EFFECT OF USING AVOCADO, CHIA OIL AND THEIR MIXTURE IN BROILER DIETS ON PRODUCTIVE PERFORMANCE AND SOME CHEMICAL CHARACTERISTICS OF MEAT

A. A. Qassim*[2] L. K. Bandr[1] F.M. Alkalani[2]
Researcher Prof. Expert
[1]Dep. Animal Produ., Coll. Eng. Sci. Agri., University of Baghdad, Iraq
[2] Dep. Animal Resou. Resear., Poult. Rese. Station, Minis. Agri., Office of Agri. Rese., Baghdad, Iraq
E-mail: alhasan.ahmed1101a@coagri.uobaghdad.edu.iq

ABSTRACT

This study was conducted in the field of the Poultry Research Station of the animal resources Department / office of Agricultural Research / Ministry of Agriculture from the period 4th April to16th May2021.This study was aimed to investigate the effect of using avocado and chia oil and their mixture in broiler diets on the final productive performance and meat cholesterol concentration and measuring meat oxidation indicators after storing it for 60 days. 300 one-day-old (Ross308) chicks were fed on diets that used avocado oil and chia with percentages of 0, 0.2, 0.4, 0.6%, respectively, and their mixture consisting of 0.0, 0.1, 0.2, 0.3 each of avocado and chia oil (50% avocado + 50% chia oil). The experiment included 10 treatments with 3 replicates for each treatment (10 birds/replicates). The results showed a high significant improvement (P < 0.01) in the productive performance of (average body weight, weight gain, feed intake and feed conversion ratio) for the interactions of avocado and chia oil mixture treatments with a usage rate of 0.6% compared with the interactions of the control treatment and the rest of the interactions of the used oils. The results showed a high significant decrease (P < 0.01) in the concentration of cholesterol, Malondialdehyde(MDA) and the peroxide value (PV) of fat for the treatments of interaction the oil mixture and the usage rates of 0.2, 0.4 and 0.6% in broiler's meat that stored for 60 days.

Key words: Average Body Weight, Meat Cholesterol, Malondialdehyde, Peroxide Value
***Part of PhD. Dissertation of the 1st author**

تأثير استعمال زيت الأفوكادو والشيا وخليطهما في علائق فروج اللحم في الأداء الإنتاجي وبعض الصفات الكيميائية للحم

الحسن احمد قاسم [2*] لمى خالد بندر [1] فراس مزاحم حسين الخيلاني[2]
باحث أستاذ خبير
[1]قسم الإنتاج الحيواني – كلية علوم الهندسة الزراعية – جامعة بغداد
[2] قسم بحوث الثروة الحيوانية – دائرة البحوث الزراعية – وزارة الزراعة

المستخلص

اجريت هذه الدراسة في حقل محطة أبحاث الدواجن التابع لقسم الإنتاج الحيواني /دائرة البحوث الزراعية / وزارة الزراعة للمدة 4 نيسان الى 16 أيار 2021. تهدف هذه الدراسة لمعرفة تأثير استعمال زيت الافوكادو والشيا وخليطهما في علائق فروج اللحم في الأداء الإنتاجي النهائي وتركيز كولسترول اللحم وقياس مؤشرات اكسدة اللحم بعد خزنه لمدة 60 يوما. استخدم فيها 300 فرخ من نوع (Ross308) بعمر يوم واحد غذيت على علائق استعمل فيها زيت الافوكادو و الشيا و بالنسب 0، 0.2 ،0.4 ، 0.6 % على التوالي و خليطهما المتكون من 0.0 ،0.1 ،0.2 ، 0.3 من كل من زيت الافوكادو و الشيا بنسبة (50 % افوكادو +50 % زيت الشيا) . تضمنت التجربة 10 معاملات وبواقع 3 مكرر لكل معاملة (10 طير/مكرر). اشارت النتائج الى حصول تحسن عالي المعنوية (P <0.01) في الأداء الإنتاجي (معدل وزن الجسم والزيادة الوزنية والعلف المستهلك ومعامل التحويل الغذائي) لتداخلات معاملات خليط زيت الافوكادو والشيا وبنسبة استعمال 0.6 % مقارنة مع تداخلات معاملة السيطرة وباقي تداخلات الزيوت المستعملة. وأشارت النتائج الى حصول انخفاض معنوي عالي (P <0.01) في تركيز الكولسترول والمالوندياليدهايد وقيمة بيروكسيد الدهن لمعاملات التداخل خليط الزيت وبنسب استعمال 0.2 و0.4 و0.6 % في لحم الفروج المخزون لمدة 60 يوم.

الكلمات المفتاحية: معدل وزن الجسم، كولسترول اللحم، المالونديالديهايد، قيمة البيروكسيد
* **البحث مستل من اطروحة دكتوراه للباحث الأول**

Received:11/4/2022, Accepted:17/7/2022

INTRODUCTION

The scientific developments that took place at the beginning of the third millennium, which included all aspects of life, including the poultry industry and the production of highly efficient commercial flocks in terms of speed of growth and food conversion, and this development led to the emergence of problems in breeding through a decrease in the immunity of birds and the occurrence of development and resistance to diseases that affect the flocks forcing breeders to use medicines and drugs on a large scale by adding them to poultry diets, but these additions have negative effects on products (meat, eggs) that are consumed by humans, which forcing researchers in nutrition science to seek to find natural food additives and alternatives that improve the health status and the immunity of birds because it contains effective natural substances (6). And then its ability to improve the productive and physiological performance of birds, and these additives include medicinal plants, oil seeds or active substances extracted from them, as well as essential oils (10). As these natural additives work positively affecting the growth and improving the performance of poultry by various ways, including stimulating the digestion and metabolism process, and may have anti-microbial properties that negatively affect the performance of birds, including broilers, which improves growth rates and rates of food utilization and it also positively affects the chemical and qualitative characteristics of the carcass, so it is used as a substitute for industrial additives, drugs and antibiotics (5). Among the oils that have been adopted in recent years is avocado oil, which is extracted from the fruits of avocado, and this oil is one of the modern nutritional oils and it is a rich source of fatty acids and antioxidants, it is characterized by containing effective compounds such as glutathione Duester (14), which reduces the risk of cancer. Ortiz et al(25) indicated that avocado oil contains biologically active compounds, its importance lies within its antioxidant role and preventing the formation of free radicals such as carotenoids, tocopherols and chlorophyll Ortiz et al (26) indicated the addition of avocado oil to hamsters and rats at a rate of 1 g / 250 g of Body weight improved the growth rate of the animals and decreased oxidative stress (free radicals) in the liver. And in another study that included adding avocado oil to the hamster's food, it found an improvement in liver function and stimulating it to produce the enzyme aspartate aminotransferase responsible for the metabolism and transport of amino groups in proteins (1). While Toro et al (34) showed that adding 5-6 A g/250 g weight of Swiss mice stimulated the body to produce androgens by regulating the metabolism of Lipoproteins in the body, in another study conducted by Nicolella et al(23) ,they discovered that avocado oil works to protect and regulate the work of the genetic material of cells, in addition to protect the cells' DNA from compounds that cause DNA damage, such as methyl Methano sulfonat and doxorubicin. In addition to its protective role of DNA and chromosomes and protecting them from damage caused by radiation, especially gamma rays (2),and another important and recently adopted oil is chia oil, which is one of the types of essential and therapeutic oils (4). In addition, it is an important source of omega 3 and 6 (7). It is a rich source of alpha-linolenic acid (11) and has excellent biological properties as an antioxidant because it contains antioxidant compounds such as tocopherols and plant sterols. One of the benefits of chia oil is that it reduces heart disease and cancer (20). Moreover, Simopoulos (32) noticed that when using chia seeds in feeding hamsters, mice and rabbits, it stimulated growth and improved the physiological indicators of the animal and reduced the concentrations of lipid oxidation indicators in the blood serum. While Ayerza et al (9) indicated that when using chia seeds in broiler diets by 15%, it increased body weight and improved the of feed conversion efficiency and the quality of fatty acids in meat. Meineri et al(19) observed that adding chia seeds to rabbit diets by 10-15% increased the body weight rate, improved feed conversion ratio, and improved the quality of fatty acids in rabbit meat. Ibrahim (17) noted that the use of chia seeds in broiler diets by 8% improved the productive and physiological performance, and the use of chia seeds led to a decrease in fat oxidation indicators in meat

stored for 30 days. This study aimed to use both avocado, Chia oil and their mixture at different levels in broiler diets, and to study their effect and the effect of the interaction between the oil type and the percentage of usage, and to find the best combination of interaction between them in the productive performance and the range of their effect on cholesterol concentration and oxidation status for the stored meat for 60 days by studying the indicators of lipids oxidation in meat.

MATERIAIS AND METHODS

This study was conducted in the field of the poultry research station of the Animal Production Department / Agricultural Research Department / Ministry of Agriculture for the period 4/4/2021 to 16/5/2021. Three hundred (Ross308) chicks of one-day old were used, with an average weight of (38.72 g).Birds were randomly distributed to 10 treatments of three replicates (10 birds/replicate). The birds were fed on diets that used avocado, Chia oil and their mixture (50% avocado + 50% Chia oil) at a percentage of 0, 0.2, 0.4, 0.6%, respectively, and with three diets according to the age of the bird, which is the starter diet (1-10 days) and grower diet (11-22 days) and finisher diet for the period (23-42 days) and according to tables (1, 2, 3).Feed and water were provided ad libitum along the duration of the experiment. Birds were housed with continuous light with the lighting parts for 1 h to reorganize the birds to extinguish the electric current and heating controlled by gas incubator. The cumulative productivity characteristics that included body weight averages, weight gain, feed intake and feed conversion ratio were measured. The estimation of the cholesterol concentration in meat was carried out in the laboratories of the Ministry of Science and Technology / Department of Environment and Water using gas chromatography (GC) technology according to the method (18). Indicators of fat oxidation in frozen chicken meat samples were measured by estimating thiobarbitic acid (TBA) values according to the method of Rahman et al. (27). The value of peroxide for fat in meat was estimated based on the method of Sallam et al. (29). The experiment statistically analyzed the effect of three factors (3×4) applied with a completely-factorial Randomize design (CRD) to study the effect of oil type, concentration and overlap in different characteristics and the significant differences between the averages were compared with Duncan's polynomial test using the pre-made statistic (S.P.S.S) (33) was used in the statistical analysis of the data according to the following mathematical model:

$Yijk = \mu + Ai+Bj+ABij + eijk$

Where Yijk = Observation values j of the treatment i ; μ = Population mean ; Ai = The effect of 1st factor is the type of oil i (1-3); Bj = The effect of the 2nd factor is the percentage of use j(1-4); ABij = the effect of interaction between the percentage of usage and the type of oil ; eijk= random error. It was assumed to be independently and normally distributed with mean zero and variance $\delta 2e$

Table 1.percent composition of starter diets (1-10d.)

Ingredients	Treatment									
	control	$A_{0.2}$	$A_{0.4}$	$A_{0.6}$	$C_{0.2}$	$C_{0.4}$	$C_{0.6}$	$M_{0.2}$	$M_{0.4}$	$M_{0.6}$
Yellow corn	39.5	39.5	39.5	39.5	39.5	39.5	39.5	39.5	39.5	39.5
Wheat	18	18	18	18	18	18	18	18	18	18
Soybean meal [1]	32	32	32	32	32	32	32	32	32	32
Protein meal [2]	5	5	5	5	5	5	5	5	5	5
Vegetable oil	3	2.8	2.6	2.4	2.8	2.6	2.4	2.8	2.6	2.4
Avocado oil[3]	-	0.2	0.4	0.6	-	-	-	0.1	0.2	0.3
Chia seed oil[4]	-	-	-	-	0.2	0.4	0.6	0.1	0.2	0.3
D.C.P	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
Lime stone	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
NaCl	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Methionine	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Total	100	100	100	100	100	100	100	100	100	100
Calculated Values[5]										
Kcal M.E. / Kg Diet	3041	3041	3040	3040	3040	3039	3038	3040	3040	3039
Crude Protein %	23	23	23	23	23	23	23	23	23	23
Crude Fat %	5.5	5.3	5.1	4.9	5.3	5.1	4.9	5.3	5.1	4.9
Crude Fiber %	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8
Ca %	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
P %	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49
Methionine + Cystine %	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12
Lysine %	1.49	1.49	1.49	1.49	1.49	1.49	1.49	1.49	1.49	1.49

[1] Soybean meal used an Argentine source of crude protein content by 48% and 2440 M.E. Kcal/ Kg.[2] Protein Meal User Product From Netherlands Origin (Brocon) Contain 40% Crude Protein 2107 Kcal / Kg M.E., Protein 5% Crude Fat 2.20% Crude Fiber 5%, Calcium 4.68% ,Phosphorus 3.85% Lysine 4.12%, Methionine 4.12% , Methionine Plus Cystine 0.42%, Tryptophan 0.38%, Threonine 1.70%.[3] Avocado oil's metabolizable energy (8840 Kcal M.E/ Kg).[4] Chi seed oil's metabolizable energy (85471 Kcal M.E/ Kg). [5]According on NRC (24).

Table 2. percent composition of grower diets(11-22d.)

Ingredients	Treatment									
	control	$A_{0.2}$	$A_{0.4}$	$A_{0.6}$	$C_{0.2}$	$C_{0.4}$	$C_{0.6}$	$M_{0.2}$	$M_{0.4}$	$M_{0.6}$
Yellow corn	46	46	46	46	46	46	46	46	46	46
Wheat	15	15	15	15	15	15	15	15	15	15
Soybean meal [1]	28	28	28	28	28	28	28	28	28	28
Protein meal [2]	5	5	5	5	5	5	5	5	5	5
Vegetable oil	4	3.8	3.6	3.4	3.8	3.6	3.4	3.8	3.6	3.4
Avocado oil[3]	-	0.2	0.4	0.6	-	-	-	0.1	0.2	0.3
Chia seed oil[4]	-	-	-	-	0.2	0.4	0.6	0.1	0.2	0.3
D.C.P	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Lime stone	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14
NaCl	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Methionine	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13
Lysine	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13
Total	100	100	100	100	100	100	100	100	100	100
Calculated Values[5]										
Kcal M.E. / Kg Diet	3158	3158	3158	3158	3158	3158	3158	3158	3158	3158
Crude Protein %	21.2	21.2	21.2	21.2	21.2	21.2	21.2	21.2	21.2	21.2
Crude Fat %	6.7	6.5	6.3	6.1	6.5	6.3	6.1	6.5	6.3	6.1
Crude Fiber %	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7
Ca %	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P %	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44
Methionine + Cystine %	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Lysine %	1.29	1.29	1.29	1.29	1.29	1.29	1.29	1.29	1.29	1.29

[1] Soybean meal used an Argentine source of crude protein content by 48% and 2440 M.E. Kcal/ Kg.[2] Protein Meal User Product From Netherlands Origin (Brocon) Contain 40% Crude Protein 2107 Kcal / Kg M.E., Protein 5% Crude Fat 2.20% Crude Fiber 5%, Calcium 4.68% ,Phosphorus 3.85% Lysine 4.12%, Methionine 4.12% , Methionine Plus Cystine 0.42%, Tryptophan 0.38%, Threonine 1.70%.[3] Avocado oil's metabolizable energy (8840 Kcal M.E/ Kg).[4] Chi seed oil's metabolizable energy (85471 Kcal M.E/ Kg). [5]According on NRC (24).

Table 3. percent composition of finisher diets(23—42)

Ingredients	Treatment									
	control	$A_{0.2}$	$A_{0.4}$	$A_{0.6}$	$C_{0.2}$	$C_{0.4}$	$C_{0.6}$	$M_{0.2}$	$M_{0.4}$	$M_{0.6}$
Yellow corn	45	45	45	45	45	45	45	45	45	45
Wheat	20	20	20	20	20	20	20	20	20	20
Soybean meal [1]	23.54	23.54	23.54	23.54	23.54	23.54	23.54	23.54	23.54	23.54
Protein meal [2]	5	5	5	5	5	5	5	5	5	5
Vegetable oil	4.6	4.4	4.2	4	4.4	4.2	4	4.4	4.2	4
Avocado oil[3]	-	0.2	0.4	0.6	-	-	-	0.1	0.2	0.3
Chia seed oil[4]	-	-	-	-	0.2	0.4	0.6	0.1	0.2	0.3
D.C.P	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Lime stone	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
NaCl	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Methionine	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13
Lysine	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13
Total	100	100	100	100	100	100	100	100	100	100
Calculated Values[5]										
Kcal M.E. / Kg Diet	3225	3225	3225	3225	3225	3225	3225	3225	3225	3225
Crude Protein %	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6
Crude Fat %	7.3	7.1	6.9	6.7	7.1	6.9	6.7	7.1	6.9	6.7
Crude Fiber %	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6
Ca %	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85
P %	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42
Methionine + Cystine %	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Lysine %	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17

[1] Soybean meal used an Argentine source of crude protein content by 48% and 2440 M.E. Kcal/ Kg.[2] Protein Meal User Product From Netherlands Origin (Brocon) Contain 40% Crude Protein 2107 Kcal / Kg M.E., Protein 5% Crude Fat 2.20% Crude Fiber 5%, Calcium 4.68% ,Phosphorus 3.85% Lysine 4.12%, Methionine 4.12% , Methionine Plus Cystine 0.42%, Tryptophan 0.38%, Threonine 1.70%.[3] Avocado oil's metabolizable energy (8840 Kcal M.E/ Kg).[4] Chi seed oil's metabolizable energy (85471 Kcal M.E/ Kg). [5]According on NRC (24).

RESUITS AND DISCUSSION

The results showed, according to Table (4), that there was a significant increase ($P < 0.01$) in the average body weight at 42 days of age for the treatment of the oil mixture compared with avocado oil and chia oil, as for the effect of the percentage of used oil, it was found that there was a significant increase ($P < 0.01$) in the treatments in which the oil was used by 0.6% compared with the rest of the proportions (0.0, 0.2, 0.4%) respectively, and a highly significant increase ($P < 0.01$) in the average body weight was observed among the treatments in which oils (avocado and chia) were used. With a percentage of (0.2, 0.4 %) compared with the treatment void of these oils, while the results showed on the level of interaction between the percentage of usage and the type of oil used that the treatment of the mixture of oil (M0.4, M0.6) and by 0.6% showed a high significant ($P<0.01$) in the average body weight (2991.67 and 3045.67) g respectively, compared with the rest of the interactions and the treatment void of the used oils. The results of Table (4) indicated that the oil mixture led to a highly significant increase ($P < 0.01$) in the total weight gain at the age of 42, as it recorded (2819.45) g compared with avocado and chia oil which recorded (2671.20, 2680.93) g, respectively. As for the effect of the oil usage percentage, it was noted that the usage percentage by 0.6% showed a highly significant surpass ($P<0.01$) in the overall weight gain rate compared with the other usage percentages (0, 0.2, 0.4 %). A highly significant surpass ($P < 0.01$) was shown for this characteristic at 0.2 and 0.4% use percentages, compared with treatments void of avocado and chia oil, and these results showed a highly significant agreement ($P < 0.01$) on the level of interaction between the percentages and the type of the used oil, as the treatment of the oil mixture (M0.6) had the highest weight gain compared to the rest of the interactions in the experiment. The results showed a highly significant increase ($P < 0.01$) in the feed consumption ratio, as the consumption of birds whose diet was mixed with oil was increased compared with birds fed on avocado and chia oil. As for the

percentages of the used oil, the results showed a high significant decrease (P<0.01) in feed consumption for birds that used oils by 0.2, 0.4 and 0.6% in their diets, which recorded the lowest consumption of feed (3699.63, 3770.19 and 3790.24) g respectively, compared with birds that did not use oils, which recorded (4,095.53) g. As for the level of interaction between the type of oil and the percentage of use, feed consumption increased significantly (P < 0.01) among birds that used the oil mixture ($M_{0.6}$) in their diets by 0.6% compared with the rest of the interactions between the type of oil and the percentage of its use. The results of the experiment (Table 4) indicate that the use of avocado oil in meat broiler diets has achieved a highly significant (P < 0.01) improvement in the feed conversion ratio compared to chia oil and the mixture. As for the effect of usage percentages, the percentages 0.2, 0.4 and 0.6% respectively, achieved the best food conversion ratio with high significant differences (P < 0.01) compared to the birds that did not use avocado and chia oil in their diets, and the interaction effect between the type of oil and the percentage of use recorded a high significant improvement (P < 0.01) for the birds fed on avocado oil. ($A_{0.6}$) by 0.6%, as well as chia oil ($C_{0.2}$) by 0.2%, and ($M_{0.2}$) oil mixture by 0.2% are the most efficient food conversion ratio compared to the rest of the interactions. The results showed, according to Table (5), that there was a significant decrease (P < 0.01) in the concentration of meat cholesterol in birds that were fed on both avocado oil and oil mixture, compared with chia oil, which recorded the highest concentration of cholesterol in meat, as for the effect of the proportion of oil The results indicated that there was a significant decrease (P < 0.01) in the concentration of meat cholesterol for birds in which oils were used in proportions (0.2, 0.4 and 0.6 %) compared with birds that did not use avocado and chia oil in their diets. In addition, a Significantly high decrease was noted (P < 0.01) in the meat cholesterol concentration of birds that used oils in their diets by 0.6% compared with the levels of 0.2 and 0.4%. And the effect of the interaction between the type of oil and the percentage of use, a highly significant decrease (P < 0.01) was observed in the concentration of cholesterol in meat of the birds of the treatments ($A_{0.2}$, $A_{0.4}$, $C_{0.6}$, $M_{0.2}$, $M_{0.4}$ and $M_{0.6}$ compared with the rest of the interaction in the study. It was observed when using avocado oil and chia oil in broiler diets that there was a significant decrease (P < 0.01) in the number of milligrams of Malondialdehyde (MDA) compared to the oil mixture of meat stored for 60 days. There was a significant decrease (P < 0.01) the effect of the percentage of use had a clear role in reducing the concentration of Malondialdehyde in meat, it is noticed that there is a high significant decrease for all percentages of use 0.2, 0.4 and 0.6% compared with the control treatment void of used oils - in addition, the percentage of use was 0.4% the least significant (P < 0.01) compared to the rest of the percentages of use and then followed 0.2 and 0.6% respectively. As for the interaction effect between the type of oil and the percentage of use on the concentration of Malondialdehyde in meat stored for 60 days, It was noticed from the results that there was a highly significant decrease (P < 0.01) in the concentration of Malondialdehyde for the interactions of treatments ($A_{0.2}$, $A_{0.4}$, $A_{0.6}$, $C_{0.2}$, $C_{0.4}$, $C_{0.6}$, $M_{0.2}$, $M_{0.4}$, $M_{0.6}$) compared with the interactions of the control treatment (A_0, C_0, M_0), in addition, a highly significant decrease (P<0.01) was observed in the concentration of Malondialdehyde for the interaction of avocado oil and oil mixture ($A_{0.6}$, $M_{0.4}$) compared with the interactions ($A_{0.2}$, $A_{0.4}$, $C_{0.2}$, $C_{0.4}$, $C_{0.6}$, $M_{0.2}$, $M_{0.6}$), and a highly significant decrease (P < 0.01) in the Malondialdehyde concentration was also observed between the interaction of avocado oil treatment ($A_{0.4}$) compared with the rest of the interactions of the treatments ($A_{0.2}$, $C_{0.2}$, $C_{0.4}$, $C_{0.6}$, $M_{0.2}$, $M_{0.6}$). The results showed a significant decrease (P < 0.01) in the value of peroxide in birds that fed on avocado oil and the mixture, compared with chia oil, which recorded the highest value of fat peroxide in meat. As for the effect of the percentage of use, a significant decrease (P<0.01) was observed in the value of fat peroxide for meat in all percentages of oils usage (0.2, 0.4 and 0.6 %) respectively, compared with those that did not use avocado and chia oil in their diets. While the

percentage of use was 0.6%, it recorded the best significant decrease ($P < 0.01$) when compared with the rest of the percentage of use (0.2 and 0.4%) in the decrease in the value of fat peroxide in meat stored for 60 days. As for the level of the interaction effect between the type of oil and the percentage of use, as the use of the oil mixture was ($M_{0.6}$) by 0.6%, to a highly significant decrease ($P < 0.01$) in the value of meat fat peroxide compared with the rest of the interactions. The reason may be due to the improvement in the productive performance of the birds that were used in their diets, the oil mixture (50% avocado oil + 50% chia), because it contains alpha-Linolenic acids and linoleic acid, which are among the 3 and 6 omega acids that its source is chia oil, in addition to the cause of its oil contains oleic acid, which is one of the omega-9 acids, which comes from avocado oil, so the oil mixture is an integrated source of necessary and essential fatty acids that stimulate growth by stimulating the liver to produce enzymes and activate the metabolism process inside the bird's body (15 and 31). The reason for the improvement in production performance may be due to the oil mixture, through the creation of a synergistic mixture of high nutritional value containing tocopherols (alpha and gamma) compounds, which are sourced from avocado oil and tocopherols (alpha, gamma, and sigma) in addition to squalene, which are sourced from Chia oil and these compounds are natural antioxidants that improve the health status of the bird and reduce oxidative stress, which leads to an improvement in the productive performance of birds that used the oil mixture in their diets (15and30), as Ayerza et al (8) indicated that the use of chia oil in feeding rats led to a improvement in the palatability of food, an increase in its consumption, and an improvement in food metabolism and absorption, and as a result, production performance may improve in general. In addition, one of the reasons that improved the production performance is the use of an oil mixture containing the necessary minerals (boron, manganese, magnesium, aluminum, calcium, zinc, arsenic and strontium), which are sourced from chia oil and in ideal proportions, as these mineral elements improve productive performance where most of these elements enter as enzymatic accompaniments to the metabolic processes inside the body, and that strontium works to increase calcium metabolism and stimulate the liver to increase calcium deposition in the bones and increase the growth rate of the bird's body. In addition to the role of arsenic, which works to kill harmful microorganisms, which improves the internal environment of the intestine, thus improving its productive performance (12). In addition, the oil mixture contains campestanol and sitostanol, which act as a natural antibiotic in reducing the number of harmful microorganisms and increasing beneficial microorganisms such as lactic acid bacteria, which creates an ideal environment for digestion and optimization of nutritional compounds in the diet, which in turn improves production performance and food conversion ratio (21). The reason for the low concentration of cholesterol in meat may be due to the use of the oil mixture because it contains sterols of the type (beta and stigma) and campesterol, which are sourced from avocado and chia oils, forming an oily mixture with a high content of plant sterols (phytosterols) that reduce the absorption of cholesterol in the intestine. In addition to its effect on increasing the formation of proteins that transport high-density lipoprotein, which in turn increases the anabolic steroid hormones, which leads to a decrease in the concentration of cholesterol and fat in meat in particular, and to improve productive performance and growth increase in general (28). The reason for the low concentration of cholesterol in the treatment of the oil mixture because it contains a high concentration of alpha-Linolenic acid, which comes from chia oil, which is one of the related fatty acids that increase the gene expression of liver cells in increasing fat metabolism and contains oleic acid, which comes from avocado oil Which increases liver metabolism and lowers cholesterol in meat (4 and 13). As for the indicators of fat oxidation in meat, the reason for their decrease may be attributed to the use of the oil mixture on a mixture of tocopherols and carotenoids, which are both sourced from avocado oil and chia, in addition to stimulating the liver to produce antioxidant enzymes such as glutathione peroxidase, preventing the

formation of free radicals, which leads to a decrease in oxidation indicators in meat (16 ,22,26).

Conclusion

We conclude from this study that the use of avocado oil , Chia oil and their mixture (50% avocado + 50% chia) improved the productive performance of broilers and reduced cholesterol concentration and fat oxidation indicators in meat stored for 60 days. Thus, the usage of oil mixture rich in omega (3, 6, 9) fatty acids and effective and antioxidant compounds at a percentage of 0.4-0.6% may enable us to produce meat classified as functional meat with high nutritional and health value for humans

Table 4. Effect of using different oil levels of avocado ,chia and their mixture and to the broiler diets on average body weight, total weight gain, total feed intake and food conversion ratio, the total period of the experiment at 42 days of age

Factor	Means ± Std. Error studied traits			
Oil type	Final body Weight (g)	Final gain (g)	Feed intake (g)	F.C.R g/g
Avocado	2709.67±30.31^{b}	2671.20±0.27^{b}	3641.88±92.59^{c}	1.36±0.05^{b}
Chia	2719.58±4.16^{b}	2680.93±4.03^{b}	3836.96±61.96^{b}	1.43±0.04^{a}
Mix	2858.50±58.66^{a}	2819.45±58.49^{a}	4037.86±41.15^{a}	1.43±0.03^{a}
Sg.	**	**	**	**
Concentration				
0	2548.67±8.24 ^{d}	2510.53±8.11^{d}	4095.53±30.34^{a}	1.63±0.01^{a}
0.2	2770.67±22.40 ^{c}	2732.00±22.28^{c}	3699.63±49.63^{c}	1.35±0.01 ^{b}
0.4	2825.44±42.36 ^{b}	2786.42±42.26^{b}	3770.19±58.90^{bc}	1.35±0.01^{b}
0.6	2905.56±36.06 ^{a}	2866.49±35.93^{a}	3790.24±42.69^{b}	1.31±0.03^{c}
Sg.	**	**	**	**
Interaction				
Control	2548.67±16.49^{c}	2510.53±16.23^{e}	4095.53±60.68^{ab}	1.63±0.02^{a}
$A_{0.2}$	2729.67±14.24^{b}	2691.27±14.33^{d}	3663.47±15.25^{c}	1.35±0.01^{bc}
$A_{0.4}$	2745.33±9.40^{b}	2706.33±9.84^{d}	3588.67±10.57^{c}	1.32±0.003^{c}
$A_{0.6}$	2815.00±17.50^{ab}	2776.67±17.67^{c}	3249.87±58.34^{d}	1.17±0.01 ^{d}
$C_{0.2}$	2734.33±29.00^{b}	269.87±28.92^{d}	3587.60±68.00^{c}	1.33±0.03^{c}
$C_{0.4}$	27339.33±18.55^{b}	2700.67±18.41^{d}	3743.57±36.65^{c}	1.38±0.01^{b}
$C_{0.6}$	2856.00±2.64^{ab}	2816.67±2.90^{c}	3921.13±18.00^{b}	1.39±0.005^{b}
$M_{0.2}$	2848.00±22.12^{ab}	2808.87±21.93^{c}	3877.83±19.15^{bc}	1.38±0.01^{c}
$M_{0.4}$	2991.67±19.22^{ab}	2952.27±19.17^{b}	3978.33±41.14^{bc}	1.34±0.01^{bc}
$M_{0.6}$	3045.67±12.12^{a}	3006.13±12.12^{a}	4199.73±46.75^{a}	1.39±0.008^{b}
Sg.	**	**	**	**

Means having with the different letters in same column differed significantly
** (P<0.01), NS: Non significant.
A: avocado oil C: chia oil M: mixture (50% avocado oil + 50 chia oil)

Table 5. Effect of using different oil levels of avocado , chia oil and their mixture to the broiler diets on cholesterol, Malondialdehyde (MDA) concentration and peroxide value after storing meat for 60 days

Factor	Means ± Std. Error studied traits		
Oil type	Meat Cholesterol mg/100 g	MDA mg /kg	PV mEq/Kg
Avocado	0.0727±0.005^{b}	0.0618±0.003^{b}	3.878±0.073^{b}
Chia	0.0773±0.004^{a}	0.0655±0.003^{b}	3.947±0.065^{a}
Mix	0.0647±0.006^{c}	0.0870±0.028^{a}	3.639±0.014^{c}
Sg.	**	**	**
Concentration			
0	0.0993±0.0001^{a}	0.0866±0.039^{a}	4.260±0.005^{a}
0.2	0.0743±0.002^{b}	0.0657±0.001^{c}	3.905±0.024^{b}
0.4	0.0618±0.002^{c}	0.0545±0.002^{d}	3.702±0.05^{c}
0.6	0.0508±0.002^{d}	0.0790±0.0002^{b}	3.418±0.11^{d}
Sg.	**	**	**
Interaction			
Control	0.0993±0.0003^{a}	0.0790±0.0005^{a}	4.260±0.01^{a}
$A_{0.2}$	0.0760±0.001^{b}	0.0660±0.005^{b}	3.916±0.01^{b}
$A_{0.4}$	0.0616±0.0008^{c}	0.0553±0.0008^{c}	3.710±0.005^{b}
$A_{0.6}$	0.0540±0.0005^{c}	0.0470±0.001^{d}	3.626±0.01^{b}
$C_{0.2}$	0.0816±0.0008^{b}	0.0696±0.003^{b}	3.983±0.01^{b}
$C_{0.4}$	0.0716±0.0008^{b}	0.0616±0.008^{b}	3.886±0.006^{b}
$C_{0.6}$	0.0566±0.0003^{c}	0.0660±0.005^{b}	3.66±0.001^{b}
$M_{0.2}$	0.0653±0.0008^{c}	0.0616±0.0008^{b}	3.816±0.008^{b}
$M_{0.4}$	0.0523±0.0008^{c}	0.0466±0.0008^{d}	3.510±0.005^{b}
$M_{0.6}$	0.0420±0.001^{d}	0.0610±0.011^{b}	2.970±0.011^{c}
Sg.	**	**	**

Means having with the different letters in same column differed significantly
**** (P<0.01), NS: Non significant.**
A: avocado oil C: chia oil M: mixture (50% avocado oil + 50 chia oil)

REFERENCES

1.Abboud R. de S., V. A. Pereira, C.A. S. da Costa, G. T. Boaventura and M. A. Chagas.2015. The action of avocado oil on the lipidogram of wistar rats submitted to prolonged androgenic stimulum. Nutr Hosp. 2015;32(2):696-701.

2.Abd El-Rahman N.A., A.SH Abd El Azime and N.H Sherif. 2013. Protective effect of avocado oil against biochemical and histological changes in whole body gamma irradiation in albino rats. Isotope and Radiation Research. ISSN 0021-1907: Worldcat:v. 45(3); p. 483-499.

3.Alagawany, M., Elnesr, S. S., Farag, M. R., Abd El-Hack, M. E., Khafaga, A. F., Taha, A. E., Tiwari, R., Yatoo, M. I., Bhatt, P., Khurana, S. K. and Dhama, K. (2019). Omega-3 and omega-6 fatty acids in poultry nutrition: effect on production performance and health. Animals . 9(8):573. https://doi.org/10.3390/ani9080573

4.Alenbrant R, T. B. da Silva, A. S. Vasconcelos ,W. Mourao and J. Corte . 2014. O cultivo da Chia no Brasil: future e perspectivas. J. Agric. Sci. Umuarama 3:161-79.

5. Al-Ghurairi R. A. S., W. Kh. A. Al – Hayani, and Y. M. A. Maaeni. 2023. The influence of genistein implantation on offspring sex ratios and their relation to estrogen levels in the blood of Iraqi chickens. Iraqi Journal of Agricultural Sciences, 54(4), 1016-1025. https://doi.org/10.36103/ijas.v54i4.1790.

6.Al-Khalani F.M. H. 2009. Effect of the supplementation different levels of Anise (*Pimipnella anisum*) seeds or Roselle flowers (*Hibiscus sabdariffa*) to the diet on performance efficiency of layer, Japanese quail and broiler. University of Baghdad-College of Agriculture Dissertation(Arabic).

7. Ayerza, R. 2009.The Seed's protein and oil content, fatty acid aomposition, and growing cycle length of a single genotype of chia (*Salvia hispanica L.*) as affected by environmental factors. J. Oleo Sci. 2009, 58, 347–354.
8. Ayerza R and W. Coates, 2002. Dietary levels of chia: influence on hen weight, egg production and sensory quality, for two strains of hens. Br. Poult. Sci. 43:283-90.
9. Ayerza R. and W.Coates.2005. Ground chia seed and chia oil effects on plasma lipids and fatty acids in the rat.Nutr. Res. 2005, 25, 995–1003.
10.Bandr L.K. 2017. Effect of using different levels of evening primrose oil (EPO) and grape seed oil (GSO) in broiler diets on production performance, and oxidation status and composition of fatty acids in meat. I. J.S.R..6(4):2506-2512.
11.Berger, M. E., Smesny, S., Kim, S. W., Davey, C. G., Rice, S., Sarnyai, Z., Schlögelhofer, M., Schäfer, M. R., Berk, M., McGorry, P. D., and Amminger, G. P. (2017). Omega-6 to omega-3 polyunsaturated fatty acid ratio and subsequent mood disorders in young people with at-risk mental states: a 7-year longitudinal study. Translational psychiatry,7(8), e1220.https://doi.org/10.1038/tp.2017.190
12.Calpe-Berdiel, L., Escolà-Gil, J. C. and Blanco-Vaca, F. (2009). New insights into the molecular actions of plant sterols and stanols in cholesterol metabolism. Atherosclerosis, 203(1),18https://doi.org/10.1016/j.atherosclerosis.2008.06.026
13.Cherian, G. Nutrition and metabolism in poultry: role of lipids in early diet. J Animal Sci Biotechnol 6, 28 (2015). https://doi.org/10.1186/s40104-015-0029-9.
14.Duester, K.C., 2001. Avocado fruit is a rich source of β-sitosterol. J. Am. Dietetic Assoc.,101: 404-405.
15.Flores, M., C., Saravia, C. E., Vergara, F., Avila, Valdés, H., and J. Ortiz-Viedma, 2019. Avocado Oil: Characteristics, Properties, and Applications. Molecules,24(11), 2172 https://doi.org/10.3390/molecules24112172
16.Hussein, S. M. 2021. Effect of peppermint (*Mentha piperita*) powder on performance, gut morphology and immune organs response of coccidiosis infected broilers. Iraqi Journal of Agricultural Sciences, 52(2), 276-290. https://doi.org/10.36103/ijas.v52i2.1289.
17.Ibrahim M. A. .2021. Effect of using different levels of chia seeds (*Saliva hispanica*) in broiler diets on productive, physological and microbial performance and qualatitive characteristics of carcass. University of Baghdad- College of Agricultural Enginering Sciences. Thesis (Arabic).
18.Madzlan K.2008.determination of cholesterol in several types of eggs by gas chromatography.J.Trop.Agric.and Fd.Sc.36(2):00-000.
19.Meineri G, P. Cornale, S. Tassone and PG. Peiretti, 2010. Effects of Chia (*Salvia hispanica L.*) seed supplementation on rabbit meat quality, oxidative stability and sensory traits. Ital. J. Anim. Sci. 9:45-9.
20.Mocking, R. J., Harmsen, I., Assies, J., Koeter, M. W., Ruhé, H. G., and Schene, A. H. (2016). Meta-analysis and meta-regression of omega-3 polyunsaturated fatty acid supplementation for major depressive disorder. Translational psychiatry, 6(3), e756.https://doi.org/10.1038/tp.2016.29
21.Monu, E., Blank, G., Holley, R. and Zawistowski, J. (2008). Phytosterol effects on milk and yogurt microflora. Journal of food science, 73(3), M121–M126. https://doi.org/10.1111/j.1750-3841.2008.00668.x
22.Mustafa, A. A., and I. T. Tayeb. 2022. The influence of dietary salvia and lavender powders on productive performance, some physiological parameters, and immunity of broiler under stocking density stress. Iraqi Journal of Agricultural Sciences. 53(6):1280-1288. https://doi.org/10.36103/ijas.v53i6.1642
23.Nicolella, H. D., Neto, F. R., Corrêa, M. B., Lopes, D. H., Rondon, E. N., Dos Santos, L. F. R., de Oliveira, P. F., Damasceno, J. L., Acésio, N. O., Turatti, I. C. C., Tozatti, M. G., Cunha, W. R., Furtado, R. A., and D. C Tavares,. 2017. Toxicogenetic study of Persea americana fruit pulp oil and its effect on genomic instability. Food and chemical toxicology : an international journal published for the British Industrial Biological Research Association, 101, 114–120. https://doi.org/10.1016/j.fct.2017.01.00

24.NRC,1994.Nutrient Requirements of Poultry.National Research Council .9 rev. ad. Natl. Acad. Press Washington.DC.

25.Ortiz-A.O., Marco A. G. , L. A.Sánchez-Briones ,E. Calderón-Cortés , R.Montoya-Pérez , A. R.Rodriguez,J. García , A. Molina , R. M. Zepeda and C. Cortés-Rojo.2015 .Protective effects of dietary avocado oil on impaired electron transport chain function and exacerbated oxidative stress in liver mitochondria from diabetic rats. J Bioenerg Biomembr. DOI 10.1007/s10863-015-9614-z.

26.Ortiz-Avila, O., E. Martínez, Mauricio, Olmos-Orizaba, Berenice Eridani, Saavedra-Molina, Alfredo, R. O., Alain R. and Cortés-Rojo, C., avocado oil improves mitochondrial function and decreases oxidative stress in brain of diabetic rats, Journal of Diabetes Research, 2015, 485759, 9. https://doi.org/10.1155/2015/485759.

27.Rahman M. H., M. M.Hossain , S. M. E.Rahman, M. R. Amin and D. H. Oh .2015. Evaluation of physicochemical deterioration and lipid oxidation of beef muscle affected by freeze-thaw cycles. In Korean Journal for Food Science of Animal Resources (Vol. 35, Issue 6, pp. 772–782). https://doi.org/10.5851/kosfa.2015.35.6.772

28.Reginster, J. Y., Seeman, E., De Vernejoul, M. C., Adami, S., Compston, J., Phenekos, C., Devogelaer, J. P., Curiel, M. D., Sawicki, A., Goemaere, S., Sorensen, O. H., Felsenberg, D. and P. J. Meunier, 2005. Strontium ranelate reduces the risk of nonvertebral fractures in postmenopausal women with osteoporosis: treatment of peripheral osteoporosis (TROPOS) study. The Journal of clinical endocrinology and metabolism, 90(5), 2816–2822. https://doi.org/10.1210/jc.2004-1774

29.Sallam KI, M. Ishioroshi and K. Samejima.2004. Antioxidant and antimicrobial effects of garlic in chicken sausage. Lebensm Wiss Technol. Dec;37(8):849-855. https://doi.org/10.1016/j.lwt.2004.04.001

30.Shen, Y., Zhang, H., Cheng, L., Wang, L., Qian, H., and X. Qi, 2016. In vitro and in vivo antioxidant activity of polyphenols extracted from black highland barley. Food chemistry, 194, 1003–1012. https://doi.org/10.1016/j.foodchem.2015.08.083

31.Shen, Y., Zheng, L., Jin, J., Li, X., Fu, J., Wang, M., Guan, Y., and X. Song, 2018. Phytochemical and Biological Characteristics of Mexican Chia Seed Oil. Molecules, 23(12), 3219. https://doi.org/10.3390/molecules23123219

32.Simopoulos A. P, 2016. An increase in the omega-6/omega-3 fatty acid ratio increases the risk for obesity. Nutrients 8:128.

33.SPSS® 22.0. Computer Software, 2017. SPSS Inc. Headquarters, 233 p., Wacker Drive, Chicago, Illinois. 60606, USA.

34.Toro M. D., R. V. R.´guez, R. L.Ascencio, and C. Vasquez.2016. Effect of an avocado oil-enhanced diet (Persea americana) on sucrose-induced insulin resistance in Wistar rats. journal of food and drug analysis 24 350-357.