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**Original Article**

# Comparative Effect of Different Organic Acids (Benzoic, Acetic and Formic) on Growth Performance, Immune Response and Carcass Traits of Broilers

**[1]Sohail R., *[2]Saeed M., [2]Chao S., [2]Soomro R. N., [2]Arain M. A., [2]Abbasi I. H. R., [3]Raza S., [2]Lu G. and [1]Yousaf M.**

[1] Department of Poultry Science, University of Agriculture, Faisalabad, Pakistan.
[2] College of Animal Sciences, Northwest A&F University, Yangling, 712100, China.
[3] Department of Theriogenology and Production, University of Ilorin, Nigeria.

## Abstract

An experiment was conducted to study the effect of benzoic, acetic and formic acid supplementation on growth performance and carcass characteristics of broilers. One hundred fifty, a day-old broiler chicks were procured from a local commercial hatchery and randomly divided into four treatment groups. Each group having thirty chicks was further sub divided into three replicates, ten chicks each. Group A, B, C were supplemented with 0.5% benzoic, acetic and formic acid, respectively, while group D was control. Data on growth performance in terms of body weight, feed intake and feed conversion ratio was noted on weekly basis. Blood sample were collected (2 birds/replicate) at 28 and 35 day of experiment to check the antibody titer against Newcastle disease and Infectious Bursal disease, respectively. Comparison by LSD test among different treatments showed that maximum weight gain was found in treatment C (formic acid) and minimum in D (control group). Significantly best feed conversion ratio was found in treatment C (formic acid) and poorer was found in treatment D (control group). The maximum significant value of IBD antibody titer (96.00GMT) was found in treatment C (formic acid) and minimum (41.67GMT) in treatment A (benzoic acid). However, the best result against ND antibody titer (104.67GMT) was found in treatment D (control group). Statistical analysis of the data on dressing percentage, breast meat, thigh meat and giblet organs weight e.g. liver, heart and gizzard revealed non-significant effect among the dietary treatment group. It was concluded that addition of organic acids (benzoic, acetic and formic) is helpful to improve weight gain, feed intake and feed conversion ratio of the birds, these factors are specifically related to efficient and economical broiler production.

**Keywords:** Benzoic, acetic and formic acid, broilers, growth promoter, immune response, carcass traits.

* Corresponding author: College of Animal Sciences, Northwest A&F University, Yangling, 712100, China.
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## Introduction

Poultry sector is one of the most vibrant segments of agriculture industry of Pakistan. This sector provides employment for about 1.5 million people. Contribution of poultry industry in livestock, agriculture and national GDP is 10.4, 5.76 and 1.2% respectively. Contribution of poultry meat to total meat production in Pakistan is 26.8%.

Poultry is susceptible to potentially large number of pathogens like *E.coli*, *Salmonella ssp*, and *Clostridia*. These pathogens are present in small intestine of birds and compete with the host for nutrients and reduce digestion of fat and fat-soluble vitamins due to deconjugating effects of bile acids. This leads to depressed growth performance and increased incidence of disease (Engberg *et al.,* 2000). In past antibiotics at sub-therapeutic level have been used to maintain intestinal microflora and to enhance birds performance (Dibner and Richards, 2005). The use of antibiotics as growth promoter has resulted in more number of resistant pathogens (Hernandez *et al.,* 2006). Therefore, use of antibiotics as growth promoter in poultry feed has been banned by the European Union (EU) in 2006.

The poultry scientists are searching for alternatives to antibiotics such as organic acids, prebiotics, probiotics and plant extracts that can give similar results in the prevention or control of infectious diseases and ultimately promote growth and improve feed efficiency. In poultry organic acids are not only used as growth promoter but also are helpful in controlling entrintic bacteria, both pathogenic and non-pathogenic (Wolfenden *et al.,* 2007). In addition organic acids have ability to lower the pH of chyme and improve the digestion of protein (Gauthier, 2002). Reduction in gastric pH increases pepsin activity (Afsharmanesh and Pourreza, 2005). Peptides in turn activate the release of hormones, including gastrin and cholecystokinin, which regulate the digestion and absorption of protein (Hersey, 1987). Therefore, acid anions have been shown to make complex with calcium, phosphorous, magnesium and zinc which results in an improved digestibility of minerals like Ca, P, Mg and Zn (Kishi *et al.,* 1999). Organic acids like acetic, butyric, lactic and propionic are produced by anaerobic, facultative and obligative micro-flora in the GI-tract which decreases pH of the tract and thus they provide protection against pathogens. One of the main factors governing bird's performance is gut health and hence profile of gut microflora of poultry plays a significant role in gastro intestinal tract health (Samik *et al.,* 2007). Single organic acid or the combination of organic acids increases the average daily weight gain, average live weight, average daily feed consumption and decreases mortality rate (Al-Kassi and Mohssen, 2009). Organic acid blend is considered to decrease the feed intake, increases body weight and weight of internal organs (Akyurek *et al.,* 2011).

Furthermore, organic acids are added in poultry feed either in uncoated form or in coated form. Uncoated forms of organic acids are thought to exert their action mainly in feed by stopping the growth of moulds and thus preventing the feed from fungal destruction and in the upper portion of the digestive tract like crop due to their rapid absorption. This may limit the horizontal transmission pathogenic bacteria like *Salmonella.* Drinking water acidification is used for improving growth performance of broilers (Cornelison *et al.,* 2005). Addition of organic acid to drinking water reduces the load of pathogens in water and crop or proventriculus and regulate gut microflora to increase digestion of feed and ultimately improve the growth performance (Philipsen, 2006). Combination of formic and propionic acids in drinking water improve weight gain and feed conversion in broilers (Desai *et al.,* 2007).

Keeping in view the useful effects of dietary organic acids, a research trial was planned to check the comparative effect of different organic acids (benzoic, acetic and formic) on growth performance, immune response and carcass traits of broilers.

## Materials and Methods

The experiment was conducted at Poultry Research Center, University of Agriculture, Faisalabad to study the effect of benzoic, acetic and formic acid supplementation on growth performance, immune response and carcass characteristics of broiler chicks. One hundred fifty,

day old broiler chicks were purchased from a commercial hatchery and reared in a group for one week (adaptation period). After 1st week broiler chicks were weighed and randomly divided into 12 experimental units (10 chicks/each). Before arrival of chicks, the house was cleaned, washed and white-washed. Chicks were brooded for first week at 95°F and then temperature will be lowered down by 5°F each week till 75°F was attained. Light was provided continuously 24 hours daily throughout the experimental period. All broiler chicks were fed same diet for one week (adaption period). Benzoic, acetic and formic acids were added in three dietary treatment groups A, B and C respectively at a level of 0.5% while group D was treated as a control group without any supplementation as given in Table 1.

**Table 1:** Feeding Program.

| Treatment groups | Feeding program |
|---|---|
| Group A | Experimental ration + 0.5% benzoic acid/ kg of diet |
| Group B | Experimental ration + 0.5% acetic acid/kg of diet |
| Group C | Experimental ration + 0.5% formic acid/kg of diet |
| Group D | Experimental ration + No supplementation |

A= Benzoic acid, B= Acetic acid, C= Formic acid, D= Control.

Duration of the experiment was 35 days which was divided into starter (8-21 day) and finisher phase (22-35 day). Diets were formulated according to NRC (1994). An iso-nitrogenous and iso-caloric starter diet (CP 21.02%, ME 2925 Kcal/kg) was formulated and fed from day 8 to 21 as given in treatment program. Similarly, an iso-nitrogenous and iso caloric finisher diet (CP 19.07%, ME 3035 Kcal/kg) was fed from day 22 to 35 as given in treatment program. The birds were fed *ad-libitum* throughout the experiment. Broiler chicks were vaccinated against Newcastle Disease (ND) and Infectious Bursal.

Blood samples of 2 birds per replicate were collected at 28th and 35th day of age for determination of antibody titer against ND and IBD, respectively. Serum was collected in sterilized 1.5 ml serum cups. The methods described by MAFF, (1984) and (Nakamura *et al.,* 1994) were used for the determination of Heamagglutination Inhibition, Indirect Heamagglutination titer against the ND and IBD, respectively. At the end of trial three birds per replicate were randomly picked up, individually weighed and slaughtered for the following data; Carcass characteristics, Dressing percentage, Breast meat yield, Thigh meat yield and Intestinal weight.

## Results and Discussion

### *Effect on Performance*

Data when subjected to statistical analysis under complete randomized design revealed significant effect of organic acids (benzoic, acetic and formic acid) on weight gain during cumulative phase (8-35 days). The maximum weight gain was observed in treatment C followed by B and A respectively. However, treatment D is significantly lower in weight gain than treatments A, B, and C. The results of Marcos *et al.,* (2004) are also in agreement with our results, who reported supplementation of organic acid mixture (30% propionic acid + 70% formic acid) in broilers feed at the rate 0.25 and 0.50% showed more weight gain as compared to birds fed organic acid mixture at higher level (1.0 and 2.0%). Similar results were found by Nadira *et al.,* (2002) who reported that supplementation of 3% lactic acid in the diet of broiler chicks significantly increased the body weight gain. Stipkovits *et al.,* (1992) reported that administration of citric acid in diets @ 0.3, 0.5 and 0.7% improved the body weight gain of birds. Different mechanism proposed for body weight gain may either be due to the fact that organic acids reduce colonization of bacteria in intestine and decrease the thickness of mucosa layer, increase villus height and function of secretion, digestion and absorption of nutrients that leads to improvement in weight gain of broilers (Iji. 1998 and Loddi *et al.,* 2004).

**Table 2:** Effect of benzoic, acetic and formic acid supplementation on weight gain, feed intake and feed conversion ratio of broiler chicks during 2-5 weeks of age.

| Age (day) | Parameters | Treatments | | | |
|---|---|---|---|---|---|
| | | A | B | C | D |
| 8- 21 | Feed intake | 1005±49.13[a] | 1033±31.02[a] | 1027±57.89[a] | 969±36.10[b] |
| | Weight gain | 677±29.68[a] | 701±14.84[a] | 692± 25[a] | 592±17.55[b] |
| | FCR | 1.49±.0082[a] | 1.47±.013[a] | 1.48±.031[a] | 1.6±.013[b] |
| 22-35 | Feed intake | 1773±61.00 | 1744±31.70 | 1770±40.99 | 1705±42.25 |
| | Weight gain | 966±27.07[a] | 957±17.61[a] | 969±15.94[a] | 839±29.93[b] |
| | FCR | 1.83±.023[a] | 1.82±.029[a] | 1.82±.018[a] | 2.03±.028[b] |
| 8-35 | Feed intake | 2779±40.93[a] | 2777±19.54[a] | 2797±29.97[a] | 2674±25.84[b] |
| | Weight gain | 1637±12.58[a] | 1655±22.54[a] | 1662±21.52[a] | 1431±16.62[b] |
| | FCR | 1.70±.0.02[a] | 1.68±.0.03[a] | 1.66± 0.02[a] | 1.86± 0.01[b] |

A= Benzoic acid, B= Acetic acid, C= Formic acid, D= Control.
Values having same super-scripts show non-significant difference.

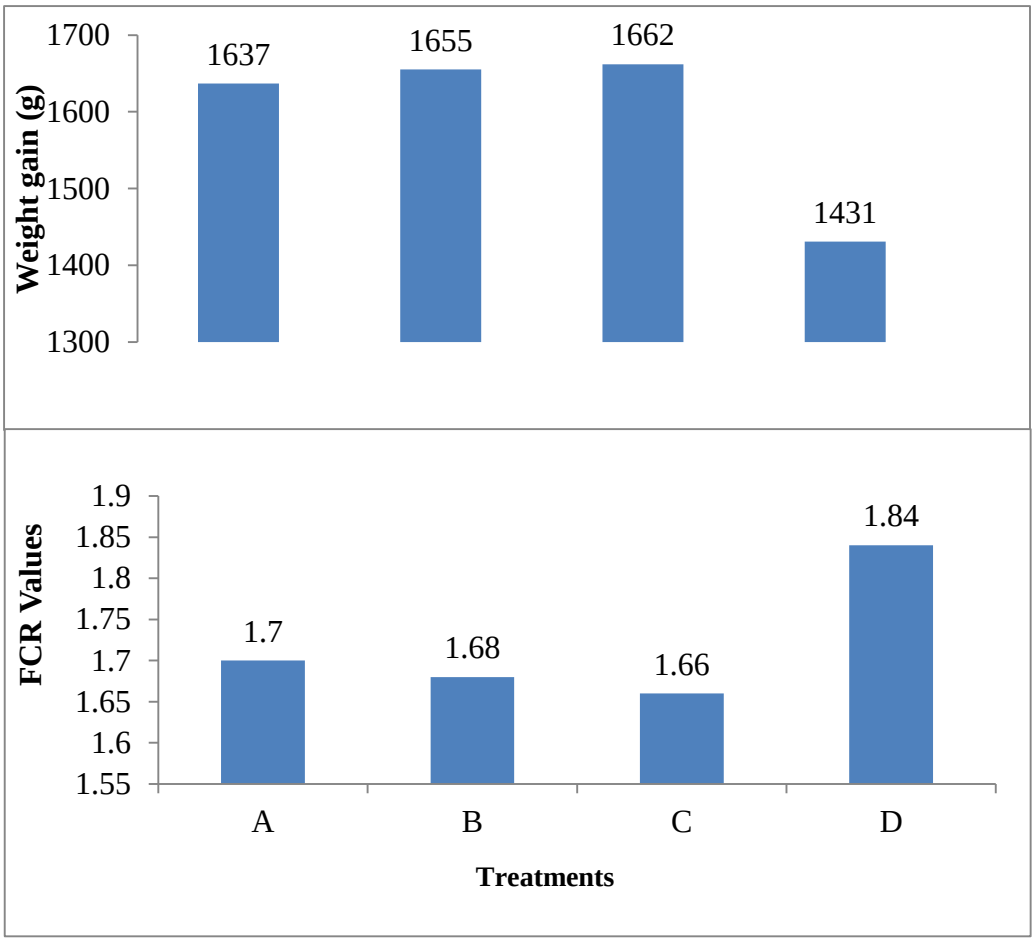


**Fig. 1:** Effect of benzoic, acetic and formic acid supplementation on average weight gain (g) and feed conversion ratio of broilers during cumulative phase (8-35 day).
A= Benzoic acid, B= Acetic acid, C= Formic acid, D= Control.

However, the present results are not in line with the findings of Moharrery and Mahzonieh (2005) who found that addition of organic acids in broilers diet did not affect body weight gain. Variations in results may either be due to variation in the level of acids used, variation in specific acid, and variation

in feed ingredients or environmental effects (Isabel and Santos, 2009). Ceylan *et al.*, (2003) also reported that addition of humic acid did not effect on body weight gain of broiler chicks. The results of the research trial are also in accordance with the findings of Vale *et al.*, (2004) who reported that supplementation of organic acids such as formic and propionic acid at level 0.25 and 0.5% in diet increased the feed intake. Best feed conversion ratio was found in treatment C followed by B and A respectively. Least significant difference test showed that the feed conversion ratio of treatment D was significantly poor as compared to all other treatment groups. Similar results were also found by Ao *et al.*, (2009) who reported that organic acid supplementation in broilers feed improved conversion ratio.

### *Effect on Immune Response*

Data when subjected to statistical analysis under completely randomized design showed significant effect on ND antibody titer by treatments. The highest value of ND antibody titer was found in treatment D followed by C, B and A, respectively (Table 3).

However, when Data subjected against infectious bursal disease (IBD) to statistical analysis showed significant effect on IBD antibody titer by treatment groups. The highest value of IBD antibody titer was found in treatment C followed by treatment D, B and A respectively.

**Table 3:** Effect of benzoic, acetic and formic acid supplementation on antibody titer against Infectious Bursal Disease and Newcastle Disease during 2-5 week.

| Parameters | Treatments | | | | | |
|---|---|---|---|---|---|---|
| | A | B | C | D | EM | P-Value |
| ND | 52.34$^{b}$ | 83.33$^{ab}$ | 83.33$^{ab}$ | 104.67$^{a}$ | 6.8 | 0.02 |
| IBD | 41.67$^{b}$ | 58.68$^{ab}$ | 96.00$^{a}$ | 2.66$^{ab}$ | 7.5 | 0.04 |

A= Benzoic acid, B= Acetic acid, C= Formic acid, D= Control.

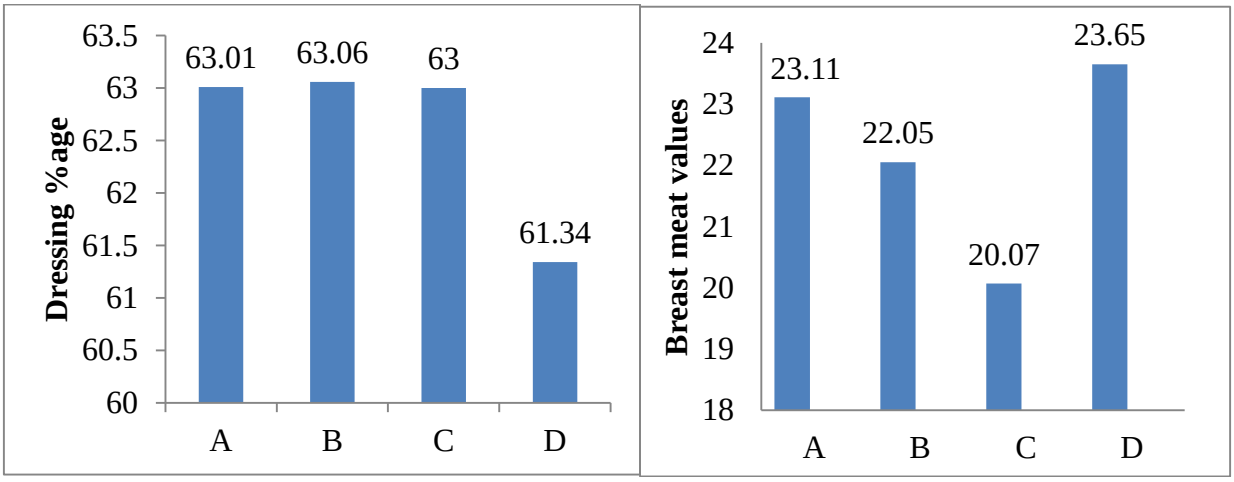


**Fig. 2:** Effect of benzoic, acetic and formic acid supplementation on average values of dressing percentage and Breast meat of broilers during 2-5 weeks.

A= Benzoic acid, B= Acetic acid, C= Formic acid, D= Control.

The results of present study are in line with the Das *et al.*, (2011) who reported that supplementation of organic acids increased antibody titer against Newcastle Disease vaccine. Serum total proteins level is directly related with the IgG concentration (Tyler *et al.*, 1996). Organic acids also enhances the bioavailability of different minerals like Zn (Boling *et al.*, 2000), Fe, Ca, and P, which are important to immunity (Mroz *et al.*, 2000; Rafacz-Livingston *et al.*, 2005).

***Effect on Carcass Characteristics***

At the end of the trial, three birds from each replicate were picked randomly and were slaughtered to get data on carcass characteristics. Statistical analysis of the data on dressing percentage, breast meat, thigh meat and giblet organs weight e.g. liver, heart and gizzard revealed non-significant effect among the dietary treatment group.

However, apparently maximum average dressing percentage was observed in group (B) supplemented with acetic acid, whereas minimum dressing percentage was observed in control group (D).

**Table 4:** Effect of benzoic, acetic and formic acid supplementation on carcass characteristics (g/100 g BW) of broilers.

| Parameters | Treatments | | | |
|---|---|---|---|---|
| | A<br>Benzoic acid | B<br>Acetic acid | C<br>Formic acid | D<br>Control |
| Dressing percentage | 63.01±1.00 | 63.06±2.16 | 63.0±2.15 | 61.34±1.95 |
| Breast meat yield | 23.11±1.83 | 22.05±0.86 | 20.07± 1.26 | 23.65±1.61 |
| Thigh meat yield | 4.49±0.28 | 4.81±0.42 | 5.00± 0.44 | 4.5± 0.20 |
| Liver weight | 1.88±0.40 | 1.74±0.96 | 1.96± 0.22 | 2.02± 0.13 |
| Heart weight | 0.53±0.011 | 0.49±0.027 | 0.55± 0.060 | 0.56±0.037 |
| Gizzard weight | 2.14±0.04 | 1.98±0.11 | 2.24±0.24 | 2.30±0.15 |
| Intestinal weight | 6.59±0.14 | 6.10±0.33 | 6.87±0.75 | 7.08±0.46 |

A= Benzoic acid, B= Acetic acid, C= Formic acid, D= Control.
NS= Non-significant.

***A: Benzoic Acid, B: Acetic Acid, C: Formic Acid, D: Control***

The results are also in line with Celik *et al.*, (2007) who added a mixture of organic acids in broilers diet at level 0.5% and found no effect on dressing percentage. The results of present study were not in line with those of Lesson *et al.,* (2005) who found that butyric acid supplementation at level 0.2% in feed improved the dressing percentage in broiler chicks. Denli *et al.,* (2003) also reported that supplementation of organic acid product; genex (propionic and formic acid salts) at 0.2% in the diet significantly improved the dressing percentage. The improvement in dressing percentage may be due to the fact that organic acid improve the utilization of all nutrient especially protein which results in better dressing percentage (Hume *et al.,* 1993The results of present study are also in agreement with results of Talebi *et al.,* (2010) how reported that addition of citric, benzoic and tartaric acid in the diet of broiler chicks had no effect on organ weight. Similar results were reported by Islam *et al.,* (2008) who found that addition of organic acids (citric and acetic) at 0.5% in the diet of broiler chicks had no effect on organ weight). Similar results were observed by Izat *et al.,* (1990) who reported that addition of buffered propionic acid @ 0.4% in the diet of broilers had no effect on organ weight.

## Conclusion

It is recommended to use organic acids in broiler diet as an inexpensive and efficient growth promoting agent without residual effects like antibiotic growth promoter.

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