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Performance, nutrient digestibility and feed cost benefit of finisher broiler chickens fed diets supplemented with Crina poultry plus®

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Abstract

A study was carried out to determine the effect of Crina Poultry Plus®, a natural blend of essential oils and benzoic acid. on the growth performance, carcass yield and nutrient digestibility of broiler chickens. Six treatment diets were formulated by the addition of Crina Poultry Plus (CPP®) at 0, 0.2, 0.3, 0.4, 0.5 and 0.6g/kg of feed. Two hundred and forty day-old chicks were allocated to the six dietary treatments with each treatment having four replicates. Each replicate had 10 broilers. The parameters measured were live weight, live weight gain, feed intake, feed conversion, protein efficiency ratio, carcass and organ characteristics, nutrient utilization and feed cost benefit. Results of growth performance showed that there were no significant differences (P>0.05) across the treatment groups, but birds fed diets supplemented with CPP® had significantly heavier body weight (BW), higher average daily weigh gain live weight gain and similar feed conversion ratio when compared with the control group. The dressing percentage, thigh, drum stick, breast cut and back cut were not significantly (P>0.05) different across the treatment groups but those fed diet supplemented with CPP® had higher values when compared with the control diet. The supplementation of CPP® improved nutrient digestibility in broiler chickens. Birds fed diet containing 0.6g of CPP® had numerically lower cost per kg of weight gained compared to other treatment groups. It can be concluded that the addition of 0.6 g CPP® in broiler diets improved performance, carcass, organ characteristics and nutrient utilization of broilers.

Keywords: Benzoic acid, essential oils, growth performance, carcass, nutrient digestibility and broiler chicken

Introduction

Sustainable poultry production is the efficient production of safe, high quality products (meat and eggs), in a way that protects and improves the natural environment, economic conditions of poultry farmers and safeguards the health and welfare of all poultry species (http://www.saiplatform.org/sustainable-agriculture/definition). Thus, meeting the nutritional requirement of the animals with the objective to optimize digestibility and absorption of nutrients is certainly one of the most important elements in poultry production (Onabanjo and Amaefule, 2017). In this respect, the gastrointestinal tract needs special attention because any impairment of the secretion of enzymes or disturbance of the microbiological equilibrium in the gut could negatively affect the digestibility of the feed, resulting in reduced growth rate or impaired feed conversion of the growing birds.

Before now, antibiotics were used to facilitate efficient production of poultry by reducing the incidence of diseases. They exacted their core activity as growth promoters at sub-therapeutic concentrations (50-100mgkg^{-1}) in feed and or water by suppressing the harmful microorganisms. They also counteracted the adverse consequences of stress responses, improving the gut health which leads to increase in feed conversion efficiency (Zulkifli *et al*., 2000).

However, in spite of these advantages, concerns were raised of the effects of indiscriminate use of antibiotics which included antibiotics resistance, resulting from the ability of bacterial population to survive the effect of inhibitory concentration of antimicrobial agents (Catry *et al*., 2003) and accumulation of antibiotic residues in tissues of poultry birds which upon consumption possess risk to human health. In view of these, antibiotics have been banned for use as growth promoters in most developed countries (EC, 2001, 2003). Researchers have continued to search for alternatives to antibiotics growth promoters.

Thus, eubiotic feed additives (EFA) such as organic acids; essential oils; prebiotics and probiotics are being used or investigated. In recent years, some of these products have been described by the general term 'eubiotics', which is related to the Greek term 'Eubiosis", referring to an optimal balance of microflora in the gastrointestinal tract. The main purpose of using eubiotics is to maintain the intestinal eubiosis, which will result in an improved health status and performance in farm animals.

Organic acids and their salts are generally considered safe and have been approved by most member states of European Union to be used as the feed additives in animal production. Organic acids work in animals, not only as a growth promoter but also as a significant tool for controlling intrinsic bacteria, both pathogenic and non-pathogenic (Naidu, 2000 and Wolfenden *et al* ., 2007) and they exert physiological effects in the proximal sections of the digestive tract (Boulduan *et al*., 1988). Organic acids in non-dissociated (non-ionized, more lipophilic) form can penetrate the bacteria cell wall and disrupt the normal physiology of certain types of bacteria (Dhawale, 2005). Acidification with various organic acids has been reported to reduce the production of toxic components by the bacteria and colonization of pathogens on the intestinal wall, thus preventing the damage to epithelial cells (Langhout, 2000). Apart from the antimicrobial activity, they reduce the pH of digesta, increase the pancreatic secretion, and have trophic effects on the mucosa of gastro-intestinal tract (Dibner and Buttin, 2002). Moreover, organic acids feeding is believed to have several beneficial effects such as improving feed conversion ratio, growth performance, enhancing mineral absorption and speeding recovery from fatigue (Král *et al*., 2011, Gálik and Rolinec, 2011; Petruška *et al.,* 2012). Examples of organic acid include fumaric acid, citric acid, formic acid, lactic acid, sorbic acid and benzoic acid.

Essential oil compounds are another group of feed additives that has potential for the replacement of antibiotic growth promoters. These essential oils are made up of active ingredients (e.g. thymol, carvacrol, eugenol, piperine cubeb, cumin) present in various plants and spices. Due to their antibacterial activity, they are able to modify the composition of the intestinal microflora and exert beneficial effects on performance of poultry. Several authors have reported an *in vivo* effect on microflora by specific formulations of essential oil in poultry.

The present study was therefore conceived to evaluate the effect of dietary supplementation of Crina Poultry Plus® on growth performance, carcass yield, nutrient digestibility and feed cost benefit of finisher broiler chickens.

Materials and methods

Experimental site

The experiment was carried out at the Poultry Unit of the Teaching and Research Farm of Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria. The area falls within the tropical rain forest zone, with an annual average rainfall of 2177mm, temperature range between 20° - 30°, with relative humidity 50-59%

depending on season (NRCRI, 2004).

Source of eubiotics

The eubiotics; CRINA POULTRY PLUS® used in this study was purchased from the manufacturer; DSM Nutritional Products, LTD., Wurmisweg, Switzerland. The product was in powder form and contains a mixture of essential oil compounds [thymol ($\geq$1%), eugenol ($\geq$0.5%), piperine ($\geq$ 0.05%), and other flavoring substances ($\leq$ 0.6%)] with the organic acid; benzoic acid ($\geq$80%).

Experimental birds and management

A feeding trial was conducted using unsexed 240, oneday old Arbor acre finisher broiler chicks (Chi® Farms) at four weeks of age. The chicks were randomly divided into 24 groups. Each group was raised in floor pens with wood shavings litter material and contained feeders and drinkers to provide *ad libitum* access to feed and water for duration of 21 days. Coccidiostats was administered to the birds during the experiments.

Experimental diets

Six experimental broiler finisher diets were formulated such that the control Diet A contained no Crina Poultry Plus®. Diet B, C, D, E and F contained 0.2, 0.3, 0.4, 0.5 and 0.6g CPP® in the control diet respectively. The ingredients composition of the broiler finisher control feeds is shown in Table 1.

Table 1: **Percentage compositions of the control broiler finisher diet (22 to 42 d) period**

Ingredients	**Finisher**
Maize	60.55
Soya bean meal	30.7
Palm kernel cake	5
Bone meal	3
Methionine	0.20
Lysine	0.10
Vitamin/mineral premix	0.25
Salt	0.2
Total	**100**
Calculated composition %	
Crude protein	19.8975
Crude fibre	4.18
ME, Kcal/kg	2957.244
Methionine	0.53
Lysine	1.11
Calcium	1.16
Analyzed composition %	
Crude Protein	18.31
Crude Fiber	6.08
Ether Extract	1.47
Dry Matter	91.59
NFE	60.51

Each 2.5 kg vitamin-mineral premix provided the following: A 8,000,000 iu, D_3 2,000,000 iu, E 5000 mg, K_3 2000 mg, Folic acid 500 mg, Niacin 15,000mg, Calpan 5,000 mg, B_2 8000 mg, B_{12} 10,000 mg, B_1 1,500 mg, B_6 1,500 mg, Biotin 20 mg.

Data collection

Growth performance

The initial live weights of birds were taken at the beginning of the experiment and final weight was done at the end of the experiment. Weight gain was obtained by subtracting initial live weight from the live weight at the end of finisher phase. Data on feed intake were also determined by difference between the quantity offered and quantity left over each day. Feed conversion ratio was determined by dividing feed intake by weight gain. The daily protein intake was obtained by multiplying the daily feed intake by the percentage crude protein of the diet while protein efficiency ratio was obtained by dividing the daily weight gained with daily protein intake.

Carcass yield

At the end of the experiment (21 days), 24 chickens of similar body weights to the group average were selected from the treatment group (one chicken per replicate), weighed and slaughtered by severing the jugular vein, they were then thoroughly bled and scalded by dipping in warm water with temperature of 50-55°C before defeathering. The internal organs were removed. After evisceration, warm carcasses were weighed immediately to determine the carcass yield. The weights of the carcass; breast, thigh, drumstick, back-cut and wings were recorded individually. The weights of these selected parts were expressed as a percentage of dressed weight of the broilers, while the weight of selected organs; gizzard, liver, spleen, heart and proventriculus were recorded and expressed as a percentage of live weight.

Digestibility trials

The nutrient retention and nutrient utilization of the broilers were determined using 24 birds per feeding experiment. Each dietary treatment had four replicates; four broilers/dietary treatment. The birds were kept in a cage unit, fed their respective treatment diets for seven days in order for them to acclimatize with the cage system and also to establish proper feed intake, the latter was done for the first four days. Thereafter, they were starved for 12 hours to clear the G.I.T (Gastro Intestinal Tract) from all previous feed digesta, and then they were fed 90% of the established feed intake for three days consecutively. Faecal droppings were collected for each day from the aluminium tray placed under each of the cage cells. The faecals were weighed immediately, sundried (30-34^{o}C) for 2(two) days, weighed, then placed in a labeled polythene bag and used for proximate analysis. At the end of the collection period, droppings from each replicate of the same treatment were bulked, milled and representative sample was taken for proximate analysis.

Digestibility parameters measured were:

$$\text{Digestibility (g/g)} = \frac{\text{Nutrient in feed} - \text{Nutrient in faeces}}{\text{Nutrient in feed}} \times 100$$

Feed-cost benefit

The economic analysis was done to determine the economic advantage or otherwise of adding blend of essential oils and organic acid to broiler diet. Cost/kg feed was gotten by summing the price per kg of feed ingredients multiplied by their proportions in the feed formula, then divided by 100. Daily feed cost (DFC) is gotten by multiplying cost per kg feed by daily feed intake while the total feed cost (TFC) was gotten by multiplying total feed intake by cost per kg feed. The cost per kg weight gained was also gotten by multiplying feed conversion ratio by cost per kg feed.

Chemical analysis and data analysis

Proximate composition of the experimental diets and faecal samples were determined according to the methods of A.O.A.C (2003). The experiments were laid out in a completely randomized design. All data analysis were done using IBM® SPSS version 20.0. The data were subjected to analysis of variance. Where treatment means were significant, separation of means was done using the Duncan's Multiple Range Test (Duncan, 1955) at 5% level of significance.

Completely randomized design model: $Y_{ij} = \mu + T_i + e_{ij}$

Where:

Y_{ij} = individual observation

μ = Overall mean

T_i = Treatment Effect

e_{ij} = Random error

Results and discussion

Growth performance

The performance of finisher broilers fed diet containing combination of essential oils and benzoic acid is presented in Table 2. In all the parameters measured, that is initial weight, final body weight, average daily weight gained, average daily feed intake, feed conversion ratio, daily protein intake and protein efficiency ratio, there was no significant (P>0.05) differences across the treatment groups. Though, the average daily weigh gained was increasing as the inclusion of CPP® increases across the treatment groups while the feed conversion ratio showed that birds fed diet supplemented with 0.6g of CPP® had the least value.

Table 2.: Effect of Crina Poultry Plus® on growth performance of finisher broilers.

Parameters	T1 (Control)	T2 (0.2g)	T3 (0.3g)	T4 (0.4g)	T5 (0.5g)	T6 (0.6g)	S.E.M
Initial weight (g/b)	827.50	910.00	907.50	859.00	870.00	930.00	12.45
Final body weight (g/b)	1841.67	1943.75	1858.33	1881.25	1983.33	2106.25	42.69
ADWG (g/b)	48.29	49.23	45.28	48.68	53.02	56.01	1.98
ADFI (g/b)	94.98	99.29	105.71	105.92	98.52	104.86	1.97
Feed conversion ratio	2.05	2.03	2.44	2.21	1.97	1.90	0.09
Daily protein intake (g/b)	18.90	19.76	21.04	21.08	19.61	20.87	0.39
Protein efficiency ratio	2.61	2.51	2.12	2.31	2.72	2.72	0.11

[a,b,c] Means across rows with different superscripts differ significantly at P<0.05; S.E.M: Standard Error of the Mean; ADWG: Average Daily Weight Gained; ADFI: Average Daily Feed Intake.

Table 3 shows the carcass yield of finisher broilers fed diet containing combination of essential oils and benzoic acid. The live weight, dressed weight, wings, breast and back Cut were not significantly (P>0.05) different among the treatment groups. The dressing percentage of birds fed diet supplemented with 0.4g of CPP® was significantly (P<0.05) higher than that of birds fed diets supplemented with 0.3g and 0.6g CPP®, while the remaining treatment groups had similar values.

Table 3.: Effect of Crina Poultry Plus® on carcass yield of finisher broilers

Parameters	T1 (Control)	T2 (0.2g)	T3 (0.3g)	T4 (0.4g)	T5 (0.5g)	T6 (0.6g)	S.E.M.
Live weight(g/b)	1770.00	1750.00	1760.00	1913.33	1845	2065	46.64
Dressed weight(g/b)	1110.00	1145.00	1085.00	1286.67	1190.00	1280.00	35.57
Dressing percentage	62.49^{ab}	65.19^{ab}	61.76^{b}	67.28^{a}	64.37^{ab}	61.90^{b}	0.68
Drum stick(%)	16.94^{a}	16.03^{ab}	17.17^{a}	15.04^{b}	15.92^{ab}	17.50^{a}	0.26
Wings (%)	13.14	12.75	12.88	12.28	12.48	12.79	0.13
Breast cut(%)	29.45	29.29	29.99	30.92	29.53	29.82	0.56
Back cut(%)	23.66	24.80	26.39	24.71	23.52	24.74	0.48
Thigh (%)	15.31^{ab}	15.72^{ab}	17.22^{a}	14.25^{b}	16.28^{ab}	17.05^{a}	0.34

[a,b,c] Means across rows with different superscripts differ significantly at P<0.05; S.E.M: Standard Error of the Mean; Def: Defeathered

Also, the drum stick of birds fed diet supplemented with 0.6g of CPP® was significantly (P<0.05) higher than birds fed diet supplemented with 0.4g of CPP®, while the remaining treatment group did not differ (P>0.05) among each other. Birds fed diets supplemented with 0.3g and 0.6g of CPP® had significantly (P<0.05) higher thigh weight as compared to that of birds fed diet supplemented with 0.4g of CPP®, while the remaining treatment groups had similar values (P>0.05).

Table 4 shows the organ weight of finisher broilers fed diet containing combination of essential oils and benzoic acid. The gizzard, liver, proventriculus, spleen and heart weight of birds fed diet supplemented with varying levels of CPP® and control diet were not significantly (P>0.05) different among the treatment groups.

Table 4.: Effect of Crina Poultry Plus® on organ weight of finisher broilers

Parameters (%)	T1 (Control)	T2 (0.2g)	T3 (0.3g)	T4 (0.4g)	T5 (0.5g)	T6 (0.6g)	S.E.M.
Gizzard	2.26	2.28	2.25	2.03	2.27	1.99	0.05
Liver	2.38	2.70	2.94	2.12	3.08	2.44	0.13
Proventriculus	0.39	0.40	0.44	0.34	0.39	0.34	0.01
Spleen	0.09	0.11	0.08	0.12	0.11	0.09	0.01
Heart	0.44	0.49	0.44	0.43	0.48	0.38	0.02

^{a,b,c} Means across rows with different superscripts differ significantly at P<0.05; S.E.M: Standard Error of the Mean

Table 5 shows the nutrient digestibility of finisher broilers fed diets containing combination of essential oils and benzoic acid. The digestible dry matter of birds fed the control diet was significantly (P<0.05) higher than those of birds fed diets supplemented with 0.3 and 0.5g CPP®, while the digestible crude protein of birds fed the control diet was significantly (P<0.05) higher than those of birds fed diets supplemented with 0.3, 0.5 and 0.6g CPP®.

Table 5.: Effect of Crina Poultry Plus® on digestible nutrients of finisher broilers

Parameters(%)	T_1 (Control)	T_2 (0.2g)	T_3 (0.3g)	T_4 (0.4g)	T_5 (0.5g)	T_6 (0.6g)	S.E.M
Dry matter	70.38^{a}	66.14^{abc}	55.51^{c}	69.48^{ab}	56.34^{bc}	65.40^{abc}	1.98
Crude protein	83.58^{a}	80.38^{ab}	74.27^{b}	81.80^{ab}	73.61^{b}	74.79^{b}	1.29
Crude fiber	62.74^{a}	37.29^{b}	10.90^{c}	39.47^{ab}	20.55^{bc}	36.75^{b}	4.73
Ether extracts	96.70^{c}	97.38^{bc}	96.90^{c}	98.45^{ab}	98.83^{a}	99.07^{a}	0.26
NFE	72.32^{ab}	72.46^{ab}	60.05^{c}	74.57^{ab}	65.86^{bc}	78.97^{a}	1.89

^{a,b,c} Means across rows with different superscripts differ significantly at P<0.05; S.E.M: Standard Error of the Mean; NFE: Nitrogen Free Extracts.

The digestible crude fiber of birds fed the control diet was significantly (P<0.05) higher than those of birds fed diets supplemented with 0.2, 0.3, 0.5 and 0.6g CPP®, while the ether extract of birds fed diet supplemented with 0.6g CPP® was significantly (P<0.05) higher than those of birds fed diets supplemented with 0.3, 0.2g CPP® and the control diet. Digestible nitrogen free extract of birds fed diets supplemented with 0.6g CPP® was significantly (P<0.05) higher than those of birds fed diets supplemented with 0.3 and 0.5gCPP®.

The economics of production of finisher broilers fed diets containing combination of essential oils and benzoic acid is presented in Table 6. There was non-significant (P>0.05) difference among birds fed diet containing different levels of the CPP® or control diet in daily feed cost, total feed cost and average cost/ kg weight gained. But the average cost/ kg of feed varied significantly (P<0.05) within the treatment groups.

Table 6.: Effect of Crina Poultry Plus® on economics of production of finisher broilers

Parameters(₦)	T1 (Control)	T2 (0.2g)	T3 (0.3g)	T4 (0.4g)	T5 (0.5g)	T6 (0.6g)	S.E.M
Av.cost/kg Feed	100.08[a]	100.78[b]	101.13[c]	101.48[d]	101.83[e]	102.18[f]	0.14
Daily feed cost	9.50	10.00	10.69	10.75	10.03	10.71	0.20
Total feed cost	199.63	210.13	224.50	225.73	210.69	225.00	4.28
Av. cost/kg WG	205.66	204.08	246.76	224.02	200.35	194.14	8.82

[a,b,c] Means across rows with different superscripts differ significantly at $P<0.05$; S.E.M: Standard Error of the Mean; Av: Av erage; WG: Weight Gained.

Discussion

Performance

Although it has been common practice in animal farming to add organic acids to feeds for both their preservative and possible growth promoting effects (Falkowski and Aherne, 1984), available literature suggests that the response of broiler chicken to dietary blend of benzoic acid and essential oils are limited. Our findings are in agreement with the report of Weber *et al*., (2012) that eubiotic feed additive (CPP®) improve performance of broiler chickens under semi-commercial conditions but the difference was in the rate of inclusion where previous experiment did not go beyond 300mg/kg of the diet.

It was observed that there was no significant differences observed which was also similar to an experiment conducted with a combination of dietary organic acid blend and oregano essential oil (Arzu *et al*., 2014), also the results were in agreement with many researchers (Izat *et al.,* 1990; Kaniawati *et al*., 1992; Houshmand *et al*., 2012) who did not find any significant effects of organic acids on growth performance of broiler chickens which may be due to climatic factors.

In another study, Józefiak *et al*. (2010) used a very low (0.1%) dietary inclusion of benzoic acid which resulted in an increased body weight gain of chickens only in the first 2 weeks of fattening, while 0.2% supplementation decreased body weight gained in the grower (15 to 35 days) and the entire period of broiler chicken fattening. The improvement in the feed conversion ratio of birds fed higher levels of CPP® could be possibly due to better utilization of nutrients resulting in increased body weight gain. Also, the improvement in performance of birds fed CPP® may be due to enhanced general performance Dibner and Buttin (2002) suggested that organic acids and their salts improve protein and energy digestibility by reducing microbial competition with the host for nutrients and endogenous nitrogen losses, by lowering the incidence of sub-clinical infections and secretion of immune mediators, by reducing the production of ammonia and other growth suppressing microbial metabolites. Probably these could be the reasons that organic acids or their salts improved feed utilization leading to better performance in the broilers.

Carcass and organs yield

Our findings are in agreement with those of Jamroz and Kamel (2002) who found higher percentages of breast muscle in broilers, also Mandal *et al*. (2000) observed that carcass yield were not affected by the dietary essential oil treatments.

The result of the present study showed no significant difference in carcass weight, carcass yield and organs weight which was similar to the findings of Ocak *et al*. (2008). Majid *et al* (2010) indicated no significant differences in the carcass yield and organs of broilers fed diet containing thyme. Khattak *et al*. (2014) revealed that breast and thigh weight were significantly higher ($P<0.05$) than control group where they fed broiler chickens with a blend of essential oils.

There were no significant differences in the weight of the proventriculus, gizzard, liver, spleen and heart weight, thus it was discovered that water-soluble extract from the essential oils enhanced hepatic metabolism and increased relative liver weight (Debersac *et al.,* 2001). Relative weights of all the organs were higher at 21d of age than at 42 d ($P< 0.05$). Relative weights of all the organs studied decreased with age; the results data are consistent with the findings of Iji *et al*. (2001).

Nutrient digestibility

There is evidence to suggest that herbs, spices, and various plant extracts have appetite and digestion stimulating properties and antimicrobial effects (Kamel, 2001). **I**mprovement of the digestibility of nutrients by Eubiotic feed additives (Hernández *et al*., 2004) triggered by an increase of the activity of digestive enzymes in the gastrointestinal tract (Lee *et al*., 2003). Plant extracts contain different molecules that have intrinsic bio-activities on animal physiology and metabolism. The supplementation of EFA improved apparent digestibility of dry matter, crude fiber, crude protein, nitrogen free extract and ether extract.

Herbs and spices have traditionally been used to stimulate the production of endogenous secretions in the small intestinal mucosa, pancreas and liver, and thus aid digestion. Plant spices, when fed together with organic acids, have stimulated proteolysis, by lowering the pH to the optimal level for pepsin activity (Kamel, 2001). In rats, the dietary inclusion of spices has increased the endogenous secretion of enzymes, bile acids and pancreatic juice (Platel and Srinivasan, 2000; 200; 2003), and reduced the transit time for digesta passage.Some spices were observed to reduce endogenous secretions, without an effect on feed consumption (Platel and Srinivasan, 2000). An increased amylase activity intestinal chyme was observed with dietary inclusion of Crina Poultry, an essential oil blend, at 21 d of age in broilers, but the effect decreased with increasing age (Lee *et al*., 2003b).

Organic acids normally used as an acidifier in poultry feeds have been considered to be attractive alternatives for improving nutrient digestibility. Ghazala *et al*. (2011) reported that dietary 0.5% of either fumaric or formic acid and 0.75% of acetic or 2% citric acid improved both metabolizable energy and nutrient digestibility, that is, crude protein (CP), ether extract (EE), crude fibre (CF) and nitrogen-free extract (NFE) in broiler diets. They do these by reducing microbial competition with the host for nutrients, endogenous nitrogen losses and production of ammonia (Omogbenigun *et al*. 2003).

Feed-cost benefits

The increase in cost of feed containing the additive was due to the cost of procuring the additive and this increased as the level of inclusion of the additive increased. The DFC and TFC was higher in birds fed diets containing the additive compared to birds fed control diet which is due to the relative increase in daily feed intake, these were compensated by low cost of feed per weight gained where birds fed diets containing additive were relatively lower to those fed control diet. However, Ndelekwute *et al.* (2014) had reported a similar result where he used formic acid as an additive for broiler chickens. This result confirmed the assertion that organic acids were added to feeds for economic reasons and also they can be used to raise broiler chickens in place of antibiotics (Ndelekwute, 2012).

Conclusion

This study showed that supplementation of a blend of essential oils and benzoic acid to diet of broiler chickens was beneficial in improving growth, higher carcass yield andfeed efficiency enhanced digestive enzyme and better nutrient digestibility. Thus, supplementation of this additive is an essential practice that can enhance the growth and survivability of broiler chickens. Thus, it is recommended that CPP® could be used in broiler diet at 0.6g/kg since the level increased performance and nutrient utilization.

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