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Influence of selected plant seeds on the performance, carcass characteristics, sensory evaluation, and economics of broiler chicken

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Abstract

The immergence of antibiotic resistance, in livestock especially poultry, led to the ban of antibiotics as a growth promoter in some part of the world. This brought about the investigations into the development of various alternatives to antibiotics that will not compromise the integrity of poultry products for safe consumption. Therefore, this study examined the possible impacts of selected plants seeds (pawpaw, mustard, and black cumin) as feed additives on the performance, carcass characteristics, and sensory evaluation of broilers. A total of 180 day-old Arbor Acre Plus chicks were randomly assigned to five treatments of four replicates in a completely randomized design. The five treatments were three plant seed additives: pawpaw (PPS), mustard (MUS), and black cumin (BCS), treatment without additives (CON, i.e., no plants seeds/medications), and treatment with medications and antibiotics (ANT). During the feeding trials that lasted for 8 weeks, body weight gain, feed intake, and feed conversion ratio (FCR) were considered performance data. At the end of the feeding trials, two birds per replicate were slaughtered for carcass parameters and sensory evaluation. Data collected were subjected to analysis of variance. Mustard seed (*Brassica juncea*) significantly ($P = 0.018$) supported carcass growth. Further, the highest feed intake was obtained in MUS while the lowest was obtained in CON birds. The PPS had higher ($P = 0.013$) BWG than in other treatments while the lowest was obtained in CON. Values of FCR were lowest ($P = 0.15$) in PPS while the highest in CON birds. Furthermore, MUS and PPS had significantly ($P = 0.018$) and ($P = 0.03$) higher live weight than CON and ANT, while MUS had higher dressed weight percentage than CON and ANT birds. Broiler meat under diet supplemented with black cumin was relatively found to be most acceptable while meat under mustard seed was the least acceptable. In contrast, the average cost realized per bird was obtained in PPS while the lowest was in CON and ANT. However, broiler diet supplemented with BCS brings about a corresponding decrease in percentage feeding cost reduction among plant supplements.

Keywords Additive · Antibiotics · Pawpaw · Mustard · Black cumin seeds

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Introduction

Due to intensification, increased morbidity and mortality, and the desire for growth promotion in animals, farmers started using antibiotics and vaccines against disease-causing organisms. However, improper dosage, non-adherence to withdrawal, and the relentless utilization of antibiotics have led to the increasing resistance of pathogens to medically important antibiotics and the accumulation of antibiotic residues in animal products. This has led to resistance of transmissible microbes (food pathogens) to medically important antibiotics (WHO 2017). This is an important food safety issue. The unintended consequences of these transfers have led to a strong recommendation for the complete restriction of the use of medically important antibiotics in food-producing animals by the World Health Organization. Therefore, there is an urgent need to empower small farmers in the developing world to meet their growing domestic consumption by improving food production from indigenous and local resources (Hodges 2009). The use of local resources which is available in each region could help us resolve this issue. Black cumin seed (Khalaji et al. 2011; Khan et al. 2012; Abd El-Hack et al. 2018), pawpaw seed (Bolu et al. 2009; Nwaoguikpe 2010), and mustard seed (Khandaker et al. 2011) have all been reported to have a growth-promoting effect on different species of poultry such as chicken and quail which serve varying purposes such as meat and egg production. Furthermore, the beneficial use of plant seeds and plant extracts in ruminant (Faniyi et al. 2016; Hernandez et al. 2017; Elghandour et al. 2017) and equine (Salem et al. 2017) is well documented. This implies that the use of plant seeds or extracts is beneficial to livestock. Besides, it shows that nature has provided local resources to help improve productivity, vitality, and health in human and animals.

Antibiotics as a growth promoter in the poultry industry has been seriously criticized since the development of antibiotic resistance through poultry products with potential harm on human health (Abd El-hack et al. 2018). Consumer awareness of the health hazard of antibiotics and synthetics and the renewed interest in non-nutritional benefits obtainable from plants have led to extensive investigation to phytogenic-based materials in livestock such as plants seed, leaves, and extracts. Plant extracts have multiple benefits to livestock rather than the monotonic function of antibiotics. Of the many benefits, improving the digestibility, which results in increased feed intake, or improving the efficiency through gut development, digestive enzyme stimulation, and animal health through gut microbial balance seems to be the benefits of the use of plant products. In addition to the growth-promoting functions, these plants also have nutritional contribution to animals, though it may be little depending on quantity in diet. They act as antibacterial, antioxidant, anticarcinogenic, antifungal, analgesic, insecticidal, and anticoccidial in farm animals (Forouzanfar et al. 2014; Nideou et al. 2017; Adegbeye et al. 2018).

The need to improve animal growth rate and replacement of synthetic antibiotics makes plant phytobiotic search a worthy course. Black cumin seed (Khalaji et al. 2011; Khan et al. 2012; Abd El-Hack et al. 2018), pawpaw seed (Bolu et al. 2009; Nwaoguikpe 2010), and mustard seed (Khandaker et al. 2011) have all been reported to have a growth-promoting effect on different species of poultry such as chicken and quail which serves varying purposes such as meat and egg production. Furthermore, the beneficial use of plant seeds and plant extracts in ruminant (Faniyi et al. 2016; Hernandez et al. 2017; Elghandour et al. 2017) and equine (Salem et al. 2017) is well documented. This implies that the use of plant seeds or extracts is beneficial to livestock. Besides, it shows that nature has provided local resources to help improve productivity, vitality, and health in human and animals. Black cumin seed, pawpaw seed, and mustard seed contain thymoquinone, benzyl-isothiocyanate, and allylisothiocyanate respectively as their bioactive ingredient (Kermanshai et al. 2001, Engels et al. 2012, Goel and Mishra 2018). Harnessing the potential of locally available resources would go a long way in reducing the cost of production on feed and drugs. Among the plant seeds, black cumin seed, pawpaw seed, and mustard seed are known to improve productivity. Seeds of black cumin and mustard are relatively abundant in the Middle East but can be obtained in Nigeria while pawpaw seed is abundant in Nigeria with little or no economic value attached to it besides its agronomic use. These plants could compete with the synthetic drugs, since most medicinal plants do not have residual effects (Tipu et al. 2006). This makes their use potentially beneficial to livestock as additives, replacement, or supplement.

Acceptability of animal products is an important parameter to be considered when recommending any organic and inorganic material for use in livestock such as plants. No matter the functionality of plants, if it deprives the consumers the benefit of good taste, it would affect the demand for such animal product. Sensory evaluation is a process used to measure, analyze, and interpret human responses to food products (Bartlett and Beckford 2015). It aims to measure panelist perception of a product before recommendation to the wider consumers. Color, taste, tenderness, aroma, and overall acceptability are parameters to measure consumers' preference to a product. Consumers expect meat to be healthy, nutritious, and tender and have a typical flavor (Ruiz et al. 2001). Therefore, it is necessary to ensure that ingredients fed to broilers are of the best quality, ensuring that the meat products meet these expectations (Bartlett and Beckford 2015). Plant seed or extract that alters the taste of meat negatively may not be recommended for use irrespective of its benefit. Thus, this study is meant to examine the impact of selected plant seeds as additives on the performance and influence on the sensory parameters of broiler chicken.

Materials and methods

Birds, housing, and management

The experiment was conducted at Joseph Ayo Babalola University Teaching and Research Farm, Ikeji-Arakeji, Osun State. A total of 180 day-old Arbor Acre Plus chicks were obtained from a commercial hatchery in Ibadan, Oyo state. Feed and water were supplied ad libitum. The trials lasted for 8 weeks and the birds were fed with a commercial broiler starter (22% crude protein and 2900 kcal/kg metabolizable energy) for the first 4 weeks and finisher (18% crude protein and 2900 kcal/kg metabolizable energy) diets for the last 4 weeks.

Experimental layout

The three plant seeds used were as follows: pawpaw (*Carica papaya*), found at different parts of South Western Nigerian States; brown mustard (*Brassica juncea*), obtained from TRS Asia's finest foods; and black cumin (from Sudan), obtained from northern Nigeria. The routine vaccination and management as outlined by the University Teaching and Research Farm were observed. Each plant seed was added to the diet at a rate of 15 g dry matter (DM)/kg of diet while oxytetracycline was added as 0.11 g/kg diet. A total of 180 day-old Arbor Acre Plus Chicks were assigned to five treatment of four replicates in a completely randomized design. The five treatments were 3 plant seed additives pawpaw seed (PPS), mustard seed (MUS), and black cumin seed (BUS), treatment without additives (CON, no plant seeds/medication), and treatment with medication and antibiotics (ANT). All birds were given vaccines. The layout of the experimental treatments is presented in Table 1.

Measurements and sampling

Performance parameters

The chicks' weights were measured at day one and weekly thereafter until slaughtered at day 56, and individual weights were calculated as average. Weekly feed intake was determined by subtracting the feed remaining at the end of the week period (7 days) from the initial feed supplied to the chicks. From the data recorded, body weight gain (BWG), feed intake, and feed conversion ratio (FCR) were calculated. Feed intake was recorded by subtracting feed offered from feed remaining, and conversion ratio (FCR) was calculated by dividing feed intake by BWG.

Table 1 Layout of the experimental treatments

Treatment	Description
CON	Negative control without medication
ANT	Positive control with antibiotics (oxytetracycline) and coccidiostat was added to the water for first 3 days
PPS	Pawpaw seed only without medication
MUS	Mustard seed only without medication
BCS	Black cumin seed only without medication

Carcass parameters

At day 56, two birds per replicate were selected at random. After slaughtering and exsanguination, the carcasses were defeathered without scalding immediately after slaughter. The non-scalding was done because of the sensory evaluation to be conducted. The dressed chickens were later eviscerated. Carcass parameters measured during this study include dressed weight (%), eviscerated weight (%), thigh, drumstick, shank, upper back, lower back, wing, and head. All carcass characteristics were expressed as g/kg live body weight except the dressed and eviscerated weight which were expressed as percentages of live body weights. Live weight, eviscerated weight, and dressed weight were measured using the CAMRY model EK3250 scale while other carcass parameters and organ weights were measured with a MEDIFIELD equipment and Scientific Ltd. electronic balance.

Sensory evaluation

This was conducted at the Food Science and Technology Laboratory of Joseph Ayo Babalola University. Breast muscle was frozen for 24 h before processing. Each meat was cooked and the water was allowed to evaporate without adding seasoning for 60 min before the meat was cut into parts. Volunteers from the Joseph Ayo Babalola University population were invited to serve on the untrained consumer taste panel, including students and college staff. Fifteen untrained panelists responded and were invited to evaluate the sensory qualities of the meat. A 9-point hedonic scale was used and they are represented as 1, like extremely; 2, like very much; 3, like moderately; 4, like slightly; 5, neither like nor dislike 6, dislike slightly; 7, dislike moderately; 8, dislike very much; and 9, dislike extremely.

Economy of production

The total cost of production was calculated as additions of cost of day-old chicks, cost of feed consumed, cost of drugs and vaccine, cost of labor, and cost of plant seed consumed or antibiotics. The cost of seed was calculated as cost of quantity of seed consumed × cost of seed. Expenses on vaccines were common for all the treatments except in ANT where medication (coccidiostat) was used.

Chemical analysis

The nutritive value and phytochemical constituents were conducted using the method of A.O.A.C (2005): crude protein (Method 988.05), ether extract (AOAC Official Method 2003.06), dry matter (Method 967.08), ash (Method 942.05), and crude fiber (Method 958.06).

The spectrometric method of AOAC (1984) and Joslyn (1970) was used for tannin analysis.

Henry (1993) and Allen (1992) method was used to analyze for alkaloids. Spectrophotometric method of Brunner (1984) was used for saponin analysis. Chemical composition of PPS, MUS, and BCS is shown in (Table 2).

Statistical analysis

Data analysis

Completely randomized design with the following model: $Y_{ij} = \mu + a_i + e_{ij}$ was used in this experiment, where Y_{ij} = any of the response variables, μ = the overall mean a_i = effect of the ith treatment (i = diets 1, 2, 3, 4, and 5), and e_{ij} = random error due to experimentation. All data collected were subjected to analysis of variance (ANOVA), SPSS version 22.0 software package. The differences between treatment means were separated by Duncan multiple range test of the same package.

Results

Broiler performance

Treatment had no effect on the FI, BWG, and FCR of birds on day 28. However, on day 56, treatment influenced the FI, BWG, and FCR of broiler chicken. Variation in feed intake value on day 56 showed that birds in MUS had the highest intake while the lowest values were in CON. The highest value obtained in PPS was similar ($P > 0.05$) to MUS but significantly ($P < 0.01$) higher than CON which was the lowest value. The value of FCR shows that CON had the highest value while the corresponding lowest value was obtained in PPS. Although PPS and CON are different ($P < 0.05$), but they are similar to ANT, MUS, and BCS. In contrast, the use of plants and antibiotics had no effect across treatments for FI, BWG, and FCR of broiler chicken on day 28 (Table 3).

Table 2 Chemical composition (g/100 g DM) and phytochemicals (mg/100 g DM) of mustard seed, pawpaw seed, and black cumin seed used in the experiment as supplements

	Mustard	Pawpaw	Cumin
Crude protein	18.68	15.78	16.68
Ether extract	13.88	3.68	2.87
Crude fiber	5.69	11.86	6.36
Ash content	4.25	5.29	5.09
Organic matter	92.11	88.59	91.97
NFE	49.61	51.99	60.96
Phytochemical			
Alkaloid	526.33	407.67	495.33
Tannin	43.33	28.00	37.00
Saponin	116.33	310.67	126.67

Carcass characteristics

The eviscerated weight (%), head, wings, thigh, and drumstick were not significantly ($P > 0.05$) affected by the treatment. However, live weight, percentage dressed weight, neck, and upper back and lower back weight were affected ($P < 0.05$). The live weight of birds in PPS and MUS was similar but significantly ($P < 0.05$) higher than that in CON and ANT which was not significantly ($P > 0.05$) different from one another. However, BCS was similar in weight to CON, ANT, PPS, and MUS. In the relative dressed weight percentage, the highest value obtained was in MUS while the lowest value was observed in CON. Birds in ANT had the highest neck weight while the lowest value was in BCS. Meanwhile, CON, PPS, and MUS are similar to ANT and BCS for neck weight. Breast muscle of birds in BCS values was the highest but similar ($P > 0.05$) to that in MUS which is significantly ($P < 0.05$) different from that in ANT which had the lowest value (Table 4).

Sensory evaluation

The treatments (CON–BCS) differ ($P < 0.05$) virtually in all the parameters measured and all scores obtained were within like very much and like slightly. Panelist scores for aroma were significant ($P = 0.01$) among treatments. Although color, taste, and aroma were not statistically different ($P > 0.05$), numerical differences exist among the treatments. Treatment PPS had the highest color scores while treatment CON had the least color score. PPS and BCS had the highest and lowest panelist score for taste, respectively. Panelist scores for aroma were virtually different ($P < 0.05$) among the treatments. Treatment MUS with the highest score was not different ($P > 0.05$) from treatment CON with the next score. In addition, treatments ANT and BCS that jointly had the least aroma score were not different ($P > 0.05$) from treatment MUS. Hence, treatments CON and MUS were different ($P < 0.05$) from treatments ANT, PPS, and MUS. Treatments MUS and

Table 3 Performance parameters of broiler supplemented with different plant seeds used in the experiment as supplements

	CON	ANT	PPS	MUS	BCS	SEM	*P* value
IW (g)	38.9	39.3	39.0	35.1	36.0	0.40	–
FI (1–28 days)	1296.5	1321.8	1347.7	1362.1	1324.3	9.92	0.276
FI (1–56 days)	4050.8^{b}	4195.0^{ab}	4277.1^{ab}	4362.1^{a}	4231.9^{ab}	38.00	0.102
BWG (28 days)	511.1	531.7	551.1	566.3	554.2	9.10	0.361
BWG (56 days)	1132.4^{c}	1222.9^{bc}	1397.0^{a}	1338.0^{ab}	1193.9^{bc}	29.91	0.013
FCR (day 28)	2.70	2.51	2.46	2.41	2.40	0.05	0.234
FCR (day 56)	3.61^{a}	3.48^{ab}	3.06^{b}	3.27^{ab}	3.55^{ab}	0.08	0.125

The letters in superscript along the same row mean $P < 0.05$ is significantly different

BWG, body weight gain; *FI*, feed intake; *FCR*, feed conversion ratio; *IW*, initial weight of birds

CON, 0 g antibiotics/plant seeds; ANT, 0.11 g/kg diet, PPS, 15 g DM of pawpaw seed/kg feed, MUS, 15 g DM of mustard seed/kg feed, BCS, 15 g DM of black cumin seed/kg feed

BCS had the highest and lowest scores of overall acceptability respectively (Table 5).

Economics of production

The highest cost of feed consumed and cost of plant seed consumed/bird were recorded in birds in BCS, 619.45 and 263.7 respectively. The lowest cost of feed consumed and cost of plant seed consumed/bird in CON, 593.36 and 0 respectively. Overall, the lowest cost of drugs and vaccine/bird was valued 8.33 in CON, PPS, MUS, and BCS respectively while the highest cost was obtained in ANT (57.28). Subsequently, average price realized/bird for CON, ANT, PPS, MUS, and BCS were 1000, 1000, 1500, 1300, and 1100 respectively. The total cost from the lowest to the highest is CON, PPS, ANT, MUS, and BCS (Table 6).

Discussion

It has been suggested that PFA augment nutrient utilization in the gastrointestinal tract (GIT) by enhancing production of digestive secretions and enzymatic activity (Applegate et al. 2010; Windisch et al. 2007). Also, extracts from spices and herbs may stimulate digestive secretions and enzymatic activity, thus exerting beneficial actions within the digestive tract (Platel and Srinivasan 2004). Harnessing the potential of locally available resources will reduce the cost of production expended on feed and drugs. Besides, the need to improve animal growth rate and replacement of synthetic antibiotics makes plant phytobiotics search a worthy course.

Result in Table 4 showed that treatment influenced the feed intake, body weight gain, and FCR on day 56 of broiler. The increase in the feed intake in MUS compared with CON may be attributed to the increase in production of digestive enzyme and improved utilization of digestive products through

Table 4 Carcass parameters (g/kg body weight) of broiler supplemented with different plant seeds used in the experiment as supplements

	Treatment						
	CON	ANT	PPS	MUS	BCS	SEM	*P* value
Live weight (g)	1257.3^{b}	1325.7^{b}	1553.4^{a}	1581.9^{a}	1419.1^{ab}	33.93	0.003
Eviscerated (%)	76.77	76.01	76.72	77.40	76.68	0.46	0.928
Dress weight (%)	62.51^{b}	64.04^{b}	64.93^{ab}	68.26^{a}	65.83^{ab}	0.58	0.018
Head	28.07	27.30	26.50	27.79	26.88	0.33	0.590
Neck	40.54^{ab}	45.85^{a}	43.26^{ab}	37.92^{ab}	34.75^{b}	1.51	0.148
Wings	92.09	96.39	92.24	95.87	97.99	1.77	0.798
Breast	181.82^{ab}	160.08^{b}	179.61^{ab}	188.96^{a}	192.65^{a}	4.21	0.117
Fore back	67.69	66.78	66.19	70.24	59.44	2.39	0.714
Hind back	75.20	97.02	83.04	75.49	69.78	3.54	0.122
Thigh	99.69	102.90	104.29	105.66	102.07	1.18	0.573
Drumstick	103.18	103.53	100.85	102.29	101.81	1.05	0.941
Shank	50.29	48.29	52.05	50.26	49.93	0.65	0.510

The letters in superscript along the same row mean $P < 0.05$ is significantly different

CON, 0 g antibiotics/plant seeds; ANT, 0.11 g/kg diet; BCS, 15 g DM of pawpaw seed/kg feed; MUS, 15 g DM of mustard seed/kg feed; BCS, 15 g DM of black cumin seed/kg feed

Table 5 Sensory evaluation of broiler supplemented with plant seeds at 8 weeks of age

	CON	ANT	PPS	MUS	BCS	*P* value	SEM
Color	2.3	2.6	3.3	2.7	2.5	0.18	1.73
Taste	3.4	2.9	3.6	3.2	2.2	0.15	2.47
Aroma	3.6[a]	2.8[c]	3.4[b]	3.8[a]	2.8[c]	0.01	2.19
Overall acceptability	3.2	3.4	3.4	3.8	3.1	0.59	3.56

The letters in superscript along the same row mean $P < 0.05$ is significantly different while those without superscript letters are not significantly different

CON, 0 g antibiotics/plant seeds; ANT, 0.11 g/kg of oxytetracycline diet; PPS, 15 g DM of pawpaw seed/kg feed; MUS, 15 g DM of mustard seed/kg feed; BCS, 15 g DM of black cumin seed/kg feed

enhanced liver function (Hernández et al. 2004). Furthermore, it could also be that mustard increased the palatability or the organoleptic smell of the seed improved intake. Increase in BWG on day 56 showed that PPS and MUS had increased weight gain than the control. This might be due to the increased feed intake or a possible enhancement in feed metabolism which could be a result of thyroxine trigger due to its contribution to metabolism in the body, thereby releasing more nutrients to be absorbed in the gut villi for body development. Thyroid hormones are very essential for body metabolism which lead to an elevated rate of metabolism and improved amino acid utilization (Abd El-Hack et al. 2018). Furthermore, it could be that papain which is a proteolytic enzyme enhanced the breakdown of protein to release the amino acids which enhanced quick growth rate. The lowest FCR in PPS is an indication of better feed utilization from the birds. It showed that the birds were able to convert what they consumed to meat better than other treatments and the controls at such level. This is in agreement with the study of Bolu et al. (2009) and Nwaoguikpe (2010). The average live weight of slaughtered birds was higher in plant seed–supplemented group compared with both positive and negative control. This is similar to the report of (Nwogwugwu et al. 2015) where bitter leaf improved slaughter weight than control but contrast the report of Ngantu et al. (2016) on the influence of ginger and garlic on Kabir chicken which had a lower live weight than the control.

The dressed weight percentage is the weight after removing visceral organs, and head, neck, shank. The breast muscle, thigh, and drumstick was highest in mustard seed–supplemented group than in the positive and negative control groups. This was within the range (66–68%) reported by Khan et al. (2012). This implies that the birds had more meat value and will command higher market price. Breast muscles are the biggest and thickest muscle collection in poultry bird's muscular component and it is responsible for a chunk of whole carcass weight. Although there was similarity between the breast muscle of mustard- and black cumin–fed birds, the highest was in black cumin–fed group while the lowest was in positive control. This is similar to the report of Guler et al. (2006) where black cumin seed at 1% improved breast weight.

Generally, the treatments were virtually different significantly in the evaluated sensory parameters (color, taste, aroma, and overall acceptability) considered in the study. Color is generally an indicator for visual assessment of the meat. The broiler meat without any supplements (CON) relatively had the color score of like very much compared with meats from broiler chickens fed diets supplemented with medication, mustard seed, and black cumin seed that were similar in color but much more closer to like moderately (score) than the diet without any supplements (CON). This tends to show that neither of the meats from the birds fed supplemented diets could be visually appealing better than the meat of broiler chicken fed diet without any supplements. The supplements could possibly have altered the structural chemistry of myoglobin, the major protein responsible for meat color (Mancini and Hunt 2005) through various reactions like oxygenation,

Table 6 Economics of broiler chicken production supplemented with different plant seeds used in the experiment as supplements

	Treatment				
	CON	ANT	PPS	MUS	BCS
Cost of DOC ( )	140.00	140.00	140.00	140.00	140.00
Total feed consumed per birds	4050	4195	4227	4362	4231.86
Cost of feed consumed/bird ( )	593.36	614.20	626.22	638.47	619.45
Cost of drugs and vaccine ( )	8.33	57.28	8.33	8.33	8.33
Average price realized/bird ( )	1000	1000	1500	1300	1100
Quantity of plant seed consumed or antibiotics/bird	0.00	0.46	66.40	68.44	65.93
Cost of plant seed consumed or antibiotics /bird ( )	0.00	4.61	66.40	164.25	263.70
Cost of labor ( )	111.11	111.11	111.11	111.11	111.11
Total cost ( )	852.11	927.20	952.06	1062.19	1142.59

DOC, day-old-chick

CON, 0 g antibiotics/plant seed; ANT, 0.11 g/kg of oxytetracycline diet; PPS, 15 g DM of pawpaw seed/kg feed; MUS, 15 g DM of mustard seed/kg feed; BCS, 15 g DM of black cumin seed/kg feed oxidation, redox, and others precipitated by the supplements' interactions with the meat. Consequently, meat from birds fed pure diet was relatively scored best. In addition, the possibility of various reactions as a result of interactions between the meat and the supplements scored majority of the meat under supplemented diets better than the meat under diet without supplement in terms of taste and aroma. Aroma and taste are the main factors that influence the sensory quality of meat (Resconi et al. 2013). The overall acceptability of the meat diet supplemented with black cumin was relatively found to be the most acceptable while meat under mustard seed was the least acceptable. Therefore, the various interaction patterns between the supplements and the meat precipitated the taste and aroma outlook of the meats that supported the overall acceptability of meat under black cumin seed supplement.

The economy of production in Table 6 showed that birds in CON had the lowest cost while those in BCS had the highest. However, the growth rate and the average cost realized per bird showed that birds in PPS might be more profitable due to the cost that would be realized at the end of the production period. Besides, the relative availability in comparison with other plant seed treatments showed that pawpaw seed might be a preferable option. Although the cost of production in ANT was lower than that in PPS, the long-term danger of using antibiotics means that such little financial difference is a good trade-off. This cost was lowest in PPS which suggests economic benefit.

This finding agrees with Agbede and Agbede (2009) and Ogundipe et al. (2011) that livestock production cost could be reduced in the third world countries by reducing the cost of feed. These findings could also go a long way to encourage the small-scale broiler farmers in their quest to improve production using natural product.

Conclusion

Plant seed supplementation affected the live weights, carcass, and organ weight significantly. Birds supplemented with MUS for 8 weeks had the highest values and seconded by PPS for almost all the indices. This, therefore, supported that dried pawpaw seed (*Carica papaya*) and mustard seed (*Brassica juncea*) are effective in terms of production overall acceptability of the meats under antibiotics; pawpaw supplementation was similar to those under diet devoid of supplement. However, meat under diet supplemented with black cumin relatively found to be most acceptable while meat under mustard seed was the least acceptable. Economically, (PPS) dried pawpaw seed supplemented in the broiler diet brings about a corresponding decrease in percentage feeding cost reduction. The seed is relatively available. Further work should be done on serum and hematology on broiler chicken to evaluate its impact on animal health.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

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