Egypt. Poult. Sci. Vol (37)(III): (667-683)(2017) **(1738)**

Egyptian Poultry Science Journal

http://www.epsaegypt.com

ISSN: 1110-5623 (Print) – 2090-0570 (Online)

IMPACT OF DIETARY CRUDE GLYCERIN ON LIVER METABOLISM OF JAPANESE QUAIL (COUTRNIX COTURNIX JAPONICA)

H. M. S. Shoukry; A. A. El-Shafei; M. A. Al-Gamal; and R. A. Abo-Salem

Dep. of Anim. Prod., Fac. of Agric., Al-Azhar Uni., Nassr City, Cairo, Egypt

Corresponding author: H. M. S. Shoukry; Email: hishameg53_1@yahoo.com

Received: 20/06/2017 Accepted: 09/07/2017

ABSTRACT: Two experiments were executed to study the impact of crude glycerin as an energy source in replacement of diet in Japanese quail on liver metabolism. In the first experiment, a total number of 180 newly hatched Japanese quail were used in a six-week study. The birds were randomly distributed into 4 experimental groups representing 4 dietary levels including crude glycerin 0% (control), 5%, 10% and 15% with three replicates 15 birds each. In the second experiment, a total number of 72 adult Japanese quail at 6 weeks of age were used in a ten week study. The birds were randomly distributed into 4 experimental groups (12 females and 6 males) representing the same dietary levels of crude glycerin used with the first experiment with three replicates 6 birds for each. In each experiment the liver fat percentage was significantly ($p \leq 0.05$) increased, while liver glycogen and hepatic cellular oxygen consumption decreased with increasing dietary glycerin levels. However, in the first experiment, male quail fed 15% glycerin showed higher creatine phosphokinase (CPK) levels compared to those fed other glycerin levels. Liver histological sections revealed fatty liver changes with increasing dietary glycerin levels. In conclusion, the results showed that the crude glycerin can be used as alternative energy source to replace (ex:corn) in growing and laying Japanese quail diets to the maximum level of 5% without adverse effects on liver metabolism.

Key words: Crude glycerin - Liver metabolism - Liver glycogen - Japanese quail.

INTRODUCTION

Because of rising the costs of dietary energy sources of alternative feed source such as glycerin, have become a focus for the livestock industry (Parsons et al., 2009). Glycerin is known to be a valuable ingredient for producing foods, cosmetics and pharmaceuticals (Thompson and He, 2006). The crude glycerin is a by–product of biodiesel (Jung and Batal, 2011) and soap industries (Mbamalu, 2013). Dozier et al. (2008) indicated that the average apparent metabolizable energy (AMEn) of glycerin was 3434 Kcal/Kg, which is similar to its gross energy content.

Glycerin forms neutral fats, fatty acid esters and phosphoglycerides (Tao et al., 1983). Glycerin can be converted also to glucose by the liver (Krebs et al., 1966) and kidneys (Krebs and Lund, 1966) and provides energy for cellular metabolism. Glycerin is water soluble and freely enters the portal blood (Sambrook, 1980). Glycerin is metabolized to glyceraldehyde-3- phosphate in the presence of glycerol kinase enzyme which acts only in the liver (Alvarenga et al., 2012). This compound is used in lipid formation (fatty acid synthesis) or glucose (gluconeogenesis) (Emmanuel et al., 1983) or oxidized for energy production via glycolysis and citric acid cycle (Rosebrough et al., 1980).

Cerrate et al. (2006) found that glycerin inclusion in the diet had a significant decline in feed efficiency in broilers. Some studies suggested that mitochondrial function or biochemistry can be associated with feed efficiency (FE) in broilers (Iqbal et al., 2004) and rats (Lutz and Stahly, 2003). Mitochondria obtained from broilers with low FE exhibited greater uncoupling of the electron transport chain (ETC) that was due to site-specific defects in electron transport resulting in higher amounts of reactive oxygen species compared with high FE.

The results of some studies (Goodridge, 1970 and Rosebrough et al., 1980) indicated that dietary glycerin caused the highest concentration of liver glycogen. Rosebrough et al. (1980) stated that glycerin promotes liver lipid synthesis in turkey hens. However, Lin et al. (1976) found that glycerin decreases the rate of fatty acid synthesis and the lipogenic activities in the chicken liver. Abd-Elsamee et al. (2010) stated that crude glycerin supplementation had no significant effect on values of aspartate amino transaminase (AST) and albumin in broilers. Furthermore, (Erol et al., 2009 and Yalcin et al., 2010) reported that glycerin did not significantly affect the serum levels of AST.

The objective of this study was to investigate the efficacy of different dietary levels of glycerin in growing and laying Japanese quail by observing their effects on liver metabolism and histology.

MATERIALS AND METHODS

Experimental birds and management of the flock:

The experiments were performed at Faculty of Agriculture Experimental Station in Al-Azhar University, Cairo, Egypt. Glycerin from soap production was included at the rates of 0% (control), 5%, 10% and 15% in the two experiments in replacement of the energy of corn. In the first experiment, a total number of 180 newly hatched Japanese quail were randomly distributed into 4 treatments each of 45 chicks in three replicates. During the first week of age, all birds

were fed a diet without glycerin. After the first week of age birds were shifted to the experimental diets containing the glycerin levels. The experimental treatments started at 1 week and lasted at 6 weeks of age. In the second experiment, a total number of 72 adult Japanese quail were randomly divided into 4 treatments 18 birds each (12 females and 6 males) in 3 replicates, these birds were adapted to the control diets for two weeks till the beginning of the 8^{th} weeks of age (the age of the experimental diet start). The experimental treatments started at 8 week and lasted at 16 weeks of age. All birds were kept in cages and they had free access to feed and water.

Experimental diets and procedures:

Chemical analysis of crude glycerin:

Chemical analysis of crude glycerin was determined according to the procedures outlined by Egyptian Petroleum Research Institute (EPRI), Table (1).

Experimental diets:

In the first experiment, diets were formulated to contain 24% crude protein with energy level 2900 Kcal ME/Kg feed. In the second experiment, diets were formulated to contain 20% crude protein with energy level 2900 Kcal ME/Kg feed. The composition and calculated analysis of the experimental diets of grower and layer diets are presented in Table (2).

Hepatic cellular oxygen consumption:

At the end of the experimental periods at 6 and 16 weeks of age for experiments 1 and 2 respectively, a total number of 24 birds (12 males and 12 female) were slaughtered in each experiment. Oxygen consumption was measured by using constant volume manometer technique by Warburg apparatus. The samples of liver were obtained from 3 replicates of 4 treatments of each experiment being two birds from each replicate (one male and one female) to measure hepatic oxygen consumption. Liver was sampled from Apex of right lobe. Afterwards, the samples were kept in Hank's media as described by (Wasley, 1972) in contact with ice until analysis was done in the same day. A total volume of 2.5 ml from the tissue extract sample with the Hank's media was placed in the flask of Warburg apparatus and strap of filter paper saturated with 30% KOH was put in the well of the flask then the reading of the manometer was recorded after agitation for one hour in 30º C incubation, according to Umbreit et al. (1972). All measurements were calculated on the basis of dry samples.

Analysis of liver glycogen and fat:

Liver samples were taken in association with the samples taken for hepatic cellular oxygen consumption. The livers of two birds per replicate were dried in oven at 60º C for 72 (hrs). Determination of glycogen in liver was done colorimetrically according to the methods described by Seifter and Dayton (1950). The method based on hydrolyzing the glycogen into glucose by hot 30% KOH. Fat content in the liver was determined gravimetrically, after extraction with diethyl ether in a Soxhlet apparatus for 8 hrs according to AOAC (1984).

Blood Sampling:

Blood sampled from two males and two females per replicate in each treatment at the end of the first and second experiments. Blood was drawn from the jugular vein in tubes includes 1mg EDTA /1ml blood between 10-12 a.m. Blood was centrifuged at 3000 rpm. for 15 minutes to separate the plasma. Plasma

was then collected and kept frozen at -20º C till analysis. The concentration of albumin, aspartate amino transaminase (AST) and creatine phosphokinase was determined colorimetrically using the commercial Kits (Diamond Company, Cairo, Egypt).

Liver histological examination:

At the end of the experiments at 6 and 16 weeks, the liver of two birds per replicate was collected at the time of slaughter and placed in neutral buffered 10% formalin. It was subsequently processed by routine paraffin embedding techniques, cut in sections, and stained with hematoxylin and eosin. All sections were read for hepatic lipidosis (Grant Maxie and Jubb, 2007) by a single person versed in lipidosis evaluation.

The statistical analysis:

Data were subjected to two-ways analysis of variance for effects of glycerin levels, sex and their interactions. Statistical analysis was done using SPSS software program package (SPSS, 2001, version 11.0). Means were separated by Duncan's multiple range test (Duncan, 1955) at 5% level of significance.

RESULTS AND DISCUSSION

The first experiment (Growing period):

Effect of dietary glycerin levels on hepatic cellular oxygen consumption and liver content of glycogen and fat in growing Japanese quail at 6 wks of age:

The effects of the dietary treatments on liver oxygen consumption and liver content of glycogen and fat in Japanese quail during growing period are shown in Table (3). Quails fed 15% crude glycerin the lowest recorded liver oxygen consumption but those fed no glycerin were the highest. However, there were no significant differences between the quail males fed 5% and 10% crude glycerin in liver oxygen consumption. Quail males fed 5% and 15% crude glycerin had higher liver oxygen consumption than females and there were no significant differences between females that were fed 5% and 10% glycerin.

Numerical decreasing in liver glycogen was noticed with increasing dietary glycerin levels in the diet. Contradictory results were reported by Goodridge (1970) who found that glycerin increased glycogen deposition in the liver of newly hatched White Leghorn chicks.

The percent of liver fat was significantly ($p \leq 0.05$) increased with increasing dietary glycerin levels where the inclusion of 15% glycerin showed the highest liver fat and the control group was the lowest. The high percent of liver fat has been reported to be due to the overestimation of metabolizable energy of glycerin or the high plasma lipids as a consequence of the stimulation of mucosal triglyceride esterification by the glycerin Narayan et al. (1977). Findings of the current study are similar to those of Goodridge (1970) who reported that glycerin markedly stimulated fatty acid synthesis in the liver of the newly hatched White Leghorn chicks.

Effect of dietary glycerin levels on plasma albumin, AST and CPK in growing Japanese quail at 6 wks of age:

The effects of the dietary treatments on plasma albumin, AST and CPK levels are given in Table (4). Plasma albumin and AST levels were not significantly affected by dietary glycerin. These results are in agreement with Abd-Elsamee et al. (2010) who reported that crude glycerin supplementation had no significant effect on average values of AST and albumin.

Males fed 15% glycerin had the highest CPK levels and there were no significant differences between females. The high CPK levels in the quail fed 15% glycerin may be attributed to increased muscle damage caused by glycerin (Hochleithner, 1994).

Effect of dietary glycerin levels on liver histological examination in growing Japanese quail at 6 wks of age:

Liver histological sections in the first experiment are shown in (Fig., 1). Fatty liver changes increased with increasing dietary glycerin levels where the quail fed 10% and 15% glycerin had the highest fatty liver changes. However, Lammers et al. (2008) reported that pigs can be fed up to 10% crude glycerin with no effect on hepatic lipidosis scores in the liver.

The second experiment (laying period):

Effect of dietary glycerin levels on liver oxygen consumption and liver content of glycogen and fat in laying Japanese quail at 16 wks of age:

The effects of the dietary treatments on liver oxygen consumption and liver content of glycogen and fat are shown in Table (5). Liver oxygen consumption was significantly ($p \leq 0.05$) decreased with increasing dietary glycerin levels. However, there were no significant differences between the males fed 5% and 10% crude glycerin but males were higher in liver oxygen consumption than females in the group that was fed 15% crude glycerin.

According to liver glycogen levels, the control group showed significantly ($p \leq 0.05$) the highest glycogen levels and there were no significant differences among those fed 5%, 10% and 15% glycerin. However, Rosebrough et al. (1978) found that dietary glycerin caused the highest concentration of liver glycogen in turkey hens. Moreover, Terblanche et al. (1981) showed that fasted rats fed glycerin diets depleted the liver glycogen stores slower than those fed control diet.

The quail fed 10% and 15% glycerin showed the highest liver fat. This increasing in liver fat percent may be because of the high energy of glycerin or the high plasma lipids as a consequence of the stimulation of mucosal triglyceride esterification by the glycerin (Narayan et al., 1977). These results are in agreement with Rosebrough et al. (1980) who found that glycerin appeared to be metabolized similarly to carbohydrate and to promote liver lipid synthesis in turkey hens. Contradictory findings also were reported by Lin et al. (1976) who demonstrated that glycerin decreases the rate of fatty acid synthesis and lipogenic activities in the chicken liver.

Effect of dietary glycerin levels on plasma albumin, AST and CPK in laying Japanese quail at 16 wks of age:

The effects of the dietary treatments on plasma Albumin, AST and CPK levels are given in Table (6). There was no significant effect of dietary crude glycerin on plasma Albumin, AST and CPK levels but females had higher plasma albumin than males. These results are similar to those reported by Erol et al. (2009) who found that glycerin did not significantly affect the serum levels of AST in laying quail. In addition, Yalcin et al. (2010) found that there were no significant effects of dietary glycerin on the serum levels of AST in laying hens.

Effect of dietary glycerin levels on liver histological examination in laying Japanese quail at 16 wks of age:

Liver histological sections in the second experiment are shown in (Fig., 2). With increasing dietary glycerin levels, fatty liver changes appeared where the quail fed 10% and 15% glycerin showed higher fatty liver changes than all of the other treatments. However, Lammers et al. (2008) fed pigs up to 10% crude glycerin without effect on hepatic lipidosis scores in the liver.

CONCLUSION

It is concluded that crude glycerin can be used as alternative energy source in growing and laying Japanese quail diets to a maximum level of 5%. The results indicated that 10% and 15% glycerin levels showed the most adverse effects on liver metabolism. Fatty liver changes were noticed with increasing dietary glycerin levels in growing and laying Japanese quail.

Table (1): Chemical analysis of crude glycerin

S.N.	Test	Results	Analytical method
1	Glycerin content (%)	78.5	ES:4087-12/2003
2	Water content (%)	18.6	Karl Fischer mks_520
3	ASH (%)	2.8	ES:4087-12/2003
4	Gross Energy of glycerin (Kcal /Kg Feed)	3966	ASTM D-240
5	Na (%)	0.09	Flame Photometer
6	K (%)	0.01	Flame Photometer

Table (2): Composition and calculated analysis of experimental diets of growing and laying Japanese quail

Ingredients	Grower diets				Layer diets			
	0%	**5%**	**10%**	**15%**	**0%**	**5%**	**10%**	**15%**
Ground yellow corn (8.5%)	56.44	51.72	46.92	42.24	63.02	57.85	53.58	48.92
Glycerin (ME 3966 Kcal/Kg)	0	3.66	7.32	10.98	0	3.66	7.32	10.98
Soybean meal (44%)	34.30	36.05	37.44	38.92	20.98	22.62	24.13	25.16
Corn gluten meal (62%)	6.30	5.64	5.44	5.00	8.34	8.22	7.33	7.33
Dicalcium phosphate	0.84	0.84	0.83	0.83	1.23	1.24	1.24	1.25
Limestone	1.18	1.18	1.16	1.16	5.51	5.51	5.49	5.49
Sodium Chloride (NaCl)	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17
Sodium carbonate (Na_2CO_3)	0.16	0.15	0.15	0.14	0.15	0.14	0.13	0.13
DL-methionine	0.13	0.15	0.15	0.16	0.12	0.12	0.14	0.14
L-lysine-HCl	0.18	0.14	0.12	0.10	0.18	0.17	0.17	0.13
Vitamin and mineral premix[1]	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Total (Kg)	100	100	100	100	100	100	100	100

Continue Table (2):

	Grower diets				Layer diets			
	0%	**5%**	**10%**	**15%**	**0%**	**5%**	**10%**	**15%**
Calculated analysis								
Crude protein%	24.09	24.01	24.07	24.03	20.04	20.24	20.00	20.01
ME. Kcal/Kg feed	2900	2900	2907	2912	2900	2902	2906	2916
Linoleic acid%	1.38	1.28	1.18	1.08	1.47	1.36	1.28	1.18
Crude fiber%	3.72	3.73	3.72	3.72	2.96	2.96	2.96	2.93
C/P ratio	120.39	120.8	120.81	121.20	144.71	143.42	145.30	145.76
Lysine%	1.31	1.30	1.30	1.31	1.00	1.01	1.03	1.01
Methionine%	0.50	0.50	0.50	0.50	0.45	0.45	0.45	0.45
Methionine + Cystin%	0.89	0.89	0.89	0.89	0.79	0.79	0.79	0.79
Calcium%	0.80	0.80	0.80	0.80	2.50	2.50	2.50	2.50
Available Ph.%	0.30	0.30	0.30	0.30	0.35	0.35	0.35	0.35
Sodium%	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Chlorine%	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14
Ash%	3.12	3.26	3.39	3.52	2.38	2.52	2.65	2.75

[1]Each 3Kg of vitamin and minerals mixture contain: Vit. A, 10,000,000 IU; Vit. D3, 2,000,000 IU; Vit. E, 10,000 mg; Vit. K3, 1,000 mg; Vit. B1, 1,000 mg; Vit. B2, 5,000 mg; Vit. B6, 1,500 mg; Vit. B12, 10 mg; Niacin, 20,000 mg; Pantothenic acid, 10,000 mg; Folic acid, 1,000 mg; Biotin, 50 mg; Choline chloride, 500,000 mg; Copper, 4,000 mg; Iodine, 300 mg; Iron, 30,000 mg; Manganese, 60,000 mg; Zinc, 50,000 mg; Cobalt, 100 mg; and Selenium, 100 mg.

Table (3): The effect of dietary glycerin levels on hepatic cellular oxygen consumption (µl. h^{-1}/100 mg dry weight), liver glycogen (mg/g dry weight) and liver fat (%) in growing males and females of Japanese quail at 6 wks of age

Glycerin levels	Oxygen consumption (µl . h^{-1}/100mg dry weight)		Main effect of glycerin	Liver glycogen (mg/g dry weight)		Main effect of glycerin	Liver fat (%)		Main effect of glycerin
	M	F		M	F		M	F	
0%(control)	4.08^{a1}±0.10	4.00^{a} ±0.10	4.04 ±0.07	51.84 ±9.22	16.47 ±9.22	34.15 ±6.52	18.23^{1} ±1.80	25.13 ±1.80	21.68^{d} ±1.27
5%	3.29^{Ab}±0.10	3.06^{Bb} ±0.10	3.18 ±0.07	25.92 ±9.22	35.20 ±9.22	30.56 ±6.52	24.68 ±1.80	30.00 ±1.80	27.33^{c} ±1.27
10%	3.25^{b}±0.10	3.07^{b} ±0.10	3.16 ±0.07	33.39 ±9.22	27.14 ±9.22	30.26 ±6.52	28.13 ±1.80	36.73 ±1.80	32.43^{b} ±1.27
15%	2.84^{Ac}±0.10	1.98^{Bc} ±0.10	2.41 ±0.07	31.55 ±9.22	20.00 ±9.22	25.78 ±6.52	32.53 ±1.80	40.13 ±1.80	36.33^{a} ±1.27
Main effect of sex	3.37±0.05	3.03±0.05		35.67 ±4.61	24.70 ±4.61		25.89^{B} ±0.90	33.00^{A} ±0.90	

[1]Mean ± standard error.

[a,b] Means having different letter exponents among rows are significantly different (p≤0.05).

[A,B] Means having different letter exponents among columns are significantly different (p≤0.05).

Table (4): The effect of dietary glycerin levels on plasma albumin (mg/dl), AST (IU/L) and CPK (IU/L) in growing males and females of Japanese quail at 6 wks of age

Glycerin levels	Albumin (mg/dl)		Main effect of glycerin	AST (IU/L)		Main effect of glycerin	CPK (IU/L)		Main effect of glycerin
	M	F		M	F		M	F	
0%(control)	1.38[1] ±0.19	1.75 ±0.18	1.56 ±0.13	12.00[1] ±1.34	13.00 ±1.34	12.50 ±0.95	90.28[b] ±92.67	163.53 ±92.67	126.91 ±65.53
5%	1.33 ±0.18	1.55 ±0.18	1.44 ±0.13	12.50 ±1.34	12.50 ±1.34	12.50 ±0.95	214.81[b] ±101.51	65.26 ±113.49	140.03 ±76.13
10%	1.48 ± 0.18	1.38 ±0.18	1.43 ±0.13	13.00 ±1.34	12.50 ±1.34	12.75 ±0.95	154.93[b] ±92.67	314.17 ±92.67	234.55 ±65.53
15%	1.37 ±0.18	1.44 ±0.18	1.41 ±0.13	12.50 ±1.34	14.00 ±1.34	13.25 ±0.95	519.14[a] ±92.67	163.36 ±92.67	341.25 ±65.53
Main effect of sex	1.39 ±0.09	1.53 ±0.09		12.50 ±0.67	13.00 ±0.67		244.79 ±47.48	176.58 ±49.14	

[1]Mean ± standard error.

[a,b] Means having different letter exponents among rows are significantly different ($p \leq 0.05$).

[A,B] Means having different letter exponents among columns are significantly different ($p \leq 0.05$).

Table (5): The effect of dietary glycerin levels on hepatic cellular oxygen consumption (µl. h^{-1}/100mg dry weight), liver glycogen (mg/g dry weight) and liver fat (%) in laying males and females of Japanese quail at 16 wks of age

Glycerin levels	Oxygen consumption (µl . h^{-1}/100mg dry weight)		Main effect of glycerin	Liver glycogen (mg/g dry weight)		Main effect of glycerin	Liver fat (%)		Main effect of glycerin
	M	F		M	F		M	F	
0%(control)	3.34^{a} ±0.08	2.98^{a} ±0.08	3.16 ±0.06	11.52 ±1.62	11.80 ±1.62	11.66^{a} ±1.15	21.60^{1} ±1.31	27.03 ±1.31	24.32^{c} ±0.93
5%	2.18^{b} ±0.08	2.16^{b} ±0.08	2.17 ±0.06	3.68 ±1.62	2.01 ±1.62	2.85^{b} ±1.15	26.37 ±1.31	30.66 ±1.31	28.52^{b} ±0.93
10%	2.04^{b} ±0.08	1.91^{c} ±0.08	1.97 ±0.06	3.13 ±1.62	2.52 ±1.62	2.82^{b} ±1.15	33.33 ±1.31	36.60 ±1.31	34.97^{a} ±0.93
15%	1.68^{Ac} ±0.08	1.10^{Bd} ±0.08	1.39 ±0.06	3.41 ±1.62	0.84 ±1.62	2.12^{b} ±1.15	32.66 ±1.31	41.47 ±1.31	37.07^{a} ±0.93
Main effect of sex	2.31 ±0.04	2.04 ±0.04		5.44 ±0.81	4.29 ±0.81		28.49^{B} ±0.66	33.94^{A} ±0.66	

[1]Mean ± standard error.

[a,b] Means having different letter exponents among rows are significantly different ($p \leq 0.05$).

[A,B] Means having different letter exponents among columns are significantly different ($p \leq 0.05$)

Table (6): The effect of dietary glycerin levels on plasma albumin (mg/dl), AST (IU/L) and CPK (IU/L) in laying males and females of Japanese quail at 16 wks of age

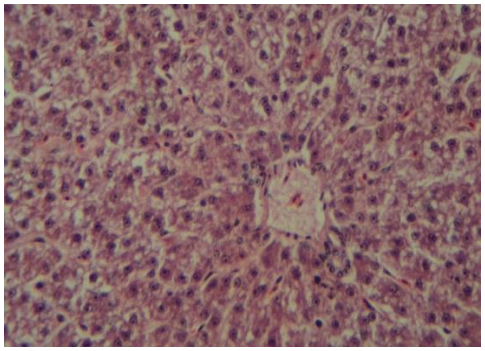
Glycerin levels	Albumin (mg/dl)		Main effect of glycerin	AST (IU/L)		Main effect of glycerin	CPK (IU/L)		Main effect of glycerin
	M	F		M	F		M	F	
0%(control)	1.34[1] ±0.14	2.22 ±0.14	1.78 ±0.10	14.00[1] ±2.13	20.50 2.13	17.25 ±1.51	109.37 ±169.87	314.89 ±169.87	212.13 ±120.12
5%	1.31 ±0.14	2.17 ±0.14	1.74 ±0.10	18.00 ±2.13	19.17 ±2.13	18.58 ±1.51	221.00 ±169.87	223.12 ±189.87	222.06 ±127.40
10%	1.34 ±0.14	2.06 ±0.14	1.70 ±0.10	18.33 ±2.13	19.17 ±2.13	18.75 ±1.51	455.00 ±169.87	189.67 ±155.07	322.34 ±115.00
15%	1.32 ±0.14	1.90 ±0.14	1.61 ±0.10	21.67 ±2.13	17.33 ±2.13	19.50 ±1.51	418.20 ±155.07	263.10 ±155.07	340.65 ±109.65
Main effect of sex	1.33[B] ±0.07	2.09[A] ±0.07		18.00 ±1.07	19.04 ±1.07		300.89 ±83.15	247.69 ±84.05	

[1]Mean ± standard error.

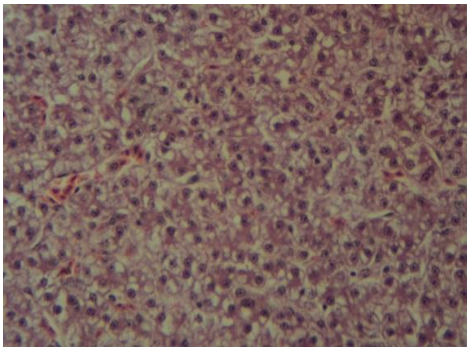
[a,b] Means having different letter exponents among rows are significantly different ($p \leq 0.05$).

[A,B] Means having different letter exponents among columns are significantly different ($p \leq 0.05$).

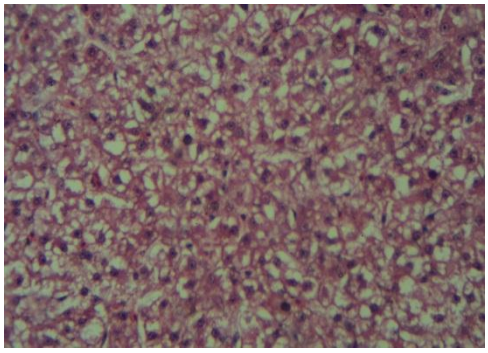
Figure (1): The effect of dietary glycerin levels on liver histological examination in growing males and females of Japanese quail at 6 wks of age



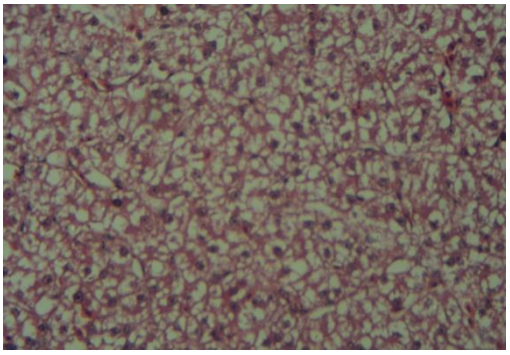
Liver showing normal (control, 0 crude glycerin)



Liver showing mild fatty changes (5% crude glycerin)

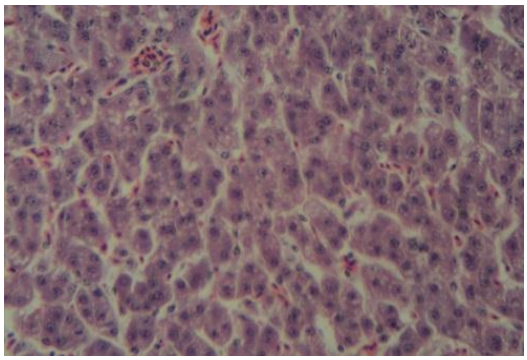


Liver showing high fatty changes (10% crude glycerin)

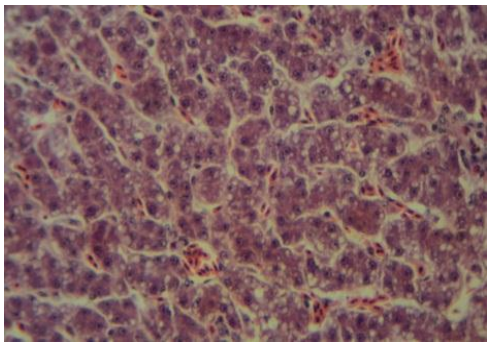


Liver showing high fatty changes (15% crude glycerin)

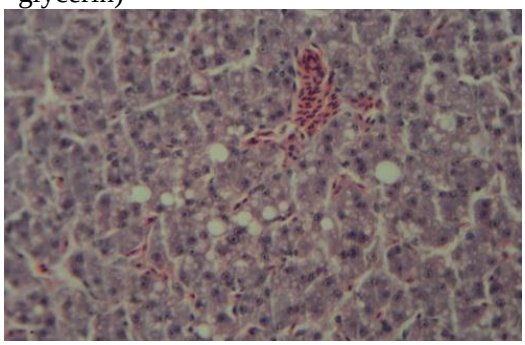
Figure (2): The effect of dietary glycerin levels on liver histological examination in laying males and females of Japanese quail at 16 wks of age



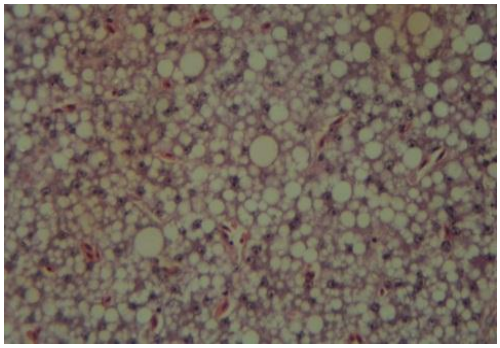
Liver showing normal (control, 0 crude glycerin)



Liver showing mild (5% crude glycerin)



Liver showing high fatty changes (10% crude glycerin)



Liver showing high fatty changes (15% crude glycerin)

REFERENCES

Abd-Elsamee, M. O.; Abdo, Z. M. A.; El-Manylawi, M. A. F.; and Salim, I. H., 2010. Use of crude glycerin in broiler diets. Egypt. Poult. Sci. J., 30(1): 281-295.

Alvarenga, R. R.; Lima, E. M. C.; Zangeronimo, M. G.; Rodrigues, P. B.; and Bernardino, V. M. P., 2012. Use of glycerine in poultry diets. World's Poult. Sci. J., 68(04): 637-644.

AOAC, 1984. Official Methods of Analysis. 14th Edition. Association of Official Analytical Chemists. Washington, DC, USA.

Cerrate, S.; Yan, F.; Wang, Z.; Coto, C.; Sacaki, P.; and Waldroup, P. W., 2006. Evaluation of glycerin from biodiesel production as a feed ingredient for broilers. Int. J. Poult. Sci., 5(11): 1001-1007.

Dozier, W. A.; Kerr, B. J.; Corzo, A.; Kidd, M. T.; Weber, T. E.; and Bregendahl, K., 2008. Apparent metabolizable energy of glycerin for broiler chickens. Poult. Sci., 87(2): 317-322.

Duncan, D. B., 1955. Multiple ranges and multiple F test. Biometrics, 11: 1-42.

Emmanuel, B.; Berzins, R.; and Robblee, A. R., 1983. Rates of entry of alanine and glycerol and their contribution to glucose synthesis in fasted chickens. Bri. Poult. Sci., 24(4): 565-571.

Erol, H.; Yalcin, S.; Midilli, M.; and Yalcin, S., 2009. The effects of dietary glycerol on growth and laying performance, egg traits and some blood biochemical parameters in quail. Revue de Medicine Veterinaire, 160(10): 469-476.

Goodridge, A. G., 1970. Regulation of lipogenesis. Stimulation of fatty acid synthesis in vivo and in vitro in the liver of the newly hatched chick. Biochem. J., 118(2): 259-263.

Maxie, M. G., ed. 2007. Jubb, Kennedy, and Palmer's Pathology of Domestic Animals. Vol. 1 to 3. 5th ed. Elsevier Health Sciences, Philadelphia, PA.

Hochleithner, M., 1994. Biochemistries. In: Ritchie, B.W., Harrison, G.J., Harrison, F.L.(Eds.), Avian Medicine: Principles and Application. Wingers Publishing, Lake Worth, FL., pp. 223–245.

Iqbal, M.; Pumford, N. R.; Tang, Z. X.; Lassiter, K.; Wing, T.; Cooper, M.; and Bottje, W., 2004. Low feed efficient broilers within a single genetic line exhibit higher oxidative stress and protein expression in breast muscle with lower mitochondrial complex activity. Poult. Sci., 83(3): 474-484.

Jung, B.; and Batal, A. B., 2011. Nutritional and feeding value of crude glycerin for poultry. Evaluation of feeding crude glycerin to broilers. J. App. Poult. Res., 20(4): 514-527.

Krebs, H. A.; and Lund, P., 1966. Formation of glucose from hexoses, pentoses, polyols and related substances in kidney cortex. Biochem. J., 98(1): 210-214.

Krebs, H. A.; Notton, B. M.; and Hems, R., 1966. Gluconeogenesis in mouse liver slices. Biochem. J., 101(3): 607-617.

Lammers, P. J.; Kerr, B. J.; Weber, T. E.; Bregendahl, K.; Lonergan, S. M.; Prusa, K. J.; and Honeyman, M. S., 2008. Growth performance, carcass characteristics, meat quality, and tissue histology of growing pigs fed crude

glycerin-supplemented diets. J. Anim. Sci., 86(11): 2962-2970.

Lin, M. H.; Romsos, D. R.; and Leveille, G. A., 1976. Effect of glycerol on lipogenic enzyme activities and on fatty acid synthesis in the rat and chicken. J. Neutrino, 106(11): 1668-1677.

Lutz, T. R., and T. S. Stahly. 2003. Quantitative relationship between mitochondrial bioenergetics and efficiency of animal growth. J. Anim. Sci. 81:141.

Mbamalu, V. C., 2013. Glycerin and the market. M.Sc Faculty of the University of Tennessee at Chattanooga , Tennessee.

Narayan, K. A.; McMullen, J. J.; Wakefield, T.; and Calhoun, W. K., 1977. Influence of dietary glycerol on the serum lipoproteins of rats fed a fat-free diet. J. Nutri., 107(12): 2153-2163.

Parsons, G. L.; Shelor, M. K.; and Drouillard, J. S., 2009. Performance and carcass traits of finishing heifers fed crude glycerin. J. Anim. Sci., 87(2): 653-657.

Rosebrough, R. W.; Geis, E. G.; Henderson, K.; and Frobish, L. T., 1978. Effect of dietary energy on hepatic glycogen metabolism in the turkey hen. Poult. Sci., 57(6): 1652-1657.

Rosebrough, R. W.; Geis, E.; James, P.; Ota, H.; and Whitehead, J., 1980. Effects of dietary energy substitutions on reproductive performance, feed efficiency, and lipogenic enzyme activity on large white turkey hens. Poult. Sci., 59(7):1485-1492.

Sambrook, I. E., 1980. Digestion and absorption of carbohydrate and lipid in the stomach and the small intestine of the pig. In: Current Concepts of Digestion and Absorption in Pigs. Natl. Inst. Res .pp: 78-93.

Seifter, S.; and Dayton, S., 1950. The estimation of glycogen with the anthrone reagent. Archives Biochem. 25(1): 191–200.

SPSS For Windows S, Chicago, IL SPSS®. Computer Software 11.00, 2001. SPSS Inc., Headquarters. Wacker Drive, Chicago, Illinois 60606, USA., pp: 233.

Tao, R. C.; Kelley, R. E.; Yoshimura, N. N.; and Benjamin, F., 1983. Glycerol its metabolism and use as an intravenous energy source. J. Parenteral Enteral Nutri., 7(5): 479-488.

Terblanche, S. E.; Fell, R. D.; Juhlin-Dannfelt, A. C.; Craig, B. W.; and Holloszy, J. O., 1981. Effects of glycerol feeding before and after exhausting exercise in rats. J. App. Physiol., 50(1): 94-101.

Thompson, J. C.; and He,B.B.,2006. Characterization of crude glycerol from biodiesel production from multiple feedstocks. App. Engineering Agric., 22(2):261-265.

Umbreit, W. W.; Burris, R. H.; and Stanffer, J. F., 1972. Manometric and biochemical techniques, 5th Edition, puplished by Durgess Company,USA. pp 1-19.

Wasley, G. D., 1972. Animal tissue culture advanced in technique, 1st Edition, published by the Williams and Wilkins Company Boltimore, England.

Crude glycerin - Liver metabolism - Liver glycogen - Japanese quail.

Yalcin, S.; Erol, H.; Ozsoy, B.; Onbasılar, I.; Yalcın, S.; and Uner, A., 2010. Effects of glycerol on performance, egg traits, some blood parameters and antibody production to SRBC of laying hens. Livest. Sci., 129(1): 129-134.

الملخص العربى

تأثيرالجلسرين الخام فى الغذاء على أيض الكبد فى السمان اليابانى

هشام محمد صالح شكرى؛ عبدالرفيع أحمد الشافعى؛ محمد عبد المنعم الجمل؛ رشدى أحمد أبوسالم

قسم الإنتاج الحيوانى- كلية الزراعة – جامعة الأزهر– مدينة نصر – القاهرة – جمهورية مصر العربية

تم استخدام الجلسرين الخام كمصدر للطاقة بديل لطاقة الذرة فى علائق السمان اليابانى خلال فترة النمو وإنتاج البيض لدراسة تأثيره على التمثيل الغذائى فى الكبد؛ فى التجربة الأولى (تجربة السمان النامى) تم استخدام عدد 180 طائر من السمان اليابانى حديث الفقس فى دراسة لمدة 6 أسابيع. تم تقسيم الطيور عشوائياً إلى أربعة معاملات وتم تقديم أربعة مستويات من الجلسرين الخام (صفر% و 5% و10% و 15%) و تنقسم كل مجموعة إلى ثلاثة مكررات كل مكررة تحتوى على 15 طائر. فى التجربة الثانية (تجربة السمان البياض) تم استخدام عدد 72 طائر من السمان اليابانى عمر 6 أسابيع فى دراسة لمدة 10 أسابيع. تم تقسيم الطيور إلى أربعة معاملات بنفس المستويات من الجلسرين الخام وتحتوى كل معاملة على ثلاثة مكررات كل مكررة تحتوى على 6 طيور(4 إناث و2 ذكر).

أظهرت النتائج زيادة فى نسبة دهن الكبد بينما إنخفض محتوى الكبد من الجليكوجين وكذلك إنخفض معدل الأكسجين المستهلك لخلايا الكبد مع زيادة مستويات الجلسرين الخام فى تجربة السمان النامى والبياض. كما أظهرت النتائج فى القطاعات الهستولوجية للكبد إرتفاع محتوى الكبد من الدهون (الكبد الدهنى) بزيادة مستويات الجلسرين الخام فى الغذاء فى تجربة السمان النامى والبياض.

وتوصى الدراسة بأنه يمكن إضافة الجلسرين الخام إلى علائق السمان اليابانى النامى والبياض حتى مستوى 5% بدون أى تأثيرات عكسية على أيض الكبد بينما الزيادة عن ذلك تؤدى إلى تأثيرات عكسية على أيض الكبد.