RESPONSE OF BROILER CHICKENS TO DIETS CONTAINING DIFFERENT KINDS OF PEPPER

Imasuen, J.A[1]. and Aikpieanyi, K.U[2].
[1]*Department of Animal Science, University of Benin, Benin City, Edo State, Nigeria*
[2]*Department of Animal Science, Ambrose Alli University, Ekpoma, Edo State, Nigeria*

ABSTRACT
This study's objective was to evaluate the effects of varying levels of black pepper, red pepper, and their combinations on broiler chickens' growth performance, carcass, and internal organs characteristics. A total of 315 one-day-old chicks were used for the study which lasted for eight weeks. Birds were randomly allotted to seven treatments in a completely randomized design, with each treatment having 45 birds, replicated three times to give 15 birds per replicate. The brooding pen was partitioned into seven units to facilitate the feeding trial's commencement from day one. Treatment 1 was the control and was offered a basal diet with no additive. The test diets were formulated by including the additives as follows: 1% black pepper (T2), 1.5% black pepper (T3), 1% red pepper (T4), 1.5% red pepper (T5), 0.5% each of black pepper and red pepper (T6), and 0.75% each of black pepper and red pepper (T7). The growth performance result showed that the additives positively influenced final body weight (BW), weight gain, feed conversion and protein efficiency ratios, as the birds fed the test diets had improvements in assessed growth parameters with significant differences (P<0.05) from the control. Treatment 7 had the highest final BW of 2825g/bird, while T2 recorded the best performances in terms of feed conversion and protein efficiency ratios (2.21 and 2.40, respectively). Dressed percentages of 81.57% and 80.72% were the highest and recorded in Treatments 5 and 2 in that order, with significant differences (P<0.05) from the control. From the results, it can be concluded that the use of black pepper, red pepper, and their combinations as feed additives effectively promotes broiler chickens' overall performance.

Keywords: *black pepper, red pepper, growth performance, carcass characteristic*

INTRODUCTION

With the increasing demand for poultry meat globally, poultry farmers want to improve their flock's productivity. They are interested in the type of feed that can achieve this goal in a reasonable period. This challenge has necessitated poultry nutritionists to offer specific nutritional strategies for the rapid growth of broilers. Feed additives that promote growth have been recommended as one of such strategic options. Besides, animal production is increasingly concerned with the quantity and quality of the final product and its implications for food security, environment, and animal welfare (Puvaca *et al*., 2013). The search for useful feed additives is continuing, and plant materials, otherwise known as phytogenics, are being extensively investigated by various authors (Ndelekwute *et al*. 2015; Imasuen and Aikhomu, 2017; Aikpitanyi *et al*., 2019).

With the identification of active components of phytogenics and some progress in mechanistic studies of these components in animals, there have been increased research efforts to use phytogenic materials to substitute chemical-based and antibiotics growth promoters in animals' diets (Li *et al.,* 2012). Phytogenic additives have also gained researchers' attention because they prevent common diseases in animals and are becoming a growing interest to consumers because they are considered natural alternatives to synthetic compounds that allay fears of residue compounds in the final product (Pearce and Jin, 2010). The effects of phytogenic feed additives on feed digestibility have also been illustrated in some studies (Demir, 2003; Moorthy 2009). Many researchers have reported an increase in body weight and improved feed conversion ratio when using these herbs and spices in poultry diets (Moorthy, *et al*., 2009, Herati and Marjuki, 2011; Aikpitanyi et al., 2019). Phytogenic additives have also been proven to affect poultry and pigs feed palatability and quality, growth promotion, gut function, endogenous enzyme secretion, nutrient digestibility, gut microbiota, and immune function (Yang *et al*., 2009; Grela *et al*., 2013; Liu *et al.,* 2014; Yazdi *et al*., 2014; Kiczorowska *et al.,* 2016).

Pepper species, for example, commonly used in human diet and traditional medicine, are being extensively assessed as phytogenics for various benefits in poultry production. Pepper has been found to have antioxidant properties (Mittal and Gupta, 2000) and anticarcinogenic effects (Nalini *et al*., 2006). Black pepper and red pepper have been reported to have antibacterial and antioxidant properties in addition to its ability to enhance secretions of gastric and pancreatic enzymes, thereby improving digestibility (Orav *et al*., 2004; Sirinivasan 2014). These favourable properties can be explored for better broiler productivity. For this reason, this experiment sought to study the efficacy of the use of black and red pepper as feed additives in broiler chicken nutrition.

MATERIALS AND METHODS

The experiment was approved by the Departmental Board of Animal Science, Faculty of Agriculture, University of Benin, Benin City, Nigeria.

Experimental Location

The experiment was carried out at the Poultry Unit of the Teaching and Research Farm of the Faculty of Agriculture, University of Benin, Benin City, Edo State, Nigeria. The area has an average annual rainfall and relative humidity of 2000mm and 72.5%, respectively (Google earth, 2018).

Preparation of test ingredients

The dried test ingredients for the study were obtained from the local market in Benin City. They were visually inspected to ensure they were evenly dried and not rotten. They were ground into fine powder using an electric grinding machine (Agro Equipment Industries, India. Model GM-3, 1HP) and stored in airtight containers until incorporated in the experimental diets.

Experimental diets

Broiler starter and finisher diets used for the feeding trial were formulated according to the recommendations of Olomu (2010). Starter diets were fed to the chicks for the first four weeks, followed by the finisher diets for another four weeks. The test ingredients (black pepper and red pepper and their combinations) were added to the diets at varying inclusion levels, as indicated in Tables 1 and 2.

Experimental animals and design

A total of 315 one-day-old Arbor Acre broiler chicks were purchased from a reputable hatchery. They were randomly allotted to seven experimental treatments from day one of brooding. The brooding pen was partitioned into seven units to ensure that birds receive the treatment diets from day one. Each experimental group was assigned forty-five birds. After the brooding period of two weeks, the chicks were moved to the rearing pens. Each treatment group was replicated three times to give 15 birds per replicate. The study was laid out in a completely randomized design, and all parameters of interest were measured, collected, and analyzed at the end of every week.

Management of animals

The birds were housed in floor pens with wood shavings as the litter material. Before the arrival of the birds, the brooding unit and pens were

Table 1: Composition of experimental broiler starter diets

INGREDIENTS (%)	T1	T2	T3	T4	T5	T6	T7
Maize	55.20	55.20	54.70	55.20	54.70	55.20	54.70
Soybean meal	28.00	28.00	28.00	28.00	28.00	28.00	28.00
Palm kernel cake	9.00	8.70	8.70	8.70	8.70	8.70	8.70
Fish meal	4.00	4.00	4.00	4.00	4.00	4.00	4.00
Bone meal	3.00	2.50	2.50	2.50	2.50	2.50	2.50
Common salt	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Vitamin/mineral premix	0.50	0.30	0.30	0.30	0.30	0.30	0.30
Black pepper	-	1.00	1.50	-	-	0.50	0.75
Red pepper	-	-	-	1.00	1.50	0.50	0.75
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**
Calculated composition							
Crude protein (%)	23.10	23.04	23.00	23.04	23.00	23.04	23.00
Metabolizable energy (Kcal/Kg)	**3240.04**	**3232.54**	**3214.94**	**3232.54**	**3214.94**	**3232.54**	**3214.94**

**The calculated nutrient compositions were derived using the following values: maize 9% crude protein and 3520 kcal/kg ME, soybean meal 48% crude protein and 3400 kcal/kg ME, palm kernel meal 21% crude protein and 2500 kcal/kg ME, fish meal with 70% crude protein and 3000 kcal/kg ME. Source: Olomu (2010).*

Table 2: Composition of experimental broiler finisher diet

INGREDIENTS (%)	T1	T2	T3	T4	T5	T6	T7
Maize	54.00	54.00	53.50	54.00	53.50	54.00	53.50
Soybean meal	20.80	20.80	20.80	20.80	20.80	20.80	20.80
Palm kernel cake	12.40	12.10	12.10	12.10	12.10	12.10	12.10
Wheat bran	7.00	7.00	7.00	7.00	7.00	7.00	7.00
Fish meal	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Bone meal	2.00	1.50	1.50	1.50	1.50	1.50	1.50
Common salt	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Vitamin/Mineral premix	0.50	0.30	0.30	0.30	0.30	0.30	0.30
Black pepper	-	1.00	1.50	-	-	0.50	0.75
Red pepper	-	-	-	1.00	1.50	0.50	0.75
Total	100	100	100	100	100	100	100
Calculated composition							
Crude protein (%)	20.62	20.56	20.52	20.56	20.52	20.56	20.52
Metabolizable energy (Kcal/Kg)	3088.15	3080.65	3063.05	3080.65	3063.05	3080.65	3063.05

**The calculated nutrient compositions were derived using the following values: maize 9% crude protein and 3520 kcal/kg ME, soybean meal 48% crude protein and 3400 kcal/kg ME, palm kernel meal 21% crude protein and 2500 kcal/kg ME, wheat bran with 15.40% crude protein and 1145kcal/kg ME, fish meal with 70% crude protein and 3000 kcal/kg ME. Source: Olomu (2010).*

thoroughly cleaned and disinfected. All materials used during the period of the study were also cleaned and disinfected thoroughly. Adequate drinkers and feeders were provided during the brooding and rearing periods to prevent aggressive competition for feed and water. Birds were allowed access to feed and water *ad libitum.* All daily and routine management practices related to feeding, watering, litter management, medication, and vaccination were diligently observed.

Growth performance studies

Feed intake, weight gain, feed conversion ratio, and protein efficiency ratio were assessed weekly. The weekly feed intake was determined by weighing the quantity of feed offered for the week and subtracting the leftover at the end of the week. The weekly weight gain was determined by the difference in the weight at the beginning of the week and the weight at the end of the week. The feed conversion ratio was calculated as stated in the formula below. It is the ratio of feed intake (g) to weight gain (g).

$$\text{Feed conversion ratio} = \frac{\text{Feed intake (g)}}{\text{Weight gain (g)}}$$

The protein efficiency ratio was calculated as the ratio of weight gain to that of protein consumed as expressed in the formula below.

$$\text{Protein efficiency ratio} = \frac{\text{Weight gain (g)}}{\text{Protein intake (g)}}$$

At the end of the eighth week, carcass and internal organ characteristics were assessed. Feed was withdrawn overnight, and six birds with liveweight close to the treatment mean weight were selected to give a total of 42 birds. They were slaughtered, scalded, and eviscerated. All necessary carcass measurements were taken with the aid of a 20kg pan scale (National scale brand. Model NS-01-20kg). The weight of internal organs was measured with a sensitive gram scale with an accuracy of 0.01g.

Statistical analysis

All data collected were subjected to a one-way analysis of variance (ANOVA) by using the general linear model procedure of SAS (2012), and differences in treatment means were compared by Duncan's multiple range test as outlined by Steel and Torrie (1997). The level of statistical significance was preset at 5%.

RESULTS AND DISCUSSION

The effect of varying levels of black pepper, red pepper, and their combinations on the growth performance of broiler chickens presented in Table 3.

Table 3: Growth performance of broiler chickens fed varying levels of black pepper, red pepper, and their combinations as additives

Parameters	TRT 1 (control)	TRT 2 (1% BP)	TRT 3 (1.5% BP)	TRT 4 (1% RP)	TRT 5 (1.5% RP)	TRT 6 (0.5% BP + 0.5 RP)	TRT 7 (0.75% BP + 0.75% RP)	S.E.M.
Initial weight (g/bird)	459.00	460.00	454.00	463.50	457.50	466.00	454.00	4.79NS
Final weight (g/bird)	2450.00^{c}	2700.00^{b}	2750.00^{ab}	2515.00^{c}	2675.00^{b}	2775.00^{ab}	2825.00^{a}	35.92*
Weight gain (g/bird)	1991.00^{c}	2240.00^{b}	2296.00^{ab}	2051.50^{c}	2217.50^{b}	2309.00^{ab}	2371.00^{a}	35.94*
Daily weight gain (g/bird/day)	47.40^{c}	53.33^{b}	54.67^{ab}	48.85^{c}	52.80^{b}	54.98^{ab}	56.45^{a}	0.86*
Total feed intake (g/bird)	6317.00^{b}	5502.50^{d}	6185.50^{bc}	6913.00^{a}	5449.50^{d}	5647.00^{d}	5829.00^{cd}	144.27*
Average daily feed intake (g/ bird/day)	140.38^{b}	122.28^{d}	137.46^{bc}	153.62^{a}	121.10^{d}	125.49^{d}	129.53^{cd}	3.21*
Feed conversion ratio (FCR)	2.38^{c}	2.21^{a}	2.28^{b}	2.31^{b}	2.27^{b}	2.28^{b}	2.29^{b}	0.02*
Protein efficiency ratio (PER)	2.23^{c}	2.40^{a}	2.33^{b}	2.30^{b}	2.34^{b}	2.33^{b}	2.32^{b}	0.02*
Mortality (%)	8.89^{c}	2.22^{a}	4.44^{ab}	6.66^{bc}	2.22^{a}	4.44^{ab}	4.44^{ab}	1.00*

TRT= Treatment, BP= black pepper, RP= red pepper, S.E.M.= standard error of mean,
a,b,c,d; Means in the same row with different superscript are significantly different (p<0.05)

The initial BW of birds across treatments at the start of the study was similar (P>0.05). However, significant differences (P<0.05) were recorded in the final live weight, weight gain, and daily weight gain. Treatment 7 (0.75% each of black pepper and red pepper) had the highest final weight of 2825g and was statistically similar to Treatment 3 (2750g/bird) and Treatment 6 (2775g/bird). The control and Treatment 4 had a significantly lower final live weight of 2450g/bird and 2515g/bird, respectively.

Weight gain (g/bird) followed the same pattern as final weight, with the highest value of 2371g/bird in Treatment 7 and the least value of 1991g/bird obtained from the control. In daily weight gain (g/bird/day), the same statistical pattern of significant difference was observed, with similarities between the control and Treatment 4 (47.40g/bird/day and 48.85g/bird/day), as well as between Treatments 3, 6, and 7 (54.67g/bird/day, 54.98g/bird/day and 56.45g/bird/day respectively).

Total feed intake (g/bird) and average daily feed intake (g/bird/day), both had varied significant differences (P<0.05). Total feed intake was highest in T4 (1% RP) with a consumption of 6913g/bird, which was also significantly different (P<0.05) from all other treatments, including the control. This was closely followed by the control with an average feed consumption of 6317g/bird, which was similar to T3 (6185.50g/bird). The lowest total feed intake of 5449.50g/bird was recorded in T5, statistically similar to T2 (5502.50g/bird), T6 (5647g/bird), and T7 (5829g/bird).

Feed conversion and protein efficiency ratios showed significant differences, as shown in Table 3. Birds on T2 (1% black pepper) had better feed conversion ratio (FCR) compared to the rest of the treatments, including the control. The birds fed the other test diets (T 3 to 7) had similar FCR, but all were better than control (T1) group. For the protein efficiency ratio (PER), T2 recorded the best performance (2.40), while the least performance was observed in the control (2.23) group.

The control had the highest mortality rate of 8.89% with no significant difference from T4 that recorded a 6.66% mortality rate. The rest of the treatments recorded significantly lower mortality rates of 2.22% (Treatments 2 and 4) and 4.44% in Treatments 3, 6, and 7.

In a similar study with various levels of red pepper, Puvaca *et al*. (2015) reported the highest BW of chicken in 0.5% red pepper treatment (2460.6 g), which was followed by 1% red pepper treatment (2442.4g) with significant differences (P<0.05) compared to other treatments. However, this is contrary to the findings of the current study where the final weight of the birds offered 1% red pepper additive was similar to the control diet. Nonetheless, at a higher level of inclusion (1.5%) and in combination with black pepper, significantly higher final weights were recorded in the groups fed the additives compared to the control. The investigations of Al-Kassie *et al.* (2011b) and Thiamhirunsopit *et al.* (2014) revealed that the inclusion of hot red pepper at varied levels in the diets of broiler chicken improved BW gain and FCR in the pepper treatment groups compared to the control group. A similar result was reported by Al-Harthi (2002) and he concluded that the effects on performance may be due to the pepper's stimulative, carminative, digestive and antimicrobial properties.

The effect of feeding broiler chicks with diets containing different levels of black pepper as feed additive was also studied by other authors and the results indicated that the birds fed the supplemented diets had significantly higher final weight, body weight gain, and better FCR compared to the control diets (Mansoub, 2011; Shahverdi *et al.,* 2013; Tazi *et al*., 2014, and Imasuen and Ijeh, 2018). This agreed with the findings of the current study in which the birds fed black pepper diets had improved growth performance compared to the control diet. Hosseini (2011) showed that black pepper increases digestion by arousing digestive liquids in the stomach, improving nutrient absorption, decreasing digesta transit velocity, and eradicating infectious bacteria. Furthermore, the digestive enzymes production induced by the ingestion of black pepper probably stimulates the liver to secrete bile, which further contributes to the digestion of food substances (Herati and Marjuki, 2011). This effect might explain why the present study recorded a positive influence of the treatments on measured growth parameters. In other studies, it

was reported that feed conversion ratio was best in 1% black pepper treatment, while the least ratio was obtained in the control, though without significant differences (Khalaf *et al*.,2007; Al-Kassie *et al*., 2011a; Ghaedi *et al*.,2014; Puvaca *et al*., 2015). On the contrary, significant differences were recorded in the present study in feed conversion and protein efficiency ratios between the treatments and the control.

In some studies (Shahverdi *et al*., 2013; Tazi *et al*., 2014), black pepper, and red pepper mixtures significantly improved final body weight, body weight gain, and feed conversion ratio of broiler chickens which agrees with the present study where the combination of black and red pepper (T 6 and 7) had improved growth performance compared to the control.

It is documented that hot pepper fed to broiler chicks at dietary doses of 1, 1.5, and 2% had no significant cumulative toxicity at doses administered (Husseiny *et al*., 2002). Therefore, it can be inferred that at the levels of inclusion in the present study, the test additives poised no toxicity challenge on the experimental birds. Puvaca *et al*. (2015) reported a mortality rate of 5.1% in the control, while the 1% black pepper and 1% red pepper treatments had 1.3% and 2.6% mortality rates, respectively. A significant decrease in mortality rate was also observed in the present study, with the control having a mortality rate of 8.89%. In comparison, the 1% black pepper and 1.5% red pepper treatments had the lowest mortality rate of 2.22% each. It is postulated that the active compounds of phytogenic additives (essential oils, phenols, flavonoids) prevent intestine-induced oxidative stress and inhibit lipid peroxidation, thereby arresting different radicals such as hydroxyl and superoxide radicals that are detrimental to birds' health and wellbeing (Zeng *et al.*, 2015; Moradi *et al*., 2016). Thus, the use of the additives in this present study was effective in enhancing the health status of the birds, which reflected in the decreased mortality rates among the treated groups.

A detailed assessment of carcass and internal organs characteristics of broiler chickens fed varying levels of black pepper, red pepper and their combinations is as given in Table 4.

average live weight of the birds selected for carcass assessment was similar to the treatment group average. Treatment 7 (0.75% each of black pepper and red pepper) had the highest live weight of 2975g/bird and was closely followed by T6 (2895g/bird) and T3 (2855g/bird). These treatments were significantly different from the control. The control had the lowest live weight

Table 4: Carcass and internal organs characteristics of broiler chickens fed varying levels of black pepper, red pepper, and their combinations as additives

Parameters	TRT 1 (control)	TRT 2 (1% BP)	TRT 3 (1.5% BP)	TRT 4 (1% RP)	TRT 5 (1.5% RP)	TRT 6 (0.5% BP + 0.5 RP)	TRT 7 (0.75% BP + 0.75% RP)	S.E.M.
Live weight (g/bird)	2550.00^{c}	2820.00^{b}	2855.00^{ab}	2605.00^{c}	2785.00^{b}	2895.00^{ab}	2975.00^{a}	25.78*
Plucked weight (g/bird)	2275.00^{b}	2575.00^{a}	2550.00^{a}	2250.00^{b}	2550.00^{a}	2625.00^{a}	2575.00^{a}	24.53*
Eviscerated weight (g/bird)	1975.50^{b}	2276.25^{a}	2275.65^{a}	1978.55^{b}	2271.75^{a}	2323.75^{a}	2291.90^{a}	24.17*
Dressed percentage (%)	77.47^{bcd}	80.72^{a}	79.71^{ab}	75.95^{d}	81.57^{a}	80.27^{ab}	77.04^{cd}	0.92*
Liver weight (%)	2.46	2.19	2.11	1.98	2.38	2.39	2.06	0.17NS
Gizzard weight (%)	1.90	1.91	1.82	2.00	1.99	1.91	1.85	0.05NS
Heart weight (%)	0.49^{ab}	0.54^{a}	0.44^{bc}	0.49^{ab}	0.46^{bc}	0.44^{bc}	0.42^{c}	0.02*
Lungs weight (%)	0.58	0.55	0.54	0.49	0.57	0.55	0.60	0.05NS
Abdominal fat (%)	1.20^{bc}	1.55^{a}	1.34^{ab}	1.24^{ab}	0.86^{c}	1.13^{bc}	1.04^{bc}	0.10*
Spleen weight (%)	0.13	0.11	0.11	0.14	0.16	0.12	0.11	0.01NS

TRT = Treatment, SEM = standard error of mean, BP = black pepper, RP = red pepper,
** = significant ($p<0.05$), NS = Not significant, a,b,c,d; means in the same row with different superscript are significantly different ($p<0.05$)*

of 2550g/bird though with statistical similarity with T4 that weighed 2605g/bird.

Plucked weight was highest in T6 with a 2625g/bird value while the least weight was obtained from T4 (2250g/bird). No significant difference was observed between the birds fed the test diets apart from T4 that was statistically similar to the control (2275g/bird). Highest eviscerated weight of 2323.75g/bird was obtained from T6, while the lowest value of 1975.50g/bird was obtained from the control. The control was similar to T4, as observed in plucked weight. The dressed percentage of 81.57% was highest in T5 (1.5% red pepper). The value had no significant difference from 80.72% in T2, 80.27% in T6, and 79.71% in T3. The lowest dressed percentage of 75.95% was observed in T4 (1% red pepper), and which had no significant difference with T7 (77.04%) and the control (77.47%).

The relative weight of the heart was highest (0.58%) in T2. This value was followed by both the control and T4 that recorded a 0.49% relative weight. They also had statistical similarity with T2. On the other hand, T7 recorded the lowest relative weight of 0.42%. However, it was statistically similar to the 0.44% obtained from both treatments 3 and 6, as well as the 0.46% relative weight from the T5. Abdominal fat percentage was least with 0.86% in T5 and was closely followed, with no significant difference by treatments 1, 6 and 7 (1.20%, 1.13%, and 1.04%, respectively). The highest abdominal fat percentage of 1.55% was obtained from T2 with statistical similarity with T3 (1.34%) and T4 (1.24%).

From the result of the carcass assessment in Table 4, it was observed that the birds offered the 1% black pepper (Treatment 2) and 1.5% red pepper (Treatment 5) diets had significantly higher dressed percentages of 80.72% and 8157%, respectively. Puvaca *et al*. (2015) reported a similar result., though the dressed percentages of 68.1% recorded in the 1% black pepper treatment and 66.6% obtained from 1% red pepper treatment were numerically less than what was obtained from this study. Al-Kassie *et al*. (2011b) also reported a significant influence of red pepper on the dressing percentage of broiler chickens, with 74.3% recorded in the group offered diet with 0.75% red pepper additive. Moradi *et al*. (2016) also reported improved carcass yield of up to 72% in the birds that received black pepper and red pepper mixtures. The investigation of Al-Kassie *et al*. (2014) supports the claim of a positive effect of phytogenic feed additives on the quality of broiler carcasses. On the contrary, the works of Al-Kassie and Witwit (2010) and Al-Kassie *et al*. (2012) reported that the use of phytogenic feed additives had no significant effect on the dressing percentage of broiler chickens at low inclusion levels less than 0.3%. However, it can be deduced that the higher dressing percentages obtained in the feed additive groups in this study may be due to the better feed efficiency and superior weight gain recorded in these groups.

The results obtained from the weights of the internal organs in this study agree with those reported by other authors (Al-Kassie *et al*., 2012; Tazi *et al*., 2014 and Imasuen and Ijeh 2018), where the inclusion of black pepper to broiler chicken diet had no significant effect on the edible giblets (liver and gizzard). In contrast, other authors reported that the inclusion of red pepper and black pepper in broiler chicken diets significantly improved liver and gizzard relative weights (Shahverdi *et al.,* 2013; Tazi *et al*., 2014). This influence is believed to have a multiplier effect on the degree of food processing and nutrient absorption, impacting growth performance.

It was also reported that red pepper, black pepper, and their mixtures in broiler diets significantly decreased the abdominal fat percentage compared to the control diet (Grashorn 2010; Tazi *et al*., 2014; Moradi *et al*., 2016). Shahverdi *et al*., 2013 found that the lowest percentage of abdominal fat was obtained in birds fed a diet with a 0.2% pepper powder mixture (0.1% red pepper + 0.1% black pepper) compared to the control diet. However, these findings are similar in part with the findings of this present study with abdominal fat percentages lowest in the 1.5% red pepper diet (T5) and both combination diets (T6 and T7) though not significantly different from the control.

CONCLUSION

The beneficial effects on performance and well-being are mainly the reasons why zootechnical additives are generally used. As observed in this

study, black pepper, red pepper, and their combinations positively influenced growth performance and carcass traits. This result gives credence to the scientific opinions that these natural additives hold great potential in improving the overall productive performance of broiler chickens and highlights the possibility of increased economic gains for poultry producers.

REFERENCES

Aikpitanyi, K.U., Igwe, R.O. and Egweh, N.O. (2019). Assessment of Ginger and Black Pepper as Feed Additives on Growth Performance and Carcass Traits of Broiler Chickens. *International Journal of Veterinary Science and Animal Husbandry.* 5(1): 033-038

Al-Harthi, M.A. (2002). Efficacy of vegetable diets with antibiotics and different type of spices or their mixtures on performance economic efficiency and carcass traits of broilers. *Journal of Agriculture Science.* 27, 3531-3545.

Al-Kassie, G.A.M., Al-Nasrawi, M.A.M. and Ajeena, S.J. (2011a). Use of black pepper (Piper nigrum) as feed additive in broilers diet. *Research Opinions in Animal and Veterinary Sciences.* 1, 169-173.

Al-Kassie, G.A.M., Al-Nasrawi, M.A.M. and Ajeena, S.J. (2011b). The effects of using hot red pepper as a diet supplement on some performance traits in broiler. *Pakistan Journal of Nutrition* 10(9), 842-845.

Al-Kassie, G.A.M., Butris, G.Y., Yutris, G. and Ajeena, S.J. (2012). The potency of feed supplemented mixture of hot red pepper and black pepper on the performance and some hematological blood traits in broiler diet. *International Journal of Advanced Biological Research* 2, 53-57.

Al-Kassie G.A.M. and Witwit, N.M. (2010). A comparative study on diet supplementation with a mixture of herbal plants and dandelion as a source of prebiotics on the performance of broilers. *Pakistan Journal of Nutrition*. 9(1):67–71.

Demir, E., Sarica, S., Ozcan, M.A and Suicmez, M. (2003). The use of natural feed additives as alternatives for an antibiotic growth promoter in broiler diets. *British Poultry Science* 44, S44-S45.

Google Earth. 2018. Http//earth google .com

Ghaedi, H., Nasr, J., Kheiri, F., Rahimian, Y. and Miri, Y. (2014). The effect of virginiamycin and black pepper (Piper nigrum L.) extract on performance of broiler chicks. *Research Opinion in Animal and Veterinary Sciences* 4, 91- 95.

Grela, E.R., Pietrzak, K., Sobolewska, S. and Witkowski, P. (2013). Effect of inulin and garlic supplementation in pig diets. *Ann. Anim. Sci*., 13: 63–71.

Grashorn, M.A. (2010). Use of phytobiotics in broiler nutrition: An alternative to infeed antibiotics? *Journal of Animal and Feed Sciences*. 19, 338 – 347

Herati and Marjuki. (2011). Effect of feeding red ginger as phytobiotic on broiler slaughter weight and meat quality. *Inter. J. Poult. Sci*. 10(12)983- 986.

Hosseini, M.N. (2011). Comparison of using different level of black pepper with probiotic on performance and serum composition on broilers Chickens. *J. Basic Appl. Sci. Res*. 1(11).2425-2428.

Husseiny, O. Shalash, S.M. and Azouz, H.M. (2002). Response of broiler performance to diets containing hot pepper and /or fenugreek at different metabolizable energy levels. *Egyptian poultry science.* 22: 387-406.

Imasuen, J.A. and Aikhomu, F.O. (2017). Effect of diet supplemented with two sources of antioxidants as feed additives on haematological parameters, serum biochemistry and antioxidant capacity of cockerels. *Savannah journal of Agriculture*. 12, 8-16

Imaseun, J.A and Ijeh, O.A. (2018). Hematological parameters, serum biochemistry and antioxidant capacity of broiler chickens fed diet supplemented with two sources of antioxidants as feed additives. *Journal of Agriculture and Veterinary Science*. Vol 10(9), PP 05-09

Khalaf, A.N., Shakya, A.K., Al-Othman, A., El-

Agbar, Z. and Farah, H. (2008). Antioxident activity of some common plants. *Turkish Journal of Biology.* 32, 51-55.

Li, S.Y., Ru, Y.J., Liu, M. Xu, B. Pealron, A. and Shi, X.G. (2012). The effect of essential oils on performance, immunity, and gut microbial population in weaner pigs. *Livest. Sci*. 145, 119–123.

Liu, Y., Song, M., Che, T.M., Bravo, D., Maddox, C.W. and Pettigrew, J.E. (2014). Effects of capsicum oleoresin, garlic botanical, and turmeric oleoresin on gene expression profile of ileal mucosa in weaned pigs. *J. Anim. Sci*., 92: 3426–3440.

Mansoub, N.H. (2011). Comparative effects of using garlic as probiotic on performance and serum composition of broiler chickens. *Annals of Biological Research.* 2, 486-490.

Mittal, R. and Gupta, R.L. (2000). In vitro antioxidant activity of piperine. *Experimental and Clinical Pharmacology*, v.122, p.271-274.

Moorthy, M., Ravikumar, S., Viswanathan, K. and Edwin, S.C. (2009). Ginger, pepper, and curry leaf powder as feed additives in broiler diet. *Int. J. Poult. Sci*. 8:779–782.

Nalini, N., Manju, Y. and Menon, V. (2006). Effect of spices on lipid metabolism in 1, 2-dimethylhydrazine-induced rat colon carcinogenesis. *Journal of Medicinal Food.* 9, 237 -45.

Ndelekwute, E., Enynihi, G., Assam, E., Ufot, U. and Out, O. (2015). Lime (Citrus auantifolia) juice as a source of natural organic acids can improve the growth of broiler chickens. Proceedings, *British Society of Animal Science* Vol. 6 Part 2, P220.

Olomu, J.M. 2010. Monogastric Animal Nutrition: Principles and practices (1st edition). A. Jacham publication, Benin City, Nigeria.

Orav, A., Stulova, I., Kailas, T., and Muurisepp, M. (2004). Effect of storage on essential oil composition of Piper nigrum fruits of different ripening states. *J. Agric. and Food Chem*. 52; 2582 - 2586.

Pearce, M. and Jin, G.L.Z. (2010). Aditivos Fitogênicos. *Porkworld* 58, 128-136.

Puvača, N., Kostadinović, L.J., Ljubojević, D., Lukač, D., Lević, J., Popović, S., Novakov, N., Vidović, B. and Đuragić, O. (2015). Effect of garlic, black pepper and hot red pepper on productive performances and blood lipid profile of broiler chickens. *European Poultry Science.* 79: 1-13.

Puvača, N., V. Stanaćev, D. Glamočić, J. Lević, L. Perić, V. Stanaćev, D. and Milić, (2013). Beneficial effects of phytoadditives in broiler nutrition. *World's Poultry Science Journal.* 69, 27-34.

Russell, J.B. and Houlihan, A.J. (2003). Ionophore resistance of ruminal bacteria and its potential impact on human health. *FEMS Microbiology Reviews*. 27(1), 65-74.

Shahverdi, A., Kheiri, F., Faghani, M., Rahimian, Y. and Rafiee, A. (2013) The effect of use red pepper (Capsicum annum L) and black pepper (Piper nigrum L) on performance and hematological parameters of broiler chicks. *European Journal of Zoological Research.* 2: 44-48

Srinivasan, K. (2014). Antioxidant potential of spices and their active constituents. *Food Science and Nutrition.* 54: 352–372.

Statistical Analysis System [SAS]. (2012). SAS/ STAT User guide, Version 9.1.2. Cary, NC: SAS Institute Inc.

Steel, R.G.D. and Torrie, J.H. (1997). Principles and Procedures of Statistics: A Biometrical Approach. 3rd edition. McGraw Hill Book Co. Inc., New York

Tazi, S.M.A., Mukhtar, M.A., Mohamed, K.A. and Tabidi, M.H. (2014). Effect of using black pepper as natural feed additive on performance and carcass quality of broiler chicks. *Global Advanced Research Journal of Agricultural Science*, 4(2): 108-113.

Thiamhirunsopit, K., Phisalaphong, C., Boonkird, S. and Kijparkorn, S. (2014). Effect of chili meal (Capsicum frutescens LINN.) on growth performance, stress index, lipid peroxidation and ileal nutrient digestibility in broilers reared under high stocking density condition. *Animal Feed Science and Technology.* 192, 90-100.

Yang, Y., Iji, P.A. and Choct, M. (2009). Dietary modulation of gut microflora in broiler chickens: a review of the role of six kinds of alternatives to in-feed antibiotics. *Worlds Poult. Sci*., 65: 97–114.

Yazdi, F.F., Ghalamkari, G., Toghiani, M., Modaresi, M. and Landy, N. (2014). Anise seed (Pimpinella anisum L.) as an alternative to antibiotic growth promoters on performance, carcass traits and immune responses in broiler chicks. *Asian Pac. J. Trop. Dis*., 4: 447–451.

Zeng, Z., S. Zhang, H. Wang, and X. Piao. 2015. Essential oil and aromatic plants as feed additives in non-ruminant nutrition: a review. Journal of Animal Science and Biotechnology. 6:7-17. doi:10.1186/s40104-015-0004-5