PHYSIOLOGICAL RESPONSES TO FAT SUPPLEMENTATION TO MUSCOVY DUCKS DIETS

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ABSTRACT

Two hundred Muscovy hatched ducklings of 5 weeks of age were randomly divided into three groups : group (1) fed control diet all over the experimental period, group (2) received the control diet supplemented with 5 % sunflower oil from 5 to 12 weeks of age. Group (3) was fed a diet as group 2 up to 8 weeks of age, then birds were fed control diet supplemented with 7.5 % sunflower oil from 9 to 12 weeks of age. Feed and water were offered *ad libitum* during the whole experimental period. Four birds from each group were randomly selected to determine the body temperature (BT) and respiration (RR) rate at 4, 8 and 12 weeks of age. Also, two males and two females from each group at 4, 8 and 12 weeks of age were slaughtered and blood samples were collected. Total counting of red blood cells (RBCs), white blood cells (WBCs), hematocrit (Hct) and hemoglobin (Hb) were determined. Plasma total proteins (TP), albumin (A), globulins (G), A/G ratio, total lipids (TL), cholesterol (Chl), glucose (Glc), calcium (Ca), inorganic phosphorus (P), GOT, GPT and alkaline phosphatase (Alk. Phos.) enzymatic activities, creatinine (Crt) and T_3 were also assayed.

The data revealed that : adding 5 % level of sunflower oil at 8 weeks of age caused increased in : RBCs, A/G, TL ($P < 0.05$), Chl ($P < 0.05$), Glc ($P < 0.05$), T_3, GPT; and caused decreases in : BT, WBCs ($P < 0.05$), Hb, TP, A, G, GOT, Alk. Phos. ($P < 0.05$), Crt, Ca and P. Adding 5 % level of sunflower oil at 12 weeks of age caused increases in : RBCs, Hct % ($P < 0.05$), Hb, TL ($P < 0.05$), Chl ($P < 0.05$), Glc ($P < 0.05$), T_3 ($P < 0.05$), GPT; and caused decreases in : RR ($P < 0.05$), WBCs ($P < 0.05$), TP ($P < 0.05$), A, G ($P < 0.05$), GOT ($P < 0.05$), Alk. Phos., Crt, Ca and P. Adding 7.5 % level of sunflower oil at 12 weeks of age caused increases in : BT, RBCs, A/G ($P < 0.05$), TL($P < 0.05$), Chl, Glc; and caused decreases in : RR ($P < 0.05$), WBCs ($P < 0.05$), Hct % ($P < 0.05$), Hb, TP ($P < 0.05$), A, G ($P < 0.05$), T_3 ($P < 0.05$), GOT, GPT, Alk. Phos., Crt ($P < 0.05$), Ca and P ($P < 0.05$).

Keywords :Muscovy ducks, dietary fat, physiological responses

INTRODUCTION

The efficiency of dietary fat utilization is dependent on their fatty acids composition and on age of animal. There is evidence that saturated fatty acids are less utilized than the unsaturated ones (*Corino and Dell'Orto, 1980*). However, the improvement induced by fat utilization was reported to be associated with age because the lipid absorption mechanism is not fully developed in young chick.

Dietary fat addition decreases feed consumption, improved feed efficiency and alters some physiological parameters.

Ali et al. (1983) pointed out that both of red blood cells (RBCs) counts and hematocrit % were not affected by excess dietary fat for Hubbard broilers.

Abdel-Ghani (1986) found that, increasing fat level in the diet decreased significantly the protein content in blood serum. On the same respect, *Abd-Alla (1988)* found that the amounts of albumin and globulins fractions of blood serum decreased with increasing oil/fat in the diets, while albumin/globulins ratio increased with oil/fat addition.

Moreover, *Ali et al. (1983)* found that total lipids and plasma cholesterol concentrations showed a tendency to increase with the increase of dietary fat content. The addition of different levels of fat caused significantly higher levels in serum total lipids of broilers at 45 and 55 day of age than the control group (*Desoke, l986*). Serum total lipids were increased significantly by adding 6 % level of fat followed by that of 8 % and 3 % levels. The significantly highest levels of serum cholesterol were observed at 45 and 55 day of age by using tallow. On the same respect, *Abdel-Ghani (1986)* found that, serum blood cholesterol and total lipids increased with increasing fat content in the diet of broilers.

Although *Ali et al. (1983)* found an increase in thyroid weights of Hubbard birds fed on excess dietary fat, *Scheele et al. (1992)* reported that triiodothyronin hormone (T_3) level in plasma decreased only in high-fat (9.4 % or 12.3 % soybean oil) whereas, low-fat diets (0.5 or 2 % soybean oil) had no influence on T_3 plasma levels of birds kept under 15 to 25 °C ambient temperature.

Abdo (1998) found that, serum GOT and GPT enzymatic activities increased significantly with increasing dietary fat levels.

The objective of the present study were to throw more light on the effect of age and dietary fat supplementation on some physiological measurements of Muscovy ducks.

MATERIALS AND METHODS

Two hundred (200) Muscovy newly hatched ducklings were used in this study. The brooding temperature was regulated to be kept at 32 °C for the first week, then reduced weekly by 4 °C till it reached 24 °C. After three weeks of age the ducks were reared under the natural environmental temperature. The birds were provided with continuous light (23 hr light+ I hr dark) from hatching to 12 weeks of age. All duckling were fed a starting diet containing 21.13 % crude protein and 2900 Kcal ME/Kg diet from hatching to two weeks of age. During 3 rd and 4 th weeks of age, birds were fed a growing diet containing 17 % crude protein and 2901.5 Kcal ME/Kg diet. At the 5 th weeks of age ducklings were randomly divided into three groups (1, 2 and 3). Birds in group (1) were fed a control diet all over the experimental period. Birds in group (2) were fed the control diet supplemented with 5 % sunflower oil from 5 to 12 weeks of age. While, birds in group (3) were fed a diet as group 2 up to 8 weeks of age, then birds were fed the control diet supplemented with 7.5 % sunflower oil from 9 to 12 weeks of age. Feed

(Table 1) and water were offered *ad libitum* during the experimental period. Four birds from each group were randomly selected to determine the body temperature (B.T.) and respiration (R.R.) rate at 4, 8 and 12 weeks of age. Body temperature was measured through the coloaca at the depth of 2 cm by using a clinical thermometer. Respiration rate was measured by counting the body wall movements per minute. Two males and two females from each group at 4, 8 and 12 weeks of age were slaughtered and blood samples were collected. Total counting of red blood cells (RBCs - *Hartman and Leesler, 1963*) and white blood cells (WBCs – *Natt and Herrick, 1952*) were determined using the haemocytometer. Hematocrit (Hct) values were determined using microhematocrit tubes (length 75 mm and diameter 1.5 mm) with microhematocrit centrifuge 3000 r.p.m. for 20 minutes (*Hunsaker, 1969*). Hemoglobin (Hb) concentration (gm/100 ml blood) was determined using the hemoglobinometer (*Pilaski, 1972*).

Table (1): Formulation and composition of the experimental diets.

Ingredients, %	Diets		
	Group (1)	Group (2)	Group (3)
Yellow corn	65.00	61.70	60.00
Soybean meal	10.50	10.00	9.75
Wheat bran	22.09	21.03	20.54
Bone meal	1.50	1.42	1.39
Lime stone	0.25	0.23	0.23
Vit. Min. permix*	0.15	0.14	0.13
Salt	0.30	0.28	0.27
Methionine	0.21	0.20	0.19
Sunflower	--	5.00	7.50
	Chemical composition of diets		
Crude protein	17.07	17.08	17.07
Ether extract	2.54	7.10	9.64

*** Contained 0.35% Zn; 0.20% Mn; 0.20% Fe; 0.15% Mg; 0.03% Cu; 0.05% Co; 0.007% I, 98.5% Na Cl; 2,000,000 IU/ton of final diet vitamin A palmitate; 250,000 IU/ ton final diet vitamin D_3; and 55,000 IU/ton of final diet vitamin E.**

Plasma total proteins (TP - gm / 100 ml) were determined colormeterically according to the method of *Gasbarra et al. (1972)*. Plasma albumin (A - gm / 100 ml) content was determined according to *Drupt (1974)*. Globulins (G - gm / 100 ml) content was calculated by subtracting albumin content from the total plasma proteins. Also, albumin/globulins (A/G) ratio was then calculated. However, plasma levels of all of total lipids (TL - *Girard et al., 1970*), cholesterol *(Watson, 1960)*, glucose (Glc - *Trinder, 1969*), calcium (Ca - *Gindler, 1972*) and inorganic phosphorus (P - *Goldenberg, 1968*), glutamic-oxalacetic transaminase enzymatic activity [GOT] and glutamic-pyruvic trarlsaminase enzymatic activity [GPT] *(Reitman and Frnkel, 1957)*, alkaline phosphatase [Alk. Phos.] enzymatic activity *(Berssey et al., 1946)* and creatinine (Crt - *Henry, 1974*) were determined. Direct radio-immune assay (RIA) technique was performed for plasma triiodothyronine [T_3] *(May, 1978)*. Data were subjected to one-way classification analysis of variance *(MSTAT, 1986)* and the Duncan Multiple Range Test *(Duncan,*

1955) was applied to test the differences among means when the mean effects of treatments were significant.

RESULTS AND DISCUSSION

Body temperature is a balance between heat production and heat loss, and it associated with the activity of the bird. Results in Table (2) revealed that body temperature slightly decreased by adding 5 % level of sunflower oil at 8 weeks of age. While, there was no any change in body temperature by adding the same level of sunflower oil at 12 weeks of age as compared with the control group. At 12 weeks of age slight increase (0.1 °C) in body temperature of birds supplemented with 7.5 % sunflower oil in the diet was recorded. However, the respiration rate has a great task to body heat regulation. Sunflower oil supplementation with 5 % level at 8 weeks of age did not affect respiration rate, while adding 5 % and 7.5 % levels of sunflower oil at 12 weeks of age tended to decrease significantly respiration rate. Sunflower oil supplementation with the level of 5 % at 8 weeks of age caused a reduction in body temperature. This result may be due to the lower heat increment of diets including fat. On the same respect, *Dale and Fuller (1979)* reported that fat supplementation caused a reduction in heat production. The RBCs counting ($l0^6/mm^3$) increased by adding 5 % level of sunflower oil at 8 weeks of age, and also by adding either 5 % or 7.5 % level of sunflower oil at 12 weeks of age (Table 2). However, the increases in the count of RBCs due to sunflower oil addition were not significant. Similar results were found by *Ali et al. (1983)*. White blood cells (WBCs) counting was significantly decreased by adding 5 % level of sunflower oil at 8 and 12 weeks of age (Table 2). Also, adding sunflower oil by the level of 7.5 % in the diet resulted in insignificant decrease in WBCs count of Muscovy ducks at 12 weeks of age. Data in Table (2) shows that using sunflower oil supplementation at level of 5.0 % to the duck diets during the growth period did not cause any change in hematocrit %. While, at 12 weeks of age adding 5.0 % level of sunflower oil caused significant increase in hematocrit %. Such result is in agreement with that of *Peebles et al. (1997)*. However, significant decrease was observed by adding 7.5 % level of sunflower oil at the same age. Results in Table (2) indicate that there were no significant change in blood hemoglobin concentration of Muscovy ducks due to sunflower oil adding at 5.0 % or 7.5 % level in the diet. The use of 5.0 % sunflower oil level during the growth period associated with a decrease in Hb concentration. However, the same level of sunflower oil tended to increase the level of Hb at 12 weeks of age (Table 2). When the level of sunflower oil was increased to 7.5 % in the diet of Muscovy ducks, the level of Hb insignificantly decreased.

Table (2): Effect of sunflower oil supplementation on body temperature (BT), respiration rate (RR) and hematological parameters of Muscovy ducks at the ages of 8 and 12 weeks.

Item	Age of 4 weeks		Age of 12 weeks			SE
	Sunflower oil addition levels					
	0.0 %	5.0 %	0.0 %	5.0 %	7.5 %	
BT, °C	42.20^{a}	41.92^{ab}	41.40^{c}	41.40^{c}	41.50^{bc}	0.14
RR, count/min	50.00^{b}	50.00^{b}	58.00^{a}	50.00^{b}	50.00^{b}	1.83
RBCs, 10^6/mm^3	3.38^{a}	4.65^{a}	3.58^{a}	3.97^{a}	4.83^{a}	0.48
WBCs,10^3/mm^3	51.75^{a}	41.12^{a}	55.12^{a}	42.75^{a}	45.00^{a}	44.61
Hct, %	38.50^{ab}	38.50^{ab}	33.50^{bc}	38.70^{a}	31.25^{c}	1.87
Hb, gm%	19.97^{a}	18.42^{a}	20.02^{a}	22.45^{a}	20.07^{a}	1.40

^{a,b,c} **Means in the same row with different superscripts are significantly (P < 0.05) different.**

Table (3) indicates that at 8 weeks of age the values of total protein, albumin and globulins in plasma decreased with adding 5 % sunflower oil level, while, albumin/globulins (A/G) ratio increased. At 12 weeks of age total plasma protein, albumin and globulins decreased when the sunflower oil level in the diet increased. The differences in total protein and globulins due to sunflower oil levels at 12 weeks of age were significant. A/G ratio significantly increased with the increase of sunflower oil level in the diet. The significant increase in A/G ratio by adding 7.5 % sunflower oil level is due to the significant decrease in globulins (Table 3). However, *Abd-Alla (1988)* found that the serum protein levels were inversely related to serum cholesterol levels. However, the decrease in total proteins of plasma in Muscovy ducks as a result of sunflower oil supplementation to the diet, was associated with slight changes in carcass protein content (*El-Badry, 1998*). Such result maybe due to the efficiency of birds to get the maximum utilization from fat and provided the energy required for high growth demands.

Data in Table (3) indicates that total lipids increased by adding 5 % level of sunflower oil at 8 weeks of age, and by adding 5 % or 7.5 % sunflower oil supplementation at 12 weeks of age. However, the changes in plasma total lipids due to sunflower oil supplementation were significant at 12 weeks of age. The improvement in fat utilization was reported to be associated with age because the lipid absorption mechanism is not fully develop in young chicks. *Polin and Hussein (1982)* reported that polysaturated fatty acids utilization was found to be highly utilized by the adult birds. The increase of sunflower oil level in the diet, which was rich in linoleic and linolenic fatty acids, was associated with high levels of total lipids in plasma of Muscovy ducks. *Hulan et al. (1984)* reported that the substitution of fats or oils rich in linoleic and linolenic for those rich in palmitic and stearic produced hyperlipidemia. The obtained results are in a complete accordance with the results obtained by *Ali et al. (1983); Desoke (1986), Abdel-Ghani (1986)* and *Wilkinson (1998)*. However, the increase in plasma total lipids by increasing sunflower oil level during the period from 9 to 12 weeks of age (before marketing) was associated with significant increases of fat deposition

in breast and thigh muscles and produced good quality carcass *(El-Badry, 1998)*.

Plasma glucose level increased significantly by adding 5 % level of sunflower oil supplementation at 8 weeks of age. This increase was about 21 %. The same trend was observed at 12 weeks of age by increasing the level of sunflower oil to 5.0 % or 7.5 % (Table 3). Such results are in compelte agreement with those of *Peebles et al. (1997)*. *Bell (1971)* reported that an increase in plasma free fatty acids concentration produced a significant increase in peripheral plasma glucagon concentration. Glucagon released from the cells of the pancreas stimulates the synthesis and release of glucose from the liver. Adipose tissues increase the release of fatty acids which in turn are converted to ketones by liver. The ketones are used as energy by brain and other tissues. Ketones are also converted to glucose by the liver [gluconeogenesis] *(Morag, 1989)*. It can be observed that the increase in plasma total lipids is associated with an increase of plasma glucose level.

Table (3): Effect of sunflower oil supplementation on plasma biochemical constituents at the ages of 8 and 12 weeks of Muscovy ducks.

Item	Age of 4 weeks		Age of 12 weeks			SE
	Sunflower oil addition levels					
	0.0 %	5.0 %	0.0 %	5.0 %	7.5 %	
Total proteins, gm/dl	5.45^{a}	5.10^{a}	5.81^{a}	5.08^{a}	4.29^{b}	0.17
Albumin (A), gm/dl	3.57^{a}	3.51^{a}	3.90^{a}	3.47^{a}	3.29^{a}	0.10
Globulins (G), gm/dl	1.88^{a}	1.61^{ab}	1.91^{a}	1.62^{ab}	0.99^{b}	0.20
A/G ratio	1.95^{b}	2.43^{ab}	2.46^{ab}	2.27^{b}	3.41^{a}	0.34
Total lipids, mg/dl	375.75^{c}	432.00^{c}	436.25^{c}	516.25^{b}	583.50^{a}	19.4
Cholesterol, mg/dl	107.03^{b}	179.50^{a}	9.93^{b}	188.00^{a}	195.75^{a}	7.40
Glucose, mg/dl	173.75^{b}	219.25^{a}	178.00^{b}	211.00^{a}	222.25^{a}	2.92

^{a,b,c} **Means in the same row with different superscripts are significantl (P < 0.05) different.**

The level of T_3 increased by adding 5.0 % level of sunflower oil at 8 weeks of age. At 12 weeks of age the level of T_3 was increased by adding 5.0 % sunflower oil level then T_3 decreased at the same age by adding 7.5 % level of sunflower oil. However, the changes in T_3 concentrations due to sunflower oil addition at 8 and 12 weeks were not significant (Table 4). Similar result was found by *Scheele et al. (1992)* who reported that high-fat diets (polyunsaturated fatty acids) of levels 9.4 and 12.3 % from soybean oil inhibited the extra thyroidal conversion of T_4 to T_3 in chicks. The high thyroid activity stimulates oxidation in the cells, which require quickly available energy substrates such as fatty acids liberated by lipolysis. However, depressed T_3 values in high fat diets to reduced heat production *(Scheele et al., 1992)*.

Data in Table (4) shows that the level of the enzymatic activity of GOT decreased significantly by adding 5.0 % sunflower oil level during the period

from 5-8 weeks. At 12 weeks of age, almost the same trend was observed. The decrease in the enzymatic activity of GOT was 8.5 % and 7.1 % by supplementation of sunflower oil 5.0 % and 7.5 % levels, respectively. However, the level of the enzymatic activity of GPT was slightly increased by adding 5.0 % sunflower oil level at 8 week of age. Also, similar results were obtained at 12 week of age by adding 5.0 % sunflower oil level, however by adding 7.5 % sunflower oil level a slight decrease was observed. This result disagree with that obtained by Abdo (1998) who reported that serum GOT enzymatic activity significantly increased with increasing fat levels. However, GPT activity results agree with those obtained by the same author who reported that serum GPT enzymatic activity significantly increased with increasing dietary fat level. Table (4) indicates that level of enzymatic activity of alkaline phosphatase decreased significantly by adding 5.0 % level of sunflower oil at 8 weeks. The same trend was noticed at 12 weeks of age by adding both of 5.0 % and 7.5 levels of sunflower oil supplementation to the diet. At 12 week of age the decrease in the level of the enzymatic activity of alkaline phosphatase due to the increase in sunflower oil level was 3.4 % and 4.5 % in birds fed 5.0 % and 7.5 % levels of sunflower oil, respectively.

Table (4): Effect of sunflower oil supplementation on plasma T_3 hormone (ng/dl), liver function (some enzymatic activity, IU/L) and some minerals (mg/dl) levels at the ages of 8 and 12 weeks.

Item	Age of 4 weeks		Age of 12 weeks			SE
	Sunflower oil addition levels					
	0.0 %	5.0 %	0.0 %	5.0 %	7.5 %	
T_3	71.55^{b}	73.05^{b}	69.95^{b}	89.05^{a}	66.45^{c}	8.03
Liver and renal function						
GOT	117.00^{a}	111.00^{ab}	117.50^{a}	107.50^{b}	109.22^{ab}	2.56
GPT	39.82^{a}	40.02^{a}	37.90^{a}	38.35^{a}	37.40^{a}	1.19
Alk. Phos.,	38.50^{a}	35.25^{b}	35.30^{b}	34.10^{bc}	32.57^{c}	0.66
Creatinine	1.26^{b}	1.14^{b}	1.19^{ab}	1.13^{b}	1.03^{c}	0.02
Minerals						
Calcium	10.15^{a}	9.74^{ab}	9.84^{ab}	9.33^{bc}	8.65^{c}	0.23
Phosphorus	4.51^{a}	4.47^{a}	4.61^{a}	4.10^{a}	2.99^{b}	0.36

^{a,b,c} **Means in the same row with different superscripts are significantly (P < 0.05) different.**

Table (4) revealed that the level of creatinine in plasma of Muscovy ducks slightly decreased by adding 5.0 % level of sunflower oil at 8 weeks of age, however, the decrease was not significant. While, at 12 week of age plasma creatinine level decreased significantly by adding 5.0 % and 7.5 % levels of sunflower oil. Such results declared that the increase of sunflower oil level in the diets of Muscovy ducks did not affect the renal function. Elevated level of creatinine are mainly associated with abnormal renal function, especially as it relates to the glomerular filtration rate *(Morag, 1989)*.

At 8 weeks of age the level of plasma calcium (mg/dl) decreased by adding sunflower oil level of 5.5 % to the diet (Table 4). The same trend was

found at 12 weeks of age that level of calcium decreased significantly as sunflower oil supplementation to the diet increased. The decrease in plasma calcium level in birds aging 12 week of age was 5.2 % and 7.3 % by adding 5.0 % and 7.5 % sunflower oil supplementation, respectively. This result may be due to the adverse effect of sunflower oil on intestinal calcium absorption. *Ahmed et al (1995)* reported that the interference of fatty acids components of fat with mineral metabolism in broilers has been documented. This is due primarily to the formation of fatty acids and cation soaps during the process of digestion. Some of these soaps formed, particularly those of calcium and magnesium are insoluble (*West et al., 1966*). Phosphorus level in the plasma of birds fed diets supplemented with 5.0 % oil at 8 weeks of age slightly decreased as compared by birds in control group. When the level of sunflower oil increased from 5.0 % to 7.5 % at 12 weeks, level of Phosphorus significantly decreased (Table 4). These results revealed that the decrease in plasma calcium as a result of increasing sunflower oil level at 12 weeks of age are associated with the decrease in plasma phosphorus. This is attributed to the relationship between calcium and phosphorus. Similar results were reported by *Atteh and Leeson (1983)* and *Abd-Alla (1988)* who pointed out that the decrease in plasma calcium content isattributed to the decrease in calcium retention due to soap formation with fatty acids supplementation.

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الاستجابة الفسيولوجية لإمداد غذاء البط المسكوفى بالدهن

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لقد تم استخدام عدد مائتين (200) من البط المسكوفى عند عمر 5 أسابيع و تقسيمهم عشوائيا إلى ثلاث (3) مجموعات : مجموعة (1) تم تغذية أفرادها على عليقة المقارنة طوال فترة التجربة (12 أسبوع)، مجموعة (2) تم تغذية أفرادها على عليقة المقارنة مضاف إليها زيت عباد الشمس بجرعة قدرها 5.0 % من عمر 5 أسابيع حتى 12 أسبوع ، مجموعة (3) تم تغذية أفرادها مثل المجموعة (2) حتى عمر 8 أسابيع ثم من عمر 9 حتى عمر 12 أسبوع تم تغذية أفرادها على عليقة المقارنة مضاف إليها زيت عباد الشمس بجرعة قدرها 7.5 %. هذا و لقد تم تقديم العليقة و الماء للطيور حسب حاجتها دون تحديد الكمية حتى نهاية التجربة. هذا و لقد تم إختيار أربعة طيور من كل مجموعة عشوائيا لتسجيل درجة حرارة المستقيم و عدد مرات التنفس لكل دقيقة عند عمر 4 ، 8 ، 12 أسبوع. كما تم إختيار ذكرين و أنثتين من كل مجموعة تم ذبحها و الحصول على عينات من دمها لتقدير العدد الكلى لكرات الدم الحمراء و البيضاء ، و النسبة المئوية للمكونات الخلوية بالدم ، كمية الهيموجلوبين (جم / 100 ملليلتر). كما تم تقدير مستوى البلازما من : البروتينات الكلية ، الألبيومين ، الجلوبيولين ، النسبة بين الألبيومين و الجلوبيولين ، الليبيدات الكلية ، الكوليسترول ، الجلوكوز ، الكالسيوم ، الفوسفور غير العضوى ، الكرياتنين ، النشاط الإنزيمى للإنزيمات الناقلة لمجموعة الأمين (GOT,GPT) و إنزيم الفوسفاتيز القاعدى ، هرمون الثيرونين ثلاثى اليود (ت$_3$).

و لقد أظهرت النتائج أن الإمداد بزيت عباد الشمس عند عمر 8 أسبوع بالجرعة 5 % تسبب فى أحداث زيادة معنوية فى : العدد الكلى لكرات الدم الحمراء ، النسبة بين الألبيومين و الجلوبيولين ، الكوليسترول ، الجلوكوز ، النشاط الإنزيمى لإنزيم GPT ، هرمون الثيرونين ثلاثى اليود (ت$_3$) ، كما تسبب فى أحداث نقص معنوى فى : درجة حرارة المستقيم ، العدد الكلى لكرات الدم الحمراء و البيضاء و النسبة المئوية للمكونات الخلوية بالدم كمية الهيموجلوبين ، البروتينات الكلية ، الألبيومين ، الجلوبيولين ، الكالسيوم ، الكرياتنين ، النشاط الإنزيمى لإنزيمى GOT و الفوسفاتيز القاعدى. إلا أن إضافة زيت عباد الشمس بجرعة قدرها 5% عند عمر 12 أسبوع تسببت فى زيادة معنوية فى : العدد الكلى لكرات الدم الحمراء ، النسبة المئوية للمكونات الخلوية بالدم ،كمية الهيموجلوبين ، الليبيدات الكلية ، الكوليسترول ، الجلوكوز ، النشاط الإنزيمى لإنزيم GOT ، هرمون الثيرونين ثلاثى اليود (ت$_3$) ، كما تسببت فى نقص معنوى فى : عدد مرات التنفس ، العدد الكلى لكرات الدم البيضاء ، البروتينات الكلية ، الألبيومين ، الجلوبيولين ، الكالسيوم ، الفوسفور غير العضوى ، الكرياتنين ، النشاط الإنزيمى لإنزيمى GOT و الفوسفاتيز القاعدى. كما ثبت أن إضافة زيت عباد الشمس عند عمر 12 أسبوع بالجرعة 7.5% سببت زيادة معنوية فى : درجة حرارة المستقيم ، العدد الكلى لكرات الدم الحمراء ، النسبة بين الألبيومين و الجلوبيولين ، الليبيدات الكلية ، الكوليسترول ، الجلوكوز ، كما سببت نقص معنوى فى : عدد مرات التنفس ، العدد الكلى لكرات الدم البيضاء ، النسبة المئوية للمكونات الخلوية بالدم ، كمية الهيموجلوبين ، البروتينات الكلية ، الألبيومين ، الجلوبيولين ، الكالسيوم ، الفوسفور غير العضوى ، الكرياتنين ، النشاط الإنزيمى لإنزيمى GPT ، الفوسفاتيز القاعدى ، هرمون الثيرونين ثلاثى اليود (ت$_3$).