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Effect of butyric acid addition on physiological and productive performance in broiler chickens

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One experiment was conducted to determine the effect of butyric acid addition on growth performance, carcass traits and haemobiochemical constituents of broiler chickens during 7- 42 days of age. A total 180 one day old broiler chicks (Arbor Acres) were obtained from commercial hatchery. Chickens were randomly distributed keeping equal initial body weight among 4 treatment groups each containing 3 replicates, 15 unsexed chicks for each. The dietary treatments including control, 0.5, 1 and 2% butyric acid. The experimental period form started at 7 day of age to 42 days of age. Final body weight, total gain, feed consumption, and feed conversion ratio were increase significantly ($P<0.05$) at levels 0.5 and 1% of butyric acid compared to the control group. Haemoglobin concentration and Haematocrit values were significantly affected. It was higher significantly ($P<0.05$) by using 1% level of butyric acid compared to the three other treatments. Also, the same result was observed in chick's added diet with 0.5% butyric acid on mean cell haemoglobin concentration. Serum total globulin was improved significantly ($P<0.05$) between the three treatments as compared to the control group. Each of serum total protein at the levels of 1, 2% of butyric acid, and plasma total glucose at levels of 0.5% of` butyric acid, are significantly higher at $P<0.05$. Total lipids, total cholesterol and low density lipoprotein at levels of 0.5, 1 and 2% of butyric acid was significantly ($P<0.05$) lower, While, the chickens were fed the same levels had higher significantly on high density lipoprotein as compared with the control group.

Keywords: Organic acids, Butyric acid, Body weight gain, Haemoglobin, Haematocrit.

INTRODUCTION

In recent years, there has been an increase in the use of organic acids as substitutes for antibiotic growth promoters because of the fears of antibiotic resistance and the implications for human health (Radcliffe, 2000; Cengiz et al, 2012). Antibiotics have been given (since about 50 years) at sub-therapeutic dosage (as feed additive) to stabilize the intestinal microflora, improving the general performances, preventing some specific intestinal pathology and to promote growth in poultry industry (Dibner and Richards, 2005).

Recently, poultry industry has paid more attention towards addressing public concern for environmental and food safety. Thus, the non-prescription use of antibiotics in poultry feeds has been eliminated or severely limited. The European Union banned the use of sub-therapeutic levels of antibiotics to prevent disease or promote growth; alternatives to antibiotics are of great interest to the poultry industry (Waldroup et al., 2003). These alternatives include acidifiers (organic acids), prebiotics, probiotics, enzymes, herbal products, microflora enhancers, and immune-modulators Organic acids have been used in poultry diets for decades and seem to elicit a positive response in growth performance (Skinner et al., 1991). Whatever, poultry industry is always looking for a new feed supplement, in order to bring improvement in feed effectiveness and chicken health? Organic acids show potential to be used instead of antibiotics and other feed additives (Hyden, 2000; Sarzamin et al., 2013). Organic acids and their salts are generally used in many countries as growth promoter, while in other many countries, the use of antibiotic as a growth promoter is banned in livestock and poultry diets. This initiate the scientists to search for alternatives which were helpful for poultry birds and livestock and having non- ignificant impact on consumer health. In alimentary canal of chickens there are two types of bacterial populations, one is pathogenic and the other is beneficial commensalisms. The former inhibits growth which is facilitated by the latter one (Samanta et al., 2010).

Organic acid supplementation has been reported to decrease colonies of pathogenic bacteria and the production of toxic metabolites, improve digestibility of protein and minerals and serve as substrates in the metabolism (Kirchgessner and Roth, 1998). Dietary supplementation of organic acids increases the feed conversion ratio and body weight in broiler chicken (Gauthier, 2000) and reduces colonization of pathogens on the intestinal wall, thus prevents damage to the epithelial cells (Langhout, 2000).

As beside antibiotics, organic acids have properties of lowering pH and consequently enhancing protein digestion.Organic acids may inspire endogenous enzymes, adjusting gut microbial flora and help in maintaining animal's health.

The objective of the experiment was to determine the effect of different levels of butyric acid addition on physiological and productive performance and haematological and biochemical blood parameters in broiler chickens during the experimental period from 7 to 42 days of age.

MATERIALS AND METHODS

The present study was carried out at the Graduate Studies Institute and Environmental Research, Damanhour University, Behera Governorate Egypt. A total 180 one day old broiler chicks (Arbor Acres) were obtained from commercial hatchery to study the effect of butyric acid addition on physiological and productive performance in broiler chickens for a period of 42 days of the experiment.

At day 7 of age, broiler chicks were randomly distributed keeping equal initial body weight among 4 treatment groups each containing three replicates, 15 unsexed chicks for each. The dietary treatments including Treatment 1 (control diet), Treatments 2, 3 and 4, control diet with addition of 0.5, 1 and 2% butyric acid, respectively.

During the experimental period (7-42 days) chicks were fed *ad libitum* starter diet from 7-24 days containing 23% crude protein, 3.39% crude fiber, 3.82% ether extract and 3000 kcal/kg metabolizable energy. A finisher diet was used from (25-42 days) containing 21% crude protein, 3.25% crude fiber, 3.93% ether extract and 3050 kcal/kg metabolizable energy. All chickens were raised under similar environmental, hygienic and managerial conditions. Feed and water was added *ad libitum*.

Data collected:

Live body weight (LBW):

The birds were individually weighed to the nearest gram weekly at 7, 14, 21, 28, 35 and 42 days of age. Chicks were weighed in the morning before offering feeds.

Body weight gain (BWG) (g):

Body weight gains from (7-14, 15-21, 22-28, 29-35 and 36-42) days of age and for the whole experimental period were calculated by subtracting initial body weight of each period from the end body weight of the same period.

Feed consumption (FC) (g/bird/period):

Feed consumption was recorded weekly at 7, 14, 21, 28, 35 and 42 days of age. The average weekly feed consumption per bird was estimated according to the following formula:

$$\text{average FC/bird/day} = \frac{\text{FC(g)/bird during a certain period}}{\text{Total number of birds during the same period}}$$

Feed conversion ratio (FCR) (feed/ gain):

Feed to gain ratio was calculated during 7-14, 15-21, 22-28, 29-35 and 36-42 days of age in the form of units of feed intake required to produce one unit of live body weight gain as follow:

$$\text{Feed conversion ratio (FCR)} = \frac{\text{FC(g)/bird during a certain period}}{\text{weight gain (g)/bird during the same period}}$$

Carcass traits

At the end of the experiment (42 days of age), three birds from each treatment were randomly chosen and slaughtered to determine the carcass weight, gizzard, liver, and heart. All percentages were calculated as relative to the live pre-slaughter weight.

Haematological parameters

At the 7 weeks of the experimental period, three birds from each group were randomly chosen for blood analysis. Blood sample were taken from the jugular vein of the birds in the morning. Heparin was used as an anticoagulant. Meanwhile, a part of each sample was withheld to obtain serum. Plasma and serum were obtained by centrifugation of blood at 3,000 rpm for 20 minutes, and stored at –20°C for later analysis.

The fresh blood samples were immediately taken to determine haematological constituents. Haemoglobin concentration (g/dl) was determined of fresh blood samples using haemoglobin meters (Tietz, 1982). Haematocrate value (HT) was recorded according to Wintrobe (Wintrobe, 1965). Red blood cells (RBC`s) were counted on a bright line haemocytometer using light microscope (Hawkeye and Dennett, 1989).

The mean cell volume (MCV), the mean cell haemoglobin (MCH) and the mean cell haemoglobin concentration (MCHC) were calculated as absolute values (Walker et al., 1990).

MCV (micron3 / red blood cell)= $\frac{\textbf{Haematocrite} \times \textbf{10}}{\textbf{Number of Rbcs}}$

MCH (µg) = $\frac{\text{Haemoglobin concentration (g/dl)} \times 10}{\text{Number of Rbcs}}$

MCHC (%) = $\frac{\textbf{Haemoglobin (g/dl)}}{\text{\%}\ \textbf{Haematocrit} \times \textbf{100}}$

Blood biochemical constituents:-

Serum total proteins were measured by the Biuret method (Armstrong and Carr, 1964). Albumin concentration was determined (Doumas et al., 1977). Globulin concentration was calculated as difference between total protein and albumin, and then albumin/globulin ratio was also calculated. Serum total cholesterol was determined (Waston, 1960). Total lipids and Serum high density lipoprotein (HDL) was determined by high density lipoprotein kit of human Gesellschaft fur Biochemica and Diagnostic (Gordon et al., 1977). Serum low density lipoprotein (LDL) was determined according to (Fruchart et al., 1982).

Statistical analysis

The statistical analysis of the experimental data was computed using analysis of variance procedure described in the (SAS, 2002), mean differences were compared using the least significant difference (Duncan, 1955).

RESULTS AND DISCUSSION

Growth performance

The results (Table 1), show the effect of butyric acids on growth performance, it was found that final body weight was a significantly differ ($P<0.05$) in average live body weight, average body weight gain, feed consumption, and feed conversion ratio at levels 0.5 and 1% of butyric acid compared to the control group.

The present results are in agreement with Antonigiovann et al., (2007) who studied the effect of the effect of supplementing butyric acid at levels of 0.2, 0.35, 0.5 and 1%. This study is show that all levels significantly increase body weight gain compared to the control. Also, supplementing butyric acid at level 2 or 3%, respectively, significantly increase body weight compared to the control of this experiment (Sheikh et al., 2010). Organic acid blends were observed that significantly improve performance average live weight (Flamand et al., 2014). Also, generally, organic acid was improved in body weight (Kamal et al., 2014).

Feeding chick's supplement with 2 or 3% butyric acid, significantly increase BWG compared to the control group (Banday et al., 2010), promoting BWG at 3% of butyric acid supplement (Sheikh et al., 2010). Also, it was observed that while dietary supplementation of butyric acid glycosides at the level of 2g/kg diet improved weight gain (Jahanian, 2011). Moreover, groups fed on 0.3% butyric acid show significant increase in live body weight gain (Azza and Naela, 2014) and feed efficiency (Jong et al., 2015)

The supplementation of 0.4% butyrate for broiler diets significantly improved FCR compared to 0.2% butyrate and control groups (Panda et al, 2009). Banday et al., (2010) Found that supplementation of 2.3% butyric acid significantly improved the FCR compared to control at $P<0.05$; on the other hand, adding 0.2% butyric acid significantly improves CFR compared with control (Riri, 2011). Dietary supplementation of organic acids increased the body weight and feed conversion ratio (FCR) in broiler chicken.

Table (1) Effect of Butyric acid on growth performance / bird / period as affected by addition of butyric acid (Ẋ ± S.E) at the 42 days of age

Parameters	Butyric acid level %				
	(0)	**(0.5)**	**(1)**	**(2)**	**Significant**
Initial body weight	142.05 ±4.47	139.88 ± 3.60	144.05 ± 3.45	139.59 ± 3.24	**ns**
Final body weight	2524.05^{b}±34.47	2612.85^{a}±51.16	2647.42^{a}±37.67	2517.65^{b}±38.15	*
Total gain	2382.00^{b}±30.00	2469.37^{a}±44.48	2495.92^{a}±30.10	2378.82^{b}±31.67	*
Feed consumption	4595.17^{a}±158.8	4147.62^{b}±163.40	4217.00^{b}±154.17	4155.86^{b}±150.71	*
Feed conversion ratio	1.928^{a}±0.04	1.676^{b}±0.03	1.685^{b}±0.03	1.745^{b}±0.03	*

Means within each rows with different superscript letter differ significantly at p<0.05.

Table 2. Carcass traits of broiler chickens (g/bird/week) as affected by addition of butyric acid (Ẋ ± S.E) at the 42 days of age

Parameters	Butyric acid level %				
	(0)	**(0.5)**	**(1)**	**(2)**	**Significant**
Live body weight (g)	2546.67^{b}±47.63	2614.80^{a}±25.94	2630.42^{a}±12.99	2531.13^{b}±12.50	*
Carcass weight (g%)	67.83± 0.74	72.25 ± 1.49	71.00 ± 0.40	69.50 ± 2.50	**ns**
Gizzard (g%)	1.44± 0.08	1.50 ± 0.11	1.45 ± 0.10	1.81 ± 0.13	**ns**
Liver (g%)	2.31^{b} ± 0.08	2.27^{b} ± 0.15	1.95^{c} ± 0.09	2.63^{a} ± 0.13	*
Heart (g%)	0.49± 0.03	0.57 ± 0.13	0.57 ± 0.05	0.48 ± 0.05	**ns**

Means within each rows with different superscript letter differ significantly at p<0.05.

Table 3. Haematological parameters of broiler chickens (g/bird/week) as affected by addition of butyric acid (Ẋ ± S.E) at the 42 days of age

Parameters	Butyric acid level %				
	(0)	(0.5)	(1)	(2)	Significant
Red blood cells count * 106 (RBCS) (cell/mm3)	2.52 ± 0.10	2.63 ± 0.14	2.96 ± 0.06	2.62 ± 0.02	**ns**
Haemoglobin concentration (HB) (g/100ml)	11.90 ^{b} ± 0.35	11.60 ^{b}± 0.55	13.40 ^{a} ± 0.38	12.10 ^{b}± 0.23	*
Haematocrit value (HT)(%)	35.20 ^{b} ± 0.71	36.20 ^{b} ± 0.65	39.90 ^{a} ± 0.06	35.50 ^{b} ± 0.61	*
Mean corpuscular volume (MCV) (micron3/ red blood cell)	134.90 ± 0.78	129.60 ± 1.33	134.90 ± 1.42	135.80 ± 1.24	**ns**
Mean cell haemoglobin (MCH) (µ/g)	45.40 ^{ab}± 0.56	44.70 ^{b} ± 0.80	45.10 ^{ab}±0.38	46.20 ^{a} ±0.52	*
Mean cell Haemoglobin Concentration (MCHC) (%)	33.80 ^{bc}± 0.22	34.60 ^{a} ±0.46	33.40 ^{c} ± 0.06	34.10 ^{b}± 0.06	*

Means within each rows with different superscript letter differ significantly at p<0.05.

Table 4. Biochemical constituents of broiler chickens (g/bird/week) as affected by addition of butyric acid (Ẋ ± S.E) at the 42 days of age

Parameters	Butyric acid level %				
	(0)	(0.5)	(1)	(2)	Significant
Serum total Protein (g\100ml)	3.56 ^{b} ± 0.10	3.64 ^{ab} ± 0.02	3.78 ^{a}± 0.08	3.93 ^{a} ±0.29	*
Serum total Albumin (g\100ml)	2.11 ± 0.08	2.01 ± 0.03	2.06 ± 0.08	2.09 ± 0.08	**ns**
Serum total Globulin (g\100ml)	1.45 ^{b} ± 0.03	1.66 ^{a} ± 0.03	1.72 ^{a} ± 0.06	1.80 ^{a} ±0.20	*
Plasma total Glucose (mg\dl)	194.50 ^{b} ± 4.33	204.70 ^{a}±0.88	199.70 ^{ab}±4.91	178.33^{c}±2.38	*

Means within each rows with different superscript letter differ significantly at p<0.05.

Organic acids feeding are believed to have several beneficial effects such as improving feed conversion ratio, growth performance, enhancing mineral absorption and speeding recovery from fatigue (Petruska et al., 2012).

Addition of butyric acid at rate of 25 g/kg of dietary decreased feed efficiency by 1.0% (Aghazadeh and TahaYazdi, 2012). However, it was appears that, when butyric acid is added low levels, may have the most promising effects on broiler performance among dietary organic acids on one hand, and improve daily feed consumption (Flamand et al., 2014), on the other.

Carcass Traits (%):

There were no significant effects between the addition of different levels of butyric acid in chicken's diets on each of carcass weight percentage, gizzard and heart. However, the results were higher on all levels of butyric compared to the control group (Table 2). Meanwhile, the liver percentage was significantly (P<0.05) affected by addition of 2% on chickens diets compared to the control group.

The results are in agreement with that on role of butyrate on colonic function (Hamer et al., 2008) which reported that addition of butyric acid has increased carcass weight and breast meat yield in broilers. In a feeding trial, the groups which were fed on 0.3% butyric acid, 0.3% fumeric acid and 0.3% lactic acid show no significant differences between various treatment groups comparing to control group (Azza and Naela, 2014).

Haematological parameters

There was no significant effect of the addition of different levels of butyric acid in chicken's diets on each of red blood cells Count (RBCS) and mean corpuscular volume (MCV) compared with the control group (Table 3). Haemoglobin concentration (HB) and Haematocrit value (HT) are significantly higher in chickens fed diet added with 1% butyric acid at $P<0.05$, as compared with the control group, their values are 12.6 and 13.35%, respectively.

Mean cell haemoglobin (MCH) was not significantly affected by the levels of butyric acid and the control group. Meanwhile, mean cell haemoglobin concentration (MCHC) was significantly higher in group fed diet added with 0.5% butyric acid at $P<0.05$.

Biochemical constituents

Serum total protein and serum total globulin was significantly ($P<0.05$) affect between the treatments and the control group (Table 4). The chickens fed diet added with 0.5, 1 and 2% butyric acid had significantly ($P<0.05$) higher in the above results as compared with the control group it was 2.24, 6.18 and 10.39% , 14.48, 18.62 and 24.13% respectively.

Plasma total Glucose was significantly ($P<0.05$) effect of the addition of level 0.5, 1% of butyric acid compared to the control group.

The results are in agreement with the reported by Yesilbag and Colpan (2006) who found that supplementation with organic acid mixture (1.0% and 1,5%) significantly increased the serum total protein concentrations. Also, Azza and Naela (2014) reported that the groups fed on 0.3% butyric acid, 0.3% fumeric acid and 0.3% lactic acid showed a significant increase in serum globulin hence, serum albumin values showed no significant difference among all groups including the control.

Lipids profiles

The chickens fed diet addition with of 0.5, 1, 2% butyric acid was lower significantly ($P<0.05$) compared with the control group on total lipids, total cholesterol and low density lipoprotein (LDL) (Table 5). While, the chickens fed diet addition with of 0.5, 1, 2% butyric acid was higher significantly ($P<0.05$) compared with the control group on high Density Lipoprotein (HDL). The present results are agree with Navid et al., (2011) who reported that the serum total cholesterol and LDL concentration were significantly ($P<0.05$) reduced by dietary supplementation with butyric acid 0.2, 0.3 % compared to the control group.

Table 5. Lipid profiles of broiler chickens (g/bird/week) as affected by addition of butyric acid ($\dot{X}$ ± S.E) at the 42 days of age.

Parameters	Butyric acid level %				
	(0)	(0.5)	(1)	(2)	Significant
Total lipids (Mg/dl)	526.70 ^{a} ± 7.24	382.00 ^{c}±9.82	380.00 ^{c} ± 7.35	435.00 ^{b}±2.89	*
Cholesterol (Mg/dl)	120.50 ^{a} ± 4.33	115.70^{b}±0.88	90.70 ^{d} ± 2.03	99.00 ^{c} ± 1.12	*
HDL (mg/dl)	32.40 ^{c} ± 0.18	42.40 ^{a} ± 2.18	36.80 ^{b} ± 1.53	35.20 ^{bc}±1.20	*
LDL (mg/dl)	34.33 ^{a} ± 1.66	30.90^{b} ± 0.10	27.50 ^{c} ± 1.59	31.40 ^{b} ± 0.39	*

Means within each rows with different superscript letter differ significantly at $p<0.05$.

CONCLUSION

Chickens in group fed diet with 0.5, 1% butyric acid was significantly ($P<0.05$) improved the live body weight, total body gain, feed conversion ratio and carcass traits compared with the control group and chickens fed diet with the 2% butyric acid.

Hematological parameters (HB, HT and MCHC) and serum total proteins were significantly ($P<0.05$) higher in chickens fed diet with 0.5 and 1% butyric acid compared with the control group. Moreover, enhance the lipid profiles metabolism. The results of current study recommend that the level of 0.5, 1% butyric acid adding to chicken diets.

CONFLICT OF INTEREST

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

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AUTHOR CONTRIBUTIONS

All authors contributed equally in all parts of this study.

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