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Studies on Crude Glycerin as Alternative Energy Source in Poultry Diets

B.H. Mousa, Hebat-Alla A.A. Alhamdani[1], Ahlam M. Awad, Husam H. Nafea and Adel A. Alhamdani

College of Agriculture, University of Anbar, Iraq
[1]Education College for Women, University of Anbar, Iraq
E-mail: Ag.baraa.hameed@uoanbar.edu.iq

Abstract: This study was aimed to study the possibility of using glycerin (biodiesel by product) as alternative energy source in broiler diets and effects on productive performance, blood parameters, carcass traits and organ weights. Two-Hundred forty broiler chicks (Ross 308), one day old were divided to five groups (0, 2.5, 5, 7.5, and 10% supplemented with crude glycerin from 1 to 42 days). Diets were formulated Iso-nitrogenous and iso-caloric to meet the requirements of birds and nutrition was *ad libitum*. There were no significant differences between groups fed on different diets with different level of glycerin and control diet without crude glycerin. Birds with 5% glycerin at 14 days recorded highest body weight with better feed conversion ratio during over all experimental period while birds with 10% crude glycerin recorded lowest body weight with low feed conversion ratio. The results of biochemical traits indicated no significant differences between treatments in total protein, albumin, globulin, glucose, HDL, VLDL, ALP, ALT and AST Enzymes at 42 days. The birds in group 2 (addition 2.5% crude glycerin) recorded lowest triglycerides, while group 3 (addition 2.5% crude glycerin) lowest total cholesterol and low density lipoproteins. No significant differences was observed between treatments in relative weights of hot carcass yield, liver, kidney, proventiculus, gizzard, heart, pancreas, spleen and bursa, while significant decrease were observed in relative weights of abdominal fat of birds fed on diets with crude glycerin as compared with control. The diets supplementation with 5% crude glycerin can be used as an alternative source of energy, especially from 0 to 21 day.

***Keywords*:** Crude glycerin, Productive performance, Carcass, Broiler

Energy sources represent the largest nutritional needs and represent the largest proportion of feed costs, and accordingly, the biological value of the feed depends on the amount of energy it contains and also on the energy relationship with other food components in the feed such as the protein and energy relationship, which is considered one of the most important nutritional relationships and on the basis of which the feed is formed. Feed must contain the minimum amount of energy that is appropriate to the bird's age, type and production, due to its effect on the productive performance of birds (summers and Lesson 2005, Plumstead 2008). Raw glycerin is a by-product from oil extraction and biofuel production process, which has increased dramatically in recent years (ANP 2015). Glycerin is considered one alternative energy sources because it has good total energy content (4320 kcal/kg). The raw glycerin contains pure glycerol at (80-95%) and because of the high energy values of this compound and attention is drawn to the possibility of using it in animal feeding (Chanjula et al 2014, Guiomar et al 2017, Hyeok et al 2017). The raw materials for production biofuels can be vegetable oils (cotton seeds, peanuts, canola, palms, sunflowers, soybeans, etc.) and animal fats (such as fish oil, animal grease and Tallow) or even fat waste from domestic, commercial or industrial processing (Van Gerpen et al 2005, Thompson and He 2006, ANP 2015). The type of raw materials and the biofuel production process affect the formation and quality of raw glycerin (Hansen et al 2009). About 10% of the production of crude glycerin is associated with the production and manufacture of oils, for every three moles of ethyl esters, one mole of raw glycerin is produced (Karinen and Krause 2006, Pagliaro and Rossi 2008, Rahmat et al 2010, Lenardão et al 2017) and increase Biofuel production every year and thus increasing the production of raw glycerin opens up prospects for its potential in chemical and industrial production (ANP 2015). Henz et al (2014) indicated that protein, lipid and dry matter were not significantly affected in broiler carcasses fed on diets supplemented with raw glycerin. Moreas et al (2016) explained that adding pure glycerin to drinking water did not significantly affect on characteristics and productive performance of birds during hot and temperate climates. Da Silva et al (2017) did not indicate any significant differences between control treatment and treatments included adding pure glycerin in broiler diets on the productive performance and ratio of protein, fat, moisture in meat and carcass. Roll et al (2018) did not notice any significant effect on deposition of

saturated and unsaturated fatty acids in carcasses fed on diets based on palm oil supplemented with crude glycerin. Mousa et al (2019) mentioned no negative effects by addition crude glycerol to broiler diets on productive performance and physiological traits. Also, Farhan et al (2019) mentioned that fat source play a primary role in metabolizable energy of broiler diets. Therefore, this study aimed to verify the possibility of adding raw glycerin in broiler diets as an alternative source of traditional energy sources and its effect on productive performance, some biochemical traits, internal organ weight and carcass yield.

MATERIAL AND METHODS

This study was conducted at University of Anbar. Two hundred–forty, one-day old unsexed Ross (308) chicks with average weight 38 gm. randomly distributed to five treatments with four replicates per treatment (12 chicks / replicate). The experimental treatments included control, second, third, fourth and fifth treatments fed basal diet with glycerin at (2.5, 5, 7.5 and 10 percent) respectively. The birds fed diets formulated to meet birds requirements based with guide of breed. Diets were iso-caloric and iso-nitrogenous (NRC, 1994). Broilers were fed in three phases feeding program starter, grower and a finisher diets. The crude glycerin was extracted from soybean oil as an initial substrate at Ministry of Science and Technology laboratory (Baghdad) and its composition was analyzed and in a commercial laboratory (Table 1).

Each replicate (pen) was supplemented with manual feeder and an automatic nipple drinker, feeds and water were *ad libitum.* The diets and chemical composition are mentioned in Tables 2, 3 and 4. Crude glycerin was supplemented with 2.5, 5, 7.5 and 10% in diets 2nd, 3rd, 4th and 5th treatments respectively. All birds were individually weighed and Feed consumption was recorded weekly. Based on data recorded, body weight gain (BWG), feed consumption (FC) and feed conversion ratio (FCR) were calculated. On day 42 of age eight birds from each treatment randomly selected, blood samples were collected from brachial vein to determined biochemical traits which included (total Proteins, total Albumin, total Globulin, Triglycerides, Cholesterol, HDL, LDL, VLDL, AST, ALT, ALP. After blood test the birds allowed to fasting for 10 hours and internal organs (liver, kidney, proventriculus, gizzard, heart, pancreas, abdominal fat, spleen and bursa) were weighed.

Statistical analysis: Data was analyzed by Statistical Analysis System (SAS) (2012) to study the effect of different factors on the characteristics were compared by Duncan (1955) multiple-range test.

Table 1. Chemical composition of crude glycerin

Characteristics	Per cent
Glycerol	86.88
Dry matter	72.61
Crude protein	0.44
PH	1.68
Moisture	9.21
Ash	3.18
Methanol	0.026
Crude fat	0.13
Sodium	1.27
Sodium chloride	3.8
ME kcal/kg	3624

*Chemical analysis of crude glycerin were determined according to A.O.A.C (2000)

RESULTS AND DISCUSSION

The effect of substitute of crude glycerin on productive performance at 14 days of age, indicated that birds fed diets supplemented with 5% crude glycerin increased significantly the live body weight than birds fed diets supplemented with 2.5, 7.5 and 10% crude glycerin. Moreover, birds fed on diets supplemented with 5, 7.5 and 10% crude glycerin recorded highest values in feed consumption as compared with birds fed diet with 2.5% crude glycerin. The birds fed control diet and T3 (5% crude glycerin) showed higher in feed conversion ratio as compared with birds fed diets supplemented with 2.5, 7.5 and 10% crude glycerin at 14 days of birds age. The productive performance indicated no significant differences in live body weight gain or feed conversion ratio at 28 days of age. The T3 (adding 5% crude glycerin) recorded highest values in feed consumption as compared with T1 or other treatments at 28 days of age. The increasing in feed consumption may be due to sweet taste of crude glycerin that improved consistency of feed, it can increase diets consumed and be more efficient absorbed in animals intestine (Min et al 2010). The glycerol considered a large component of crude glycerin, and that could be decrease the passage of nutrient in digestive interact and increasing utilization in small intestine and that may be refer useful from energy uptake in animals. However, at 42 days of age production performance characteristics live body weight gain, feed consumption and feed conversion ratio were not affected by addition of crude glycerin. The results of this study were in agreement with of Waldroup (2007) and Abd-Elsamee et al (2010) who mentioned that addition crude glycerin to feeds did not affect in productive performances at 5 or10% crude glycerol in broiler diets as an energy source replaced with yellow corn.

Table 2. Ingredient and chemical analysis of starter diets

Ingredients	Percent				
Maize	58.62	55.6	52.5	49.4	46.4
Soybean (48%)	32.5	33	33.6	34.2	34.7
Animal protein *	5	5	5	5	5
Crude glycerin	–	2.5	5	7.5	10
Sunflower oil	1.5	1.5	1.5	1.5	1.5
Limestone	1.28	1.3	1.34	1.34	1.34
Dicalcium phosphate	0.3	0.3	0.3	0.3	0.3
DL-methionine	0.53	0.53	0.53	0.53	0.53
Lysine	0.15	0.15	0.11	0.11	0.11
Salt	0.12	0.12	0.12	0.12	0.12
Total	100	100	100	100	100
Chemical composition, calculated**					
M.E. (kcal/kg)	2998	2998	2998	2998	2998
Crude protein %	22.5	22.5	22.5	22.5	22.5
Fat	4.3	4.2	4.1	4.0	3.9
Crude fibre	2.7	2.6	2.6	2.5	2.5
Meth. + Cyst.	1.03	1.03	0.98	0.98	0.97
Lys.	1.40	1.41	1.42	1.43	1.43
Calcium	0.92	0.93	0.95	0.95	0.95
Available phosphorus	0.45	0.45	0.45	0.44	0.44

* (Protein concentrate contains) : 40.5% C.P 5%, Ca3.6%, Methionine 4.11% ,Methionine and Cystine 3.84% , Lysine 4.67%, Metabolizable Energy 2104 Kcal/kg 2.50 mg. Sodium, 1.70 mg. threonine 0.42mg, Tryptophan, 4.20 mg choline and each 1 kg of concentrate contains: 100000 IU vitamin A: 33000; IU vitamin D3 100 mg., vitamin E 2.55 mg. ; vitamin K3, 25 mg. ; vitamin B1 10 mg.; B2 50 mg.; vitamin B6 24 mg. , vitamin B12, 51; mg niacin; 1.5 mg.; folic acid , 15 mg.; biotin;500 µg. and 13.5 mg. pantothenic acid
**Calculated based on feed intake Tables of National Research Council (1994)

Table 3. Ingredient and chemical analysis of grower diets

Ingredients	Percent				
Maize	64.8	61.8	58.7	55.7	52.5
Soybean (48%)	26	26.5	27.1	27.6	28.3
Animal protein *	5	5	5	5	5
Crude glycerin	–	2.5	5	7.5	10
Sunflower oil	2.1	2.1	2.1	2.1	2.1
Limestone	1.35	1.35	1.35	1.35	1.35
Dicalcium- phosphate	0.1	0.1	0.1	0.1	0.1
DL-methionine	0.35	0.35	0.35	0.35	0.35
Lysine	0.15	0.15	0.15	0.15	0.15
Salt	0.15	0.15	0.15	0.15	0.15
Total	100	100	100	100	100
Chemical composition, calculated**					
M.E. (kcal/kg)	3101	3101	3101	3101	3101
Crude protein %	20.0	20.0	20.0	20.0	20.0
Fat	5.1	5.0	4.9	4.7	4.6
Crude fibre	2.5	2.5	2.5	2.4	2.4
Meth. + Cyst.	0.96	0.96	0.96	0.95	0.95
Lys.	1.25	1.25	1.26	1.27	1.28
Calcium	0.89	0.89	0.89	0.89	0.89
Available phosphorus	0.40	0.40	0.40	0.40	0.40

* See table 2 for details

Table 4. Ingredient and chemical analysis of finisher diets

Ingredients	Percent				
Maize	65.6	62.6	59.5	56.4	53.39
Soybean (48%)	23.8	24.3	24.9	25.5	26
Animal protein *	5	5	5	5	5
Crude glycerin	–	2.5	5	7.5	10
Sunflower oil	3.5	3.5	3.5	3.5	3.5
Limestone	1.25	1.25	1.25	1.25	1.25
Dicalcium -phosphate	0.3	0.3	0.3	0.3	0.3
DL-methionine	0.35	0.35	0.35	0.35	0.35
Lysine	0.11	0.11	0.11	0.11	0.12
Salt	0.09	0.09	0.09	0.09	0.09
Total	100	100	100	100	100
Chemical composition, calculated**					
M.E. (kcal/kg)	3200	3200	3200	3200	3200
Crude protein %	19.0	19.0	19.0	19.0	19.0
Fat	6.5	6.4	6.3	6.1	6.0
Crude fibre	2.5	2.4	2.4	2.3	2.3
Meth. + Cyst.	0.90	0.89	0.89	0.88	0.89
Lys.	1.14	1.14	1.15	1.16	1.17
Calcium	0.85	0.85	0.85	0.85	0.85
Available phosphorus	0.40	0.40	0.40	0.40	0.40

*See table 2 for details

Table 5. Inclusion biodiesel by-product (crude glycerin) as an alternative energy source on body weight gain, feed consumption and feed conversion ratio of broiler

Items	Glycerin Inclusion (%)					SEM	P-value
	0	2.5	5	7.5	10		
Starter							
BWG (g)	330 ab	317 b	338 a	326 b	325 b	8.42	0.4715
FC (g)	362 ab	360 b	372 a	375 a	371 a	6.93	0.0622
FCR	1.12 b	1.14 ab	1.11 b	1.16 a	1.15 a	0.04	0.4533
Grower							
BWG (g)	791	790	809	756	766	26.68	0.2418
FC (g)	1429 b	1451 ab	1469 a	1457 ab	1455 ab	17.89	0.6271
FCR	1.82	1.84	1.82	1.93	1.91	0.04	0.1635
Finisher							
BWG (g)	1341	1368	1357	1381	1348	36.06	0.5218
FC (g)	2339	2372	2395	2343	2367	23.29	0.7857
FCR	1.75	1.75	1.77	1.71	1.76	0.05	0.5431
0-42 day							
BWG (g)	2460	2473	2503	2461	2437	36.32	0.0515
FC (g)	4127	4181	4233	4180	4191	35.73	0.7263
FCR	1.69	1.70	1.70	1.71	1.73	0.02	0.0173

*Means in same rows with different superscripts is differs significantly (P< 0.05)

The broiler feed supplemented with crude glycerin at 5-10% had no side effect on productive performance and that may be refer with economic evaluation due to high prices of feeds, and crude glycerin prices is decrease with overproduction in most the world.

Effect of supplementation of crude glycerin with different levels on some blood biochemical indicated that addition of crude glycerin to diets had no significant effect in protein, globulin, albumin, glucose, total cholesterol, high density lipoprotein, very low density lipoprotein, low density lipoprotein, GOT, GPT and alkaline phosphate (Table 6). The birds fed on diets crude with glycerin with 5% recorded significant decrease in cholesterol, triglycerides , low density lipoprotein as compared with control and decrease may be due to crude glycerin improve lipogenesis in storage tissues by circulating of triglycerides in blood. Abd-Elsamee et al (2010) also observed that birds received diets with 2, 4, 6 and 8% glycerol had not affect on some blood biochemical parameters. However, different finding in glycerin supplemented poultry diets might be due to glycerin species, glycerin used, composition of diets, levels of glycerin addition in diets and the duration of supplementation.

The inclusion of crude glycerin to diets did not affect internal organ weights of birds, except for abdominal fat. The levels 2.5, 5, 7.5 and 10% of crude glycerin had no negative effect on hot carcass yields, liver, kidney, proventriculus, gizzard, heart, pancreas, spleen or bursa weights**.** The relative weights of some internal organs, such as heart and liver, are known to be related with body weight. In present study the differences were not based on feeding crude glycerin**.** Abd-Elsamee et al (2010) observed that broilers consumed diets with different levels of glycerol did not differ with birds fed basal

Table 6. Inclusion biodiesel by-product (crude glycerin) as an alternative energy source on some blood biochemical parameters of broiler

Item	Glycerin Inclusion (%)					SEM	P-value
	0	2.5	5	7.5	10		
Protein (gm/dl)	3.76	3.69	3.36	3.39	3.47	0.25	0.24
Albumin (gm/dl)	1.93	2.12	1.73	1.92	1.89	0.19	0.28
Globulin (gm/dl)	1.84	1.58	1.64	1.48	1.59	0.15	0.33
Glucose (mg/dl)	186.84	192.6	188.6	188.3	196.9	10.71	0.74
Triglycerides (mg/dl)	135.8 a	120.1 b	127.3 ab	141.5 a	129.6 ab	14.13	0.77
Cholesterol (mg/dl)	152.1 a	135.9 ab	128.2 b	144.3 a	146.9 a	6.76	0.19
HDL (mg/dl)	47.6	51.4	48.0	52.7	53.4	2.71	0.25
LDL (mg/dl)	77.5 a	60.7 b	54.8 b	63.5 ab	67.8 ab	7.63	0.15
VLDL (mg/dl)	27.15	23.99	25.45	28.29	26.0	3.45	0.23
ALP (U/L)	355.8	335.6	342.4	403.4	367.2	14.34	0.19
ALT (U/L)	6.68	6.34	7.01	7.34	7.68	4.59	0.73
AST (U/L)	162.00	173.68	164.34	161.00	171.68	0.68	0.82

Table 7. Inclusion biodiesel by-product (crude glycerin) as an alternative energy source on carcass yield and internal organ (%) of broiler

Item	0	2.5	5	7.5	10	SEM	P-value
Hot carcass yield	77.8 *	77.0	76.9	74.0	74.9	0.74	0.240
Liver	1.76	1.65	1.60	1.72	1.79	0.14	0.829
Kidney	0.14	0.13	0.13	0.12	0.12	0.04	0.463
Proventriculus	0.426	0.414	0.421	0.414	0.454	0.07	0.908
Gizzard	1.966	1.890	1.881	2.013	1.937	0.13	0.925
Heart	0.427	0.489	0.457	0.413	0.434	0.04	0.999
Pancreas	0.225	0.215	0.234	0.228	0.242	0.062	0.936
Abdominal fat	2.11 a	2.03 ab	1.98 b	1.92 bc	1.89 c	0.30	0.37
Spleen	0.12	0.14	0.12	0.14	0.13	0.06	0.69
Bursa	0.15	0.12	0.14	0.11	0.12	0.06	0.98

*Means in same rows with different superscripts is differs significantly (P< 0.05)

diet for dressing percentage, the relative weight of internal organs, weight of immune organs. Topal and Ozdogan (2013) also concluded that addition of crude glycerin 40 or 80 g/kg feed did not affect on internal organ weights of broilers (unsexed). Some previous studies were in contrast with our results. Coşkun (2007) observed that gizzard, heart, and liver percentage weights of broilers fed a diet with glycerol 50 g/kg were lower than control group. Jasim and Mousa (2018) reported that broiler fed diets supplemented with crude glycerol had no effect on relative weights of internal organs (liver, heart, gizzard, bursa and Proventriculus). Mousa et al (2018) noticed that significant decrease in abdominal fat of broiler fed crude glycerol with 0 and 10%. Moreover, crude glycerin had the ability to decrease rate of fatty acid synthesis and lipogenesis enzymes activity in liver and tissues.

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