EFFECT OF DIETARY SUPPLEMENTATION OF ORGANIC ACIDS ON CARCASS CHARACTERISTICS, SERUM BIOCHEMICAL PARAMETERS AND LIVABILITY OF BROILER CHICKEN

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Abstract

An experiment was conducted for a period of 42 days using two hundred, day-old commercial broiler chicks (Ven Cobb 400) to study the effect of dietary supplementation of organic acids on carcass characteristics, serum biochemical parameters and livability of broiler chicken. The birds were divided into four treatment groups with five replicates of ten chicks in each replicate using completely randomized design. The dietary treatments consisted of T1 (control ration as per BIS (2007)), T2 (Control + 0.2 per cent propionic acid), T3 (Control + 0.2 per cent formic acid) and T4 (Control + propionic acid and formic acid each at 0.2 per cent). The data on carcass characteristics (carcass weight, giblet yield, weight of internal organs and dressing percentage) and blood parameters (total protein, serum total cholesterol, HDL cholesterol, triglycerides, Ca and P) were used for evaluation of work. The results revealed that dietary addition of propionic acid increased ($p<0.05$) the serum concentration of HDL cholesterol and lowered serum triglycerides than other treatment groups. The serum total cholesterol, calcium and inorganic phosphorus was statistically similar among the treatment groups while the serum total protein was higher ($P<0.05$) for T3 group. The values observed falls within the normal physiological range reported for the species. Moreover, the carcass characteristics were not affected by any of the dietary treatments. The per cent livability was higher for T1 and T4 groups. The results suggest that organic acid supplementation did not enhance the carcass characteristics in broiler chicken. However, propionic acid at 0.2 per cent level in the diet improved the lipid profile in them.

Keywords: Organic acid supplementation, carcass characteristics, broiler chicken

Poultry industry has paid more attention towards addressing public concern for environmental pollution and food safety. With restriction on the use of antibiotics, other feed

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additives (such as organic acids, probiotics, prebiotics, enzymes, immunostimulants, herbs etc.) have been included in the diet to improve the performance of poultry. Organic acids have been used for feed preservation from microbial and fungal destruction for many years. When used at correct dosage, organic acids elicit pH dependent antimicrobial activities; which act as a powerful tool for maintaining gut health and reduce mortality rates in broiler birds. Organic acids are natural constituents of plant and animal tissue and therefore reduce the risk of residues in meat. Various organic acids (acetic, citric, formic, isobutyric, lactic and propionic acid) were screened regarding their use as feed additives in broiler production. Studies have been conducted worldwide to explore the use of organic acid as growth promoters and it revealed that the body weight gain, carcass weight, meat yield and abdominal fat per cent were improved by the dietary addition with acidifiers. The present study was conducted to evaluate the effects of organic acids on carcass characteristics, serum biochemical parameters and livability of broiler chicken.

Materials and Methods

Two hundred, day-old straight run commercial broiler chicks (Ven Cobb) of either sex were formed the experimental units. The birds were allotted to four treatment groups (T1, T2, T3 and T4) with five replicates of ten chicks each. The birds were maintained in deep litter system of management with facilities for feeding and watering during the experimental period of six weeks. The control group were fed diet as per BIS (2007) specifications, while the other three dietary treatment groups were supplemented with propionic acid at 0.2 per cent, formic acid at 0.2 per cent and combination of propionic acid and formic acid each at 0.2 per cent levels, respectively. The birds were fed with standard broiler pre-starter ration up to one week of age, starter ration from two to three weeks of age and finisher ration up to six weeks of age. The ingredient compositions and chemical compositions of the four different broiler pre-starter, starter and finisher rations are presented in Tables 1a and 1b, respectively.

Table 1a. Per cent ingredient composition of broiler rations

Sl. No.	Ingredient	Experimental rations		
		Pre-starter	starter	finisher
1	Yellow maize	47.71	48.80	53.50
2	De-oiled soybean meal	43.00	40.60	35.00
3	Vegetable oil	5.21	6.55	7.50
4	Dicalcium phosphate	2.35	2.37	2.35
5	Calcite	0.50	0.52	0.60
6	L-Lysine[1]	0.16	0.11	0.03
7	DL-Methionine[2]	0.20	0.18	0.16
8	Salt	0.50	0.50	0.50

Sl No.	Feed additives	T1	T2	T3	T4
1	Propionic acid[3]	0	0. 20	0	0.20
2	Formic acid[4]	0	0	0.20	0.20
3	Vitamin AB_2D_3K mix[5]	0.125	0.125	0.125	0.125
4	Choline chloride[6]	0.10	0.10	0.10	0.10
5	Trace mineral mix[7]	0.10	0.10	0.10	0.10
6	Vitamin B complex[8]	0.01	0.01	0.01	0.01
7	Toxic binder[9]	0.10	0.10	0.10	0.10
8	Anticoccidial[10]	0.02	0.02	0.02	0.02

1. L-Lysine Monohydrocloride 98.5 per cent (Promois)
2. DL-Methionine 99 per cent (Promois: Feedgrade)
3. Propionic acid 99 per cent (Varsha Group, Banglore)
4. Formic acid 85 per cent (Varsha Group, Banglore)
5. Rovimix AB_2D_3K (DSM Nutritional Products) containing Vitamin A – 82,500 IU, Vitamin B_2 – 50 mg, Vitamin D3 – 12,000 IU and Vitamin K – 10 mg per gram.
6. Choline chloride 60 per cent. (Corn cob N.B Group Company Ltd.)
7. Supplimin-TM, (Shree Pharma, Mehsana, India) contains- manganese sulphate equivalent to elemental manganese 54 g, zinc sulphate equivalent to elemental zinc 52 g, ferrous sulphate equivalent to elemental iron 30 g, copper sulphate equivalent to elemental copper 4 g, potassium iodide equivalent to elemental iodine 1 g, cobalt sulphate equivalent to elemental cobalt 0.1 g, chromium chloride equivalent to elemental chromium 0.2 g, Selenomethionine 100 ppm.
8. Meriplex (Vesper Pharmaceutical Group Pvt., Ltd. Bangalore) containing Vitamin B_1 – 8 mg, Vitamin B_6 – 16 mg, Vitamin B_{12} – 80mg, Niacin -120 mg, Calcium pantothenate – 80 mg, Vitamin E50 – 80 mg per gm, Folic acid – 8 mg and Calcium – 86 mg.
9. UTPP- 5 powder (Bio-Tech, Bangalore) containing treated Aluminosilicates, Propionates, Formates and Acetates.
10. Coxistac 120 (Vitec nutrition Ltd.) containing 120 g salinomycin sodium

The chicks were vaccinated against Ranikhet disease and Infectious Bursal Disease (IBD) as per the recommended vaccination schedule. At sixth week of age, five birds from each treatment were slaughtered to study the carcass traits. Blood samples were collected during slaughter without anticoagulant and the obtained serum samples were stored at -20^{0}C for the estimation of calcium and inorganic phosphorus using blood analyser and total proteins, total cholesterol, HDL cholesterol and triglycerides were estimated using the standard diagnostic kits. The mortality of birds if any, from different treatment groups was recorded and post-mortem examination was conducted in each case to find out the cause of death. Data collected on various parameters were analyzed statistically using one way ANOVA method as described by Snedecor and Cochran (1994). Means were compared by Duncan's Multiple Range Test (DMRT) using statistical package for social studies (SPSS 20.0v, 2011) software.

Results and Discussion

Carcass characteristics

The supplemental effects of propionic acid, formic acid and their combination on carcass characteristics of broiler chicken are shown in Table 2. The carcass weight, dressing percentage and giblet yield did not show any significant difference among the four dietary treatments.

Table 1b. Chemical and mineral composition of the pre-starter rations, %*

Parameter	Pre-starter	Starter	Finisher
Dry matter	90.45	90.36	91.97
Crude protein	23.28	22.44	20.65
Ether extract	2.22	6.38	7.66
Crude fibre	4.22	4.84	7.54
Nitrogen free extract	62.90	58.98	57.13
Total ash	7.38	7.37	7.00
Acid insoluble Ash	1.23	1.33	1.30
Gross energy kcal / kg	4113.37	4319.96	4528.25
Calcium	1.12	1.23	1.28
Phosphorus	0.49	0.54	0.52

Similar results were reported by Garcia *et al.* (2007) and Bozkurt *et al.* (2009) regarding the effect of formic acid supplementation on the carcass weight of broiler birds. Fallah and Rezaei (2013) observed no significant effect on carcass weight of broilers due to the addition of 0.3 per cent blend of organic acids or their salts in the diet. However, beneficial effect of dietary addition of propionic acid for increase in carcass weight was reported by Izat *et al.* (1990), Hume *et al*. (1993) and Brzoska *et al.* (2013). The present study suggests that the addition of acidifiers in the diet did not improve ($p>0.05$) the dressing percentage and giblet yield of birds maintained on different dietary treatments.Well established evidence by Al-Kassi and Mohssen (2009), Panda *et al.* (2011), Brzoska *et al*. (2013) and Mishra *et al*. (2013), indicated that dietary inclusion of feed acidifiers and their blends could increase the dressing percentage in broiler chicken, which was in contrast with the observations of present study. However, a significant reduction in dressing percentage with formic acid supplementation was reported by Garcia *et al.* (2007).

The weight of internal organs such as heart, liver, gizzard, spleen and intestine as percentage of carcass weight are presented in Table 3.

The results of the present study indicated a significant improvement ($p<0.05$) in the per cent weight of the intestine by formic acid supplementation compared to control group. Similarly, formic acid supplemented as blend with propionic acid also increased the per cent weight of intestine indicating the influence of formic acid over propionic acid. Optimum levels of acidifiers could elicit an antimicrobial effect similar to antibiotic growth promoters by thinning of the intestinal wall, thereby reducing the weight of the intestine (Engberg *et al.,* 2000). A series of reports by Broek (2000) and Dibner (2004) suggested similar antimicrobial mode of action for organic acids. However, no such effect was observed in the present study by acidifier supplementation. Definitive data are lacking with respect to effect of dietary organic acids on the intestinal tissues of poultry in comparison to the effects of antibiotics. Furthermore, Brzoska *et al.* (2013) and Venkatasubramani *et al.* (2014) reported no effect on per cent weight of internal organs

Table 2. Slaughter data of birds maintained on four dietary treatments

Parameters	Carcass Parameters				p value
	T1	T2	T3	T4	
Live weight, g	2242.40 ± 64.08	2283.40 ± 68.13	2168.60 ± 96.21	2215.00 ± 81.76	0.77
Carcass weight, g	1594.20 ± 55.47	1638.40 ± 45.20	1524.20 ± 78.63	1556.80 ± 68.87	0.62
Giblet yield, %	4.03 ± 0.10	4.42 ± 0.13	4.65 ± 0.15	4.43 ± 0.29	0.16
Dressing percentage, %	71.04 ± 0.46	71.78 ± 0.46	70.20 ± 0.57	70.21 ± 0.69	0.18

Table 3. Weight of Internal organs of birds maintained on four different dietary treatments as percentage of carcass weight

Parameters	Weight of internal organs as percentage of carcass weight				p value
	T1	T2	T3	T4	
Heart	0.60 ± 0.01	0.66 ± 0.01	0.71 ± 0.03	0.87 ± 0.13	0.07
Liver	2.60 ± 0.12	2.88 ± 0.16	3.00 ± 0.08	2.89 ± 0.18	0.26
Gizzard	2.48 ± 0.13	2.62 ± 0.19	2.92 ± 0.21	2.55 ± 0.16	0.32
Spleen	0.11 ± 0.01	0.15± 0.02	0.14 ± 0.02	0.15 ± 0.03	0.59
Intestine	6.27^{b}± 0.27	6.33^{b} ± 0.30	7.63^{a} ± 0.47	6.73^{ab}± 0.11	0.03*

* a, b – means with different superscripts within the same row differ significantly ($P<0.05$)

Table 4. Serum lipid profile of birds maintained on four dietary treatments, mg / dl

Parameters	Serum lipid profile, mg per dl				p value
	T1	T2	T3	T4	
Total Cholesterol	99.67 ± 0.34	96.89 ± 1.69	98.40 ± 1.45	96.61 ± 1.67	0.41
HDL Cholesterol	47.18^{b} ± 2.32	55.73^{a} ± 0.61	49.73^{b} ± 1.83	49.65^{b} ± 2.04	0.03*
Triglycerides	50.92^{b} ± 3.66	56.43^{b} ± 2.31	54.58^{b} ± 4.43	77.54^{a} ± 1.16	<0.001*

*a, b – means with different superscripts within the same row differ significantly (p<0.05)

by supplementation with either propionic acid, formic acid or blends of organic acid in the diets of broiler birds.

Blood parameters

The observations recorded for lipid profile in the present study are shown in Table 4, and the values observed falls within the normal physiological range reported for the species.

The serum total cholesterol concentration was unaffected by dietary treatments. Similar results were reported by Hernandez *et al.* (2006) on formic acid supplementation and Brzoska*et al*. (2013) on propionic acid supplementation. The HDL cholesterol concentrations were significantly higher (p<0.05) for propionic acid supplemented group which is in agreement with the earlier reports of Khosravi *et al.* (2008). However, Brzoska *et al.* (2013) failed to find any effect on serum HDL cholesterol by propionic acid supplementation in broiler chicken. The dietary addition of propionic acid and formic acid blends increased the serum triglycerides in the experimental birds. As against the results of the present study, Fallah and Rezaei (2013) reported a significant reduction in serum total cholesterol and triglycerides in broiler birds supplemented with blend of organic acids and their ammonium salts at 0.3 per cent level.

The serum calcium and inorganic phosphorus concentration of birds maintained on four dietary treatments (Table 5) did not show any significant difference among different treatment groups. Formic acid tend to reduce the gut pH and increase the absorption of minerals into blood stream (Ghazalah *et al.,* 2011). Subtle changes in the concentration of organic acids may not be able to produce such effect, as evident by the results of the present study. However, the serum total protein concentration (Table 5) was increased by formic acid supplementation than other three dietary treatments. Similar observation on serum total protein concentration was reported by Ghazalah *et al*. (2011) with three dietary levels of formic acid (0.25, 0.5 and 1.0 per cent).

Livability

During the course of the experiment four birds from group T2 and two birds from group T3 *i.e.* a total of six birds died out of 200 birds and the per cent livability recorded was 100, 94, 96 and 100 for groups T1, T2, T3 and T4, respectively. Although positive effects were observed with propionic acid supplementation, similar responses in livability of birds were not observed in this study.This agrees with the results obtained by Izat *et al.* (1990) and Jin *et al.* (1998). The mortality of birds in groups T2 and T3 during the first week of age might be due to the susceptibility of chicks in their early hatch life to infections due to various environment and management factors.

Supplementation with acidifiers did not improve the carcass characteristics in broiler chicken. Dietary addition of blend of organic acid can reduce the mortality rates

Table 5. Serum minerals and total proteinconcentrations of birds maintained on four dietary treatments

Parameters	Treatments				p value
	T1	T2	T3	T4	
Calcium, mg/dl	10.08 ± 0.90	9.50 ± 0.78	9.92 ± 0.83	10.02 ± 0.66	0.95
Inorganic phosphorus, mg/dl	4.61 ± 0.66	5.45 ± 0.58	4.91 ± 0.45	5.02 ± 0.24	0.71
Total protein, g/dl	7.70^{bc} ± 0.24	8.64^{ab} ± 0.50	8.90^{a} ± 0.32	7.05^{c} ± 0.24	0.01*

*a, b, c – means with different superscripts within the same row differ significantly (p<0.05)

in chicks than the addition of a single organic acid. However, propionic acid at 0.2 per cent level can increase the serum concentration of HDL cholesterol, which was beneficial for the health of the birds.

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