenolic compounds'' (Ribeiro *et al*., 2007). Many studies have been carried out examining the role of tannins in the prevention of lipid oxidation (Schiavone *et al*., 2008; Wang *et al*., 2008; Liu *et al*., 2009).

Therefore, the current study aimed to investigate the possibility to increase n-3 long chain PUFAs especially EPA and DHA fatty acids in broiler meat by adding FO to broiler diet and to prevent lipid oxidation for maintaining the broiler meat quality by adding different sources of antioxidants. In addition, to study the impact of adding fish oils and antioxidants to broiler diets for improving the productive performance and immune response of broiler chicks.

MATERIALS AND METHODS

1. Experimental method:

A total of 120 (one-day-old) Cobb-500 broiler chicks were obtained from a local commercial hatchery with an average weight (41.2g±1.2g). Birds were randomly divided into 4 groups with 3 replicates, 10 chicks each. All birds were fed on isocaloric and isonitrogenous diets (starter and grower) containing the same ingredients (basal diet) except the sources of oils and antioxidants. The first group was fed on the basal diets containing 2% soy oil (control group) while, the 2nd, 3rd and 4th groups were given the basal diets containing 2% fish oil (FO): 2% FO with 200 mg/kg of Vit. E and FO with 0.2% SCT, respectively. Chickens of all groups were fed starter diets from one-to 14 days of age (DOA) and grower diets from 15 to 35 DOA. The basal control diets were formulated to satisfy nutrients needed as recommended by the manual of the strain used. The basal diets were formulated depending on chemical analysis of ingredients according to the recommendation of the National Research Council (NRC, 1994). Feed and water were offered *ad-libitum* during the experimental period, which lasted for five weeks, and the fatty acids composition of the supplemented oils is presented in Table (1).Vitamin E was supplied by Adisseo Inc. French, it contains 50% α- tocopherol. Sweet chestnut tannin (supplied by Silva Team, San Michele di Mondov, Italy) is extracted from chestnut wood by heat and low-pressure treatment; only the water-soluble fraction is retained and subsequently dehydrated. The product is commercially available as a fine brown powder (92 to 95% dray matter) with a pure tannin content of 77% on a dry matter (DM) basis (Tabacco *et al*., 2006). The chemical composition of SCT used in this

study contained 2.9% water; 77.8% tannin; 17.7% nontannin; 1.6% insolubles ; 0.24% crude fiber and 1.7% ash (pH 3.26, 10% solution). Tannin percentage was obtained by gravimetric analysis of vegetable tanning agents by using the filter Freiberg-Hide powder method (Kuntzel, 1954).

Table (1).Fatty acids composition of the supplemental oils (as % of total fatty acids).

Fatty acid	Soy oil	Fish oil
C12:0	0	0.25
C14:0	0.18	1.92
C14:1	0.163	5.034
C16:0	15 955	11.96
C16:1	0.06	15.1
C18:0	5.06	3.03
C18:1 n9	18.94	9.21
C18:2 n6	50.01	18.25
C18:3 n3	5.04	7.81
C20:4 n6	0.08	5.39
C20:5 n3	0	7.49
C22:6 n3	0	9.72
SFA	21.195	17.16
MUFA	19.163	29.344
PUFA	55.13	48.66
n9	18.94	9.21
n6	50.09	23.64
n3	5.04	25.02
n6/n3	9.94	0.94

SFA = saturated fatty acid; **MUFA** = monounsaturated fatty acid;
PUFA = polyunsaturated fatty acid

2. Slaughtering trail:

At the 35 DOA, 10 chicks from each treatment were randomly taken, weighed individually, slaughtered by severing the jugular vein, and their feathers were removed manually, and autopsied. At autopsy, the heart, liver, gizzard (muscular, thick-walled part of a bird's stomach for grinding food, typically with grit), spleen and abdominal fat were removed, weighed and their weights proportionate to the live body weight (LBW) was obtained, then the giblets: liver, heart, gizzard and neck percentages were calculated. The empty eviscerated carcasses were weighed and the dressing percentages were calculated. Breast, femur and wing weight were also recorded to the nearest gram and calculated as apercentage of LBW. Weights of bursa of Fabricius, and thymus gland were recorded and their relative weights as a percentage of LBW were calculated.

3. Analysis of Amino acids, protein, moisture and minerals of broilers meat

Samples from breast (BM) and thigh (TM) muscles were taken from the slaughtered birds to determine the level of protein, moisture and minerals according to AOAC (1990) and amino acid profile according to AOAC (2012) at the

Laboratories of Agriculture Research Centre.

4. Humoral Immune Response: Immunization and Titration against SRBCs:

Forty chicks (ten chicks for each treatment) were intramuscularly injected with 0.5ml Sheep red blood cells (SRBCs) suspension at 21 DOA and repeated at 28 DOA. Blood samples were collected from the injected birds, seven days after the first and the second immunization at 28 and 35 days of age, respectively and were centrifuged (4000 rpm/ 5min), plasma were decanted and stored at -20^{o}C until the evaluation of the primary and secondary antibody responses (Hitchner *et al.*, 1980). The antibody responses were measured using microtitre plate, U-shape of 96 wells.

5- Physical (sensory) properties of meat:

Breast muscles (BM) and thigh muscles (TM) samples were taken from the slaughtered birds and subjected to sensory evaluation.The tests were done 15 days of storage at −20°C. Sensory characteristics, taste, odor, color, tenderness, acceptability, texture and aftertaste were evaluated by ten of trained consumer panel, who had experience in poultry meat sensory analysis. They were asked to rank the acceptability of the product using a 10-point scale (1 =very bad; 10 = extremely excellent). Panelists were instructed to evaluate the samples in arandomized order.

6- Statistical analysis:

Data were subjected to the analysis of variance using the General Linear Models Procedure (GLM) of the Statistical Analysis System (Swinscow, 1981)**.** Differences among treatment means were detected using Duncan's multiple range test was calculated (Duncan, 1955).

RESULTS AND DISCUSSION

The effect of dietary oils and antioxidants supplementation on carcass traits was shown in Table (2). No significant (P>0.05) difference among treatments was observed in carcass traits (carcass %, liver %, heart%, gizzard %, abdominal fat %, breast %, wings % and femur %) of broilers. Similar results were also obtained by Schiavone *et al*. (2008) who fed broiler chicks on different levels (0, 0.15, 0.20 and 0.25%) of Sweet chestnut tannins (SCT). They found no significant differences on carcass traits, leg and breast. Also, Safamehr *et al.* (2008) found that feeding male broiler 2% and 3% FO had no significant effects on carcass yield, abdominal fat, thighs, breast, liver, gizzard, andheart among treatments.

Table (2). Effect of dietary supplementation with Fish oil sources and antioxidants on carcass traits.

Items	Control	FO	FO+ 200mg/Kg Vit. E	MSE + 0.2% SCT	
Carcass %	**71.06**	**72.58**	**72.12**	**71.75**	**1.59**
Liver %	**2.86**	**2.43**	**2.69**	**2.42**	**0.34**
Heart %	**0.58**	**0.58**	**0.56**	**0.59**	**0.09**
Gizzard %	**1.81**	**1.47**	**1.49**	**1.53**	**0.25**
Giblets %	**5.25**	**4.47**	**4.74**	**4.53**	**0.48**
Abdominal fat, %	**1.95**	**1.50**	**1.45**	**1.58**	**0.40**
Breast %	**24.16**	**25.14**	**24.5**	**25.09**	**0.90**
Wings %	**7.05**	**6.3**	**7.13**	**6.57**	**0.52**
Femur %	**22.17**	**23.7**	**22.95**	**23.44**	**0.85**

FO = Fish oil; SCT = Sweet chestnut tannins; Vit. E = Vitamin E
MSE = Mean squared error

The effects of dietary oils and antioxidants supplementation on amino acid profile in broiler meat was shown in Table (3). It is clear that with the exception of the level of Valine (Val) and Hisitidine (His) (essential amino acid); Glycine (Gly), Cystine (Cys) and Aspartic (Asp) (non-essential amino acid under certain conditions),that were higher for control group , the FO groups produced meat of higher content of most essential and non - essential amino acid and the superiority was shown for group of FO with vit E followed by those of FO with SCT.

Table (3).Effect of dietary supplementation with Fish oil sources and antioxidants on Amino acid.

Amino Acid (%)	control	FO	FO + 200 mg/Kg Vit E	FO + 0.2% SCT
Essential amino acid				
Isoleucine (ILE)	3.62	3.70	3.95	3.85
Methionine	1.76	2.14	2.1	1.97
Therionine (THR)	3.18	3.56	3.55	3.66
Valine (VAL)	4.04	3.92	3.93	3.89
Leucine(LEU)	6.12	6.43	6.53	6.44
Phenylalanine(PHE)	3.59	3.61	3.89	3.8
Lysine (LYS)	6.63	6.82	7.12	6.8
Non-essential amino acid				
Glycine (GLY)	3.69	3.65	3.55	3.56
Alanine(ALA)	4.54	5.04	5,15	5.02
Aspartic (ASP)	7.54	7.08	7.43	7.38
Serine (SER)	2.56	3.13	2.84	3.17
Glutamic (GLU)	10.79	11.32	11.78	11.42
Proline (PRO)	3.11	3.14	2.98	3.71
Tyrosine (TYR)	2.82	3.11	3.16	2.98
Hisitidine (HIS)	4.18	3.43	3.15	3.34
Argnine (ARG)	5.12	5.25	5.12	5.09
Cystine (CYS)	1.51	1.04	1.4	0.77
Total amino acid	40.37	50.43	49.86	49.8

The effect of dietary oils and antioxidants supplementation on protein and moisture was shown in Table (4). It is clear that FO produced meat of higher content of protein. Mansoub (2011) found that feeding high n-3 diet increased WBC count, total protein, and globulin in chicken plasma. No difference among treatments was observed in moisture of broilers meat compared to control.

Table (4). Effect of dietary supplementation with fish oil sources and antioxidants on protein and moisture of broilers meat.

	Control	**FO**	**FO** +200 mg/Kg Vit E	**FO + 0.2% SCT**
Protein	85.7	86.5	85.2	85.4
Moisture	8.20	8.10	8.30	8.80

The effect of dietary oils and antioxidants supplementation on minerals was shown in Table (5).No difference among treatments was observed in minerals of broilers meat compared to control. Baird *et al*. (2008) reported that no significant effect of a highn-3 PUFA (fish oil diet) on bone mineral density of birds.

Table (5). Effect of dietary supplementation with fish oil sources and antioxidants on minerals of broilers meat.

Minerals (%)	Control	FO	F0 +200 mg/Kg Vit E	FO + 0.2%SCT
P	0.94	0.92	0.76	0.97
K	1.28	1.28	1.04	1.24
Na	O.60	0.64	0.72	0.68
Ca	0.085	0.077	0.197	0.079
Mg	0.063	0.057	0.037	0.054
Fe	0.057	0.268	0.061	0.136

The effect of dietary oils and antioxidants supplementation on immune response was shown in Table (6). Inclusion of FO with or without antioxidants in broiler diets improved antibody titer against sheep red blood cells (SRBCs) in primary immune response (p=0.001) compared to control. Broiler chicks fed FO, FO + 200 mg Vit. E/ kg and FO + 0.2% SCT diets had significantly higher antibody titer against SRBCs in secondary immune response compared to the control. No significant (P>0.05) difference among treatments was observed in thymus and spleen percentages. The addition of FO + SCT to broiler diets significantly (p=0.05) increased bursa % compared to the control.

Supplementation of dietary FO improved the immune system (Tobarek *et al*., 2002), These results could be due to omega-3 which considered to be a substrate for the generation of prostaglandin, leukotriene and interleukin levels (Kidd, 2004). Also, the length and degree of saturation of the specific omega-3 PUFAs have a major impact on the effects of dietary supplementation on immune function (Wall *et al*., 2010). Metabolically, the n-3 long chain PUFAs, EPA and DHA have much greater impact on reducing inflammation than the shorter chain á-linolenic acid (Zainal *et al*., 2009; Duda *et al*., 2009). These results were in agreement with Chekani-Azar *et al*. (2010) who found that the chickens fed FO rich in n-3 long chain Polyunsaturated fatty acids (PUFAs) showed an increase in humoral immune activity in response to the injection of SRBCs. Feeding broilers with 1.5%, 3.0% and 6% FO had higher levels of anti-SRBCs titers compared to control group (Saleh *et al*., 2009). The supplementation of 3% FO in the diet improved the immune system (Wall *et al*., 2010). This is similar to Hosseini and Bahrami (2011) who reported a direct relationship between the dietary FO level and the humoral immune response against SRBCs. Also, Ebeid *et al*. (2011) reported that the inclusion of n-3 PUFAs in quail diets enhanced the antibody. Jameel *et al.* (2015) showed that the dietary addition of 0.5% FO may stimulate the development of the immune response and antibody production against New castle disease in broilers.

Dietary Vit. E supplementation at 110 or 220 mg/kg of feed enhanced phagocytic activity of macrophages toward opsonized Sheep red blood cells (SRBCs) (Konjufca *et al*., 2004). Also, Singh *et al*. (2006) reported that chickens receiving supplements of 200 mg Vit. E/kg produced significantly higher antibody titres. This was associated with an increased serum

concentration of total immunoglobulin and circulatory immune complexes. A significant increase in humoral immune responses against SRBCs when chickens were provided with higher concentrations of dietary á-tocopherol (200-300 mg/kg) (Boa-Amponsem *et al.,* 2006). Moreover, Ebeid *et al*. (2013) reported that dietary Vit. E caused an improvement in the antibody titers against Sheep red blood cells (SRBCs) of growing rabbits. Maroufyan *et al*. (2012) reported that there was no effect of dietary fats on the bursa of Fabricius weight. The numerical increase of bursa % maybe attributed to added antioxidants in broilers diets. Where, chickens given 200 mg Vit. E/ kg had significantly heavier bursa (Singh *et al.,* 2006).

Table (6). Effect of dietary supplementation with fish oil sources and antioxidants on immunological parameters of broiler chicks.

SRBCs antibody (1/log 2) titre	Control	FO	FO+ 200 mg/kg Vit E	FO+ 0.2% SCT	MSE	P-value
Primary (4th wk)	2.40^{c}	3.60^{b}	4.60^{a}	4.80^{a}	0.632	<.0001
Secondary (5th wk)	5.00^{c}	6.60^{b}	8.20^{a}	8.20^{a}	0.775	<.0001
Lymphoid organs %						
Bursa %	0.207^{c}	0.220^{B}	0.225^{b}	0.278^{a}	0.038	0.04
Thymus %	0.323	0.325	0.348	0.387	0.049	0.32
Spleen %	0.107	0.103	0.118	0.128	0.023	0.55

a,b,c,d Means within rows with different superscripts differ significantly.
FO = Fish oil; **SCT** = Sweet chestnut tannins; **SRBCs**= Sheep red blood cells;
Vit. E =Vitamin E

The effect of dietary oils and antioxidants supplementation on chemical analysis of broiler meat was shown in Table (7). No significant difference among treatments was observed in chemical properties (Moisture %, Crude protein (CP) %, Ether extract (EE) % and Ash %) of broilers meat.

Moisture, fat, protein and ash of broilers meat were not affected by levels of dietary FO (Jeun-Horng *et al*., 2002). In addition, Narciso-Gaytan (2008) showed that breast and thigh muscle total moisture contents were not affected by FO or Vit. E level. Schiavone *et al.* (2008) fed broiler chicks with different levels (0, 0.15, 0.20 and 0.25%) of sweet chestnut tannin and they found no significant differences on chemical composition of the leg and breast meat.

Table (7). Effect of dietary supplementation with fish oil sources and antioxidants on chemical analysis of broiler meat.

Items	Control	FO	FO + 200mg/kg Vit E	FO + 0.2% SCT	MSE
Moisture %	74.18	73.44	74.02	74.23	0.99
Crude protein %	18.75	19.6	19.25	18.96	0.86
Ether extract %	6.01	5.95	5.60	5.80	0.39
Ash %	1.13	1.06	1.18	1.00	0.11

FO = Fish oil; **SCT** = Sweet chestnut tannins; **Vit. E** = Vitamin E

The effects of dietary FO, and antioxidants inclusion on the sensory characteristics of chickens breast and thigh meats was shown in Table (8). It was generally evident that, all experimental treatments were differed significantly (P =0.0001). In which, the most preferred breast and thigh meat was from birds receiving the basal diet (control), recording the highest mean panel scores, the least (p=0.0001) sensory quality scores were obtained for the group of single FO addition, followed by those fed FO in blend with either vit E or SCT. Thus, supplementation of these antioxidants with FO had slightly improved the eating quality traits of broiler meats when compared with the single FO addition.These results might be attributed to the high level (2%) and long period of FO exposure. This submission was agreed with Lopez-Ferrer *et al*. (1999) had revealed that the sensory properties of breast and thigh muscles of chickens fed 8.2% of FO were very poor. Surai and Sparks (2000) showed that sensory quality of poultry meat may be adversely influenced by dietary supplementation with FO. The moderate improvement, achieved herein, in the sensory traits score of broiler meat with the addition of the antioxidants (Vit. E and SCT) could be due to their antioxidant function in poultry meat reducesthe oxidation values (lipidhydroperoxides, TBA, and cholesterol oxidation products) and prevents the formation of primary and secondary(Grau *et al*., 2001) oxidation products and total volatiles (De Winneand Dirinck, 1996). Thus, a higher PUFAs content of poultry meat increases the degree of unsaturation and, as a result, increases the susceptibility to oxidation. This may then lead to off-flavors and odors and, consequently, lower consumer acceptability. In this respect,(Rymer and Givens 2005) illustrated that the balance of volatile compounds resulting from an oxidative breakdown of n-3 PUFAs causes decrease in meat sensory properties and fishy aroma and oily after taste of poultry fed a higher level of n-3 PUFAs. From the current findings, it was suggested that poultry meat can been riched with long chain n-3 PUFAs without affecting the sensory characteristics of the meat if higher concentrations, than those used in the present study, of either Vit. E or SCT are included in the broiler diet, where both antioxidants are necessary to maintain a balance between maximizing the n-3 PUFAs content in edible tissues and maintaining an acceptable taste of the meat.

Therefore, further studies are needed to identify the optimum dose of FO supplements which would not lower meat quality, as well as, the required level of the tested antioxidants that could maintainthe preferred acceptability of poultry meat.

Table (8). Effect of dietary supplementation with Fish Oil and antioxidants on physical (sensory) properties of broiler meat.

Items	Control	FO	FO +200mg/kg Vit. E	FO + 0.2% SCT	MSE	P-value
Test	8.80_{a}	4.40_{g}	7.20_{e}	6.10_{f}	0.19	<.0001
Oder	8.70_{a}	5.40_{e}	8.00_{c}	7.40_{d}	0.33	<.0001
Color	8.50_{ab}	6.30_{e}	8.30_{bc}	7.80_{d}	0.23	<.0001
Tender	8.10_{a}	3.60_{d}	7.60_{b}	7.20_{c}	0.24	<.0001
Acceptance	8.70_{a}	2.80_{f}	7.00_{e}	7.30_{d}	0.25	<.0001
Texture	9.50_{a}	3.10_{f}	7.10_{e}	7.60_{d}	0.27	<.0001
After taste	9.10_{a}	2.70_{e}	6.50_{d}	6.70_{d}	0.24	<.0001

a,b,cMeans within rows with different superscripts differ significantly.
FO = Fish oil; **SCT** = Sweet chestnut tannins; **Vit. E** = Vitamin E

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تاثيرزيت السمك ومضادات الاكسدة على صفات الذبيحة والاستجابة المناعية والمعادن والاحماض الامينية لدى لحوم بدارى التسمين

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المستخلص

اجريت الدراسة بهدف بحث امكانية زيادة اوميجا 3 الاحماض الدهنية الغيرمشبعة طويلة السلسلة فى لحوم دجاج التسمين وذلك باضافة زيت السمك الى العليقة وكذلك المحافظة على اللحوم عن طريق منع اكسدة الدهون وذلك باضافة مضادات اكسدة طبيعية يالاضافة الى معرفة تاثير زيت السمك ومضادات الاكسدة على صفات الذبيحة والاستجابة المناعية والمعادن والاحماض الامينية لدى لحوم بدارى التسمين.

اجريت هذة الدراسة فى معمل فسيولوجى الدواجن التابع لقسم انتاج الدواجن بكلية الزراعة – جامعة عين شمس و معامل قسم الانتاج الحيوانى بالمركز القومى للبحوث . تم استخدام 120 كتكوت تسمين عمر يوم وتم تقسيمهم عشوائيا الى اربع مجموعات كل مجموعة تتكون من ثلاث مكررات وكل مكررربة 10 كتاكيت وتم تغذية الطيورلمدة خمسة اسابيع . المجموعة الاولى تم تغذيتها على وجبة متزنة تحتوى على 2% زيت فول الصويا بدون اى اضافات (المجموعة الضابطة) . المجموعة التانية تم تغذيتها على عليقة تحتوى على 2% زيت السمك والمجموعة التالتة تم نغذينهاعلى عليقة تحتوى على 2% زيت سمك + 200ملجم/كجم فيتامين (ه) والمجموعة الرابعة تم تغذيتها على عليقة تحتوى على 2% زيت سمك + 0.2% من شجرة نبات ابوفروة. اظهرت النتائج عدم وجود فروق ذات دلالة احصائية بين المعالجات المختلفة على خصائص الذبيحة بالمقارنة بالمجموعة الضابطة. ولا يوجد اختلاف ملحوظ بين المعالجات المختلفة على الاحماض الامينية والبروتين والرطوبة والمعادن لدى لحوم بدارى التسمين بالمقارنة بالمجموعة الضابطة. كذلك لم تؤثر المعاملات المختلفة على التركيب الكيميائى لدى لحوم بدارى التسمين. كما أتضح ان اضافة زيت السمك مع مضادات الاكسدة او بدون مضادات الاكسدة قد ادى الى تحسن الاستجابة المناعية للطيور بالمفارنة بالمجموعة الضابطة وان اضافة مضادات الاكسدة ادى الى تحسن درجة الخصائص الحسية لدى لحوم يدارى التسمين. وقد اتضح ان اضافة زيت السمك مع مضادات الاكسدة او بدون مضادات الاكسدة الى عليقة الدواجن قد ادى الى زيادة اوميجا 3 الاحماض الدهنية غير المشبعة طويلة السلسلة.