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Research Article

EFFECT OF INCLUSION OF DIFFERENT LEVELS OF LIQUID CORN GLUTEN ON PERFORMANCE, CARCASS CHARACTERISTICS AND BLOOD PARAMETERS OF BROILER CHICKENS

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ABSTRACT

Experiment was conducted to evaluate the effect of inclusion of liquid corn gluten to broiler diet on growth performance, carcass characteristics and blood parameters. In a randomly complete design two hundreds (200) day old broiler chicks (Ross 308) were divided into 20 groups, ten chicks per group, and five experimental diets were formulated and each diet was given to four replicates from 1-42 days of age. Diets were fed to the chickens from 1-14 (starter), 15-28 (grower) and 29-42 (finisher) days of age. Liquid corn gluten was used at levels of Zero (control), 2.5, 5.0, 7.5 and 10 % in iso-caloric and iso-nitrogenous diets. Chicks had free access to feed and water and exposed to continuous light (22 h) during experimental period. Experiment was performed in 1*1 floor pens. Feed intake, body weight gain, was recorded and feed conversion ratio was calculated. The results indicated that liquid corn gluten at level of 5% had positive effect on body weight gain and feed conversion ratio, but reduced feed intake during starting, growing and finishing periods. Body weight gain was increased (P<0.05) and feed conversion ratio was reduced (P<0.05) due to added liquid corn gluten. Oven ready carcass, thigh and breast were significantly (P<0.05) affected due to liquid corn gluten and were increased. Added liquid corn gluten had significant (P<0.05) effect on blood cholesterol, glucose and were reduced due to 5% inclusion level. Overall, results showed that liquid corn gluten can be used in broiler diet without any negative effects on performance, carcass characteristics and some blood parameters.

***Keywords**: Liquid Corn Gluten, Broiler, Performance, Cholesterol, Glucose*

INTRODUCTION

The increasing trend of poultry production forced poultry producers to seek for cheaper and available raw materials resources. Plant and animal by-product from agriculture and industry sectors can be considered in this regard. One of these by-products which is a by-product of ethanol production is liquid corn gluten (LCG).

Historically LCG has primarily been fed to beef cattle; dairy animals include dairy sheep, swine and poultry (Rosentrater, 2012). The swine industry used nearly 10% of LCG, whereas the poultry industry used around 9% of total % LCG.

Liquid corn gluten can be substituted for corn and other energy sources for poultry (Salim *et al.*, 2010). LCG exists in two forms (dry and wet) and has unique characteristics. It is necessary to know more information about it’s nutritional value for poultry (Schroder, 2007).

LCG is a sub-production of wet mill. The process of milling starts with separation of corn seeds and after separation of external materials, the seeds is soaked in water and sulfur dioxide in order to be inflated. In this stage the obtained liquid separated and condensed (Schroder, 2007).

LCG is a by-product which is produced from residue and waste of ethanol processing plant (Salim, *et al.*, 1986). During fermentation process and yeast production, corn seeds mixed with water, then baked and produced liquid starch, in this stage, ethanol is produced (Rosentrater, 2005). The obtained compounds are rich in essential nutrients like protein, lipid, fiber, vitamins and minerals which exist in condensed form and called liquid corn gluten.

LCG is a suitable ingredient which can be used in poultry diets. Different factors including variation in corn composition and the materials which is added to LCG during processing may affect nutritional value and physical characteristics of LCG. (Martinez- Amezua *et al.*, 2007).

Reports indicated that, the amount of gross energy is depends on its fat content, but its digestible energy is different and it may be affected by non-starch polysaccharides present in LCG (Swiatkiewicz and Koreleski, 2008).

LCG contains 35% in-soluble fiber and 6% soluble fiber (Stein and Shurson, 2009). Its available phosphorus is 74% of total phosphorus (Kim *et al.*, 2008; Limpkins and Batal, 2004; Batal and Dale, 2003). High percentage of available phosphorus in LCG during ethanol production process is due to distillation and high temperature applied through drying of seeds (Dale and Batal, 2005).

Reports showed that LCG can be used between 5 to 20% in laying hens diet without any negative effect on egg production and egg weigh Lumpkins *et al.*, (2005). Researchers (Noll and Brown, 2005) reported that 20% LCG in s tarter and grower diets of turkey had not effect on performance.

MATERIAL and METHODS

Diets and Birds

In a completely randomized design, two hundreds (200) day-old mixed sex broiler chicks (Ross 308) were divided into 20 groups, 10 birds per group. Five iso-energetic, iso-nitrogenous experimental diets contained zero, 2.5, 5.0, 7.5 and 10 % liquid corn gluten were formulated (Table 1). Each diet was given to four replicates, with 10 chicks housed per floor pen. The diets were fed as starter (1-14 d), grower (15-28 d) and finisher (29-42 d). Liquid corn gluten was prepared from Glucosan Distiller factory, Iran (www.glucosan.ir).

The diets were fed as mash and birds had free access to feed and water during the experimental period. Light was continuous during the whole experimental period over 22h. The temperature was controlled and reduced from 33 ^{0}C to 22 ^{0}C until day 21 and sustained until the end of experiment. All chicks were weighted at day one and each week thereafter.

Corrected feed intake (for feed wastage) per pen was recorded and feed conversion ratio was calculated on pen weight basis. Dead chickens were weighted at the time of removal and included for feed conversion calculation.

Measurements and Analytical Methods

At day 42, two chickens were randomly selected from each replicate and blood samples were collected from wing vein. Blood samples were kept in ice and delivered to lab for determination of glucose, cholesterol, triglyceride, LDL, HDL and VLDL.

At the end of experiment, one bird was selected and slaughtered, plucked and eviscerated. The relative weight of carcass was measured by dividing the carcass weight by live body weight. Carcass parts and abdominal fat was measured and their relative weights were calculated.

All collected data were examined by an analysis of variance using the general linear model (GLM) procedure, SAS, 2002. Means with significant F ratio were separated by Duncan method.

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Table 1: Composition of experimental diets

Ingredients (%)	**Starter**					**Grower**					**Finisher**				
Corn	58.15	56.65	54.25	53.60	52.00	63.58	61.80	60.30	58.80	57.30	67.15	65.65	64.05	62.55	61.05
Soy bean meal	35.70	34.70	34.60	32.65	31.70	28.90	27.90	27.90	25.90	24.90	24.70	23.70	22.70	21.70	20.70
LCG	00.00	2.50	5.00	7.50	10.00	00.00	2.50	5.00	7.500	10.00	00.00	2.50	5.00	7.50	10.00
Protein supplement [1]	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Canola oil	2.30	2.30	2.30	2.40	2.45	4.03	3.95	3.95	3.95	3.95	4.30	4.30	4.30	4.30	4.30
Di-calcium phosphate	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
Oyster shell	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Lysine	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
DL-Methionine	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Salt	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Vitamins and minerals Supplement [2]	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Calculated analysis															
ME (Kcal/Kg)	2900	2900	2900	2900	2900	3100	3100	3100	3100	3100	3200	3200	3200	3200	3200
Crude protein %	23	23	23	23	23	20	20	20	20	20	18	18	18	18	18
Lysine %	1.1	1.1	1.1	1.1	1.1	1.0	1.0	1.0	1.0	1.0	0.85	0.85	0.85	0.85	0.85
Methionine %	0.5	0.5	0.5	0.5	0.5	0.38	0.38	0.38	0.38	0.38	0.35	0.35	0.35	0.35	0.35
Calcium %	1.0	1.0	1.0	1.0	1.0	0.9	0.9	0.9	0.9	0.9	0.8	0.8	0.8	0.8	0.8
Available phosphorus %	0.45	0.45	0.45	0.45	0.45	0.40	0.40	0.40	0.40	0.40	0.38	0.38	0.38	0.38	0.38

1- Protein supplement contained; Protein, ME,1100 Kcal/Kg; Protein,11%; Lysin, 2.6%; Methionine,4.0%, P.,5.6% and Ca,1 6.0%

2- Supplied per kg of diet; Vit A, 11000 IU; Vit. D3, 2300 IU; Vit. E, 40 IU; Vit. K3, 2 mg; Thiamine,2 mg; Riboflavin, 8.0 mg; Pyridoxine, 4.0 mg; Niacin, 40 mg; Pantothenic acid, 10 mg; Vit. B12, 0.02 mg; Folic acid, 0.7 mg; Biotin, 0.15 mg; Mn, 100 mg; Zn, 60 mg; Fe, 80 mg; Cu, 8.0 mg; Iodine, 0.8 mg; Se, 0.3 mg.

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RESULTS AND DISCUSSION

RESULTS

Composition of liquid corn gluten is indicated in Table 2. It is a condensed compound of protein, Ca and P than corn. It is relatively a good source of ME and protein. Low pH may be consider as it's beneficial character which can produce suitable gut environment.

Effect of LCG on feed intake was significant (P<0.05) and the lowest was observed when feed intake belonged to control group during starting, growing and finishing period (Table 3). As level of LCG was increased (daily feed intake was decreased. The highest feed intake was observed with control diet and the lowest belonged to diet contained 10% LCG.

Liquid corn gluten significantly (P<0.05) increased daily weight gain (Table 4). As LCG was increased, daily weight gain was increased, but the highest daily gain was observed at 5% inclusion of LCG, at all stages of rearing periods.

Table 2: Composition of LCG

Chemical composition	%
Dry matter	52-55
Crude protein	25
Metabolizable energy	2800 kcal.kg
Calcium	1
Phosphorus	0.3
Methionine	0.5
Lysine	0.2
pH	4-5
Ash	8.10
Lactic acid	13-18

Table 3: Effect of varying levels of LCG on feed consumption of broiler Chicks (g/b/d)

Replacing levels %	1-7 -day-old	7-14 day-old	14-21 day-old	21-28 day-old	28-35 day-old	35-42 day-old	Total mean
Control(zero)	42.58[a]	72.50[a]	108.25[a]	138.43[a]	145.68[a]	176.39[a]	113.68[a]
2.5	39.64[ab]	71.33[a]	102.96[ab]	118.14[b]	143.77[ab]	176.64[a]	108.74[a]
5.0	37.71[ab]	65.46[ab]	94.96[ab]	108.57[b]	136.07[b]	165.70[b]	101.31[b]
7.5	34.28[bc]	58.57[bc]	90.21[bc]	105.93[bc]	127.32[c]	163.89[b]	96.70[bc]
10	29.64[c]	56.43[c]	76.39[c]	105.93[b]	137.46[ab]	175.71[b]	93.32[c]
Significant level	*	*-	*	*	*	*	*
SEM	0.14	0.09	0.12	0.04	0.07	0.05	0.04

SEM is standard error mean, ns not significant at 5% level

Table 4: Effect of varying levels of LCG on body weight broiler Chicks (g/b/d)

Replacing levels (%)	1-7- day-old	7-14 Day-old	14-21 Day-old	21-28 Day-old	28-35 Day-old	35-42 Day-old	Total mean
Control(zero)	14.89[d]	26.51[c]	56.30[c]	103.45[b]	84.67[b]	84.07[c]	61.76[d]
2.5	17.42[c]	27.28[bc]	27.28[b]	117.22[a]	91.09[b]	99.23[b]	69.08[b]
5.0	19.15[a]	43.55[a]	43.55[a]	123.39[a]	130.01[a]	128.24[a]	87.71[a]
7.5	18.51[b]	28.56[b]	28.56[d]	100.17[b]	87.11[b]	88.64[c]	62.19[c]
10	17.38[c]	25.90[c]	25.90[dc]	76.45[c]	71.75[c]	76.50[d]	53.69[d]
Significant level	*	*	*	*	*	*	*
SEM	0.04	0.52	0.52	2.69	2.52	1.84	0.352

*SEM is standard error mean, ns not significant at 5% level, * significant at 5% level*

As indicated in Table 5, feed conversion ratio was affected by added LCG. Feed conversion ratio was significantly (P<0.05) improved by LCG. The best feed conversion ratio was observed at level of 5% LCG inclusion during starting, growing and finishing periods. All diets contained LCG showed better feed conversion ratio comparing to control diet.

Table 5: Effect of varying levels of LCG on feed conversion ratio of broiler Chicks (Gram food. gram gain)

Replacing levels (%)	1-7-day-old	7-14 Day-old	14-21 Day-old	21-28 Day-old	28-35 Day-old	35-42 Day-old	Total mean
Control(zero)	2.87^{a}	2.73^{a}	1.92^{a}	1.31^{a}	1.72^{b}	2.08^{a}	2.11^{a}
2.5	2.27^{b}	2.60^{a}	1.65^{ab}	1.70^{bc}	1.57^{bc}	1.78^{b}	1.81^{b}
5.0	1.96^{bc}	1.50^{c}	1.15^{c}	0.94^{c}	1.47^{d}	1.28^{c}	1.31^{d}
7.5	1.85^{bc}	2.05^{b}	1.79^{ab}	1.06^{b}	1.46^{b}	1.85^{b}	1.68^{c}
10	1.70^{c}	2.18^{b}	1.45^{cd}	1.42^{a}	1.93^{a}	1.06^{a}	1.79^{bc}
Significant level	*	*	*	*	*	*	*
SEM	0.14	0.08	0.11	0.04	0.06	0.04	0.03

*SEM is standard error mean, ns not significant at 5% level, * significant at 5% level*

Effect of LCG on carcass components is shown in Table 6. All carcass parts were affected significantly (P<0.05) due to inclusion of LCG. Oven ready carcass was increased at 5% inclusion level. Percentage of breast and thigh were the highest at level of 5% LCG. Percentage of abdominal fat was also increased significantly (P<0.05) due to 5% added LCG.
Effect of LCG inclusion on blood parameters is indicated in Table 7. Glucose, cholesterol and triglyceride were decreases significantly (P<0.05) due to inclusion of LCG. Glucose, cholesterol and triglyceride were the lowest at level of 5% inclusion. Effect of LCG on LDL and VLDL were not significant. Only HDL was affected significantly (P<0.05).

Table 6: Effect of varying levels of LCG on carcass characteristics of broiler in 42 day-old Chicks (Percent of live weight)

Replacing levels (%)	carcass (Percent)	Breast (Gram)	Breast (Percent)	Thigh (Gram)	Thigh (Percent)	Fat (Percent)
Control(zero)	74.80^{d}	652	33.17^{d}	263	10.26^{d}	1.69^{a}
2,5	77.61^{b}	665	34.05^{b}	252	10.76^{b}	2.03^{a}
5.0	78.13^{a}	690	36.09^{a}	288	11.08^{a}	2.98^{a}
7.5	72.05^{ac}	645	33.00^{ac}	259	10.16^{ac}	2.52^{a}
10	71.05^{c}	630	32.91^{c}	250	10.12^{c}	2.60^{a}
Significant level	*	Ns	*	ns	*	ns
SEM	1.13	0.7	1.12	2.12	0.8	0.45

*SEM is standard error mean, ns no significant at 5% level, * significant at 5% level*

Table 7 Effect of varying levels of LG on blood parameters of broiler chicks (mg/dl)

Replacing levels %	Cholesterol	Glucose	triglyceride	HDL	LDL	VLDL
Control(zero)	140.50^{a}	185.00^{ab}	94.12^{a}	104.50^{a}	35.62	17.00
2.5	91.75^{b}	212.75^{a}	79.12^{b}	108.50^{a}	39.37	14.06
5.0	83.75^{b}	108.50^{c}	74.87^{b}	86.37^{b}	42.62	14.80
7.5	89.13^{b}	159.25^{b}	73.50^{b}	110.25^{a}	43.37	15.20
10	67.13^{b}	187.00^{ab}	72.00^{b}	120.75^{a}	37.65	15.10
Significant level	*	*	*	*	Ns	Ns
SEM	12.8	16.92	6.08	7.90	6.80	1.09

Discussion

Inclusion level higher than 5% as indicated in the present experiment, reduced feed intake, which may be attributed to LCG palatability and changes in diet texture.

Use of LCG in the diet of broilers increased daily body gain, but the trend showed reducing pattern beyond 5% inclusion rate. Results of present experiment are not in consistence with the finding of Lumpkins *et al.*, 2004, because they reported that DDGS up to 12% had not adverse effect on daily gain. High levels of LCG in the diet may reduces digestibility and absorbability, resulting in growth depression. Adverse effect of CG on digestibility has been reported by Babcock, *et al*., 2008.

Feed conversion ratio was improved due to increasing of LCG, but beyond 5% inclusion, it showed reducing trend which was consistence with reduction in feed intake and body weight gain. The results obtained in this experiment is in agreement with the finding of Lumpkins *et al.*, 2004 who indicated increase in feed conversion ratio due to high levels of corn gluten in the diet of broilers.

Oven ready carcass was increased by 5% LCG. It was as the result of increased body weight. Breast and thigh were increased due LCG in the diet. Body weight and eviscerated carcass influence carcass parts, which lead to improvement in dressing percentage. Abdominal fat was increased at high levels of LCG which may be due to lower assimilation of amino acids and consequently higher fat deposition.

Lower blood glucose, triglyceride and cholesterol at 5% LCG were observed which can be related to better utilization of dietary nutrients like energy, protein and amino acids at this level, because of suitable gut environment and health (Salim, *et al.*, 2010).

Overall, the results of this experiment indicated that LCG can be considered as an alternative ingredient for poultry diet. At 5% inclusion, LCG increased performance of broilers. Although, higher levels (10%) had not adverse effect on performance, but it showed diminishing return regarding body weight gain, feed conversion ratio and carcass parts.

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