PalArch's Journal of Archaeology of Egypt / Egyptology

The effect of adding different levels of flaxseed oil on the qualitative characteristics and fatty acids of Chinese goose eggs raised in Iraq

Miad Mohamed Sherif [1], Prof.Dr. Majid Hassan Al-Asadi [2]

College of Agriculture, University of Basra, Department of Animal Production

Corresponding author Email [1]: myiedmh3@gmail.com

Miad Mohamed Sherif 1, Prof.Dr. Majid Hassan Al-Asadi 2. The effect of adding different levels of flaxseed oil on the qualitative characteristics and fatty acids of Chinese goose eggs raised in Iraq. Palarch's Journal of Archaeology of Egypt/Egyptology 18(8), 3125-3135, 2021. ISSN 1567-214x

Keywords: Goose eggs, flaxseed oil, fatty acids

ABSTRACT

This study was conducted in the field of geese belonging to the Agricultural Research and Experiment Station / College of Agriculture / University of Basra for the period from December 29, 2020 to February 22, 2021. For a period of 35 days to study the effect of adding different levels of flaxseed oil on the qualitative characteristics and fatty acids of Chinese goose eggs raised in Iraq. 36 geese were used in the experiment and the birds were randomly distributed to four treatments T1 control and T2 adding 1% of flaxseed oil T3 adding 2% of flaxseed oil and T4 adding 3% of flaxseed oil from the first day of starting the experiment until 35 Day, each treatment included 9 weights. Each treatment included three replicates and each replicate contains three weights fed on balanced diets of energy and protein. The results of the study showed that the treatments to which flaxseed oil was added, especially the fourth treatment, were significantly superior to the control treatment in egg weight and weight. Yolk, white, shell, yolk guide, lower cholesterol levels, increased palmitic and linolenic fatty acids, in addition, adding 3% of flaxseed oil to the diet changed the proportions of fatty acids in egg yolks. Geese and that the consumption of this type of eggs may have a beneficial health effect.

Introduction

Functional foods are a group of foods that contain some nutritional components with a health effect in addition to their high nutritional value. Recently, interest in functional foods has increased due to changes in lifestyle and the increase in chronic diseases, as these foods promote health by providing physiological benefit . Examples include those that contain specific minerals or vitamins, or to which biologically active fatty acids or substances such as phytochemicals, antioxidants, Alba poetics . ((Kaewsutas et al 2017))

New trends have begun about the possibility of producing designer eggs, which are rich in omega-3 and polyunsaturated fatty acids (n-3 PUFA), which are found in vegetable oils, including flaxseed oil, and this

plays an important role in human nutrition because it helps reduce the incidence of coronary artery disease and high Blood pressure and diabetes as well as some inflammatory diseases such as arthritis and dermatitis. These diseases are a growing problem in MENA countries due to the predominance of animal fats (Al-Daraji et al., 2010).

Eggs are a source of protein and fats such as phospholipids and polyunsaturated fatty acids (Sunginoet al., 1997). It was noted that when laying hens were fed food rich in omega-3 sources, eggs rich in these sources were produced because of the correlation between the levels of these nutrients in the feed with their levels in the egg yolk, and that natural eggs did not contain Eicosapentanoic, EPA, Docosahexaenoic, DHA, in addition to that eggs Natural is considered poor in the proportion of Alpha-Linolenic Acid (ALA) fatty acid, as it reaches 2%, and the most important sources rich in unsaturated fatty acids are flax, fish and walnut oils, and these acids are very important for human health to maintain the functions of cell membranes (1994Ibeas and Lorenzo,) . It has an important role in reducing some cases of cancer (Thomson and B. He., 2006)), and it has a role in regulating and reducing some kidney diseases (Marchiol, 2002). And the production of hormone-like substances that mediate physiological processes such as activity Muscles, nerves and metabolic processes (Jia Feng et al., 2020). Several studies have shown that unsaturated fatty acids preserve the risk of heart disease and atherosclerosis (Harris and Isley., 2001)), in addition to limiting the growth of prostate and breast cancer, and are beneficial. For the health of the fetal brain, visual development and enhance immunity (Lewis, 2000. For this reason, the English Ministry of Health recommended adding these acids to infant formula in order to strengthen the body's immunity, prevent cardiovascular diseases, brain development, improve eyesight and regulate blood pressure (Aji et al., 2007). Numerous studies have been done to modify the quality of fatty acids in egg yolks by modifying dietary fats in laying hens. Agboola (2016) showed that diets supplemented with vegetable oils, including flaxseed oil, with moderate levels of alpha-linolenic acid and high levels of linoleic acid increased omega-3 fatty acids. Arachidonic and docosahexaenoic in egg yolk, but did not affect the level of Eicosapentanoic acid. Therefore, the current study aimed to find out the effect of adding different levels of flaxseed oil on the qualitative characteristics and fatty acids in the yolk of Chinese goose eggs raised in Iraq.

Materials and working methods

This study was conducted in the field of geese belonging to the Agricultural Research and Experiment Station / College of Agriculture / University of Basra for the period from December 29, 2020 to February 22, 2021. For 35 days. 36 geese were used in the experiment. The birds were randomly distributed to four treatments T1 control and T2 adding 1% of flaxseed oil T3 adding 2% of flaxseed oil and T4 adding 3% of flaxseed oil since the first day To start the experiment, and up to 35 days, each treatment included 9 goats. Each treatment included three replicates, and each replicate contained three goats fed on balanced diets of energy and protein.

Table (1) The chemical composition of the ration.

Feed material	Percentage of adding linseed oil			
	T1 0%	T2 1%	T3 2%	T4 3%
yellow corn	52	51	46	47
fodder wheat	26	22	25	19
wheat bran	0	0	5	9
soybean meal (48%)	11	10	11	11
flaxseed oil *	0	1	2	3
Protein Center **	5	5	5	5
Limestone	5	5	5	5
Mixture of vitamins and minerals	0.5	0.5	0.5	0.5
salt	0.5	0.5	0.5	0.5
TOTAL	100	100	100	100
represented energy	2926	2897	2936	2922
raw protein (%)	15.3	15	15.5	15.4
Calcium (%)	2.22	2.22	2.23	2.23
Phosphate(%)	0.44	0.48	0.48	0.45
methionine(%)	0.59	0.59	0.59	0.59
methionine + cysteine (%)	0.63	0.61	0.62	0.61
Lysine (%)	0.82	0.80	0.83	0.84

*Special 5-Brocom protein concentrate: a product from the Dutch company WAFI, each kg of it contains: representative energy

Its calories are 2100 kilos, crude protein 40, crude fat 5%, crude fiber 2%, calcium 6.5%, phosphorous 4%, allicin 85.3%, methionine 7.3%, methionine + cysteine 4%, and sodium 20.2%.

- The values of the chemical composition of the feed materials included in the diet were calculated, according to what was mentioned in 1994 (NRC)

Eggs were collected daily and the following tests were conducted

The qualitative characteristics of eggs were measured according to the method indicated by Al-Fayyad and Naji, 2010. Calculating the weight of the egg, yolk, white and shell using a sensitive scale

Characteristics of yolk

Yolk weight (gm): according to the weight of the yolk using a sensitive scale, the relative weight of the yolk (%) according to the following equation:

$$\text{Relative weight of yolk \%} = \frac{\text{Yolk weight}}{\text{Egg weight}} \times 100$$

Yolk height (m): The height of the yolk was measured using a three-base micrometer

Yolk diameter (m): I used a digital vernia measuring machine to measure the diameter of the yolk

Yolk guide: according to the equation below

$$\text{Yolk guide} = \frac{\text{Yolk height (m)}}{\text{Yolk diameter (m)}}$$

Attributes of whiteness

The weight of the egg white (gm): according to the weight of the egg white, by applying the following equation:

White weight (gm) = egg weight (gm) – (yolk weight + shell weight)

The relative weight of the egg white, %, according to the following equation

$$\text{Relative weight of albedo \%} = \frac{\text{White weight}}{\text{Egg weight}} \times 100$$

The unit is

Albumen condition (Haugh Units)

This was measured according to the next formula:

Hugh Units= 100x log (H- 1.7 W0.37 +7.57). (1.7, 7.57 And 0.37 are constants).

Where:

H= the height of thick albumen.

W= the egg weight.

As for the measurement of the weight of the crust (g), it was done using a sensitive scale that reads to the nearest two decimal places

Determination of cholesterol in egg yolk

The cholesterol concentration in egg yolk samples was estimated according to the method mentioned by Al-Obaidi (1999). As for the standard cholesterol, it was banned according to the modified Al-Salihi (2012) method. The yolk fat cholesterol was extracted according to the following equation.

$$\text{Cholesterol concentration (mg/ml)} = \frac{\text{Read absorption form.}}{\text{Read cholesterol absorption standard}} \times 200$$

Fatty acid estimation

Methyl esterification of fatty acids

The method mentioned by AOAC (1990) was followed in preparing the sample. This method depends on the reaction of glycerides with alcoholic potassium hydroxide, which was prepared (by dissolving 11.2 g of hydroxide (KOH) with a small amount of pure methyl alcohol at a concentration of

99.8%) and then completing the volume to 100 mm alcohol. Then, the esterification process was carried out with a weight of 1 gm of egg yolk fat sample in a 15 ml tube, then 5 ml of methylated potassium hydroxide solution was added, then the tube was shaken well using Vortix for 5 minutes, then 5 ml of pure hexane was added. At a concentration of 99.9%, then the contents of the tube were shaken again well until the materials were separated into two layers. The upper layer contains esters of methyl fatty acids in hexane, while those in the lower layer are the saponified materials.

Diagnosis of some fatty acids using chromatography-mass spectrometry.

The samples were diagnosed by gas chromatography connected to a mass spectrometer in the laboratory of the Ministry of Science and Technology / Department of Environment and Water according to the following separation conditions:

Coulomb type _DNS, Carrier gas _N2, Speed _ml/min 1, Heat program _Oven 100 C Hold 1 min / 280 C (6C /min)), Pressure _0.5 Bar. The temperature of the environmental carrier and the injector was 280°C. Then the GC oven program was set to an initial temperature of 100°C for one minute, after which the oven temperature was raised to 280°C at a rate of 6°C per minute and the spectra of curves were matched in the spectral library.

The complete random design was used to analyze the effect of different treatments on the studied traits and the significant differences between the means were compared with Duncan's test, and SAS (2001) program was used to analyze the data.

Results and discussion

Qualitative characteristics of eggs

Table (2) shows the effect of adding different levels of flaxseed oil to the diet on the qualitative characteristics of Chinese goose eggs raised in Iraq. It is clear from the results that there were significant differences (P<O.O5) between treatments A in the qualitative characteristics of eggs. Treatment T4 showed a significant superiority in all qualitative characteristics compared with other treatments, as the weight of the egg reached (142.66, 147.00, 154.00, 159.34) g, respectively. As for the weight of the white and yolk, it was 73.00 (66.80, 68.17, 71.72) and (58.63, 60.53, 62.66, 66.01) g for the treatments, respectively, for the treatments T4, T3, T2 and T1. As for the weight of the shell, no significant differences appeared between T4 and T3. Which showed a significant difference with the control deal out T1, which reached (19,21 19.77) respectively compared to the control deal out (16.60) gThe reason for the superiority of the addition treatments in the qualitative characteristics of eggs compared to the control treatment may be due to the preparation of the ration with sources of oils that contain a percentage of unsaturated fatty acids, and this leads to providing the geese's requirements of essential fatty acids and improving the absorption of fat-soluble vitamins, and this leads to an improvement in egg weight. And the rest of the qualitative characteristics when calculating the general average of the mass of the egg. These fatty acids are also involved in the synthesis of steroid

hormones in the ovary (estrogen and progesterone), and these hormones play a role in the growth and development of the oviduct and ovary (AL_Daraji, 2010). Al-Hassani (2000) also showed that the increase in the concentration of these two hormones contributed to improving the egg weight rate because of their growth and development in the oviduct. These results were in agreement with Ayerza and Coates (2001), who noticed an improvement in yolk weight and egg weight and specifications when adding flax oil to laying hens' diets.As for the reason for the high rates of egg weight, it may be due to the role of the hormone estrogen, which works to stimulate growth oviduct and increasing the secretion of the tubular glands that secrete it also helps to manufacture special proteins in the oviduct, such as albumin, ovalbumin, lysozyme and the precursor of yolk proteins (Sturkie, 2000).Al-Fayyad and others (2012) indicated that there is a positive correlation between the weight of the egg and its components. As for Al-Husseini (2000) it was shown that the reason for the increase in the weight of the yolk may be due to the increase in estrogen, which stimulates the growth of the oviduct and helps to form proteins related to the oviduct, as well as It promotes the formation of yolk from the liver.

As for the reason for the superiority in the weight of the crust, it may be due to the role of estrogen, if it works to supply the uterus with calcium necessary for the process of manufacturing the crust, by increasing the absorption of calcium from the gastrointestinal tract (Al-Fayyad and Naji 1989).

Table (2) The effect of adding different levels of flaxseed oil on the qualitative characteristics of Chinese goose eggs raised in Iraq (Average ± standard error).

indicators				
characteristics	T1	T2	T3	T4
egg weight	0.87±142,66 d	2.01±147,00c	0.66±154,00b	±1.53 159,34 a
Whiteness weight	66.80±0.29 c	68.17±0.81b	71.72±0.09 a	73.00±0.29a
yolk weight	58.63±0.52 d	60.53±0.53 c	62.66±0.39 b	66.01±0.92a
shell weight	0.21±16.60b	0.88±17.66b	0.15±19.21a	0.28±19.77a

Transactions

The first treatment: the control treatment without addition, T2: the second treatment: the addition of 1%. From flaxseed oil to the ration, T3: the third treatment, adding 2% flaxseed oil to the ration, T4.S: adding 3% of flax seed oil to the ration S. N indicates that there are no significant differences between the means of the coefficients. * The different letters within the same column indicate that there are significant differences between the groups at the probability level of .0.05

Qualitative traits of whiteness

Table (3) shows the effect of adding different levels of flaxseed oil to the diet on the qualitative characteristics of whiteness, whiteness height and he unit of eggs of Chinese goose raised in Iraq. The results did not show significant differences in the percentage of whiteness for all treatments. While the results showed a significant (P<0.05) superiority of treatment T4 and T3 in the rise of whiteness, as they reached. (12.87, 11.77) compared with the control treatment, which amounted to (8,88), and treatment T4 was significantly superior in the unit of hue compared with treatments T3, T2 and T1, which reached (76.22, 85.75, 92.35, 97.05) for the treatments, respectively. Eggs with thick white, gelatinous consistency and high height are considered to be of good quality. The reason for the high whiteness and hue unit may be due to the effect of fatty acids that play a role in improving growth and increasing the rate of egg production while improving egg weight (). To the role of the estrogen hormone, which works to stimulate the growth of the oviduct and increase the secretion of the tubular glands, as well as helps to manufacture special proteins in the oviduct, including albumin, ovalbumin and lysozyme. This increases the gelatinous texture of the eggs and thus increases the percentage of whiteness (Sturkie, 2000 .).

Table (3) Effect of adding different levels of flaxseed oil to the diet on the qualitative characteristics of whiteness, whiteness height and Hu unit of eggs of Chinese goose raised in Iraq. (Average ± standard error)

indicators				
characteristics	T1	T2	T3	T4
characteristics of whiteness	46.82±0.24	46.37±0.81	46.57±0.09	45.81±0.29
whiteness height ml	8.88±0.32 c	10.40±0.05b	11.77±0.00a	a12.87±0.01
Hu unit	76.22±2.38d	85.75±0.01c	92.35±0.09b	a97.05±0.19

Transactions

T1: the first treatment: the control treatment without addition, T2: the second treatment: the addition of 1%. From flaxseed oil to the ration, T3: the third treatment, adding 2% flaxseed oil to the ration, T4.S: adding 3% of flax seed oil to the ration S. N indicates that there are no significant differences between the Average of the coefficients. * The different letters within the same column indicate that there are significant differences between the groups at the probability level of .0.05

Qualitative traits of yolk

Table (4) shows the effect of adding different levels of flaxseed oil to the diet on yolk quality characteristics, yolk index and cholesterol percentage of Chinese goose eggs raised in Iraq. The results show that there is a significant effect (P<0.05) of adding oil to the diet in improving the traits, as the treatments T4, T3 and T2 showed a significant superiority in the yolk index compared with the control treatment T1 which amounted to (0.40, 0.43, 0.43, 0.44) for the treatments, respectively. Also, cholesterol decreased when

flaxseed oil was added to the diet, and the lowest percentage was in the T4 treatment compared with the T1 control treatment, reaching (7.73, 4.09) mmol / liter, respectively. As for the percentage of yolk, there were no significant differences between all the treatments. The quality of the yolk is determined by its high and circular shape. The higher the diameter of the yolk, the higher the quality of the yolk, which is affected by the nature of the fatty acids in food.

The addition of vegetable oils, which are characterized by high levels of unsaturated fatty acids, will lead to an increase in the percentages of these unsaturated acids in the yolk, and thus will be reflected in lowering the proportion of cholesterol and increasing the yolk index. Kema, et al, 2010. The cholesterol level in the egg yolk has also decreased significantly by feeding flaxseed oil. As a result of reducing hepatic synthesis, as well as increasing the activity of beta-oxidation, as well as the reduction of cholesterol may be due to the effect of flaxseed oil on its inhibition of hepatic VLDL production. Also, flaxseed oils work on a slight decrease in the solids of the yolk, and this leads to a reduction in cholesterol levels. Vasko et al. (2005)

Table (4) Effect of adding different levels of flaxseed oil to the diet on the traits yolk ratio, yolk index and cholesterol ratio of Chinese goose eggs raised in Iraq (Average ± standard error)

	T1	T2	T3	T4
traits yolk ratio	41.09±0.52	41.17±0.53	40.68±0.39	41.42±0.92
yolk index	0,06±0,40a	0,01±0,43a	0,01±0,43a	0,03±0,44a
cholesterol ratio mg/g	7.73±0.03c	6.75±0.32b	6.02±0.32b	a 4.09±0.30

T1: the first treatment: the control treatment without addition, T2: the second treatment: the addition of 1%. From flaxseed oil to the ration, T3: the third treatment, adding 2% flaxseed oil to the ration, T4.S: adding 3% of flax seed oil to the ration S. N indicates that there are no significant differences between the means of the coefficients. * The different letters within the same column indicate that there are significant differences between the groups at the probability level of .05

Table 5 shows the effect of adding different levels of flaxseed oil to the diet on the levels of fatty acids in the yolk of Chinese goose eggs raised in Iraq. The results showed that there were no significant differences in the proportion of palmitoleic acid, oleic, citric and linoleic acid among all treatments. While the treatment, T2, T3, and T4 showed a significant superiority in palmitic acid and linolenic acid over the control treatment T1, which reached (34.87, 31,17, 31,17) and (3.44,2.93,3.6) compared to the control treatment, which amounted to (0.17, 30.34). For palmitic acid and linolenic acid, respectively, this may be due to the action of flaxseed oil in increasing the level of omega-3 in the egg yolk. Reducing the risk of developing cardiovascular diseases (Her et al., 2017. It is worth noting that both omega-3 and omega-6 fatty acids share the same enzyme for metabolic

processes, which is called fatty acid desaturase)
Raising n-3 levels has a significant effect on reducing the risk of cardiovascular disease (Her et al., 2017. It is worth noting that both omega-3 and omega-6 fatty acids share the same enzyme needed for metabolic processes, which It is called a fatty acid desaturase, and in turn, this enzyme begins with the metabolism of omega-3 fatty acid, then omega-6 (Wen et al., 2019).

Table No. (5) The effect of flaxseed oil on the levels of fatty acids in the yolk fat of Chinese goose eggs raised in Iraq (Average ± standard error)

Acid name	T1 control	T2	T3	T4	level of significance
Palmitic	^{b}30.34±0.13	^{a}31.17±0.20	^{a}31.17±0.20	^{a}34.87±0.01	*
Palmitoleic	0.49±0.09	0.50±0.01	0.50±0.04	0.52±0.06	N.S
Oleic	42.15±0.02	42.20±0.03	42.32±0.02	43.07±0.03	N.S
Stearic	8.78±0.03	8.21±0.01	9.04±0.07	9.16±0.08	N.S
Linoleic	8.21±0.05	8.25±0.07	8.14±0.12	9.09±0.10	N.S
Linolenic	^{b} 0.17±0.01	^{a}3.44±0.03	^{a}2.93±0.02	^{a}3.64.±0.21	*

Conclusions

The current study showed that by adding different levels of flaxseed oil to the diet of Chinese geese bred in Iraq, the percentage of 3% improved the qualitative characteristics of eggs by increasing egg weight, yolk and white weight, and decreasing cholesterol concentration. Moreover, adding 3% of flaxseed oil to the diet changes the levels of fatty acids in the egg yolk, and through this, healthy eggs can be produced by adding flaxseed oil in the diets of geese, and the consumption of this type of eggs may have a beneficial health effect.

References

1. Fayadh, Hamdi Abdel Aziz and Naji, Saad Abdel Hussein. 1989. Poultry Products Technology. The first edition, Directorate of Higher Education Printing Press, Ministry of Higher Education and Scientific Research, Republic of Iraq
2. Al-Hassani, Zia Hassan. (2000). Physiology of domestic birds, Directorate of Dar Al-Kutub for printing and publishing. Baghdad - - Ministry of Higher Education and Scientific Research – University of Baghdad – College of Agriculture
3. Al Fayadh, Hamdi Abdel Aziz and Naji, Saad Abdel Hussein and Nadia, Nayef Abdel Hajo (2011). Technology of Poultry Products (Part One). Second Edition. Directorate of Higher Education. Baghdad.
4. A.O.A.C. (1990). Association of Official Analytical Chemists , Official Methods of Analysis . 11th ed Washington , D.C., USA.
5. Agboola, B. R. O. Omidiwura, A. Oyeyemi, E. A. Iyayi, A. S. Adelani (2016) Effects of Four Dietary Oils on Cholesterol and Fatty Acid Composition of Egg Yolk in Lay World Academy of Science, Engineering and Technology International Journal of Nutrition and Food Engineering
6. Aji, S. A. H., G. A. Al-Kassie, R. A. Al Khalidi, Y.J. Jameel. 2007.

Commercial

7. Al-Daraji H. J., A. S. Al-Hassani, H. A. AlMashadni, W. K. Al-Hayani and H. A. Mirza. 2010. Effect of dietary supplementation with sources of omega-3 and omega-6 fatty acids on certain blood characteristics of Laying Quail. Int. J. Poult. Sci. 9(7): 684–694.
8. Ayerza, R. and W. Coates, 2001: Omega-3 enriched eggs: The influence of dietary αlinolenic fatty acid source on egg production and composition. Can. J. Anim. Sci. 81: 355-362.
9. Dalton, M.N.2000.Effects of dietary fats on reproductive performance, egg quality, fatty acid composition of tissues in Japanese quail (Coturnix cotunix japonica). M.Sc. Thesis, Faculty of the Virginia Polytechnic Institute and State University, USA
10. Harris, W. S. and W. L. Isley. 2001. Clinical tried evidence for the cardio protective effects of omega-3 fatty acids. Current Atherosclerosis Reports. 3: 174-179.
11. Ibeas, C., L. Izquierdo and M. Lorenzo. 1994. Effect of different level of n-3 highly unsaturated fatty acids on growth and fatty acid composition of fish. Aquaculture. 127: 177-188.
12. Lewis, N. M. 2000. Enriched eggs as sours of n-3 polyunsaturated fatty acid for humans. Poult. Sci. 97(7): 97-97
13. Marchioli, BRF, E. Bobba, C. Chieffo, DD Gregorio, RD Masscio, M. Franzosi, E. Geraci, G. Levantesi, AP Maggioni, L. Mantini, RM Marfisi, G. Mastrogiuseppe, N. Mini, G. Nicolosi, M. Santini, C. Schweiger, L. Tavazzi, G. Tognoni, C. Tucci and F. Valagnessa. 2002. Early protection against sudden death by n-3 PUFA after myocardial infraction: Time-course analysis of the results of the GruppoItaliano per 10 studio dellasopravvivenzanellInfartoMiocario (GISSI). PervenzioneCirculaion. 105: 1897-1903
14. SAS, Institute. 2001. SAS User's Guide: Statistics Version. 6. 12 end., SAS Institute. Inc. Cary, NC.
15. Souza, J.G.; F.G.P. Costa; R.C.R.E. Queioga; J.H.V. Silva; A.R.P. Sculer and Goulart, C.C. 2008. Fatty acid profile of eggs of semi-heavy layers fed feeds containing linseed oil. Braz. J. Poult. Sci., 10: 37-44
16. Stadelman, W. J. and Cotterill, O. J. (1986). Egg Science and Technology . 3rded .AVI.Publishing company lnc. Westport. Connecticut
17. Sturkie, P. D. (2000). Avian physiology. 5th Edition . Springer Verlag , New York Berlin Heidelberg Tokyo
18. Sungino, H., T. Nitoda, L. R. Juneha. 1997. General Chemical Composition of Hen in Hen Eggs Their Basic and Aoolied Science (EDS) Yammamoti. Juneha. L, R. Hatla and M. Kine. CRC Press.
19. Thomoson, J. C. and B. B. He. 2006. Charactization of crude glycerol from biodiesel production from multiple feed stocks. Apple. Eng-Agric. 22(2): 261-265.
20. Turkey Production Manual, (Translated Arabic) Vol:10, No:2, 2016
21. Wilgus, H.S. and Van Wangener, A. (1936). The hight of firl albumen as a measure of it's condition. Poult .sci ., 15 = 318- 312
22. Jia Feng, Shuo Long, Hai-jun Zhang, Shu-geng Wu, Guang-hai Qi and Jing Wang .2020. Comparative effects of dietary microalgae oil and fish oil on fatty acid composition and sensory quality of table eggs. Poultry Science 99:1734–1743

https://doi.org/10.1016/j.psj.2019.11.005

23. Kemal Küçükersan1, Derya Yeşilbağ2*, Seher Küçükersan1. 2010. Influence of Different Dietary Oil Sources on Performance and Cholesterol
24. Content of Egg Yolk in Laying Hens . Journal of Biological and Environmental Sciences · Januar. https://www.researchgate.net/publication/267678798
25. Vasko, L., M. Tukova and R. Kastel. 2005. Metabolic parameters of laying hens and production of eggs after supplementation of food rations with a higher content of PUFA from flax and fish oil. Slovensky Veterinary Asopis 30:38-40
26. Her, I., M. Persia, and E. Bobeck. 2017. Comparative omega-3 fatty Acid enrichment of egg yolks from first-cycle laying hens fed flaxseed Oil or ground flaxseed. Poult. Sci. 96:1791–1799.
27. Wen, Z., Y. Wu, Z. Qi, X. Li, F. Li, X. Wu, and P. Yang. 2019. Rubber Seed oil supplementation enriches n-3 polyunsaturated fatty acids And reduces cholesterol contents of egg yolks in laying hens. Food Chem. 301:125198
28. SAS, Institute. 2001. SAS User's Guide: Statistics Version. 6. 12 end., SAS Institute. Inc. Cary, NC
29. Yogesh Hole et al 2019 J. Phys.: Conf. Ser. 1362 012121