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RESEARCH ARTICLE

Effects of Graded Levels of Crude Glycerine Addition to Diets on Growth Performance, Carcass Traits and Economic Efficiency in Broiler Chickens [1][2]

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Summary

The aim of the current study was to evaluate the effects of graded levels of crude glycerine addition to diets on growth and economic performance, carcass yield, organ weights and moisture levels of meat in broiler chickens. For this purpose, a total of 270 one day old male chicks (Ross 308) were randomly divided into 3 equal groups which fed with isocaloric and isonitrogenous diets with graded levels (0%, 5% and 10%, respectively) of crude glycerine. Each of experiment group was constituted by 5 subgroups with 18 birds each. The birds had ad libitum access to feed and water until termination of the experiment at d 42. Results indicated that 5% dietary crude glycerine addition improved body weight, body weight gain and feed conversion ratio compare with birds fed with basal diet at d 42 ($P<0.01$). Similarly, dietary 10% crude glycerine supplementation also increased growth performance and improved FCR in broiler chickens at 28th and 42nd days of experiment ($P<0.05$ and $P<0.001$, respectively). Moreover, birds fed with 5% dietary crude glycerine had showed over 20% higher relative economic efficiency compare than birds fed basal diet. As a conclusion, dietary crude glycerine addition improved growth and economic performance and Feed Conversion Ratio of broilers in both supplementation levels.

Keywords: *Broiler, Carcass, Economic efficiency, Glycerine, Growth performance*

Rasyona Artan Düzeylerde Ham Gliserin İlavesinin Broylerlerde Büyüme Performansına, Karkas Özelliklerine ve Ekonomik Etkinliğe Olan Etkileri

Özet

Bu araştırmanın amacı, rasyona artan düzeyde ham gliserin ilavesinin broylerlerde büyüme ve ekonomik performans, karkas randımanı, iç organ ağırlıkları ve etin nem düzeyi üzerine etkilerinin belirlenmesidir. Bu amaçla toplam 270 adet bir günlük yaşta erkek broyler civciv (Ross 308) her biri izokalorik ve izonitrojenik olan ve artan düzeylerde (sırasıyla %0, %5 ve %10) ham gliserin içeren yemlerle beslenen üç eş gruba ayrılmıştır. Her bir deneme grubu her biri kendi içinde 18 adet civciv içeren 5'er alt gruba ayrılmıştır. Hayvanlar denemenin sonlandığı 42. güne kadar yem ve suya ad libitum olarak ulaşmışlardır. Deneme sonunda %5 düzeyinde ham gliserin ilavesinin canlı ağırlık, canlı ağırlık artışı ve yemden yararlanma oranlarını bazal rasyonla beslenen hayvanlara göre önemli ölçüde iyileştirdiği belirlenmiştir ($P<0.01$). Benzer olarak rasyona %10 düzeyinde ham gliserin ilavesi denemenin 28. ve 42. günlerinde büyüme performansını arttırmış ve yemden yararlanma oranını iyileştirmiştir (sırasıyla, $P<0.05$ ve $P<0.001$). Buna ilaveten, %5 ham gliserin ile beslenen hayvanlar bazal rasyonla beslenenlere göre %20 daha yüksek göreceli ekonomik etkinlik göstermiştir. Sonuç olarak rasyona ham gliserin ilavesi, her iki düzeyde de, broylerlerde büyüme ve ekonomik etkinlik ile Yemden Yararlanma Oranı'nı iyileştirmiştir.

Anahtar sözcükler: *Broyler, Büyüme performansı, Ekonomik etkinlik, Gliserin, Karkas*

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INTRODUCTION

In poultry industry, because of increasing prices of energy rich feedstuffs, there is remarkable effort for searching of energy alternatives for chicken diets. In this content, researchers focus on the use glycerine as a less expensive energy source in poultry diets [1]. Glycerine, also known as glycerol or glycerin, is a by-product of biodiesel production and usage of this product as an energy source for animal diets has been got attention in recent years [2-4]. Glycerine has been evaluated for poultry as a feed ingredient which provides energy for cellular metabolism [5-9]. Moreover, several studies have been performed for understanding effects of dietary glycerine addition on performance in broiler chickens [4,7-9], quails [10], and laying hens [11]. Simon et al.[7] observed that dietary glycerol addition at level of 5 and 10% had improving effect on body weight gain, feed intake and feed efficiency similar to Suchy et al.[12] who evaluated that effect of pure and raw glycerol addition to diet on production parameters and slaughter traits in male and female broiler chickens. They found that birds fed diet with glycerol had signicantly higher body weight, feed intake and carcass trait compare with birds fed with basal diet. On the other hand, Cerrate et al.[9] reported that feed intake and body weights of birds were decreased with 10% glycerine addition to diets in broilers. However authors stressed that addition of glycerine to diets at a level of 5 and 2.5% had improvement effect on breast yield as a percentage and dressed carcass of birds.

Even though pure glycerine can be used in many different applications including food, cosmetic, drug and weapon industries, and generally recognized as safe for use in animal feed usage of crude glycerine, which find a place to itself in animal feeds recently, has some concern about residual level of methanol sodium, fatty acid and moisture content in it [3,9,11]. In this point, because of contradiction results from different studies about the effect of dietary glycerine addition on performance and carcass characteristics in broiler chickens, and insufficient number of study about the usage of crude glycerine in diets of birds; the aim of present trial was evaluated the effect graded level of dietary crude glycerin on growth and economic performance, carcass yield, organ weights and moisture levels of meat in broiler chickens.

MATERIAL and METHODS

In this experiment, 270 one-day-old male Ross 308 broiler chicks were randomly divided into 3 groups according to the dietary regimen and each group was constituted by 5 subgroups of 18 birds.

The experimental protocol was approved by Local Ethics Committee of Selcuk University.

In the control group, chickens were fed with basal standard diets based on corn and soybean meal by recommendations of NRC [13], more specifically with a starter diet [23% crude proteins (CP) and 3100 kcal/kg metabolically energy (ME)] for the first 10 d of trial then with a grower diet [22% CP and 3150 kcal/kg ME] for the between 11 to 28 d of experiment, and then with a finisher diet [21% CP and 3200 kcal/kg ME] for the 3rd and the last 14 days of trial *(Table 1)*. Birds from the groups 2 and 3 received standard diets supplemented with 5% or 10% glycerol, respectively for the whole experimental period. Feed and water were provided *ad libitum*. The birds were housed in wire-bottomed pens fitted with electrical heaters during the 42 days experimental period. The temperature started at 33°C (from the 1st day to the 3rd day) and was gradually reduced (2-3°C/week) according to normal management practice. Chicks were maintained on a 24 h constant light schedule until the end of the experiment.

Body weights were determined by pen on days 1, 14, 28 and 42 and feed intakes were measured during each rearing period. Similarly, the cumulated body weight gains (expressed as g/bird and calculated body weight differences of birds from the 1st day to the 14th, 28th and 42nd days, respectively) and feed conversion ratios (expressed as g of consumed feed/weight gain in g) were calculated for each rearing period. On the day 42, 3 birds from each pen for which the body weight was closed to the mean value were slaughtered by cervical dislocation. The weight of the carcass, liver, spleen, gizzard, heart, glandular stomach and cloacal fat were recorded and all values were expressed as percentages of the carcass weight for a same bird. The duodeno-jejunal contents were collected from 3 other birds from each pen slaughtered on the d 42 and the samples were diluted with deionised water for determine pH levels of intestine.

By the end of trial, experiment groups were economically evaluated by using two procedures with a help of consideration the costs of feeds, labor, equipments, nursing and chicken meat from actual market prices; one of them was the total cost needed to obtain one-kilogram carcass weight and second was the net revenue per unit of total.

Data from present study were analyzed by Anova using SPSS 11.50 program (Inc., Chicago, II, USA). Significant differences among treatment were determined using Duncan's multiple range tests [14] with a 5% level of probability.

RESULTS

The growth performance and the feed intakes in broilers according to the dietary treatments are summarized in the *Table 2*. The body weights (BW) and the body weight

Table 1. *Feedstuffs and nutrient composition of experiment diets*
Tablo 1. *Deneme rasyonlarının yem ham madde içerikleri ve besin madde değerleri*

Ingredients	Feeding Stage								
	Starter (0 to 10 d)			Grower (11 to 28 d)			Finisher (29 to 42 d)		
Crude glycerin[1]	0	5	10	0	5	10	0	5	10
Corn	52.33	46.33	40.38	54.13	48.13	42.13	54.8	48.73	42.63
Soybean meal	32	33.05	34.00	31	32	33	31.13	32.2	33.3
Gluten	7	7	7	6.5	6.5	6.5	5	5	5
Vegetable oil	4	4	4	4.5	4.5	4.5	5.5	5.5	5.5
Limestone	1	1	1	0.9	0.9	0.9	0.9	0.9	0.9
DCP	2.25	2.25	2.25	2	2	2	2	2	2
Salt	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Vitamin mix[2]	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Mineral mix[3]	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
Methionine	0.35	0.35	0.35	0.2	0.2	0.2	0.1	0.1	0.1
Lysine	0.50	0.45	0.45	0.2	0.2	0.2	0	0	0
Total	100	100	100	100	100	100	100	100	100
Calculated Analyses									
CP	23	23	23	22	22	22	21	21	21
ME	3107	3106	3107	3152	3153	3153	3201	3201	3200
Ca	1.02	1.03	1.03	0.92	0.93	0.93	0.92	0.93	0.93
Avail. P	0.50	0.50	0.50	0.46	0.46	0.46	0.46	0.46	0.46
Met+sist.	1.13	1.12	1.11	0.96	0.95	0.94	0.82	0.82	0.81
Lizin	1.46	1.44	1.45	1.2	1.21	1.22	1.03	1.04	1.06

[1] Chemical composition of crude glycerin; 4.13% ash, 0.17% salt, 9.11 pH, and 0.45% methanol; [2] Vitamin premix supplied the following per kilogram of diet: vit-A 15.000 IU, vit-D_3 5.000 IU, vit-E 50 mg, vit-K_3 10 mg, vit-B_1 4 mg, vit-B_1 8 mg, vit-B_6 5 mg, vit-B_{12} 0.025 mg, niacin 50 mg, pantothenic acid 20 mg, folic acid 20 mg, biotin 0.25 mg, vit-C 75 mg, kolin 175 mg ; [3] Mineral premix supplied the following per kilogram of diet: Mn 100 mg, Zn 150 mg, Fe 100 mg, Cu 20 mg, I 15 mg, Co 0.5 mg, Se 0.2 mg, Mo 1 mg, Mg 50 mg

gains (BWG) during the first 14 d of experiment showed no significant variance among treatment groups, whereas, BW were significantly increased in birds fed with 5% and %10 crude glycerine (CG) supplemented diet compared to bird fed with basal diet at 28 and 42 days of experiment ($P<0.05$ and $P<0.01$, respectively). Furthermore, the mean of BW and BWG results cumulated over the whole experimental period (1 to 42 d) were markedly increased in graded level CG supplemented broilers ($P<0.05$ and $P<0.01$, respectively). On the other hand, although the differences were not significant among groups, the highest feed intakes (FI) for the all periods (starter, grower and finisher) were also observed in birds supplemented with 5% CG. Feed conversion ratio (FCR) was not significantly altered in the CG supplemented birds compared to the controls at d 14 while it improve by 5% and 10% CG addition at 28^{th} and 42^{nd} days of experiment ($P<0.001$ and $P<0.01$, respectively).

As shown in *Table 3*, the carcass traits (including carcass yields, moisture of breast and drumstick), the relative organ weights (100 x organ weight/carcass weight) and intestinal pH levels were summarized. Even though there were no significant variances in carcass traits according to the 3 dietary regimens, the lowest carcass yield was recorded for birds supplemented with 10% CG but differences among treatments were not significant. The relative gizzard ($P<0.05$) weights were significantly decreased in birds supplemented with 10% CG compared to birds fed with basal diet. By contrast, cloacal fat percentages (not significant) were higher in 10% CG supplemented broilers than control group birds. Intestinal pH levels showed no significant differences between treatment groups, however supplemented birds (5% and 10% glycerine, respectively) present more alkaline pH compare with birds fed with basal diet.

The results for economic evaluation of graded level of dietary CG inclusion was summarize in *Table 4*. Our finding indicated that 5% dietary CG supplementation had improving effect on relative economic efficiency (REEF) in broiler chickens. Chicks fed with 5% dietary CG showed over 20% higher results then birds fed with basal diet. On the other hand when CG level increased (to 10%) REEF of chickens decreased over 5% than birds fed without any CG addition in their diets.

Table 2. *Effects of dietary graded levels of crude glycerin (CG) supplementation on growth performance of broiler chickens*
Tablo 2. *Rasyona artan düzeylerde ilave edilen ham gliserinin (HG) broylerlerde büyüme performansına etkileri*

Treatment	Day 1	Days 1 to 14				Days 1 to 28				Days 1 to 42			
CG level (%)	BW, g	BW, g	BWG, g	FI, g	FCR[1]	BW, g	BWG, g	FI, g	FCR[1]	BW, g	BWG, g	FI, g	FCR[1]
0	46.21	362.56	316.35	427.39	1.35	1112.60[b]	1066.39[b]	1751.33	1.64[a]	2110.73[b]	2064.52[b]	3734.48	1.81[a]
5	46.12	373.03	326.92	430.28	1.32	1221.96[a]	1175.84[a]	1794.29	1.53[b]	2282.20[a]	2242.09[a]	3813.86	1.70[b]
10	46.14	359.72	313.59	408.28	1.30	1198.17[a]	1152.03[a]	1702.24	1.48[b]	2228.90[a]	2182.77[a]	3649.83	1.67[b]
SEM[2]	0.17	3.74	3.76	5.34	0.01	18.67	18.65	16.94	0.02	25.75	25.75	31.27	0.02
P	NS	NS	NS	NS	NS	*	*	NS	***	**	**	NS	**

*[1] **FCR** = Feed conversion ratio was calculated by dividing feed consumption (g) to BW gain (g) per pen basis, [2] **SEM** = Standard error of the mean, **NS** = Not significant at P>0.05; * P<0.05; ** P<0.01; *** P<0.001, [a,b] Means within a treatment and column with different subscripts differ significantly*

Table 3. *Effects of dietary graded levels of crude glycerin (CG) supplementation on carcass yield (%), meat moisture levels (%), relative organ weights (g/100 g body weight), and intestinal pH in broiler chickens*
Tablo 3. *Rasyona artan düzeylerde ilave edilen ham gliserinin (HG) broylerlerde karkas randımanı (%), et nem düzeyleri (%), göreceli organ ağırlıkları (g/100 g canlı ağırlık) ve bağırsak pH üzerine etkileri*

CG Levels (%)	Carcass Yield	Moisture of Breast Meat	Moisture of Drumstick	Intestinal pH	Cloacal Fat Pad	Liver	Spleen	Heart	Gizzard	Glandular Stomach
0	74.92	75.92	77.04	6.28	1.34	2.09	0.11	0.46	1.41[a]	0.37
5	74.59	76.35	75.74	6.30	1.42	1.84	0.09	0.42	1.34[ab]	0.33
10	69.93	76.00	76.16	6.36	1.58	1.97	0.11	0.47	1.19[b]	0.34
SEM	1.29	0.12	0.31	0.03	0.09	0.05	0.01	0.01	0.03	0.01
P	NS	NS	NS	NS	NS	NS	NS	NS	*	NS

__NS__ = Not significant at P>0.0, [a,b] Means within a treatment and column with different subscripts differ significantly

Table 4. *Effects of dietary graded levels of crude glycerin (CG) supplementation on economic efficiency in broiler chickens*
Tablo 4. *Rasyona artan düzeylerde ilave edilen ham gliserinin (HG) broylerlerde ekonomik yararlanım üzerine etkileri*

Cost of Items (Per Bird)	Level of Dietary CG (%)		
	0	5	10
Fixed costs (TL)[a]	1.52	1.52	1.52
Feed cost (TL)	4.48	4.64	4.51
Total cost (TL)	6.00	6.16	6.03
Carcass weight (CW, kg)	1.58	1.71	1.56
Cost/kg CW (TL)	3.80	3.60	3.87
Total revenue (TL)[b]	8.69	9.41	8.58
Net revenue (TL)[c]	2.69	3.25	2.55
Relative economic efficiency[d]	100.00	120.82	94.80

a- *All stable prices (including transport, bird and poultry house costs) of whole rearing period for each bird,* ***b-*** *Assuming that the selling price of one kilogram carcass weight is 5.50 TL,* ***c-*** *Net revenue per unit total cost,* ***d-*** *Relative economic costs of treatments when costs of birds fed with basal diet assume 100%*

DISCUSSION

In present study, effects of CG (by-product of biodiesel industry) on the growth performance were evaluated in broiler chickens. It was determined that addition of CG into broiler diets at level of 5% and 10% showed significant promoting effects on growth performance (BW and BWG), particularly in the growing and finisher period of rearing. The growth performance was similar during the first 14 d of trial in broiler chickens, after than it showed remarkable increased for birds fed with graded level CG supplemented diets. This result might be related with AME_n of glycerine 10% higher than corn [13] so it is a replacement of carbohydrates in diet [15]. Similarly, FCR results also showed significant variances among treatments not starter but grower and finisher rearing period of experiment. Dietary 5% and 10% CG supplementation resulted in depression of FCR values compare birds fed with basal diet. For present trial, graded level of CG addition to diet had improvement effect on FCR in birds. However, the feed intake has not significantly differed between groups for the whole experimental period but it was slightly increased (not significant) in birds consume graded level of CG in their diets at d 42, probably, palatability increasing affect of CG. These findings showed positive correlation with number of studies [4,7,12,16] which have reported dietary glycerol supplementation had positive effects on growth performance in broiler chickens. Suchy et al.[12] substituted 50% of dietary soybean oil with pure and raw glycerol in a ratio of 1:2 in male and female broilers. They observed that BW of both male and female chickens in experimental groups was significantly higher than birds in control group at d15 and d40 of experiment (P<0.05, P<0.01, respectively). But contrary to our findings in present trial, they found that dietary glycerol addition in different forms (in pure and raw) had increasing effect on FI for whole 40d rearing period in broiler chickens.

Moreover, Simon et al.[7] also observed improvement effect of dietary glycerol at levels of 5% and 10% on BW and BWG in broiler chickens. These differences between studies probably related to variances of glycerol content especially metabolizable energy density of products.

The results from present trial were in disagreement with previous studies which have reported glycerol addition had negative [5] or no effects [1,8,9] on growth parameters in birds. Lin et al.[5] concluded that substitution of dietary energy source at a level of 42.2% with glycerol had significantly detrimental effects on FI. But Simon et al.[8] observed different level of dietary glycerol addition (from 5% to 25%) had no negative effect on FI and FCR in birds. Similarly, Cerreta et al.[9] found that birds fed diets with 10% glycerine addition showed significantly less FI than those fed diets with 0 or 5% glycerine and therefore had significantly reduced BW. On a contrary, Mclea et al.[16] observed that increasing level of glycerin addition had improving effect on FCR in birds. These incompatible results from different studies may be related to variances of dietary glycerol level or different content of glycerol, particularly varied methanol and fatty acid content of glycerol.

Although the 10% of dietary CG addition tended to decreased the carcass yield in the present study, we noticed that inclusion of CG in broiler diets had no significant effect on carcass traits (including moisture of drumstick and breast meat) and relative organ weights (except gizzard) with an agreement with previous studies [9,12]. In present trial, we also observed that the relative cloacal fat weight tended to increase in broilers fed with glycerol supplemented, especially at a level of 10% CG due to overestimation of metabolically energy assigned to glycerine [18]. Similarly, Lessard et al.[6] have also found out that inclusion of 5% glycerol had increased the cloacal fat pad weight. However, the variances among treatments had no statistical meaning for this finding for present trial. On the other hand, the relative gizzard weight ($P<0.05$) was significantly depressed in glycerol supplemented birds, especially at a level of 10% CG, compared to the control birds. These findings were in accordance with previous study in which Sehu et al.[4] have also observed significant depression of relative gizzard weight with 10% dietary glycerol addition in broiler chickens.

Results from economic evaluation indicated that dietary CG inclusion, especially at a level of 5% had improvement effect on REEF in broiler chickens. However, same tendency for REEF was not observed for birds fed with 10% CG included diets. Contrary, these birds showed lesser REEF results compare than birds fed without any dietary CG inclusion, probably cause of they represent same carcass weight like as control birds with more expensive diet costs. This finding showed partly agreement with Abd-Elsamee et al.[1] results, who found that increasing level of dietary glycerine addition, particularly at a level of 6%, had improvement effect of economic efficiency in broilers.

In conclusion, the results of the current study indicate that graded level (5% and 10%) crude glycerine addition to diets, especially 5% CG, had improvement effects on growth performance (BW, BWG) and FCR in broilers chickens. Moreover, birds fed with 5% dietary CG had present over 20% higher relative economic efficiency compare than birds fed basal diet. However, all other parameters, including carcass parameters and organ weights (except gizzard), were not significantly affected by dietary CG inclusion. As a result, this experiment indicates that graded level of CG inclusion, particularly at a level of 5% CG, could be effectively used in diets with higher profitability in broiler chickens.

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