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Effect of dietary Black pepper (*Piper nigrum)* on the performance of broiler

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Abstract

An experiment was conducted to determine the dietary effect of different levels of ground black pepper (*Piper nigrum*) on growth performance and apparent nutrient digestibility of broiler chickens. There were five dietary treatments each containing 0, 0.25, 0.50, 0.75 and 1.00 % black pepper (BP) fed at both starter and finisher phases. One hundred and fifty (150) day old chicks of Arbor-acre strain were divided into five dietary groups having three replication with 10 in each. The five dietary treatments were randomly assigned into five groups. The birds were fed and watered *ad libitum.* At the starter phase 0.25 and 0.5 % BP improved live weight significantly (p<0.05). Feed intake was significantly (p<0.05) reduced at 1.00% BP. There were no significant differences (P>0.05) in daily gain, feed: gain ratio and protein efficiency ratio. At the finisher phase, final live weight was improved by 0.25% (p<0.05). Final live weight, feed intake, weight gain, feed: gain ratio and protein efficiency ratio were negatively affected by 0.75 and 1.0%BP. Fecal moisture was significantly (P<0.05) reduced by 0.25% while dry matter, protein and ether extract digestibility were improved by all the levels of BP. None of the BP levels improved crude fibre digestibility (p>0.05) over the control. NFE and energy utilization were improved by 0.25 and 0.5%, but significantly (p<0.05) reduced by 1.00% BP.

Key words: apparent nutrient digestibility, black pepper, broiler chickens, growth performance

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Introduction

With the increasing demand of poultry meat over the world, poultry farmers want to improve the productivity of their broiler chickens. They are interested in the type of feed that could achieve this in a good period of time. This challenge has necessitated poultry nutritionists to offer certain nutritional strategies for rapid growth of broilers. Feed additives that promote growth have been recommended as one of the strategic options. Pharmaceutical antibiotics as one of the options have been widely used (Maynard *et al.* 1984), but drug resistance problem emanating from their use has made nutritionists to look inwards for alternative feed additives to antibiotics. Such feed additives are probiotics (Cheeson 1994; Ziggers 2009), prebiotic (Simmering and Blaut 2001; Patterson and Burkholder 2003; Gibson et al. 2004), yeast culture (Raju et al. 2006; Banerjee 2007; Gao et al. 2008), organic acids (Leeson et al. 2005; Marco 2008; Ndelekwute *et al*. 2012, 2013, 2014) and feed grade enzymes (Choct 2007). The search is continuing and plant materials otherwise known as phytogenics have been adjudged to be good alternatives (Platel and Sirinivasan 2004; Wei and Shibamoto 2007; Ndelekwute et al. 2015).

Phytogenic compounds such as essential oils and spices have been reported to exhibit growth promoting properties (Duke 1994; Gwendolyn 2002; Alciceck *et al*. 2003; Chand *et al*. 2005; Windisch *et al*. 2007). Considering the health hazard, the feed manufacturer and poultry rearer's have been actively looking for an efficacious alternatives. Black paper could be one of the alternative growth promoting source. Black pepper is a spice which is 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;

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Sirinivasan 2007). Generally, spices are reported to have positive effect on villi, nutrient absorption and digestal viscosity (Lee *et al*. 2004a;Lee *et al*. 2004b; Sirinivasan 2007). These positive properties could be explored for better broiler productivity. Therefore, the objective of the experiment was to determine the effect of black pepper on growth performance and nutrient digestibility of broiler chickens.

Materials and Methods

The experiment was conducted at the Teaching and Research Farm of Department of Nutrition and Forage Science of the Michael Okpara University of Agriculture, Umudike, Nigeria for period of 7 weeks.

One hundred and fifty (150) day old chicks of Arbor-acres strain were divided into five dietary groups having three replication with 10 in each. The five dietary treatments were randomly assigned into five groups in a completely randomized design (CRD). The five dietary treatments are : BP1 = diet without BP (control), BP2 = diet with 0.25% BP, BP3 = diet with 0.5% BP, BP4 = diet with 0.75% and BP5 = diet with 1.0% BP. The diets were isonitrogenous (22 %) and isoenergetic (12 MJME/kg) for the starter diet (Table 1) and also finisher diet (20% CP and 12.00 MJME/kg) (Table 2). Trial and error method using Microsoft Excel package according to *Ndelekwute et al.* (2014) was used to formulate the diets.

The black pepper seeds used in this study were purchased from the market in dry form. The seeds were separated from some stalk debris contained in the mixture. Thereafter, the seeds were ground into powder form and stored in an air-tight plastic container.

The birds were stabilized for one week in the brooding room with control diet (BP1). At the second week, the birds were weighed and divided into five dietary groups and transferred to a rearing house covered with water proof material where brooding continued till the third week. Five experimental starter diets were supplied randomly into five groups up to fourth week. The five finisher diets were also offered to five respective groups for last three weeks. The birds were vaccinated against Newcastle disease and Infectious bursal disease. The birds were weighed out in every week and feed intake was also recorded. At the end of the feeding experiment, a digestibility trial was conducted in a metabolism cases. The metabolism cages used were thoroughly washed and disinfected. One bird from each of the three replicates of a treatment was transferred to a metabolism cage. The birds were acclimatized for four days in the cages with the respective diets. Feces was collected and weighed for three days at the same time the feed intake of each bird was recorded for three days. Collected fecal samples were oven dried at 60^{o}C to constant weight. Dry fecal samples were ground to pass 1mm sieve and stored in a refrigerator. Chemical compositions of feed and faeces samples were determined according to the method described in AOAC (1990). Metabolizable energy value of feed and faeces were also calculated.

Data for live weight and feed and nutrient intake were recorded and used to calculate the feed: gain ratio and protein efficiency ratio. All data collected were subjected to analysis of variance (ANOVA). Significant means were separated using Duncan New Multiple Range Test (DNMRT) according to Steel and Torrie (1980).

Results

Effect of black pepper on feed intake and performance of broiler at the starter phase is shown in Table 3. The initial live weight of the chicks at the end of the stabilization period showed no significant differences (p>.05). Final live weight and feed intake were significantly (P<0.05) influenced due to different levels of Black paper inclusion. Black pepper induced dose dependent influence on the parameters both significantly (P<0.05) and marginally (P>0.05) expressed. BP at 0.25 and 0.50% produced heavier body weight compared to the control (BP1). At 1.00%, there was a significant reduction in live weight at the same time and 1.0% BP negatively affected feed intake.

However, there were no significant differences (P>0.05) in feed: gain ratio, protein intake and protein efficiency ratio. The effect of supplimentation of BP on finisher broiler performance is shown on Table 4. All the parameters were significantly (P<0.05) influenced. While 0.25% produced the highest live weight, 0.75 and 1.00% recorded the lowest. There was no significant difference between the control (BP1) and 0.50%(BP3). Daily gain produced by 0.25% (BP2) though similar to the control was significantly better than the other levels. Beyond 0.50%, daily gain significantly (P<0/05) reduced compared to the control. Feed intake was significantly (P<0.05) depressed at 0.75 (BP4) and 1.00% (BP5). Similar trend was also observed in feed: gain ratio, protein intake and protein efficiency ratio. Table 5 shows the effect of black pepper on fecal moisture and nutrients digestibility of the broiler. All the indices considered were significantly (P<0.05) influenced by black pepper addition except fibre in comparison to the control. Fecal moisture did not reduce beyond 0.25% level. Black pepper showed dose related improvement on dry matter, crude protein and either extract digestibility which increased as the level of black pepper was increased. Digestibility of nitrogen free extract and Metabolizable energy utilization were significantly (P<0.05) reduced by black pepper at 1.0% but were improved at 0.25 and 0.5%.

Table 1. Ingredients and Nutrients Composition of Starter Diets

Parameters (%)	**BP1 (0.00%)**	**BP2 (0.25%)**	**BP3 (0.50%)**	**BP4 (0.75%)**	**BP5 (1.0%)**
Maize	55.0	55.0	55.0	55.0	55.0
Soybean meal	28.0	28.0	28.0	28.0	28.0
Fish meal	3.00	3.00	3.00	3.00	3.00
Palm kernel cake	10.3	10.1	9.8	9.55	9.30
Bone meal	3.0	3.0	3.0	3.0	3.0
Black pepper	-	0.25	0.50	0.75	1.00
Salt {NaCl)	0.25	0.25	0.25	0.25	0.25
Lysine	0.10	0.10	0.10	0.10	0.10
Methionine	0.10	0.10	0.10	0.10	0.10
Premix*	0.25	0.25	0.25	0.25	0.25
Total	100	100	100	100	100
<u>Chemical composition (%)</u>					
Crude protein	22.1	22.1	22.1	22.0	22.0
Ether extract	3.92	3.94	3.96	3.98	4.00
Crude fibre	5.01	4.98	4.95	4.92	4.89
Ash	7.04	7.05	7.06	7.07	7.08
NFE	52.5	52.3	52.2	52.2	52.1
Calcium	1.20	1.20	1.20	1.10	1.10
Phosphorous	1.01	1.01	1.01	1.00	1.00
Lysine	1.12	1.12	1.12	1.12	1.12
Methionine	0.65	0.65	0.65	0.65	0.65
Energy (MJME/kg)	12.0	12.0	12.0	12.1	12.1

*premix supplied per kg diet: vitamin A 15,000 I.U, vitamin D_3 13000 iu, thiamin 2mg, Riboflavin 6mg, pyridoxine 4mg, Niancin 40mg, cobalamine 0.05g, Biotin 0.08mg, chooline chloride 0.05g, Manganese 0.096g, Zinc 0.06g, Iron 0.024g, Copper 0.006g, Iodine 0.014g, Selenium 0.24mg, Cobalt 0.024mg and Antioxidant 0.125g. BP = Black pepper. NFE = Nitrogen free extract.

Table 2. Ingredients and Nutrients Composition of Finisher Diets

Parameters (%)	BP1 (0.00%)	BP2 (0.25%)	BP3 (0.50%)	BP4 (0.75%)	BP5 (1.0%)
Maize	56.0	56.0	56.0	56.0	56.0
Soybean meal	25.0	25.0	25.0	25.0	25.0
Fish meal	3.00	3.00	3.00	3.00	3.00
Palm kernel cake	13.3	13.1	12.8	12.6	12.3
Bone meal	3.0	3.0	3.0	3.0	3.0
Black pepper	-	0.25	0.50	0.75	1.00
Salt {NaCl)	0.25	0.25	0.25	0.25	0.25
Lysine	0.10	0.10	0.10	0.10	0.10
Methionine	0.10	0.10	0.10	0.10	0.10
Premix*	0.25	0.25	0.25	0.25	0.25
Total	100	100	100	100	100
Chemical composition (%)					
Crude protein	20.2	20.1	20.1	20.0	20.0
Ether extract	6.20	6.21	6.21	6.30	6.30
Crude fibre	6.20	6.20	6.10	6.10	6.10
Ash	6.80	6.80	6.88	6.89	7.08
NFE	53.1	53.2	53.2	53.2	52.98
Calcium	1.11	1.11	1.11	1.01	1.00
Phosphorous	0.88	0.87	0.86	0.85	0.84
Lysine	1.05	1.04	1.03	1.02	1.01
Methionine	0.50	0.49	0.48	0.47	0.46
Energy (MJME/kg)	12.0	12.1	12.1	12.1	12.1

*premix supplied per kg diet: vitamin A 15,000 I.U, vitamin D_3 13000 iu, thiamine 2mg, Riboflavin 6mg, pyridoxine 4mg, Niacin 40mg, cobalamine 0.05g, Biotin 0.08mg, choline chloride 0.05g, Manganese 0.096g, Zinc 0.06g, Iron 0.024g, Copper 0.006g, Iodine 0.014g, Selenium 0.24mg, Cobalt 0.024mg and Antioxidant 0.125g. BP = Black pepper. NFE = Nitrogen free extract.

Table 3. Effect of Black Pepper on Performance of Starter Broiler Chicks

Parameters	BP1 (0.0%)	BP2 (.25%)	BP3 (0.50%)	BP4 (0.75%)	BP5 (1.0%)	SEM
Initial body weight (g)	113	113	111	109	108	3.11
Final body weight (g)	820^{bc}	890^{a}	892^{a}	851^{ab}	792^{c}	13.0
Daily weight gain (g)	33.70	37.00	37.20	35.30	32.50	2.18
Daily feed intake (g)	69.00^{a}	70.30^{a}	69.00^{a}	67.20^{ab}	65.40^{b}	2.16
Feed: gain ratio	2.05	2.00	1.86	1.90	2.00	0.04
Daily protein intake (g/bird)	14.80	15.00	14.80	14.34	2.30	1.21
Protein efficiency ratio	2.28	2.46	2.52	2.45	2.32	0.13

^{abc}. Means along the same row with different superscripts are significantly different at P<0.05. SEM = Standard error of the means. BP = Black pepper.

Table 4: Effect of Black Pepper on Performance of Finisher Broilers

Parameters	BP1 (0.00%)	BP2 (0.25%)	BP3 (0.50%)	BP4 (0.75%)	BP5 (1.0%)	SEM
Initial body weight (g)	820bc	890a	892a	851b	792c	13.0
Final live weight g/bird	1984^{b}	2104^{a}	1968^{b}	1755^{c}	1716^{c}	65.7
Daily weight gain g/bird	55.40^{ab}	57.80^{a}	51.20^{b}	43.00^{c}	44.00^{c}	2.60
Daily feed intake g/bird	128^{ab}	134^{a}	$119b^{c}$	115^{c}	111^{c}	21.80
Feed: gain ratio	2.30^{b}	2.32b	2.33b	2.66a	2.52a	0.15
Daily protein intake g/bird	25.30^{ab}	26.70^{a}	23.10^{ab}	22.70^{b}	22.00^{b}	3.65
Protein efficiency ratio	2.19^{a}	2.17^{a}	2.16^{a}	1.89^{b}	2.00^{b}	0.09

^{abc}. Means along the same row with different superscripts are significantly different at P<0.05. SEM = Standard error of the means. CON = Control, BP = Black pepper.

Table: 5. Effect of Black Pepper on Fecal moisture and Nutrient Digestibility

Parameters (%)	BP1 (0.00%)	BP2 (0.25%)	BP3 (0.50%)	BP4 (0.75%)	BP5 (1.0%)	SEM
Fecal Moisture	73.1^{a}	61.8^{b}	74.8^{a}	76.4^{a}	78.0^{a}	3.34
Dry matter	68.3^{b}	76.6^{a}	77.3^{a}	78.0^{a}	78.9^{a}	4.08
Crude protein	61.1^{b}	78.3^{a}	81.6^{a}	82.6^{a}	82.7^{a}	4.89
Crude fibre	38.6^{ab}	39.6^{ab}	38.3^{b}	40.30^{ab}	41.4^{a}	2.01
Ether extract	78.0^{b}	86.3^{a}	88.9^{a}	87.4^{a}	87.2^{a}	5.08
NFE	63.5^{b}	77.2^{a}	73.9^{a}	65.1^{b}	56.9^{c}	3.89

^{abc}. Means along the same row with different superscripts are significantly different at P<0.05. SEM = Standard error of the means. BP = Black pepper. NFE = Nitrogen free extract.

Discussion

The reduction in live weight at 1.0% level of the black pepper at the starter phase signifies that at a higher level black pepper could become detrimental to growth. Abaza *et al.* (2008) reported improvement in live weight and weight gain of broiler chickens feed 0.1% black pepper oil at 4 weeks of age, confirming the importance of black pepper as growth promoting additive. Poor feed intake at 1.0% could be linked to the poor growth recorded at that level. Despite the fact that the feed: gain ratio was not significant black pepper at each level showed marginal superiority in the three parameters mentioned. According to Abaza *et al*. (2008) overall feed intake was lowered in chicks fed higher level of black pepper thus supporting this work. However, their earlier work, Abaza *et al.* (2003) contradicted the present work if feed: gain ratio is to be considered. They reported that 0.25% black pepper improved feed gain: ratio.

Performance trend at this phase could be used to show that the initial body weight which was significantly (P<0.05) different, could not have significantly contributed to the result of the final live weight of the birds. The black pepper could have constituted the main factor that significantly influenced the final live weight at the finisher phase. There were two clear reasons for these assertions. First, the live weight produced by 0.75% at the starter phase was numerically higher than the control, but at the end of the experiment it became significantly inferior to the control indicating negative effect of the black pepper at that level. Secondly, 0.50% at the starter phase produced live weight which was significantly higher than the control, but at the end of the finisher phase it was similar to the control. Based on this, it could be said that prolong feeding of black pepper at 0.50% and above could be detrimental. From available reports, not much have been said concerning the use of black pepper seeds in poultry diets, but the result on body weight especially at 0.25% was consistent with some reports on other spices (Windisch *et al.* 2007); herbs (Lee *et al*. 2004a); plant extracts (Chand *et al*. 2005; Mushtag *et al*., 2007 ; Javed *et al*. 2009) and essential oils (Abaza *et al*. 2008). This could be linked to better protein digestibility as shown in Table 5 as earlier reported by Abd EL-Latif *et al*. (2002).

properties include stimulation of digestive enzymes, saliva, hydrochloric acid and mucus; anti-oxidation effect, ability to improve the number and height of villi, reduction in crypt depth, anti-flatulence ability and anti-microbial activity according to Mathe (1996); Jang *et al*. (2004); and Sirinivasan (2007).

The negative effect of black pepper at higher levels could be due to the presence of heavy metals such as lead, cadmium, tin and silver (Abou-Arab and Abou Donia 2000), antinutritional factors and terpernoids reported to contain in black pepper which resulted to poor growth (Abaza *et al*. 2008).

The result of the apparent digestibility of nutrients found in the present experiment are confirmed with the earlier report by Javed *et al*. (2009) who indicates that the plant extracts at certain levels improved digestibility. Lee *et al*. (2003) and Windisch *et al.* (2007) also reported that spices and essential oils could be used to aid digestion in monogastric animals. Many reasons have been ascribed to this. Jang *et al*. (2004) attributed better nutrient digestion to antimicrobial property of the essential oil in black pepper. Sirinivasan (2007) linked it to the ability of black pepper to induce saliva secretion, hydrochloric acid and mucus production. Other studies have shown that the spices or their active ingredients have positive effect on bile acid secretion (Platel and sirinivasan 2000). Platel and Sirinivasan (2000) attributed that the pungent properties black pepper stimulated digestive enzymes activities. The inability of the black pepper to improve digestibility of fibre could have resulted to the The lower feed intake at higher levels could be due to pungent characteristics of spices (Lee *et al*. 2004a) which the black showed. The reduced feed consumption could also be ascribed to strong taste produced by black pepper (black pepper taste hot) in the feed. Lee *et al.* (2004a) reported that spices produced feed aversion in rodents due to their pungent odour.

Performance of birds fed diet containing 0.25% black pepper over the control could be attributed to reported growth promoting properties inherent in black pepper. These insignificant reduction of fecal moisture at levels higher than 0.25%.

Poor nitrogen free extract digestibility and energy utilization exhibited at 1.0% could have been one of the factors that resulted to the poor growth performance of the birds at that level (Table 4). Lee *et al*. (2004a) had cautioned that high doses of active principles in essential oils of spices could lead to poor digestibility at higher level. This could have been the reason for the poor nitrogen free extract digestibility and energy utilization at 1.0%. Further more, it has been reported that essential oils impaired absorption of alanine in rat (Kerydiyyeh, 2000). The author postulated that it could be due to inhibition of the transport mechanism (Na+-K+-ATPase) in enterocyte by the essential oils. This could be a good reason why 0.75 and 1.0% black pepper, significantly reduced live weight (Table 4) despite higher protein digestibility. Absorption of alanine and probably other amino acids would have been impaired

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