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Improving broiler productive performance and reducing environmental pollution by manipulating feed consumption

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This study was conducted to investigate the effect of decreasing feed consumption of broiler chicks with maintaining the nutrients intake on performance, physiological and behavioural parameters. A total 500 one-day chicks were randomly divided into 5 treatments with 4 replicates, 25 birds each. The treatment are the control diets, control + 50 k.cal increase in Metabolizable Energy ,ME, (T1), control diet + 100 kcal increase in ME (T2), control diet + 150 k.cal increase in ME (T3) and control diet + 200 k.cal increase in ME (T4) for starter and grower diets. Diets composition depended on nutrients intake to provide all groups with the same nutrients levels with gradual decrease in the amount of feed intake for starter and grower phases. Results obtained refereed to decreasing feed intake with maintaining the nutrients intake improved ($P>0.05$) broiler performance. Moreover, feed utilization improved ($P>0.05$) via decreasing the excreta output, improving nutrients digestibility and decreasing the energy losses for feeding and drinking behaviors. The treatments exhibited no adverse effect on all physiological parameters with slight improvement in immunoglobulin and HDL compared with the control group. In conclusion, decreasing feed consumption with maintaining nutrients intake of broiler chicks can improve performance and reduce environment pollution during starter and grower periods.

Keywords: Broiler, nutrients manipulation, environmental pollution, feed efficiency, behaviour.

INTRODUCTION

Modern poultry industry aims to increase the performance, reduction of costs and wastes output (Martins et al., 2013). One of the major problems facing the poultry industry is the large-scale accumulation of wastes including litter (Bolani et al., 2010). The litter conditions significantly influence broiler performance and, basically, the profits of growers and integrators. Litter is consisting of bedding material, droppings, feathers, feed and water wasted (Casey et al., 2017). The amount and composition of freshly excreted manure vary considerably and is primarily influenced by the diet composition; this result a considerable amount of waste can contaminate the environment as a result of high levels of nitrogen, phosphorus, potassium and some minerals in the excreta of birds (Kaiser et al., 2009). The attempts to reduce the environmental pollution from poultry feeds have been fueling interest of research in recent years; for example, using either feed restriction systems (Sahraei, 2013) or using some exogenous enzymes to decrease the output nutrients such as phytase enzyme to reduce phosphorus in excreta (Nagata et al., 2011). But the previous methods may influence the performance or increase the cost of production. In practice, behavioural measures are often the starting point for assessing an animal's response to its environment and hence its welfare (Dawkins, 2003). Four principles are used to assess good broiler welfare; good feeding, housing, health and appropriate behavior (Welfare Quality, 2009). Therefore, the following trial was undertaken to evaluate the effect of nutrients condensation and decreasing feed consumption on the productive performance, behavior traits, physiological parameters, digestion coefficients and the amount of excreta in broiler during starter and grower stages.

MATERIALS AND METHODS

Birds, housing and management:

This experiment was conducted at the Department of Veterinary Hygiene and Management (Poultry Research Unit), Faculty of Veterinary Medicine, Cairo University, Giza, Egypt. On day of hatch (DOH), 500 unsexed Avian-48 broiler chicks with initial weight of 45 ± 1.0 g were randomly divided into 20 floor pens set up with fresh, clean wood shavings bedding materials, with an available surface of 2.5 m^2 each and environmentally controlled. The lighting continuous program was 24 hrs per day.

Experimental design and diets:

Chicks were assigned to 5 treatments; each treatment consisted of four replicates, 25 chicks each. The control diet (CON), CON + 50 kcal increase in ME (T1), CON + 100 kcal increase in ME (T2), CON + 150 kcal increase in ME (T3) and CON + 200 kcal increase in ME (T4) for starter and grower diets (Table 1). Each treatment received one of the respective diets that varied in dietary nutrients levels according to the nutrition guide of Avian-48 broiler breed. The experimental diets depended on feed and nutrients intake to provide all groups with the same nutrients levels with gradual decrease in the amount of feed intake for starter (DOH to 10th d) and grower (d 11th – 21th d) stages are presented in Table 2.

Measured Parameters:

(i) Productive performance parameters: Body weight; all chicks were weighted at the end of starter and grower stage (10 and 21 days old, respectively) to calculate the average individual live body weight and body weight gain. Feed consumption (g/chick) was calculated at 10 and 21 days old. Body weight gain and feed intake were used to calculate starter and grower feed conversion ratios.

Behavioral Measurements;

After the adaptation period and for three days per week twice per day, each pen was observed for a total of 15 minutes by instantaneous scan sampling, the behaviours were recorded as the proportion of the total number of birds seen during an instantaneous scan sample (Helle et al., 2007). The following behaviour parameters were recorded; feeding, drinking, elimination, resting and preening behaviours.

Blood biochemical parameters;

Twelve Blood samples from each group were collected at 21 days old. The parameters measured were; total protein serum was determined using commercial kits (Pasteur, Lab) according to(Finley et al,. 1978), serum albumen by colorimetrically, serum globulin according to the equation Globulin = total protein – albumin according to (Coles, 1986), total glycerides estimated by the method described by Wood(1990), cholesterol was estimated by the method according to Shareef and Al-Dabbagh, (2009), high density lipoprotein was performed according to(Friedewalad et al., 1972), Serum uric acid was determined according to the method of Caraway (1955) and Glucose concentration was determined according to,(Wahlefeld 1974).

Digestion trial was carried out at the end of grower period. Eight chicks of each experiment were separated and housed in digestion cages. Feed and water were offered *ad-libitum* during the three days collection period. The feed consumption was recorded and quantity of excreta, were collected every 24 hrs. The collected samples were dried at 60 ^oC until constant weight was achieved, then, excreta weighed, ground, mixed well and stored for analysis according to (A.O.A.C., 1990). The parameters recorded were; Excreta Wight (EW) (g/bird/d), Excreta weight % (EWP), dry matter digestibility (DMD), crude protein digestibility, organic matter digestibility (OMD) and Regression coefficient between feed intake and EW, EWP, DMD and OMD was analyzed.

Statistical methods:

The data pooled through the experiment were statistically analyzed by General Linear Model

Table 1: Composition and chemical of broiler starter and grower diets

Stage / Ingredients	Starter					Grower				
	Control	T1	T2	T3	T4	Control	T1	T2	T3	T4
Yellow Corn	61.88	59.68	57.27	54.45	51.63	57.83	55.8	56.32	56.76	57.12
Soybean meal (44)%	24.31	24.78	25.94	27.43	28.92	33.7	33.9	30.1	26.1	22.6
Soybean Oil	0.00	1.02	2.21	3.48	4.75	4.4	5.4	5.4	5.4	5.45
Corn gluten meal	9.38	10.00	10.00	10.00	10.0	0.0	0.69	3.80	7.10	10.0
Limestone	1.70	1.73	1.73	1.76	1.78	1.6	1.64	1.67	1.71	1.74
Mono-calcium ph.	1.69	1.73	1.78	1.82	1.86	1.52	1.55	1.63	1.72	1.78
Salt	0.30	0.305	0.31	0.315	0.32	0.3	0.305	0.31	0.315	0.32
Vit. & min. premix*	0.30	0.305	0.31	0.315	0.32	0.3	0.305	0.31	0.315	0.32
DL-Methionine	0.07	0.07	0.08	0.08	0.09	0.19	0.2	0.16	0.12	0.1
L-Lysine HCl	0.37	0.38	0.37	0.35	0.33	0.16	0.21	0.30	0.46	0.57
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Chemical composition (Calculated)										
Met. Energy K.Cal/kg	2990	3040	3090	3140	3190	3090	3140	3190	3240	3290
Crude protein %	22.0	22.4	22.7	23.1	23.5	20.0	20.32	20.64	20.96	21.28
Calcium %	1.00	1.015	1.03	1.045	1.06	0.96	0.975	0.990	1.005	1.02
Phosphorus %	0.50	0.51	0.52	0.53	0.54	0.48	0.488	0.496	0.504	0.512
Methionine %	0.52	0.53	0.54	0.55	0.56	0.51	0.522	0.526	0.532	0.538
Lysine%	1.25	1.27	1.29	1.31	1.33	1.20	1.22	1.24	1.26	1.28

Chemical composition of feedstuffs was calculated according to NRC (1994). * Vitamin & mineral premix Vitamin A as retinol (1 million IU/g) vitamin E as retinol (200000 IU/g), Vitamin D3 (2500 IU/gm) and vitamin K (50%) were purchased from local market in Egypt. [2] Each 1 kg diet (control) contains vitamin A 10000 IU, vitamin D3 2500 IU, vitamin E 20 mg, vitamin K3 3.0 mg, vitamin B_1 1.0 mg, vitamin B_2 5.0 mg, vitamin B_6 3.0 mg, Vitamin B_{12} 0.015 mg, pantothenic acid 10.0 mg, nicotinic acid 30 mg, folic acid 1.0 mg, Biotin 0.05 mg, manganese 100 mg, zinc 60 mg, iron 33 mg, copper 9 mg, iodine 1.0 mg, selenium 0.3 mg and cobalt 0.20 mg.

Table 2: Amounts of feed fed to chicks according to treatments and age of chicks.

Treatments* / Days	Control	T1	T2	T3	T4
1 ST week gm/bird	114.0	112.2	110.4	108.6	106.9
8	30.0	29.5	29.0	28.6	28.1
9	35.0	34.4	33.9	33.3	32.8
10	39.0	38.4	37.7	37.1	36.6
Total starter gm/bird	218.0	214.5	211.0	207.6	204.4
11	44.0	43.3	42.6	42.0	41.3
12	49.0	48.2	47.5	46.7	46.0
13	55.0	54.1	53.3	52.5	51.7
14	60.0	59.0	58.1	57.2	56.4
15	66.0	64.9	63.9	62.9	62.0
16	72.0	70.9	69.7	68.7	67.6
17	78.0	76.8	75.6	74.4	73.3
18	84.0	82.7	81.4	80.1	78.9
19	91.0	89.6	88.1	86.8	85.5
20	96.0	94.5	93.0	91.6	90.2
21	104.0	102.3	100.7	99.2	97.7
Total grower gm/bird	799	786.3	773.9	762.1	750.6
Total period gm/bird	1017.0	1000.8	984.9	969.7	955.0

*Control= Avian 48 nutrients specification, T1= control + 50 k.cal increase in ME, T2= control diet + 100 kcal increase in ME, T3=control diet + 150 k.cal increase in ME and T4= control diet + 200 k.cal increase in ME, for starter and grower diets. Diets composition depended on nutrients intake to provide all groups with the same nutrients levels with gradual decrease in the amount of feed intake for starter and grower phases.

Procedures (GLM) described in SAS User's Guide, (2004). The differences among treatments means were subjected to significance ($P< 0.05$) by Duncan's Multiple Range-test (1955), where the statistical model was:

$Y_{ij} = \mu + T_i + e_{ij}$ Where:

Y_{ij} = Observed value of a given dependent variable.

μ = Overall adjusted mean.

T_i = Fixed effect of treatments, where i=1, 2… etc.

e_{ij} = Random error associated to each observation.

RESULTS

Broiler performance is presented in Tables 3. Feed intake was significantly ($P< 0.05$) decreased in each of starter, grower and total periods within treatments groups compared with control one. Body weight and body weight gain had the same trend at all periods, where the values of them were significantly ($P< 0.05$) increased in treatments compared with control except treatment 4 which recorded the lowest values compared to other treatments. Feed conversion ratio (FCR) were significantly ($P< 0.05$) improved due to treatments compared to control. Generally, treatment 3 which contained 150 Kcal increases in metabolizable energy recorded the best performance compared to other treatments.

Behavioral parameters are summarized in Table 4. The birds showed the lowest feeding and drinking behaviors in treatment groups compared with the birds in control group. In the other side, the resting percentages were more in all treatments compared with the control group. No differences were detected due to treatment in elimination and preening behavior.

Physiological parameters are shown in Table 5. There was no significant differences ($p>0.05$) due to the experimental treatments on each of total protein (TP), albumen, immunoglobulin (Ig), uric acid and glucose values. However, the treatments were improved the TP and Ig values compared with control one. A significant improvement ($p\leq0.05$) were detected in HDL values between all the treatments and the control one while treatment 4 which had 200 kcal ME increase were recorded the lowest value of cholesterol.

Digestion coefficients of dry matter, organic matter and crude protein are presented in Table 6. Digestibility of dry matter and organic matter were significantly ($P\leq 0.05$) affected by treatments

Table 3: Effect of experimental treatments on o broiler performance parameters from 1-21 days old.

Stage	Treatments* / Parameter	Control	T1	T2	T3	T4	P Value
Starter	Feed Intake g/chick/day	218.0±0.23[a]	213.8±5.25[ab]	207.6±0.61[bc]	205.0±0.46[cd]	198.2±1.04[d]	0.004
	Live Body Weight (g)	186.7±0.27[a]	181.3±2.97[a]	185.6±2.92[a]	187.7±0.66[a]	169.4±0.038[b]	0.0016
	Body Weight Gain (g)	147.7±0.27[a]	142.3±2.97[a]	146.6±2.92[a]	148.7±0.66[a]	130.4±0.04[b]	0.0016
	FCR g feed/ g gain	1.48±0.003[a]	1.50±0.006[a]	1.42±0.032[b]	1.38±0.003[b]	1.52±0.01[a]	0.0007
Grower	Feed Intake g/chick/day	795.4 ±3.75[a]	785.7±0.81[b]	774.0±0.0[c]	762.0±0.06[d]	651.0±0.09[e]	<0.0001
	Live Body Weight (g)	618.9±2.91[b]	623.6±1.90[b]	642.9±4.42[a]	650.9±3.37[a]	581.9±0.92[c]	<0.0001
	Body Weight Gain (g)	432.3±3.20[c]	442.4±4.87[bc]	457.3±7.33[ab]	463.2±2.71[a]	412.5±0.87[d]	0.0005
	FCR g feed/ g gain	1.84± 0.023[a]	1.78±0.017[b]	1.69±0.026[c]	1.65±0.009[c]	1.58±0.003[d]	<.0001
Total	Feed Intake g/chick/day	1013.4±4.01[a]	999.5±4.41[b]	981.6±0.61[c]	967.0±0.52[c]	859.2±0.95[d]	<.0001
	Live Body Weight (g)	579.9±2.91[b]	584.6±1.91[b]	603.9±4.42[a]	611.9±3.38[a]	542.9±0.92[c]	<.0001
	FCR g feed/ g gain	1.75±0.01[a]	1.71±0.01[b]	1.63±0.01[c]	1.58±0.01[d]	1.56±0.003[d]	<.0001

[a, b, c, d] Means in each column bearing the same superscripts are not significantly different (P<0.05). *Control= Avian 48 nutrients specification, T1= control + 50 k.cal increase in ME, T2= control diet + 100 kcal increase in ME, T3=control diet + 150 k.cal increase in ME and T4= control diet + 200 k.cal increase in ME, for starter and grower diets. Diets composition depended on nutrients intake to provide all groups with the same nutrients levels with gradual decrease in the amount of feed intake for starter and grower phases.

Table 4: Effect of experimental treatments on broiler behaviour parameters response (%).

Stage	Treatments / Parameters	Control	T1	T2	T3	T4
Starter	Feeding	22.1±0.57[a]	18.7±0.51[ab]	16.9±0.23[b]	20.6±1.5[ab]	17.56±1.29[b]
	Drinking	5.3±0.75[a]	2.26±0.14[b]	4.53±0.26[ab]	6.53±1.18[a]	5.3±0.98[a]
	Elimination	2.26±0.14[a]	1.26±0.43[a]	1.76±0.14[a]	1.0±0.57[a]	1.6±0.63[a]
	Preening	9.16±0.08[a]	11.13±0.54[a]	8.56±1.41[a]	11.8±1.27[a]	11.73±0.31[a]
	Resting	45.8±1.35[c]	57.7±3.2[ab]	52.26±0.14[b]	60.23±0.14[a]	57.4±1.03[ab]
Grower	Feeding	22.88±1.71[a]	20.18±3.19[a]	22.27±3.18[a]	17.25±2.42[a]	17.68±1.1[a]
	Drinking	7.35±0.86[a]	4.39±1.62[b]	2.33±0.16[b]	2.71±0.28[b]	2.69±0.44[b]
	Elimination	4.74±0.53[a]	3.02±1.44[a]	3.59±1.89[a]	4.73±1.08[a]	3.65±0.61[a]
	Preening	9.41±1.25[a]	8.8±2.97[a]	7.13±1.33[a]	6.93±1.74[a]	8.05±1.7[a]
	Resting	44.0±3.16[a]	49.65±3.37[a]	45.55±7.16[a]	47.0±3.41[a]	47.93±7.3[a]
Total	Feeding	22.49± 1.5[a]	19.44±0.75[a]	19.585 ±1.25[a]	18.925 ±2.1[a]	17.62±1.25[a]
	Drinking	6.33±0.75[a]	3.32±0.4[b]	3.43 ±0.65[b]	4.62±0.14[b]	4.0±0.25[b]
	Elimination	3.5±0.45[a]	4.1±0.1[a]	4.7 ±0.44[a]	3.9±0.15[a]	3.6±0.6[a]
	Preening	9.285 ±1.15[a]	9.965±1.25[a]	7.845 ±1.4[b]	9.365±0.95[a]	9.89±1.7[a]
	Resting	44.9±2.5[b]	53.675±3.00[a]	48.905 ±2.55[b]	53.615±1.05[a]	52.665±3.5[a]

[a, b, c, d] Means in each column bearing the same superscripts are not significantly different (P<0.05). *Control= Avian 48 nutrients specification, T1= control + 50 k.cal increase in ME, T2= control diet + 100 kcal increase in ME, T3=control diet + 150 k.cal increase in ME and T4= control diet + 200 k.cal increase in ME, for starter and grower diets. Diets composition depended on nutrients intake to provide all groups with the same nutrients levels with gradual decrease in the amount of feed intake for starter and grower phases.

Table 5: Effect of experimental treatments on blood biochemical parameters

Treatment* / Parameter	Control	T1	T2	T3	T4	P value
TP mg/dl	2.80	3.16	2.96	2.97	2.98	0.26
Albumen mg/dl	1.89	1.85	1.85	1.90	1.91	0.93
Ig mg/dl	0.91	1.31	1.11	1.07	1.07	0.26
TG mg/dl	121.2^{a}	131.5^{ab}	108.7^{bc}	96.8^{c}	126.3^{ab}	0.02
Cholesterol mg/dl	143.0^{ab}	151.7^{ab}	154.9^{ab}	159.6^{a}	128.4^{b}	0.002
HDL mg/dl	64.47^{b}	91.7^{a}	94.4^{a}	88.2^{a}	83.5^{a}	<.0001
Uric acid mg/dl	5.6	6.0	5.2	6.0	5.4	0.32
Glucose mg/dl	255.7	251.2	241.9	247.4	252.9	0.64

$^{a,\ b,\ c,}$ Means in each column bearing the same superscripts are not significantly different (P<0.05). *TP= total protein, Ig= immunoglobulin, TG= total glycerides and HDL= high density lipoprotein. *Control= Avian 48 nutrients specification, T1= control + 50 k.cal increase in ME, T2= control diet + 100 kcal increase in ME, T3=control diet + 150 k.cal increase in ME and T4= control diet + 200 k.cal increase in ME, for starter and grower diets. Diets composition depended on nutrients intake to provide all groups with the same nutrients levels with gradual decrease in the amount of feed intake for starter and grower phases.

Table 6: Effect of experimental treatments on excreta weight, percentage and nutrients digestibilities at the end of grower period (21 days old).

Treatment** / *Item	Control	T1	T2	T3	T4	P value
Excreta weight g/bird/d	30.0^{a}	29.0^{ab}	25.6^{dc}	26.6^{bc}	23.2^{d}	0.003
Excreta % of feed consumed	25.3^{a}	25.3^{a}	22.8^{b}	23.9^{ab}	21.8^{b}	0.015
DMD	73.2^{c}	73.2^{c}	76.2^{ab}	74.8^{bc}	77.2^{a}	0.004
OMD	75.6^{c}	75.4^{c}	77.9^{ab}	77.0^{bc}	79.0^{a}	0.008
CPD	90.7^{c}	91.0^{bc}	91.9^{ab}	93.1^{a}	91.9^{ab}	0.003

$^{a,\ b,\ c,\ d}$ Means in each column bearing the same superscripts are not significantly different (P<0.05). * DMD = dry matter digestibility, OMD= organic matter digestibility and CPD = crude protein digestibility. **Control= Avian 48 nutrients specification, T1= control + 50 k.cal increase in ME, T2= control diet + 100 kcal increase in ME, T3=control diet + 150 k.cal increase in ME and T4= control diet + 200 k.cal increase in ME, for starter and grower diets. Diets composition depended on nutrients intake to provide all groups with the same nutrients levels with gradual decrease in the amount of feed intake for starter and grower phases.

Table 7: Prediction equations among feed consumption and each of excreta weight, excreta %, DMD % and OMD %.

Y	X	Regression equation	R^2	P-value
Excreta weight (g)	Feed intake g/chick/d	Y=-31.701+0.5225X	0.8606	<.0001
Excreta percentage (%)	Feed intake g/chick/d	Y= -4.5814 +0.2542	0.6377	0.0004
Dry matter digestibility	Feed intake g/chick/d	Y = 109.28 -0.3064X	0.6694	<.0001
Organic matter digestibility	Feed intake g/chick/d	Y = 106.82 -0.2661X	0.6818	<.0001

decreased with decreasing the feed consumption. There was highly significant (P≤0.05) relation between feed consumption weight and excreta weight output (g), excreta percentage of feed intake (%), dry matter digestibility and organic matter digestibility. The interpretation equations were shown in Table 7.

DISCUSSION

The results of performance herein showed that decreasing feed consumption via feed manipulation and condensation of nutrients in the feed were significantly enhanced all performance and did not adversely affect physiological parameters via improving the digestibility of DM, OM and CP, reducing the amount of excreta output and reducing the energy consumed for feeding and drinking behaviors.

In this experiment each treatment received diets according to the nutrition guide of Avian-48 broiler. the experimental diets provide all groups with the same nutrients levels but with gradual decrease in the amount of feed intake, from Table 2 the amount of feed received through both phases starter and grower was, 1017 gm feed /bird in control group, 1000.8 gm /bird in T1, 984.9 gm /bird in T2, 969.7 gm /bird in T3, and 955 gm /bird in T4. The results of performance herein showed that decreasing feed consumption via feed manipulation and condensation of nutrients in the feed were significantly affected on all performance parameters due to many reasons. The reasons may be 1) as feed intake was reduced, feeding and drinking behaviors were reduced and chicks resting percentage increased that may cause reduction of energy used to practice these behaviors, 2) accordingly, dry matter, organic matter and crude protein digestibility were increased. Broiler chickens growth performance has been increased over the last years; mainly due to the genetic progress, improvements of feed and feeding and environmental control (Wilson, 2005). Broilers that consume feed *ad-libitum* showed high growth rate and in the same time accompanied by deposition of fat, mortality increased, high incidence of metabolic and skeletal disorders(Zubair and Leeson, 1996). *Ad-libitum* feed may result a considerable amount of waste can contaminate the environment as a result of high levels of nitrogen, phosphorus, potassium and some minerals in the excreta of birds[4]. These results also may be related to high energy level with experimental groups during the nutrient condensation, these results agree with the finding of Leeson et al.(1996); Cheng *et al.*(1997) and Hidalgo *et al.*(2004) who found that wide caloric/protein ratios in poultry ration with additional fat can be used for maximum gain and feed efficiency. Also, feeding broilers diets containing high apparent metabolizable energy concentrations improved live body weight.

From Tables 2 and 3 the growth performance during starter and grower stages, feed intake was decreased with increasing level of metabolizable energy, 3140 Kcal/kg in T2 reported the lower feed intake and higher growth rate compared with control group of 2990 Kcal. The same was observed in grower stage T4 feed on 3240 Kcal/kg showed lower feed intake and higher live weight compared with control group of 3090 Kcal, this agree with (Greenwood et al., 2004) and (Nahashon et al., 2005) as they found that birds fed on high metabolizable energy diet had greater live body weight than those low energy diet. (Coon et al., 1981) found a significant improvement in the feed conversion ratio using a diet with high energy level.

The results in Table 5 indicated insignificant effects of high energy diets on serum constituents except in chicks feed 3140 and 3240 kcal/kg diet for in starter and grower, respectively had the highest values of cholesterol and high density lipoprotein, this result agree with (Elmansy, 2006) who reported that the higher level of energy (3200 Kcal ME/kg diet) induced a higher level of triglyceride and cholesterol.

The feed intake was as decreased, the excreta amount voided decreased, from table 3, 4 and 6, we observed that with decreasing the amount of feed offered per day, the amount of feed intake per bird was decreased and consequently the feeding activity decreased and elimination behaviour reduced this give more time for dry matter, organic matter and crude protein digestion, so the end result was reduction in the excreta weight and excreta percentage, in addition to increase dry matter, organic matter and protein digestibility. The lower excreta weight and percentage achieved were 23 gm/bird/day and 21 % respectively in T4 in the same time the high dry matter, organic matter and crude protein digestibility were 77.2, 79, and 91.9, respectively in the same group; this resulting in minimal fecal waste and, therefore, minimal concerns about environmental pollution compare with other groups. This agree with Adeyemo *et al.*(2017) they concluded that crude protein, gross energy digestibility was higher significantly in restricted feeding birds and Fassbinder-Orth and Karasov,(2006) they referred that dry excreta production was significantly correlated with feed intake where chicks produced significantly less excreta, per unit of intake during feed restriction.

CONCLUSION

In conclusion, the results of the trial suggested that early decreasing the feed consumption with maintaining nutrients intake of broiler chicks for the first 21 days of age, might have positive effects on performance, blood biochemical profile and reducing environment pollution through improving digestibility of nutrients.

CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

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AUTHOR CONTRIBUTIONS

HMR and KG designed and executed the experiment and also contributed the manuscript writing reviewed the manuscript. FA collected the blood samples and measured the blood parameters. All authors read and approved the final version.

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